FISHING:
AN ASPECT OF OCEANIC ECONOMY

AN ARCHAEOLOGICAL APPROACH

FRED M. REINMAN

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PREFACE

The archaeologist is constantly being asked to make inferences about many of the non-preservable areas of culture based on materials found in his excavations. In regions of good preservation or in areas of complex civilization, these reconstructions and the inferences made from them can provide a relatively full picture of the prehistoric way of life. For the archaeologist who must work within areas—such as Oceania—with a simpler way of life and fewer items of material culture (as well as a climate in which preservation is a great problem), the task of reconstruction is much more difficult. Clues to the uses of the environment in this region are often confined to a few broken stone, shell, and bone tools, occasional food remains and pottery sherds, and less frequently, perishable items such as matting, netting, cordage, or tools of wood. Ethnographic and ethno-historical collections and accounts also provide data which may be used. From these, the investigator must wring as much information as possible about how the people lived and how they exploited their particular environmental area.

In general, this paper will discuss fishing as an aspect of economy with an appraisal of the possible significance of this activity for culture history, the uses that prehistoric Oceanic peoples made of the sea as a source of food, and the tools employed by them in that exploitation. The gathering of food from the sea has great antiquity, and probably nowhere has it been of greater importance than in the islands of the Pacific. Anthropologists have long recognized this, but the ethnographer, with few exceptions, though highly cognizant of the techniques used to exploit the resources of the sea, tends to treat the land-oriented aspects of the economy most intensively. Nevertheless, shellfish gathering, fishing, sea mammal and turtle hunting, and the collection of crustaceans and edible seaweeds have all provided important additions to the diet. In the most easterly of the Oceanic regions, where animal life was scarce, these activities formed the most important source of protein in an otherwise vegetable fare. These factors, plus the fact that fishing equipment comprises a large percentage of the artifact remains found in some prehistoric sites, make it important that the archaeologist understand as fully as possible how the islanders

exploited the different habitats of the marine environment, and the relationships between these habitats and the technology employed in that exploitation. In addition, we must begin to seek a greater understanding of what the tools and techniques employed mean in terms of food to the native peoples.

A survey and analysis of the ethnographic, ethnohistoric, and archaeological data on the fishing tools and techniques have indicated that the emphasis on some classes of fishing equipment was greater in Micronesia and Polynesia than in Melanesia (Anell, 1955). In particular, various kinds of fishhooks appear to be much more characteristic of the former two areas than the latter. Although these distributional differences may be historical in origin, I am suggesting that where the fishhook is used as a normal part of the fisherman's equipment, there is an increased potential for acquiring food from the sea. Groups that employ the fishhook are therefore culturally better adapted to the maritime aspect of their economy than those that do not. How the fishhook became a part of the Oceanic technology—by diffusion or invention—is not yet clear, but one interpretation of the present evidence suggests an introduction from North-east Asia by way of Japan, through the northern Pacific into Polynesia. It is in this latter area of atolls and Oceanic 'high' islands, lacking in native terrestrial fauna, that fishing was the most important source of protein food. According to Beals and Hoijer,

... the inhabitants of many Pacific Islands . . . although usually classed as horticulturalists, gain a large portion of their food from the sea. In some cases, as among the Gilbert and Marshall Islanders of Micronesia, several hundred people per square mile are concentrated on islands offering very poor opportunities for farming. Only fishing keeps such large populations alive. (1961, p. 339)

It is with these ideas in mind that the background and development of fishing will be discussed with a brief analysis of the uses that the Pacific Islanders made of this aspect of their economy. At this preliminary level, much of the material is frankly speculative, but its aim is to enable the archaeologist to see fishing as a functioning part of the economic picture, and, hopefully, it will enable us to make better inferences about this aspect of the economy from the remains of fishing equipment recovered in our excavations.

Parts of the pages that follow were originally submitted as a doctoral dissertation at the University of California at Los Angeles. The original format has undergone many changes and these were in part suggested by my doctoral committee: Drs. C. W. Meighan, chairman, W. A. Lessa, J. B. Birdsall, R. T. Morris, and J. E. Spencer. For their help and constructive criticism I am exceedingly grateful. For encouragement in the revision of the manuscript for publication a large share of thanks must go

to Dr. Donald Collier, Chief Curator of the Department of Anthropology, Field Museum of Natural History. For a long and arduous job of typing and retyping the manuscript and the correcting of innumerable errors I owe a debt of gratitude to Miss Lillian Novak, of the Department of Anthropology. For help with drawings and the photography, Gustaf Dalstrom, artist, and the Division of Photography of the Museum are to be acknowledged. Last, but by no means least, is the work of the final editing of the manuscript which was done by Mr. Edward G. Nash, Editor. To all I owe a great deal. Naturally, sole responsibility for errors is my own.

I
FISHING: AN ASPECT OF
OCEANIC ECONOMY

Introduction

The division of the cultural prehistory of the world into Paleolithic, Mesolithic, and Neolithic implies, from one point of view, a sequential development in the technological ability of mankind. From the ecological point of view, it implies that man became increasingly adapted to particular ways of life within particular environment situations. This adaptation included increasing control over man's food supply and generally resulted in a larger and more stable food base. As a result, as one comes forward in time, we expect, using this general scheme, to find groups becoming increasingly more complex technologically, with parallel developments occurring in the stability and extent of the food supply. In addition, we find people living in larger and larger aggregates.

This idea of adaptation or 'living into' various environments also forms the basis for shifts within the larger cultural historical divisions such as the change from random, unspecialized gathering to more selective and intensified collecting (Braidwood, 1960, p. 145). The Mesolithic period of prehistory, in which this latter change occurred, was a time in which the environment came to be more fully exploited than in the previous period. According to Clark (1961, p. 63), this broadening of the subsistence activities provided a transition, in the Old World, from the earlier hunter-fisher way of life of the Upper Paleolithic to the new economy which began with the cultivation of plants. It was from this broadening of the subsistence base that most of the 'more advanced' food procuring techniques ultimately developed. The range of possible choices include combinations of agriculture, horticulture, and pastoralism, as well as the continuation of hunting and gathering. Within this latter category, closer adaptation to a maritime way of life is also a possibility. While this latter is rarely the main subsistence focus of either food-gatherers¹ or agriculturalists, it is frequently found in conjunction with these, and it is in this context that it forms the focus of this work.

¹ According to Honigman, fishing as the main subsistence focus among true food-gatherers is "limited largely to the southern coast of South America and the North Pacific coast of North America." (1959, p. 308)

The Use of Aquatic Foods

Since very early times there has been relatively clear evidence that the sea has formed an important source of food for peoples living along its margins. In many areas, fishing, the gathering of shellfish, the hunting of different kinds of sea mammals, and the capture of turtles constituted an important source of protein which supplemented a diet of terrestrial plants and animals. The earliest firm evidence for the use of the sea came from the Mousterian site of Devil's Tower in Gibraltar where limpets and mussels were recovered from nearly all the levels of the excavation (Garrod, 1928). Even earlier evidence of the use of fish is said to come from a pre-Zinjanthropus level at Olduvai Gorge in Africa (Ryder, 1963, p. 301). Fish remains have also been found below a dated level of 40,000 years ago in Niah Cave in Borneo (Medway, 1958, p. 635). These latter two cases, however, apparently refer to fresh rather than saltwater varieties of fish and indicate that at this time the sea had yet to become an important food source. At later periods in time, large shellmounds are known from many areas of the world. These contain, in addition to shellfish, the remains of other forms of aquatic life, both fresh and saltwater. In addition to faunal remains, the archaeologist also finds tools which indicate the importance of the aquatic environment as a source of food to early man. These finds—although rare in the early periods—begin in the Upper Paleolithic. By the time of the Mesolithic and the Neolithic they include nearly the entire range of fishing and sea hunting equipment: harpoon parts, gorges, stone net and line sinkers, fishhooks, net fragments, traps, hook-making implements, and many others.

This interest in the sea is primarily the result of favorable location and the recognition of the potential of this aspect of the environment as a source of food. A recent summary of the archaeological evidence for the use of fish and sea foods (Ryder, 1963) suggests that the sequence of events from the simplest shoreline gathering (sometimes called strandloping) to the more highly complicated techniques for sea mammal hunting and fishing was a gradual development over a relatively long period of time. The earliest materials noted above, suggest that the sea was not being exploited at all at this time, but that inland lakes and streams were the source of both fish and shellfish. The first evidence for saltwater fishing comes from the end of the Upper Paleolithic in southern France and northern Spain where the remains of inshore varieties of saltwater fish (wrasses and labrids) were found (Ryder, 1963, p. 302). No fishing equipment came from these sites, and it is not known what implements or techniques were employed in catching them, but it is probably safe to assume that at this time they were of a very simple nature.

Methods of Exploitation

Strandlooping or the gathering of foods along the beaches and on the reefs was probably the earliest method of exploiting the sea. Both fish and shellfish may be obtained in this way with only the hands or at most a simple pointed or sharpened stick to spear or prize the quarry from the rocks or water. In addition to fish and shellfish, sea mammals and turtles may also be taken with simple implements when they come ashore periodically. These implements include clubs, knives, ropes and the simple spear. With these, early man was capable of obtaining a variety of foods in especially favorable ecological areas. Shellfish, the most important of these foods to early man, have continued to play an important part in the diet of many peoples. These collecting activities, however, are generally associated with a relatively low level of cultural attainment (Clark, 1952, p. 63), and the place of shellfish in the diet of groups that actively fished and hunted sea mammals was usually of a relatively minor nature.

In order more fully to exploit the inshore areas, especially of the sea, a number of technological devices were needed. In some instances these were probably new inventions (like the fishhook), while others may have been applied to the new environment by transferring them from land-oriented hunting activities (Hornell, 1950, p. 1). Among these latter devices were nets of various types, spears, arrows, clubs, traps, and perhaps the gorge.¹ All of these objects could be used without a great deal of modification, some simply requiring additions such as weights or floats to counteract or utilize the buoyancy of the water. Once these inventions or transfers had been made, primitive man was able to supplement that part of his diet obtained on land with a relatively reliable source of food without having to leave the shallow waters of the reef or shoreline.

Greater exploitation of the sea required the use of two further relatively complicated technological devices: some form of boat or raft, and the invention of the fishhook. With the first, man was no longer confined to the beaches and the shallow inshore waters, but was able to effectively exploit the offshore waters either for new foods or in pursuit of a quarry that used the sea as a means of escape. With the second implement, the fishhook, man was no longer confined in his exploitation to the surface waters of the sea, but was now able to effectively explore and utilize the sub-surface regions and successfully capture mid- and deep-water fish. In Europe neither the boat nor the fishhook appears in the archaeological record

¹ The gorge is one of those devices that are known to have been used on both land and sea as a catching device (Anell, 1955, p. 72). Whether it began as a hunting device and was transferred as is suggested here, or whether it was originally a fishing implement is as yet unknown; however, it is an old implement archaeologically and apparently precedes the fishhook as a catching device.

until the end of the Mesolithic (Ryder, 1963, p. 301), and this is apparently the first recorded instance of their use. According to Clark (1952, p. 62), deep sea or offshore fishing in Europe did not really become effective until after the advent of the Neolithic and the beginning of farming. With the start of agriculture and the growth of towns and large population increases, the demand for products of the sea resulted in a more efficient fishery which included deep sea fishing, and whale and other sea mammal hunting.

To summarize the above generalized sequence of events, the following chart lists the activities that may be included in a list of possible methods for exploiting the sea for food. They are listed in a presumed ascending order of technological specialization; that is, the bottom category, littoral gathering, is presumed to be the most simplified in terms of the required technological equipment. The topmost categories, however, require a much greater level of technological competency. These categories are not to be thought of as mutually exclusive of one another, but rather, as categories of increasing specialization. Conceivably, groups operating with techniques of the highest category could embrace all of the techniques included in the categories found lower on the scale.

POSSIBLE METHODS OF MARITIME EXPLOITATION
(in terms of relative technological complexity)

A. *Boat Using:*

1. Sea Mammal Hunting (open sea)
2. Fishing (lagoon and deep sea)

B. *Non-Boat Using:*

1. Fishing (inshore and shoreside angling, use of nets, weirs, traps, etc.)
2. Sea Mammal Capture (from shore rookeries, etc.)
3. Littoral Gathering (strandlooping: shellfish, fish, seaweeds, etc.)

Segments of this general sequence of events in world prehistory have also occurred in the archaeological records of more localized situations. Groups entering a new area with access to the sea will generally make increasing use of this aspect of the environment once it is recognized as a potential source of food. For the archaeologist, this is reflected in a gradual increase in the types of implements used for exploiting the sea. In the offshore islands of California, changes in the relative proportions of the various food remains found in the sites have been interpreted as indicating gradually increasing adaptation to the use of sea foods (Reinman, 1964), especially fish and sea mammals, with apparent decreasing emphasis on the gathering of shellfish.

Increasingly restrictive possibilities for land-oriented economic pursuits can also result in greater usage of the sea as a food source, and in Oceania we have an example of this latter course of events. Here, move-

ments out from the Asian mainland resulted in occupation of environments that became increasingly restrictive in their possibilities for hunting, the gathering of wild plant foods, and horticulture. As the Asian mainland and the large islands of Indonesia and Melanesia were left behind, the native flora and fauna generally decreased in variety from West to East. On the low atolls even the possibilities for horticulture were restricted to the raising of tree and root crops. The difficulties of maintaining adequate supplies of the pig, dog, and chicken were such that by the time the easternmost areas of Polynesia were settled, the dependence upon the sea as a source of protein had become very great. In eastern Polynesia, ethnographic and archaeological evidence of the variety of implements used to fish, all testify to the importance of the sea to these groups.

Oceania

The evidence for the Asian mainland as the starting point for the movements which ultimately peopled all of Oceania has recently been summarized by Suggs (1960). Although his primary concern was with movements of Polynesian peoples, his evidence bears directly upon the point of general movement from East Asia into the islands of the Pacific. Briefly, he has summarized the evidence for the movement from the mainland as showing that the Polynesians diverged from a population pool which developed on the South Asian coast and under the impetus of the developing cultures of North China began their movement across the Pacific. This can be traced archaeologically using "certain characteristic artifact types as cultural indices" (1960, p. 72), and, by about 1000 B.C., Malayo-Polynesian speakers were settled as far as eastern Melanesia. Other movements were also occurring as part of a general eastward thrust and all of these factors suggest that at this time a general population movement into Polynesia from the western fringes of this area began. Although some points of this specific account have been criticized (Golson, 1961), the mainland-to-the-islands movement of Oceanic peoples has been well established and agreed upon.

Other evidence in the form of plant and animal distributions also points to Asia as a source. Barrau has studied the pattern of agriculture throughout Oceania. In discussing the variations in vegetable food patterns in Polynesia and Micronesia prior to the arrival of Europeans, he notes,

. . . the number of species . . . decreased from west to east . . . [with] . . . all of the important species . . . found in Melanesia and Indonesia. . . . The coral islands, where the environment is the least favorable for horticulture have the fewest food plants; and such areas may have inhibited the spread of certain plants throughout the Pacific. (1961, p. 19)

In general, the plants useful to man can be traced to an Indo-Malayan center of origin (Barrau, 1963, p. 4). In addition to the attenuation of species, island size is also an important factor, for the higher islands provide a much wider variety of micro-climates and micro-environments than the low islands. In the latter, we have essentially a single environment and a single plant zone characterized by a strandline or seashore association (Freeman, 1951, p. 36). On the high islands, the number of zones is greater and Barrau was able to divide Melanesian subsistence economies into five main areas, each having its own combination of practices based on its own particular natural environment (1958, pp. 11-35; also fig. 4). For agriculture, these zones are probably the most important variable (Murdock, 1963, p. 148), and, as a result, the variability of plant life on the high island is much greater than that found on the coral or low atoll.¹

The only native mammals in Oceania, with the exception of those found in Australia and New Guinea, were the bat and the rat (Freeman, 1951, p. 39). The only domesticated animals carried by the people coming into Oceania were the dog, the pig, and the chicken (Suggs, 1960, p. 21). However, the evidence of their arrival in the different areas and island groups is confused and incomplete. Archaeologically, it is not at all clear that these animals were always present in the earliest levels of the few sites for which we have evidence, and in many they apparently do not appear until very late. In New Caledonia they are not found until the time of European contact (Gifford and Shutler, 1956, p. 28). In Fiji, the pig, dog, and chicken are found in the Early Period (as defined by Green, 1963), but only the pig and dog are known from the Marquesas Islands (Suggs, 1961). The earliest dating for these remains is that from the Marquesas (124 B.C. $\pm$ 150 years) and, on this basis and an evaluation of the available evidence, it must be assumed that man came into many areas of Oceania without these valuable animals.²

On the other hand, despite some attenuation from West to East, the resources of the sea were, in most places, extremely abundant. There is also a great deal more uniformity in their distribution (Wiens, 1962, p. 230f). According to Randall, the fish fauna of the tropical Pacific, with the exception of Hawaii (which exhibits some endemism because of isolation), “. . . is particularly uniform” (1955, p. vii).³ The species within

¹ “. . . [The] . . . strong attenuation in land biota and a striking decrease in geological diversity, result(s) in a definitely greater poverty of resources in the smaller islands.” (Fosberg, 1963, p. 154)

² It is also entirely possible that the animals in question might have arrived without man, being carried in drifting canoes. (Sharp, 1957, p. 133)

³ Schultz et al., finds a somewhat greater degree of endemic species within this broad zone, with the greatest, however, being in Hawaii. (1953, p. xix)

this fauna belong to the broad Indo-Malaysian zoogeographic zone which forms the center of distribution for all of the Indo-Pacific fauna.

The number of species is also very great; over 400 species have been recorded from Raroia (Harry, 1953, p. 44). The number of these that may be used for food by the natives is large. Hiatt recorded 175 species of fish and invertebrates utilized by the Arnoese in the Marshall Islands with the possibility that the number may reach 200 species. This number of food fish was recorded in spite of an almost "total lack of fishing for pelagic fish with migratory habits such as the tunas and spearfishes" (Hiatt, 1951, p. 1). (Presumably fishing for these pelagic varieties would increase the numbers of species utilized.) In the Gilberts, there is a very great dependence on the sea for food due to intermittent conditions of drought, especially on Onotoa. Three hundred and ninety-six species of fish, of which a large number serve as food, were recorded from this atoll plus others. In addition, 55 different species of invertebrates, almost all of which served for food, were recognized by the natives (Banner and Randall, 1952; Randall, 1955). On Raroia, however, only about 50 species of fish are used for food,

... and the natives are rather selective even among the preferred species. The number of fish that the natives will occasionally eat totals higher, but acculturation gradually makes fishing seem less desirable to them. (Harry, 1953, p. 176)

This kind of selectivity may be due to a combination of low population (127) at the time of the study and an abundance of sea resources (over 400 species to choose from).

Given this relative uniformity of sea resources, it seems logical to assume that, except for areas where the land forms presented less than favorable conditions for marine life, the prehistoric Oceanian peoples found the sea one of the most stable and reliable food sources. Although it is clear that not all reef-lagoon systems are equally utilizable by man (Rappaport, 1963, pp. 160, 173), in the atolls and small islands, for the most part, it was deficiencies in the terrestrial rather than the marine areas of the ecology which were crucial for man's survival. In other words, the sea, for all practical purposes, provided a relatively constant source of food.

Zimmerman's comments on conditions in Hawaii when man first discovered it are, in my opinion, applicable to much of the 'Oceanic' island world.

Man found the land extremely poor in vegetable foods. There were no coconuts, no bananas, no taro, no breadfruit, no yams, no sweet potatoes—none of the basic foods of the Polynesians were originally found here. The edible native plants were herbs, all of little importance. There were no land mammals except an uncommon bat, no snakes, no lizards, no frogs, and no true freshwater fish. Although few in kinds, land birds abounded. Myriads of sea birds nested over all the islands under

conditions most unlike those of today. In season, the eggs and young of some birds provided an abundant and excellent source of food. Man's main source of protein, however, was the sea, which in early times, teemed with a seemingly inexhaustible and easily obtainable supply of food. It was the sea that sustained man until he could establish his own sources of food on the land. It was food from the sea that made it possible for the Polynesians to spread so widely. (1963, p. 57)

On the high and the low islands and the atolls, the natural foods were gradually supplemented by cultivation of tree and root crops. On the smaller islands and atolls, to a greater extent than on the larger islands, the possibilities were limited by such features of the natural environment as the lack of soil, inadequate water, and periodically occurring 'natural' disasters such as hurricanes, 'tsunamis' and droughts. Even after the establishment of taro, coconut, and other terrestrial crops, a continuing susceptibility to natural hazards would make for a continuing utilization of the sea and its food on these lower land surfaces. While it is not suggested that the resources of the sea ever became the most important source of food, it is reported that they did form a more important focus of subsistence activities on the low coral atolls than on the high islands (Bentzen, 1949, p. 54; Fischer, 1957, p. 98). This was especially true during times of hardship discussed above (Catala, 1957, p. 118; Fischer, 1957, p. 98).

A further expectation, for which some data exist,¹ is that the technological developments occurring on the coral atolls in connection with the fishing complex would be much greater as a result of this maritime interest than it would be on the high islands. This is a result of the greater necessity for regarding the sea as a food source in the former areas. If this is so, we would expect to find a greater variety of fishing equipment on the atolls than on the high islands. However, because of the probable intercommunication between land areas and the rapidity of transmission of new ideas, methods, and techniques, as well as the actual equipment, this would be a difficult aspect to evaluate² or see in process. Archaeologically, the distribution of equipment is probably relatively similar within island areas, but ethnographically, the evidence suggests to at least one author a major division between Micronesia, Polynesia and the northeast Asian mainland on the one hand, and Melanesia, Indonesia and south-east Asia on the other (Anell, 1955).

In summary, our thesis is that certain expectable consequences in subsistence techniques and technology occurred in Oceania as a result of

¹ On Ifaluk, "Fishing, which involves a greater variety of techniques and apparatus than all the rest of the food quest, is man's work . . ." (Burrows and Spiro, 1953, p. 104, underlining mine.)

² But Fischer notes for the eastern Carolines that "in general the low islanders know more techniques and are better fishermen than the high islanders." (1957, p. 98)

movements from the western island/eastern Asiatic mainland area out into the islands of Oceania. This movement led into a region in which one of the most important environmental factors was the sea. The paucity of land forms, the scarcity of natural resources and the restrictive nature of the environmental conditions led to greater utilization of the resources of the sea. As a consequence of this greater use, concomitant changes occurred in the nature of the technological equipment used to exploit the environment; tools, especially the fishhook, for exploiting the sea and its food resources came to be a technological focus of the Oceanic groups.

For the archaeologist, both the subsistence techniques and the technology involved are indicated by the preservation in the middens of tools and food remains. Both have been found in relative abundance in sites already excavated, and with these, much more of the way of life pursued by the prehistoric populations of the Pacific can be inferred. By comparing the ethnographical data with the as yet scanty archaeological reports we should be able not only to see changes over time in this adjustment, but also to compare differences that have occurred in the ecological adjustment as the occupation of the island world progressed. Presumably, the adjustment began prior to the occupation of the easternmost group of islands—Polynesia. Since the latter area is the most easterly of the areas occupied, the initial expectation is that they will show the greatest adjustment or adaptation to the sea at all time levels; they were presumably settled last and also provided many of the most limited ecological zones.

II

THE FISHING HABITAT

In a paper entitled "The Rubric Fishing and Fisheries," Hewes (1948) has commented on the distinctions which place fishing apart from the hunting and capture of land animals.

The habitat of the quarry apparently is the decisive factor which sets fishing apart from other forms of hunting and gathering. Two aspects of the distinctiveness of the realm in which fishing operates are noteworthy. First, the special behavior of objects in the water, brought about by bouyancy, turbulence, solubility, and refractions of light; second, the dimensional characteristics of the aquatic environments. The second aspect is so obvious that it ordinarily has escaped comment. . . . (p. 238)

Since most fishing devices must be placed, inserted, or thrust in and out of water, their construction and materials must be adapted to aquatic conditions. . . . (p. 238)

The reality of the dichotomy between land hunting and gathering on the one hand, and fishing on the other . . . yields a definition of 'fishing' based upon the habitat of its objects. This is an ecological rather than a taxonomic definition. . . . (p. 239)

Despite some blurring (Hewes, 1948, p. 239; Anell, 1955, p. 76), this distinction between land and water habitats is important for the kinds of technological devices employed in each of them. Further distinctions may be made in terms of the quarry and the technological devices employed to secure that quarry. Since our concern is with the marine habitat, only this will be considered along with the various kinds of technological implements that have been developed to exploit that habitat.

Habitat

The historical sequence of events discussed in Chapter I also has significance for understanding the ways in which the various areas occupied by sea life are utilized by primitive man. Fish biologists have broken these habitats down into a number of ecological categories (Cloud, 1952; Harry, 1953; Randall, 1955; Hiatt and Strasburg, 1960), but for the purposes of understanding how they are exploited for food by man, these classifications seem overly complicated.¹ Principally, they may be grouped together into

¹ Wiens lists fifteen ". . . of the more prominent observable ecological zones and communities that have been described. . . ." (1962, p. 250)

two main categories: inshore and offshore habitats (fig. 1). Within these, further distinctions may be made so that in the inshore habitat, the reef flats, and the shallow water regions of the lagoonward and seaward beaches form a unit distinct from the lagoon area. In the offshore category, the seaward slope zone and the deep water regions further from shore can be thought of as a unit as well. In addition, the lagoon, and the offshore category have not only a horizontal zonation in terms of distance from the land, but more important, I think, they have a vertical zonation in terms of depth from the surface. This latter distinction is important for the techniques that are employed in the various areas. A single implement—the fishhook—is the primary device used to exploit the sub-surface waters of the marine environment.

Inshore Habitats

Reef Flats and Shallow Water Zones

The reef flat and shallow water regions of the inshore habitat are those near the main beaches and shorelines, including the mouths of fresh or brackish water streams, the peripheries of the lagoons, the reef flats of the various types of reef formations found in the tropical Pacific, and any area which can be exploited by the fisherman by walking, wading or swimming. In short, the water is sufficiently shallow that devices such as rafts, floats or boats are not required to exploit it. This region is the favorite place for gathering shellfish, groping for reef-fish by hand, torch fishing, spearing, knifing or clubbing fish. Here we find the use of small and medium hand nets of various types and, in the somewhat deeper areas, large seines and seine-like devices. Within this area are two further natural features which are utilized for some special techniques: tide pools and reef channels.

Tide pools form a refuge for small fish, crustaceans and other life forms and are frequently searched by the native people. Techniques involving the use of various fish poisons are also employed in the larger pools.¹ This involves spreading or submerging the poison which is extracted from a few well-known fruits, or the leaves, bark or branches of certain trees and vines. This poison narcotizes the fish in the pool, making their capture an easy task.

Reef channels result from the action of freshwater streams which empty into the sea or the lagoon and the passages formed in the reef either as the result of wave action or other factors which inhibit the growth of coral in that particular area.² These channels often provide a favorite fishing

¹ Further information on this aspect of fishing can be obtained from Hornell (1950), Heizer (1953), and Quigley (1956).

² Inhabitants may also remove or rearrange these corals or coral heads to make channels or to provide areas of coral within which fish may take refuge and thus make them easier to capture.

FIG. 1. Idealized cross-section of an atoll showing inshore and offshore habitats and zones of exploitation (not to scale: after Tracey, Cloud, and Emery, 1959).

ground because of the large amounts of food that concentrate there. This is the result of the action of the tides or of streams which carry small organisms and plants from the land. The amounts of plankton in these areas of outwash currents or in places near human habitation make them zones of abundant fish life. The fish feed on the plankton and, in turn, are fed upon by larger carnivorous fishes.¹ In particular, on the outer reef edge, the surge channels contain a fish fauna that is “. . . so varied and complex that it defies adequate description. . . .” (Hiatt and Strasburg, 1960, p. 116).

This entire inshore area is a region in which the techniques and devices employed by the native fishermen are expectably adapted to shallow water fishing and include fish poisoning; short spears for probing the tide pools and reef flats; as well as movable or permanent traps of various kinds that may be self-acting or use the rise and fall of the tides to trap the fish; and nets of all kinds for blocking the reef passages, surrounding large schools of fish, or for use as dip or throw nets. This inshore habitat is also an area which is liable to overexploitation, for in most island situations it is combed daily for its sea life.

Lagoon

This is an area of relatively deep water² found within the confines of a surrounding or fringing reef. On atolls, this is usually the central area of the atoll while on the larger islands a lagoon may be formed by a barrier reef or sandbar some distance from the shoreline. Except for the fringes of the lagoon, many of the techniques employed here require the use of boats or other forms of flotation in order to be effective. As already noted, the shallower parts of this area are utilized for netting and trapping and other techniques that do not necessarily require boats. In the areas of deeper water angling with hooks and baited lines is important. However, not all areas of the lagoon are equally important, nor are all areas of it fished. As already mentioned, the usable area is determined by the concentrations of food for the fish. This, in turn, depends upon the number of reef passages into the lagoon; where the human settlements are located; the position of streams that enter the lagoon; and the wind and circulation patterns within the lagoon system. Areas of heavy concentrations of food formed important fishing grounds and were often the sites of

¹ See Wiens (1962, p. 246ff) for further details on this.

² Of the 56 atolls in the Marshall and Caroline Islands for which charted depths are given, 86 percent have maximum lagoon depths of 100 to 300 feet, 59 percent have maximum lagoon depths of 100 to 200 feet, and 28.5 percent have maximum lagoon depths of over 200 feet. The remaining 12.5 percent of lagoons are less than 100 feet deep. Two lagoons, both in the Caroline Islands, appear to have depths of over 300 feet. (Wiens, 1962, p. 30)

important aboriginal settlement or were owned by high ranking individuals or groups.

In summary, all of the techniques employed by the Oceanic peoples may be used within these two zones of the inshore habitat. In the shallow waters and on the surface the use of the spear and fish arrow, nets of all kinds, traps, weirs, and surface-oriented angling techniques were all practiced. In the deeper waters of the lagoon angling with the hook and baited line seems to be the major means of exploiting this zone. The importance of this lagoon-reef-shallow water habitat should not be underestimated, for it provides the bulk of the marine resources utilized throughout the Pacific.

Offshore Habitat

Seaward Slope and Deep Sea Zones

By this is meant all those areas of deep water found outside the fringing or barrier reefs of the island or atolls.¹ Regular use of this region in aboriginal times seems to have been limited to a relatively few techniques—some of these rather specialized—involving the use of different kinds of fishhooks in trolling for various kinds of fish such as the bonito and dolphin, shark fishing with the hook and/or the noose, and the catching of very deep-dwelling species of fish such as the *Ruvettus*. In general, this zone regularly required the use of boats, often the large sailing canoes.

Between the seaward slope part of this zone and the inshore surge channel buttresses is a coralliferous bench which must have been a very important region for fishing, for at Raroia in the Tuamotu archipelago, Harry found that as a result of outwash from the lagoon with the resultant concentrations of plankton

... a large percentage of the total fish fauna lived on this shelf. Sharks constantly patrol this area, apparently continually circling the atoll for food. Tuna, barracuda, and jacks also scout these waters. Larger sea basses are in greater abundance in this zone (as are also the previous fishes mentioned) than anywhere else on the atoll. (1953, p. 21)

He also notes that the presence of sharks in this region is the major deterrent to the use of any fishing techniques which necessitate the fisherman's entering the water. This zone and the deep waters of the lagoon are the areas in which the vertical zoning of the water becomes important for our consideration. A division into a surface and sub-surface layer is sufficient for present purposes although, in time, further subdivisions may be more significant. The surface layer is one in which all of the techniques noted

¹ The landward end of this zone begins beyond the coralline ridges and surge channels of the seaward reef front (see fig. 1). It should also be noted that the differences in these zones may be found on the windward and lee sides of the islands and atolls.

above could be employed, whereas the latter area, the sub-surface layer, is peculiarly suited to the use of the fishhook and the fishhook alone.

Surface and Sub-Surface Fishing

In order to understand more fully how man utilized the different habitats of the sea, an important distinction can be made, I think, in the kinds of techniques and technological devices that are employed in these two vertical layers.¹ By using these terms, I am trying to distinguish between two more or less arbitrary levels of activity at which fishing occurs. The division between these levels is not clearly definable, but is partially based on the devices themselves and how they are used by fishermen and partially upon the feeding characteristics of the fish. Many of the techniques of fishermen are confined to the upper layers of the water and require a sighting of the fish in order to be effective.² Some implements, by virtue of their construction and the techniques associated with them, are also limited in their use to these upper layers of water. These implements and techniques, plus the visual aspect, help to define the lower limits beyond which these would be ineffective. The sub-surface layer is arbitrarily the layer beyond those defined by the above criteria.

It is more difficult to put an actual figure on the depths which can be assigned to these more or less arbitrary layers. Factors which operate to change them from one locality or another, especially the visual aspect, are the conditions of the bottom and the clarity of the water. In Hawaii, for instance, it is claimed that the fishermen, down to a depth of 20 fathoms, "could explore the bottom visually after chewed roasted kukui nuts were spat on the surface to aid visibility" (Buck, 1957, p. 285). The flesh of chewed coconut was also said to be used for this purpose (Beaglehole,

¹ The terms "surface" and "sub-surface" are occasionally encountered in the anthropological literature. Anell uses the term "surface fishing" to characterize Western Polynesian fishing techniques (1955, p. 96). Lethbridge makes a distinction on the basis of the feeding habits of fish, noting that both surface and bottom feeders exist and that the "surface feeders have to be caught by different methods from those employed for catching fish near the bottom (1952, p. 36). Hornell also makes a distinction between surface and bottom fishing in discussing Bengalese fishhooks (1950, p. 23). A recent article on sea angling distinguishes three levels of activity—surface, midwater, and bottom fishing—which are defined on the basis of the type of bait or lure that is used to take the fish (*Encyclopedia Britannica*, 1, 1962, p. 941). Alexander also makes a distinction between trolling and bottom fishing (1902, p. 769). Beaglehole, in discussing Pukapukan fishing, includes a diagram in which an area of water 3 to 10 fathoms deep (18–60 feet) is labelled sub-surface water (1938, p. 52, fig. 3).

² Here we must consider the possibility of extending this range by diving into the water. This, however, would not greatly increase the depths at which the devices would operate, presumably being limited to the depth at which an unequipped diver could work. This is not much beyond 10 to 12 fathoms, and on the basis of the literature, I would assume that much of this work takes place in between 3 and 8 fathoms of water (18 to 48 feet).

1938, p. 62).¹ Beyond this depth, fishing grounds were generally discovered by experiment with ground bait and baited hooks. According to Buck, in Hawaii shallow fishing grounds were those up to 80 fathoms (480 feet) in depth, while the deep fishing grounds were found between 200 and 400 fathoms (1200 to 1600 feet) in depth (1957, p. 285), but these refer only to grounds exploited by angling.

Shells from excavations in Japanese sites have been identified as having a habitat range of from 30 to 120 feet in depth (Kidder, 1959, p. 51). These presumably were gathered by divers. While 120 feet is apparently within visual range of surface operations, it is much more likely that the bulk of these shells were gathered from the upper limits of their range, somewhere between 30 and 50 feet. In general, it is this range that would seem to be close to the limits of effective surface fishing; beyond this depth, the fishhook is the main device utilized for fishing.

The Use of the Fishhook

Fishing with the hook may be done in any of the ecological zones described above. It is, however, essentially an individual technique, and as such is considerably less efficient in competition with many of the other inshore and surface oriented techniques and implements. Netting, spearing, and trapping are generally more effective as a means of catching large numbers of fish in these inshore regions, and as a result, the use of the hook is kept to a minimum. Since the use of the hook is primarily directed against individual fish, it is most effective in terms of the amount caught for the effort when employed against larger fish. These are nearly always inhabitants of the deeper offshore waters.

A recent paper by Brock concerned with the selective fishing action of particular types of fishing equipment, notes

Longline gear, as used for tuna fishing, characteristically takes the larger tuna. It is presently used to harvest a major portion of the world's catch of tuna, especially yellowfin tuna, *Thunnus albacares*, and the bigeye tuna, *Thunnus obesus*, from the tropical waters of the Atlantic, Pacific, and Indian Oceans. It is apparently the only method useful for the harvest of these species and, largely of the albacore, *Thunnus alalunga*, in the open ocean far from land. (1962, p. 3)

More important, Brock indicates that surface fishing with seines or live bait consistently produces smaller fish, whereas the larger fish are taken in the sub-surface waters with the longline gear. The minimum depth for fishing with this gear is 148 feet with depths much greater than this being realized (Brock, 1962, p. 4). Now while longline gear is a relatively modern technique and is employed only at distances beyond the general fish-

¹ A more modern method is to use vegetable oil mixed with water which is sprayed on the water.

ing areas exploited by the prehistoric fisherman, it does suggest that hooks are more effective in the sub-surface areas of the sea and, further, that the sub-surface layers do produce the larger fish. If so, the really effective use of the offshore habitat involves angling with the fishhook where the chance of obtaining a larger-sized fish in return for the effort compensates in part for the reduced quantity that are available.

When we consider the two habitats discussed earlier, the inshore and offshore zones, it should be noted that most implements and techniques employed in them are confined—with native techniques—to the shallowest level of these habitats, the upper part of the surface layer. The requirements of visual sighting of some, and the method of use of others, suffices to keep the bulk of the fishing implements in, at most, a few feet of water. Shellfish gathering is also concentrated in the upper layers of the water, although the range may be extended by diving downward to the limits of the unequipped diver. Hand groping for fish and spearing may also take place at these depths. In addition, a few basketry traps may also have been used at somewhat greater depths than the bulk of the surface-oriented equipment. An open basket or net weighted with a stone sinker is said to have been in use in the Caroline Islands at depths up to 25 fathoms (Tolerton, 1949, p. 127) and other enclosed traps are said to have been set in deep water far from shore (Lewis, 1951, p. 66) and in the New Hebrides at depths up to 75 fathoms (Brown, 1935). These latter implements can be considered intermediate between hooks and the bulk of the tools employed in fishing.

Below these implements oriented to the surface and possibly the intermediate zones the fishhook is the sole device for exploiting the remaining areas of the sea. It may thus be considered as an addition to the range of technological equipment utilized by the fisherman. When used in conjunction with nets, traps, and the rest of the tools employed, a much greater proportion of the total potential of the marine environment could be exploited. Without the fishhook, and especially without both hook and boat, the potential returns from the environment would be greatly reduced.

III

FISHING METHODS IN OCEANIA¹

Introduction

The methods employed in Oceania to obtain fish, shellfish, and other resources of the sea, with minor exceptions for local developments, are those generally found in use in other areas of the world in which exploitation of the sea is important. These include a wide variety of techniques used for shellfish to more complicated operations involving nets, traps, spears and harpoons, as well as hooking devices of different types. In addition, associated items such as boats, baits, bait containers and other items are also found. In the following cursory examination of the methods employed in the Pacific area, only four general categories will be discussed: spearing and harpooning, netting, trapping, and angling. This leaves out a wide variety of relatively simple techniques which are nearly ubiquitous in their distribution and involve the taking of fish, shellfish, and crustaceans with the hands, sometimes aided by simple tools. I have assumed on the basis of the data that nearly all coastal peoples gather shellfish² and resort to hand capture at various times. But the four methods above (and combinations and variants of them) provide the bulk of the fish food utilized in Oceania. From this general survey, a better idea will be obtained of how the sea is used by the Oceanic fisherman, as well as some understanding of the part that these methods play within the different culture areas.

Melanesia

In Melanesia fishing as a means of subsistence was apparently important only to the coastal groups (Lewis, 1951, p. 64; Cranstone, 1961, p. 76),

¹ The bulk of the data for this survey comes from the Melanesian, Micronesian and Polynesian culture areas. In part, this is dictated by the greater availability of the ethnographic sources for these areas, and in part by the difficulty of separating the indigenous methods from those that have been brought into the Malaysian area by the various groups that have moved into and through this region. Ethnographic sources are available, but deal primarily with the techniques of relatively modern times. Classifications of the types of gear (Kesteven, 1949, pp. 47-58, Umali, 1950, pp. 12-16) indicate the wide variety of tackle employed, as well as its similarity to that used in other areas. The emphasis in this region does seem to be, however, on nets and traps, with many different kinds in use.

² However, Gifford explains the lack of mollusk remains on Yap as being due perhaps to the fact that Yapese women do not usually gather mollusks. (1959, p. 161)

although freshwater fishing along streams and in lakes provided a welcome addition to the diet for inland groups. With few exceptions, most of the fishing undertaken in this area was confined to the reef, lagoons, and in-shore regions of the islands and atolls.

Micronesia

Fishing in Micronesia was important as a source of food, especially to peoples inhabiting the low islands and atolls. Combined with the gathering of shellfish, it supplied most of the animal food available to the inhabitants of the high islands (Block, 1935, p. 43). Fish are said to be the main economic resource of the eastern Carolines (Fischer, 1957, p. 69) and one of the principal articles of diet on Ulithi (Lessa, 1950a, p. 35), Yap (Muller, 1917, p. 57), Ifaluk (Burrows and Spiro, 1953, p. 35), on the Palaus (Kramer, 1926, p. 69; Barnett, 1949, p. 1), the Marianas (Thompson, 1945, p. 31), Nauru (Hambruch, 1915, p. 122), the Marshalls (Kramer and Nevermann, 1938, p. 114; Military Government Handbook, 1943, p. 95; Mason, 1947, p. 71), and the Gilberts (Woodford, 1895, p. 345; Catala, 1957, p. 118).

Polynesia

According to all accounts, the Polynesians were excellent fishermen and fish formed an important part of their diet, often being their chief flesh food (Coulter, 1931, p. 9; MacGregor, 1935, p. 7; Buck, 1944, p. 208). According to Buck, in Hawaii fishing was the "most varied and extensive food procuring occupation" (1957, p. 285), and on Mangareva it was the "principal food supply" (1938, p. 197). In all of the groups of Polynesia, with the possible exception of Easter Island,¹ the people are acknowledged to be excellent fishermen, and Ellis claims for the Society Islands that "In no part of the world, perhaps, are the inhabitants better fishermen . . . [and] . . . their variety of fishing apparatus is astonishing" (1831, 1, p. 145). The kinds of techniques used are similar to those in the rest of Oceania, as are the implements used in conjunction with them.

Fishing Methods

Following is a brief description and the distribution of each of the four methods employed to take fish in Oceania. There is a great deal of similarity in the techniques associated with specific implements throughout the

¹ Metreaux notes that "it is impossible to get even an approximate idea of the importance of fishing in pre-missionary times. Fishhooks are found in great abundance in caves, carved fish are common in petroglyphs, and fishing episodes are numerous in folklore. But Eyraud . . . states that fish had an insignificant place in the native diet and was considered a great delicacy. At the present time fishermen are few and go out only occasionally. . . . Ever since Captain Cook's time men have complained of the scarcity of fish." (1940, p. 172)

areas discussed, although some differences do occur.¹ The major differences seem to be in the distribution of the various devices used; certain implement types are absent from specific areas either as the result of cultural historical factors or local environmental conditions. For example, the simple hook was apparently unknown in Western Polynesia (Burrows, 1938, p. 10) and its absence would seem to be the result more of historical than environmental factors. On the other hand, the bonito spinner, widespread in Oceania, is not used in the more southerly Polynesian regions: Niue, southern Cook Islands, Austral Islands, Rapa, Mangareva, and Easter Island (Anell, 1955, p. 185). Its absence from these areas "suggests environmental rather than cultural influence" (Burrows, 1938, p. 12) since these groups are on the southern peripheries of the distribution of the bonito. As a result, in these areas, the bonito was not an important source of food.

SPEARING

The use of the fish spear is very common in Oceania. Both simple spears (generally a pointed stick) and many pronged spears were used, the latter often being barbed. The amount of its use varied widely and in some areas of Melanesia spearing was the commonest method employed for taking fish, according to some writers (Haddon, 1912, p. 157; Silas, 1926, p. 191; Landtman, 1933, p. 29). In Polynesia, on Raroia, spears provide the bulk volume of fish (Danielsson, 1955, p. 182). On the other hand, in New Zealand, according to Best, spears enjoyed only limited use and were employed to take flounder, eels (1934, p. 258), and the sting ray (1924, p. 415).

In some cases in Polynesia it is difficult to know whether or not the spear is of recent introduction, although it is widely used (Birket-Smith, 1956, p. 158). Thus, on Easter Island (Metreaux, 1940, p. 189), Niue (Loeb, 1926, p. 96), the Tokelau Islands (MacGregor, 1937, p. 94), and Mangaia (Buck, 1934, p. 145), the spear is either of recent introduction or the exact form and age of earlier types could not be determined.

During the day, the spear was employed while walking along the shore or along the reef flats at low tide when small fish, octopus, crayfish, etc., all could be caught. Outflowing tides often transformed the small reef channels into natural spearing grounds for the fisherman who stood on the reef and speared the fish that were either entering or leaving the lagoons and tidal creeks on the ebb and flow of the tide. On the larger islands with streams flowing to the sea, the fishermen often stand at the mouths of these creeks and streams to spear fish that enter and leave with the rise

¹ Buck describes two ways of taking bonito in which the fishing gear is handled differently. (1932a, p. 186)

FIG. 2. Harpoon Heads from Polynesia; a-b, New Zealand harpoons of bone (after Skinner, 1937, Figs. 1, 24); c, Marquesan harpoon of bone (after Suggs, 1961, Fig. 35); d, bone harpoon from Marquesas (from Fuller collection). Not to scale.

and fall of the tide. In some areas of New Guinea these streams are so muddy that the catching of fish by this method becomes more a matter of chance than skill. The fish cannot be seen and the fishermen randomly thrust their spears into the water. According to Landtman, the fish are so numerous that even this technique produced a large catch (1933, p. 30).

At night, the spear was most commonly used in torchlight fishing along the shore or on the reef flat. Here, small parties of men and women would wander along the reef holding aloft a torch of coconut fronds or other material. The light attracted the fish, which were then speared.¹ Spears were also used from canoes and when diving into deeper water. Occasionally they were employed as a secondary means of making a catch when enroute to other types of fishing, such as the capture of turtle and dugong

¹ Knives and clubs were also used to dispatch fish thus attracted.

(Landtman, 1927, p. 143). Garfish, which are often caught with a baited line (Anell, 1955, p. 29), are also taken by spearing in some areas of Melanesia and Micronesia. In all areas, both large and small fish were speared. Sharks, the sting ray, eels, and turtle were caught with this implement. In Micronesia, on the island of Kusaie, Sarfert notes that even crabs were taken on the reefs by spearing (1919, p. 111). In a few places the bow and arrow was substituted and used in essentially the same manner as the spear (Landtman, 1927, p. 143; Held, 1957, p. 342).

HARPOONING

Ethnographic instances of harpooning in Oceania are primarily concerned with the capture of turtle and dugong; the latter apparently

FIG. 3. Type of harpoon used in Torres Straits area.

confined in its distribution to the western regions. In Polynesia harpoons are known only from the Marquesas, New Zealand, and Chatham Islands where they were used to take a large member of the ray family and, more rarely, sharks (Anell, 1955, p. 66).¹ On Mokil in the Caroline Islands, the harpoon is used for taking both turtle and porpoise (Bentzen, 1949, pp. 68-69). It is employed in both inshore and offshore areas and is used on the reef or from the shore as well as from canoes.

The Melanesian harpoon, on the other hand, is commonly used for catching the dugong. This is a bulky, vegetable-feeding animal living on various grasses which grow on the reef.² Fishermen frequently harpoon the dugong from an elevated platform constructed in the shallow water. The exact location is chosen by close observation of the feeding grounds. When an area is found which shows signs of having been browsed, the platform is erected; the fishermen know that the dugong will return nightly until the grass is gone (Haddon, 1912, p. 167). Turtle is also occasionally harpooned from these same platforms (Haddon, 1912, p. 168; Riley, 1925, p. 123; Landtman, 1933, p. 26; Held, 1957, p. 343), and, occasionally, taken here in nets as well (de Ricci, 1875, p. 215; Deane, 1921, p. 176; Armstrong, 1928, p. 19).

¹ This implement differs from that used in Melanesia, according to Anell, in that it is bound to the side of the shaft (female head) whereas the Melanesian harpoon head is socketed in the shaft (male).

² The turtle also feeds on this grass and, for this reason, in some areas it is called turtle grass.

In summary, most of the uses of the spear and harpoon are in relatively shallow water situations in which the prey is close to the surface of the water; areas such as the reef flat or shoreline and the surface layers of the deeper areas of water.¹ In the inshore situations, it is generally the smaller, reef-inhabiting varieties of fish that are speared, although larger varieties are occasionally taken.

TRAPPING

The use of basketry traps of various sizes and shapes was an important method of taking fish. These ranged in size from small to large, some from Melanesia being over three meters long and looking like great cylindrical balloons made of bamboo and rattan (Finsch, 1893, p. 25; Lewis, 1951, p. 65). Traps of this nature are set in many regions of the reef and lagoon. They are also occasionally set a mile or more at sea, according to Lewis (1951, p. 66). In addition to the taking of fish, they are also used to take shrimp, eels, lobster and the lamprey, the latter in New Zealand (Taylor, 1870, p. 498; Best, 1924, p. 430; 1934, p. 258). They may be baited or unbaited, and are often weighted down with large stones. Occasionally, they will have a float attached to them when sunk in relatively deep water, so the fisherman can relocate them.

In Melanesia the smaller traps are frequently placed on the water bottom and covered over with slabs and chunks of coral, thus forming a natural hiding place for fish. The bait may be various kinds of fish or shellfish, or in some cases simply leaves (Hadfield, 1920, p. 94). In Polynesia a very common form of trap was round with a single opening at the top used to take crayfish and was widely distributed (Buck, 1938, p. 299). Other forms included an elongated barrel-shape with openings at either end and various cylindrical forms, also with funnel-shaped openings at either end. These different kinds of traps are found on most of the groups except they do not seem to have been used on Easter Island, and Buck specifically says that "self-acting traps were not made . . ." on Manahiki and Rakahanga (1932a, p. 159). In the Tokelaus, MacGregor found that fish traps were not common in 1932 but that in the past "... a circular fish trap with an entrance in the top was used . . ." (1937, p. 94). Further, on Tongareva, Buck does not find either walled fish traps or self-acting traps to have been used (1932b, p. 197), nor does Burrows mention traps (although he does note the use of stone weirs) for Futuna, where he finds the fishing industry decadent (1936, p. 145). They are not mentioned by Loeb as being on Niue either (1926).

¹ I am disregarding here the recent introduction into many areas of Oceania of the underwater spear gun which has attained a great deal of popularity with the young men as a fishing technique and sport. With the use of this device, fish can be taken at depths limited only by the diver's ability.

A wide variety of basketry traps was known from the Palau Islands (Kramer, 1926, pp. 82-86) and Yap (Müller, 1917, pp. 75-78). These traps were used alone or in conjunction with nets and weirs. For other areas the use of basketry traps is noted, but in some areas they have become rare (e.g., on Nauru, Sarfert, 1919, p. 109) or were apparently never a major means of taking fish.¹ According to Fischer, basketry traps are used mainly on the low islands in the eastern Carolines and many of the high island dwellers no longer know how to construct them (1957, p. 99). On Sonsorol the use of basketry traps was said to be known, but not carried out because of the lack of a lagoon and the rockiness of the reef (Eilers, 1935, p. 92).

Traps were also frequently employed in conjunction with fish fences or dams of various kinds. These dams were often thrown up blocking a tidal channel or small stream in such a way that the fish were forced along it until moved into a trap either at the apex of two walls or at various openings along the face of the fence. These fences were made from stone or coral, palm leaves woven to form a mat, or fences constructed from reeds or poles placed in the bottom with secondary materials woven in between them.

Another type of leaf weir or fence is also to be found through much of western Polynesia and is recorded from Tonga, Samoa, Wallis Island, and possibly Futuna. These are temporary weirs and have been described by Burrows as follows:

Whole green coconut leaves are carried out into the water, arranged in a semicircle or crescent with the end toward shore, and weighted down with blocks of coral. The leaflets project upward, forming a barrier some 2 feet high which confines at least a fair proportion of the fish that come in with every high tide. Along the line of the crescent are a number of salients with their points seaward. Narrow openings are left at these points. As the tide goes out, the fish, seeking an opening through the weir, swim toward these openings. By each one stands a woman with a conical trap . . . and a basket to hold the fish. (1937, p. 103)

This same type of weir has been described by Buck for Samoa (1930, p. 433). He also notes a similar type made of banana leaves. They are still in use on Tonga (Vaea and Straatmans, 1954, p. 201).

A final method of trapping fish was to build some type of wall or enclosure which took advantage of the ebb and flow of the tide. A wall of stone or other materials was constructed on the seaward or lagoonward slope of the reef or atoll low enough to be submerged at high tide but sufficiently high to be exposed when the tide ebbed. This allowed the fish

¹ In the Marianas the use of stone fishponds was reported by Freycinet, but by 1819 they had been replaced by weirs of reeds and today they are made of chicken wire (Thompson, 1945, p. 33). I do not find any report of the use of basketry traps. The weirs remain in use but are not common (Bowers, 1950, p. 177).

FIG. 4. Types of Stone Fish Traps found in Oceania: a, simple stone wall enclosing a portion of the reef flat (after Alexander, 1902, p. 800); b, common arrow-shaped trap; c, circular variant from the Caroline Islands (after Sarfert, 1919, p. 110). (continued on next page)

d

FIG. 4. *continued*.—d, more complicated variant from Yap (after Müller, 1917, p. 77); e, trap from the Tuamotu Islands (after Emery, 1934, Fig. 11a).

e

to swim in freely at high tide, but with the lowering of the water level they were confined behind the wall.

In Micronesia, these walls are found on nearly all of the island groups.¹ They are most frequently built of coral. A common form resembles a large arrow of stone with the point facing the sea or lagoon (see fig. 4b, also Burrows and Spiro, 1953, p. 108; Catala, 1957, p. 131; Kramer, 1926, p. 81). They are also seen in channels between the reefs or islets. Although some are still in use they were probably of greater importance in pre-contact times, for now they are frequently reported as falling into disrepair (Fischer, 1957, p. 100).

In Polynesia the traps are also generally made from coral stone and frequently incorporate part of the reef or other exposed land areas in the construction. These are known from much of the region² and range in shape from simple V-shaped enclosures to very complicated labyrinths with a number of enclosures in a single trap (see fig. 4). They are found on both the sea and lagoon reefs, and as has been previously mentioned, are often found between islets in a single atoll. On Oahu these traps have been described by Stokes, who said that one of them was known to have taken every kind of fish but the whale (1909, p. 23); however, the kinds of fish described as being commonly caught are mostly reef varieties. On Raroia, Danielsson found that these traps were no longer used because of a lack of community spirit (1955, p. 185). The fish concentrated by these stone traps or weirs were taken with nets, basketry traps, spears and dip-nets. Stone enclosures were also used for the ponding of fish, and were particularly numerous on Hawaii (Coulter, 1931, p. 9).

NETTING

The use of nets for fishing is, like the spear and the use of traps, widespread throughout Oceania. In Melanesia, the use of nets is reported as unknown from the Torres Straits region (Haddon, 1912, p. 159) and also was apparently unknown to the Kawai peoples in British New Guinea

¹ The Marianas (Thompson, 1945, p. 33), Palau (Kramer, 1926, p. 81), Yap (Christian, 1899, p. 243; Müller, 1917, p. 77), Lukunor and Nanoluk (Kramer, 1935, p. 55; Tolerton, 1949, p. 116), Ifaluk (Burrows and Spiro, 1953, p. 108), Ponapac (Hambruch and Eilers, 1936, p. 331), Kusaie (Sarfert, 1919, p. 110), the Marshalls (Kramer and Neverman, 1938, p. 123; Mason, 1947, p. 72; Spoechr, 1949, p. 62), the Gilberts (Drews, 1945, p. 171; Catala, 1957, p. 131), and on Kapingimarangi (Eilers, 1934, p. 90; Buck, 1950, p. 267).

² Cook Islands (Buck, 1944, p. 217; Gold, 1956, p. 363), Tuamotus (Emory, 1934, p. 23, figs. 9-11; Danielsson, 1955, p. 185), Society Islands (Cheesman, 1927, p. 97; Emory, 1933, p. 82), Samoa (Buck, 1930, p. 444; Hirsch, 1958, p. 293), Hawaiian Islands (Stokes, 1909; Bennett, 1931, p. 24; Coulter, 1931, p. 9; McAllister, 1933a, p. 28), Manihiki and Rakahanga (Buck, 1932a, p. 159), Mangareva (Emory, 1939, p. 17).

near the Fly River estuary (Landtman, 1933, p. 31). Although well known in Polynesia, their use is apparently dying out in many areas, such as Tonga (Vaea and Straatmans, 1954, p. 204), Tubuai (Aitken, 1930, p. 56), Mangareva (Buck, 1938, p. 294), and Uvea (Burrows, 1937, p. 102). Formerly they were extensively used,¹ and in Tonga it is said that netting was the favorite method of taking fish (Koch, 1955, p. 173; West, 1865, p. 118). Some of these nets were of immense size. In Hawaii, netting was the "most diversified and profitable method of catching fish" (Buck, 1957, p. 289), and on Samoa, Stair obtained the names of 100 different methods of fishing, "... 34 of which were with nets ..." (1897, p. 201).

Nets range in size from small hand nets with wooden or bamboo frames, used alone or in pairs, to large seine and purse-seine nets used for community fish drives or as drag nets in suitable places.²

According to Birkett-Smith, the use of the ordinary fish net and the dipnet is nearly universal in Micronesia (1958, pp. 161-62). Although on occasion a number of individuals may band together to surround a shoal of fish which are taken in the individual hand nets, the smaller nets are generally individually used by people wandering over the reef flats and along the streams for the taking of small fish and crustaceans. In this manner the nets are primarily employed by women and children, although men may occasionally use them as well.

Somewhat larger nets were used by the men for reef fishing. These took a variety of forms, and were used as scoop nets or dip nets. The latter form was generally square with the corners attached to two crossed poles; a line or third pole was attached at the crossing of the poles. Let down into the water, they remained flat. When a fish crossed them they were raised by means of the poles and the fish trapped in the slight bag that resulted. A larger version of this net required four men, mounted on tripod platforms, to each raise a corner of the net at the proper time.

¹ However, Danielsson says that on Raroia in pre-European times "... the unfavorable environment and the existence of sharks ..." limited net fishing. It is very little practiced now. (1955, p. 184.)

² The range and variation in the shape and size of nets in Polynesia have been well described in the literature. The following is a partial list of references in which these data can be obtained. It is by no means exhaustive, generally neglecting many early travellers' accounts in which netting is mentioned. Those that are given are ones in which descriptive and comparative material can be found. Western Polynesia (Buck, 1930; Whitcombe, 1930; Burrows, 1936, 1937; Koch, 1955; Vaea and Straatmans, 1954), Hawaiian Islands (Beckley, 1888; Titcomb, 1952; Buck, 1957), Central Polynesia (Aitken, 1930; Buck, 1932a, 1932b, 1938, 1944; Danielsson, 1955; Handy, 1923, 1932; MacGregor, 1937; Metreaux, 1940), New Zealand (Best, 1924, 1929, 1934). To appreciate the variety of nets found in Micronesia one needs only turn to the reports of the Südsee Expedition, 1908-10 (Thilenius, 1913) to find described and illustrated most of the kinds in use at the turn of the century.

The largest catches were made, however, with the use of the large seine and purse nets. Most of these efforts were of a communal nature, and in Melanesia often involved whole tribes (Hopkins, 1928, p. 161). The nets themselves ranged in size from 50 to 100 feet up to sizes of at least 600 feet in length, one of this size being purchased by Finsch in the late 1800's (1893, p. 25). Most of these were made with wooden floats of various kinds, with sinkers of stone and shell. Many of these large nets were used as set nets on the reef flat or in the lagoon to take advantage of the movements of fish with the ebb and flow of the tides. Frequently, large numbers of fishermen beat the water, forcing or driving the fish toward the set net. In areas of the lagoon where the water was sufficiently deep these nets were also frequently employed with canoes or swimmers to surround schools or shoals of fish. The enclosed school was then dragged into shallower water or the whole net was then hoisted and emptied into the accompanying canoes. In areas where the bottom was sandy or without dangerous obstructions which could tear the net, it was often employed as a drag net, being towed by canoe or swimmers from deeper to shallower water near the beach.

In Micronesia fish drives into nets and traps were rather common and the use of large seines was apparently more common in earlier times than it is now (Wedgewood, 1936, p. 10; Bentzen, 1949, p. 65; Tetens, 1958, p. 30). In this area today, the throw or casting net is coming to be more commonly used. It is known from early times in the Marianas where it was probably introduced by the Spanish (Anell, 1955, p. 18), although Thompson attributes its introduction to the Japanese (1942, p. 127). It is also found sporadically throughout the rest of Micronesia and is probably either of Japanese or east Asian derivation (Anell, 1955, p. 26). All of the net forms common to Melanesia and Micronesia are also known in Polynesia. All in all, fishing with the net was a very productive method, and the Oceanic peoples relied on it heavily to keep them supplied with the necessities of the sea.

In addition to nets, long lines or ropes made from, or entwined with, split coconut leaves are also used to entrap fish. They may be used as a drag-net or as a simple surround with the fish being removed by dip-nets or other means. They are also sometimes affixed to the ends of nets to increase the horizontal area swept of fish. This technique is said to be widespread and in some areas of Micronesia is supposed to be one of the most effective and productive means of fishing (Bentzen, 1949, p. 61; Burrows and Spiro, 1953, p.109).

ANGLING

A work by Anell (1955) comprehensively summarizes most of the available data on angling with the hook and line in Oceania. This section on angling is primarily derived from this source. Anell deals specifically with the distribution of the gorge, simple hooks (including two-piece bait hooks which function like simple hooks), compound hooks (primarily the bonito spinner), and large wooden hooks for shark and *Ruvettus*.

The taking of fish with hooks of various kinds was widely practiced at the time of European contact. The gorge and simple hooks of thorn, fishbone, wood, turtle and pearl shell, bone, and the shell of coconut, as well as large wooden hooks and various kinds of compound hooks were used. Some items, like the gorge have nearly a worldwide distribution (Anell, 1955, p. 83) and are believed to be old and successful items in the fishing kit.

GORGE FISHING

The gorges used in Oceania are mainly of two types: straight and bent at an angle (see fig. 5a), the latter occasionally having one arm longer than the other. They are made from a wide variety of materials including wood, mussel, pearl, and turtle shell, pandanus thorns, fishbone, and animal teeth. The gorge is usually pointed at each end with the line attached to the center. When baited, it is set so it lies closely parallel with the line. Upon swallowing the bait, the fish creates a tension in the line which pulls the gorge crosswise in its gullet piercing the sides and effectively preventing escape. The flying fish is the fish most frequently sought with this kind of implement.

In use, two methods of fishing were most commonly employed. The first involves setting the gorges out individually or in long lines attached to floats. This is the most common method and is found in use throughout Oceania. In Melanesia the floats are of wood and often highly carved to represent birds, fishes, and other forms. A stone sinker is generally attached to one end of the float to make it stand upright in the water and thus visible for long distances. In Micronesia and Polynesia, on the other hand, the floats are usually hollow coconut shells, although short horizontal floats of hibiscus wood are also used.

The second method consisted of trolling a baited or unbaited gorge behind a moving canoe. As with the above technique, the flying fish is the usual quarry. The gorge used with this method was usually of bent form. Trolling in this manner is confined to Micronesia.

Other methods of use were probably known and specimens of gorges affixed to hand lines would seem to indicate that angling with this imple-

FIG. 5. Gorge and various forms of Simple Fishhooks from Oceania: a, single point fish gorges with line and float; b-h, i, n-p, barbed and unbarbed rotating hooks of pearl shell; j, fishhook made of coconut shell; k-m, fishhooks of turtle shell (all except g from Fuller Collection).

ment was also practiced. Ethnographic accounts of this practice are rare, however. On Yap in Micronesia, the gorge was fastened to a rod and line which was stuck in the sea bottom in shallow water, and Buck also describes its use for catching small fish in the Cook Islands (1944, p. 236). Anell notes its importance in the Ellices and Samoa in western Polynesia (1955, p. 77). Further east in the rest of Polynesia, gorge fishing does not seem to have been important for it is unknown from Tahiti, the Tuamotus, Easter Island, and the Marquesas. In the north in Hawaii and in the south in New Zealand and the Chatham Islands it was apparently used only to take eels.

SIMPLE HOOKS

Angling with simple hooks was a relatively common practice in much of Oceania by the time of European contact. Fishhooks made from a single piece of material as well as compound forms with separate shank and point leg are known; the latter functioning like the one-piece hook. According to Anell,

There are three important form-criteria for the simple fishhooks: the general shape of the hook, its elaboration intended to make the catch more secure, and the way in which the line is attached. (1955, p. 115)

Round, V- and U-shaped hooks are known, but the latter is the most common form. Elaborations upon this general shape to make the catch more secure are confined to the addition of single or multiple barbs or the use of an incurving point leg. This latter feature is more typical of Polynesia where barbing is also known, while barbing is more characteristic of Micronesia. On the other hand, "the lack of any kind of elaboration intended to secure the catch" is typical of Melanesia (Anell, 1955, p. 117). Finally, the method of attachment is apparently to the inner head of the shank in spite of differences in the form of the shank head.

A wide variety of materials was used to make fishhooks and included some very primitive forms made from naturally occurring hooks, such as thorns and insect parts. Shells of various kinds, wood, bone, stone, and turtle shell were all used. In general, the simple hooks employed baits of various kinds which were usually tied on the hook. Angling with a hand-held line was the common practice, although in Melanesia many of the simple hooks were trolled from a moving canoe (Anell, 1955, p. 117). Permanent or temporary stone line sinkers were also widely used to lower the hook to the proper depths for fishing.

Little is known of the simple hook types from some areas of Oceania. In the Marshall and Gilbert Islands little record of the hook types formerly in use has been preserved (Anell, 1955, p. 95), while in many areas of Melanesia and western Polynesia simple hooks are unknown. Why none

FIG. 6. One- and two-piece bone fishhooks from Oceania

are found in this latter area is uncertain. Buck feels that they may never have occurred here because of a lack of technological development in this direction. He cites the use of the gorge in Samoa as evidence for the simplicity of the development of bait-bearing hooks (1930, p. 494).¹ Burrows, on the other hand, assumes that they probably did occur and were abandoned in favor of the bonito hook and other types of tackle (1938, p. 131), while Duff (1946, p. 139) suggests their loss due to rapid cultural change in this region. Anell tends to agree with Burrows, for he says,

As a general tendency it may be said of fishing in western Polynesia that the natives obviously devote themselves chiefly to fishing near the surface. Thus, while simple hooks, shark hooks and ruvettus hooks are not used, we found here the perhaps best-developed types of spinner hooks in different sizes, as well as the snare which is the only shark-catching device. It is, however, very likely that simple hooks were once used here, and the distribution of certain types and traits of the hooks of Micronesia, northwestern Polynesia, and southern Melanesia, seems to confirm this supposition. (1955, p. 96)

Nevertheless, despite these assumptions, simple hooks remain unknown in this area even after recent excavations (Golson, 1962a, pp. 172-176).

The compound-hook forms which function as simple bait hooks are found only in Polynesia. These consist of a point and shank lashed together at the base and used with bait. Their distribution is apparently limited to Hawaii, Easter Island, the Society Islands, and New Zealand. According to Anell, these probably developed from simple hooks and represent local developments (1955, p. 110).

SPINNER HOOKS

The compound spinner hooks of Oceania are basically of two types: those with the line affixed only to the top of the lure and those known as the Polynesian type with the line affixed to the point base as well (see fig. 7). The former type is known from the Solomon Islands, except for sporadic recordings on New Guinea. This is the only area in Melanesia in which "bonito fishing is carried on really intensively" (Anell, 1955, p. 152). It is also widely distributed in Micronesia. This group of hooks is much less homogeneous than the Polynesian form and appears to be the earlier form (Anell, 1955, p. 152). The latter type is known from the western and central Carolines in Micronesia and throughout Polynesia, with the exception of areas beyond the periphery of the southern distribution of the bonito. It is also found on the outliers on the eastern fringes of Melanesia.

¹ Anell feels, however, that the presence of the gorge, rather than being a sign of limited development, is merely evidence that it was effective as a catching implement and thus was retained.

FIG. 7. Spinner hooks of various kinds from Oceania

FIG. 8. Wooden hooks of various sizes from Oceania

The shank of the hook is generally made from pearl shell although other materials are used as well: mussel, tridacna, or other shell, bone, wood, and stone. Points, on the other hand, are usually made from bone, pearl, and turtle shell. These hooks are used unbaited and are trolled behind a moving canoe, the different tints of the shank and the general fishlike shape acting as a lure. The point of the hook is unbarbed for easy removal of the fish. Trolling for the bonito takes place in the deeper waters of the lagoon or outside the reef depending upon the movements of the fish. Bonito are rarely taken with any other type of equipment.

WOODEN HOOKS

The large wooden hooks from Oceania are of two closely related types: shark hooks of a great variety of form and finish and the *ruvettus* hook (see fig. 8). The latter hook is a very specialized form used to take *Ruvettus* and other deep-dwelling species of fish. They are all quite similar throughout their range of distribution. Many forms are considered intermediate between these two types and were used for either shark or *Ruvettus*. In Melanesia, the shark hook was used in many regions including the Polynesian outliers. The *ruvettus* hook, however, was unknown except on the outliers: Tauu, Nuguria, Ontong Java, Nukumanu, Sikiana, and Nissan. This form is very similar to that found in the Ellice Islands in Polynesia.

The hooks for shark and the intermediate forms for either shark or *Ruvettus* are also found in Micronesia. In the Gilberts there is less difference between the two forms than anywhere else in Oceania (Anell, 1955, p. 230). In Polynesia shark hooks are widely known except in the western region. In this area only sporadic recordings from the Ellices, Rotuma, and two doubtful instances from Tonga and Samoa are known. The distribution of the *ruvettus* hook is more limited and is confined to Polynesia and the Polynesian outliers in Melanesia (Anell, 1955, map 15). It is found on the Ellice, southern Cook, Austral, Society, and Tuamotu Islands. In the latter group, as well as in Hawaii and New Zealand, it was a late introduction.

Both the shark and the *ruvettus* hooks were baited. The former were generally trolled behind a canoe while the latter were used in still-line angling. Shark fishing took place during the daytime, while *Ruvettus* fishing generally occurred at night when the sea was calmer. This was important since the fishing ground was often several miles from shore.

Summary

From this review of the methods, techniques, and types of equipment employed by the Oceanic fishermen it can be seen, I think, that each was

suited to exploit one or another of the habitats of the maritime environment. Some were better suited to one area than another, but it is apparent that at and after the time of European contact, the taking of fish and other sea life was an important occupation of most groups who had access to the coastal waters in the various island groups. With few exceptions, most of the techniques and types of fishing equipment utilized were widespread in their distribution. Thus, the gathering of shellfish and the use of spears, traps, and nets are found in Melanesia, Micronesia, and Polynesia. The use of fishhooks is also found in each of the areas, but with distinct differences in their use and development. Those employed in Melanesia seem to be less well developed and less a part of the economic picture than those from Micronesia and Polynesia. Anell, in his analysis of fishing equipment from these areas finds "a very distinct border between the Melanesian and Polynesian culture" and concludes

... that the typical Melanesian fishing implements belong to the south Asiatic culture sphere of which Melanesia seems to constitute an easterly outpost. The implements typical of Polynesia and Micronesia, on the other hand, belong to the North-Eurasian fishing culture, except in those cases where they have a pure inter-Oceanic distribution. (1955, p. 247)

Papers by Heyerdahl (1961), Parsonson (1963), and Skinner (1957) have also pointed to possible cultural relationships between Oceania and these more northern areas, citing similarities between the types of fishing gear, adzes, and other items.

Fishing technology and the distribution of the various classes of hooks used for angling are significant for the understanding of how people have adapted to the sea as a source of food. A considerable number of the techniques described above are primarily adapted to shallow water fishing, that is, to the taking of fish near or at the surface. Among the angling implements, only the spinner hook and the gorge are used to exploit this surface zone. Deeper-water fishing is done with the use of various one- and two-piece bait-bearing hooks or wooden hooks with some type of sinker that will enable the hook and bait to reach the requisite depth. Although it is possible that traps may be set to float at the depths required to take fish from subsurface waters, this, if done, is apparently a rare occurrence. As a result, the simple and wooden hooks can be regarded as a rather unique response to this particular aspect of the sea, for it is used to exploit an area that would normally be unavailable to the other implements and methods. This is not to say that it produces larger catches of fish, although there is some evidence that it does procure the larger fish of particular species than do seining techniques (Brock, 1962). But when the methods involved in the use of the hook are used in conjunction with the other techniques, the exploitation of the sea for food is more complete.

As such, fishhooks can be considered complementary to the other techniques, rather than as an item which replaces or displaces any of them. For example, the use of the net is undoubtedly the most productive form of taking fish, and we find it in use among nearly all primitive as well as modern fishermen. For the taking of schooling fish or as a surrounding and trapping device it is probably unsurpassed in the amount of fish produced for the effort. However, as noted above, its use is confined to relatively shallow or surface water, and is, for the primitive fisherman, of no use for deep-dwelling species. The hook, on the other hand, becomes of vital interest at just this point. With it, a far greater range of the potential exploitable environment is available and poor days for the more productive techniques can then be supplemented. In addition, it must be assumed that new types of fish would also be taken; types that may have been known but were rare catches in the nets and traps or by spearing.¹

Viewing the distribution of fishing equipment in Oceania with these ideas in mind, it is apparent that in terms of surface and subsurface fishing, there are distinct differences in how the sea was used in Melanesia as compared with Micronesia and Polynesia. Nets, traps, spears and harpoons are surface oriented and in use throughout nearly all of Oceania. The gorge, the spinner hook, and apparently the shark hook are also surface exploiters, the latter being trolled. Only the ruvettus hook and one- and two-piece simple hooks exploit the subsurface layers. If our assumptions about the functions of the hook are correct, this suggests that it was in Micronesia and Polynesia that fishing was of the greatest economic importance and that nearly all of the total potential of the maritime environment was being exploited.

¹ Anell explains the beginnings of fishing for the *Ruvettus* in just such a manner, with this species accidentally being taken either when setting a hook and line too deep or catching a *Ruvettus* in the upper part of its depth range. Once known, the value of the fish was recognized, and new types of gear were evolved out of existing types (1955, p. 236).

IV

ARCHAEOLOGICAL EVIDENCE FOR THE USE OF MARITIME RESOURCES

Introduction

The use of the sea, rivers, and lakes as a source of food has a respectable antiquity in eastern Asia, Japan, and along the southeast Asian coast. The remains of innumerable animals and fish are found in Niah Cave in Borneo and the deepest food bone is said to be that of a "large fish, found . . . well below the 40,000 years date line" (Medway, 1958, p. 635). In addition, fish and turtle "formed a significant proportion of the cave men's diet in all ages. . . ." (Medway, 1959, p. 151) and the bone was also used for dolls and ornaments (Harrison and Medway, 1962). In Japan the dates from the Natsushima Shell Mound indicate the use of shellfish at least 9,000 years ago. In addition to supplying food, the sea also supplied sting-ray spines, presumably to tip spears, at an early date. These have been found in Indonesia associated with the Ngandong Bone Industry which van Heekeren calls an upper Pleistocene industry, possibly associated with Solo man (1957, p. 46).

A brief summary of the more readily available reconstructions of the prehistory of East Asia and the western Pacific will be given since the people who ultimately settled the Oceanic regions probably began their movements from these regions. In addition, archaeological site reports in which some indication of a utilization of the sea or freshwater lakes and rivers as a source of food are considered. The remains of technological equipment such as fishhooks, net sinkers, and other material are considered as being indicative of an interest in this aspect of the economy. Much of these data have been derived from summary articles, especially for Japan, the south China coast, Formosa and Indonesia. The purpose of this general survey is to help put what evidence is available on the use of the sea into some kind of perspective relative to the movement of peoples out of this area and into the island world, as well as providing indications of the use and non-use of the various categories of fishing implements and the different sectors of the marine habitat.

Japan

The earliest evidence for the use of the sea in the Japanese Islands comes from the Natsushima site on the island of Honshu. Two dates were

obtained on shell and charcoal which date this mound at 9450 ± 400 (7490 B.C.) and 9240 ± 500 (7280 B.C.) years ago (Radiocarbon Supplement, 1960, p. 45).¹ It is not yet known what kinds of shellfish were in the earlier shell mound or if fishing implements and remains were also recovered in the excavations.

The period of Japanese prehistory with the greatest interest for our reconstruction is the Jomon period. Sites in this period are generally shell mounds, but include mounds containing the bones of other animals and fish, as well as evidence of plant remains in the later periods. Only at the very end of the Jomon and the beginnings of the succeeding Yayoi period do we have evidence for agriculture consisting of the remains of millet, buckwheat, sesame seed and the kidney bean. Rice was introduced somewhat later. (Kidder, 1959, p. 54)

According to Fairservis, the heaviest concentration of Jomon sites is in Honshu, primarily in the north and eastern coastal areas (1959, p. 146), with considerably fewer sites in the southern areas. This distribution, the northern Asiatic similarities of pottery, tool types and houses, and the absence of agriculture and the potter's wheel indicate that "Japan owes its basic prehistoric culture to the hunters and fishers of northern Asia" (Fairservis, 1959, p. 148). Many local variations occur in Jomon tools and pottery and these differences are most distinct in the north and south. Thus, sea mammal hunting and fishing were the principal economic pursuits of the north, while shellfish gathering, the hunting of deer and the gathering of acorns were the staples of the south (1959, p. 148). Above all, the Jomon is characterized by the variety of pottery types found in the sites, and most of the divisions of this period are based on these. (Kidder, 1959, p. 34)

On the other hand, according to Groot, the earliest Jomon shows many striking resemblances to the Hoabinhian and Bacsonian cultures of southeast Asia (1951, p. 30). In particular, the stone tools have many Hoabinhian characteristics, with those of particular sites corresponding perfectly to those of southeast Asia. Although differences do exist, especially in the presence of pottery in many of the Japanese sites, Groot feels that these are two manifestations stemming from a common "basic Asiatic culture without pottery" (1951, p. 30).

¹ More recently, two dates from non-shell middens on the island of Hokkaido of 7700 ± 200 (5739 B.C.) and 7680 ± 200 (5719 B.C.) increase the acceptability of the earlier dates for Natsushima (Oba and Chard, 1963, p. 75).

Kidder's description of the inhabitants indicates that

Jomon man lived near the sea coast and earned his subsistence by gathering and eating shell-fish. Sea shells of greater abundance were preferred in the early stages, though as time progresses there was a ready switch to fresh-water shells as they became more accessible. (1959, p. 36)

The remains of deer (*Cervus nippon*) and wild boar (*Sus leucomystax*) in the Jomon middens (Kidder, 1959, p. 50), indicate the importance of hunting, especially in the Middle and Late periods. Wild birds were also taken and fish were plentifully represented in the remains. The largest amounts of fish were

. . . those which could be easily caught in the inlets especially at high tide; these include perch, mullet, gilthead, snapper, dragonet, and some seabream, but remains of deep-sea fish, like the tunny, shark, stingray, and even the whale, attest to the extreme antiquity of the widespread fishing industry. (Kidder, 1959, p. 51)

Although fishhooks and harpoon heads are found in the early sites, they are said to be rare. They become more plentiful in the Middle and Late periods (Kidder, 1959, p. 51).

As noted earlier, the earliest dates for the use of the sea are from Natsushima. However, the most readily available site report in which the midden remains, as well as the artifacts, are reported describes the Middle Jomon site of Ubayama on Tokyo Bay (Groot and Sinoto, 1952). This is a large shellmound dating from 2566 to 2579 B.C. Both round and square pit houses were found in the mound as well as other pits which probably served for storage. The pottery types were all from the Middle and Late Jomon periods and the stone and bone implements included chipped and polished stone axes (round and quadrangular), pitted hammerstones, a bone fishhook which was barbed, a male harpoon head which was unbarbed, and net sinkers made of pottery (no stone net sinkers were found).

A wide variety of shellfish and fish remains as well as the remains of dog, whale, wild boar, deer (common in the midden), badger, raccoon, dog, and the hare (relatively rare) were found in the site.

About 90% of all the bones excavated at Ubayama belong to the wild boar and deer. The numbers of boars and the number of deer whose bones were excavated at the spots C and D . . . might perhaps be as high as one thousand . . . most of the animals were full grown. (Groot and Sinoto, 1952, p. 24)

Twenty edible species of bivalves (18 clams, 2 oysters) and 15 marine and two freshwater species of edible gastropods were also found. In addition, the remains of cuttlefish (*Sepia esculenta* and *S. subculcata*) were present. Two clam species were very important; *Meretrix meretrix*, the most common edible bivalve of Japan (comprised over 81 percent of the middens at

TABLE 1.—Chronology* and Radiocarbon Dates from Japan

Period	Site—Pottery Type	Chronology	Radiocarbon Dates
Yayoi			
Late		c. 100–300 A.D.	
Middle		c. 100 B.C.–100 A.D.	
Early		c. 300–100 B.C.	
Jomon	Angyo (or Kamegaoka in Tohoku)	c. 1000–250 B.C.	
Late	Kasori (Kusaka Shell Mtd.) Horinouchi		Kusaka Shell Midden 3060±110 (1100 B.C.) years
	UBAYAMA—Shell Mound	c. 2000–1000 B.C.	Ubayama Shell Mound 4513±300 (2566 B.C.) years
Middle	Katsusaka Moriso	c. 3000–2000 B.C.	4526±220 (2579 B.C.) years
	Sekiyama—Kurohama Hanazumi	c. 3700–3000 B.C.	
Early	Kayama Inadari—Tado	c. 4500–3700 B.C.	
Pre-Jomon(?)	Kojohama Site (non-shell)	?	7680±200 (5730 B.C.) years
	Natsushima Shell Mound	?	7700±200 (5750 B.C.) years 9240±500 (7280 B.C.) years 9450±400 (7490 B.C.) years

* Jomon and Yayoi chronology after Kidder (1959).

Ubayama), and *Venerupis semidecussata*. Six other species were also fairly common. Most of these are shallow water species and are easily gathered. Six other species were identified, but were much rarer since they inhabit somewhat deeper water (depths up to 60 meters).

Twelve species of fish were identified, of which six species are relatively shallow water dwellers and are easily caught in inlets and bays. A few deep-water species were also taken but were not numerous. These included *Thynnus orientalis*, which is the commonest tuna of Japan (Okada, 1955, p. 141), and is a pelagic and circumtropical fish (Fowler, 1928, p. 133). Despite the relative absence of fishhooks in this particular sample, fishhooks in this period of the Jomon are relatively common (Kidder, 1959). In summary, we can say then that fishing, including some deep sea fishing, was practiced by the early inhabitants of the Japanese islands by at least 2500 B.C.

During the next period, the Yayoi, agriculture became important, especially rice culture. All the major Yayoi sites contain evidence of its presence (Kidder, 1959, p. 95). Gathering of wild foods continued, however, and sea foods also remained an important source of protein.

Although the gathering of shell-foods was not quite so routine, and the fewer numbers of shell-mounds of this period reflect the economic changes, fishing was conducted on an increasingly ambitious scale if one can judge by the larger size of the net sinkers made of both stone and clay. The Urigo shell-mound . . . yielded many bone hooks, and shells and fish bones of both fresh-water and sea-water varieties. (Kidder, 1959, p. 102)

From this we can see that fishing and the use of the resources of the sea began early and continued up to the present. The evidence for the use of shellfish goes back more than 9,000 years and that for the remains of fish perhaps 4,500 years, while evidence for the presence of fishhooks dates from Early Jomon, at least 6,000 years ago. The presence of one-piece bait hooks indicates that the subsurface, as well as the surface, waters were being exploited and the identified remains of deep sea fish partially confirms this assumption. The spinner hook found in the Oceanic regions is apparently lacking from these collections. A possible shank of a two-piece bait hook is illustrated by Munro (1908, fig. 27, nos. 3 and 4), but examples of this kind seem rare. Mention of the gorge is also rare in the literature; however, Anell cites the presence of both stone and bone gorges from this area (1955, p. 80).

South China and Formosa

Much of the early period of the south China area's prehistory is still relatively unknown. A number of recent papers have considered this the area from which the Polynesians began their migrations out into the Pa-

TABLE 2.—Relative Chronology of South China and Formosa
 (Constructed from Chang 1956, 1959, 1963)

Southwest China	Southeast China	Formosa
Han (206 B.C.—220 A.D.)	Han (206 B.C.—220 A.D.)	(c. 16–1700 A.D.) Historic Times
		Black and Grey, Red Polished Pottery
Bronze Age		
		A.D.
		B.C.
Neolithic	Geometric Ware (c. 1100 B.C.) Lungshanoid Ware (c. 1500 B.C.)	Brown, Black and Red Pottery
Sub-Neolithic (ceramic)	Corded-ware-chipped axe	Cord-Imprinted Pottery (prior to c. 1600 B.C.) (Hoabinhian axe ?)
Sub-Neolithic (pre-ceramic) (Bacsonian ?)	→ ?	↓
Mesolithic (c. 4000 B.C.) (Hoabinhian—affinities with SE Asia)	→ ?	?
↓		

cific (Beyer, 1948; Chang, 1959, 1963; Suggs, 1960). It is an important region for our discussions for in the early period the southwestern part of China was apparently a segment of the widespread Hoabinhian-Bacsonian area. This industry is identified by the presence of unifacial and bifacial worked cobble tools and an economy based on the gathering of shellfish (freshwater), as well as the hunting of game (deer, pig, rhinoceros). Associated with these remains are finds of skeletal material which have consistently been called Melanesoid or Papuan in its affinities (Stein-Callenfels, 1936; Tweedie, 1953; Chang, 1959, 1963).

Chang has divided the southern part of China into a southwestern and a southeastern area (1959). Both areas, according to Chang's evaluation, were modified under the impulse of events occurring in the north China plain. In the southeast four stages have been postulated (see Chart 2). The earliest stage is characterized by the presence of chipped stone axes, partially ground stone axes, and cord-marked pottery. Nothing is known of the food-getting activities of the inhabitants of these sites, but presumably they followed a pattern similar to that of the southwestern region; non-agricultural hunters-gatherers-fishers. It is possible that this tradition was "derived from the southwest by the way of the South China Sea and the Tonkin Bay Coasts" (Chang, 1959, p. 79). In the second stage agriculture arrived in this area from the north, moving down along the

coasts. Sites of this stage are few and relatively scattered but gradually increase in number as one moves north, until they merge with the Lungshanoid cultures of the north China region (Chang, 1959, p. 80). Evidence for cultivation by these people is found in the remains of rice, wheat, millet, sesame, peanuts, water chestnuts, broad beans and sweet melon seeds (Chang, 1959, p. 81). Presumed agricultural implements as well as the remains of animals (pigs and dogs, possibly cattle, sheep, and horse) were found in the living sites.

Fishing and mollusc shell collecting were both important, as is not only suggested by the location of the settlements, but is also indicated by finds of shell-mounds, turtle shells, shell implements, net sinkers, fish-spears, fish-harpoons, fish bones, and painted net designs . . . hunting does not seem to be particularly important and deer and bear were the principal game. (Chang, 1959, p. 81)

The next stage, the Geometric Stamped Ware Stage, is essentially a continuation of the preceding one. People lived in settled farming villages and cultivated rice and fruits. Domesticated animals included pigs, dogs, cattle, and perhaps the horse. In addition:

Fishing, hunting and gathering apparently continued, as indicated by remains of animal and fish bones, turtle shells, mollusc shells, fish designs on pottery, and fish-hooks. At some of the coastal settlements, such as those in the Hai-feng district, fishing as a means of subsistence seems to be predominant. (Chang, 1959, p. 83)

This period of development continued until its submergence in the Historic Yin-Shang, Chou, and Han periods of Chinese history.

This southeastern area is "essentially maritime-oriented and is historically known as *Pai-Yueh*, the navigators" (Chang, 1959, p. 97). According to Chang, it is probable that as the result of seaward expansion from this area the Malayo-Polynesians came into being.

In the southwest¹ life was changed more slowly (Chang, 1963, p. 122) and Mesolithic and Bacsonian sub-Neolithic remains are found scattered throughout the whole region; these remains extend into "Thailand, Malaya, and possibly the Archipelago" (Chang, 1959, p. 84). Habitation in caves and rockshelters was favored though open sites were also used. The bearers of this culture

. . . seem to shift dwellings between caves, rockshelters, and open camps subsisted by gathering, hunting, and fishing, and had no pottery. Many of the sites have shell-middens, containing a large amount of fragments of bones of wild dogs, deer, boars, bears, rhinoceros, bisons, snakes, fish, birds, and turtle shells. (Chang, 1959, p. 85)

¹ This area includes Szechwan, western Hupei, the Yunnan-Kweichow plateau, the limestone area of Kwansi and Viet-nam, the coastal plains of Tonkin Bay, and Hainan (Chang, 1959, p. 84).

Many important sites are known from this region and some are represented by large shell middens.¹

The appearance of cord-marked pottery and fully polished stone tools marked the end of the Hoabinhian-Bacsonian Mesolithic stage and the beginning of the Sub-Neolithic (ceramic) stage in this area. Evidence for these changes is stratigraphically indicated at sites in Bacson and Annam (Chang, 1959, p. 85). In all of the sites so classified, there is no evidence for agriculture, and we may assume that the earlier hunting and gathering subsistence continued. This is borne out by excavations in Hang-Rao cave in Annam where animal bones, potsherd, shouldered axes, and numerous hearths were found, as well as digging conducted in the large shell mound at Samrong Sen (Chang, 1959, p. 86; Worman, 1949, p. 320). At this latter site, shellfish gathering and fishing without agriculture were apparently the main subsistence base. The fish and shellfish are apparently of freshwater species if the location of the site is any indication.

Formosa

The culture history of Formosa apparently reflects to some extent events that were occurring on the mainland. The earliest Formosan sites contain cord-impressed pottery with ". . . Hoabinhian axes, necked axes, certain kinds of polished flat axes and tapa beaters" (Chang, 1956, p. 379). No non-pottery sites have been found. Seven cultural phases have been postulated on the basis of pottery typology. The most important sites stratigraphically are four: Feng-pi-t'ou, Shui-yuan ti, Chiang-t'ou, and Yuan-shan (Chang, 1956, p. 376). These are primarily shell mounds. More recent excavations have also been conducted in other sites which also contain evidence of the use of molluscs, mostly of marine species, although a few are freshwater forms (Shih and Sung, 1956; Yang, 1961). In summarizing the archaeology of this area Chang concludes:

. . . that most of the prehistoric inhabitants of Formosa belonged to the old Indonesian substratum of ancient South China. They possessed some foreign cultural elements as the result of contact with the early inhabitants of North China, as well as the ancient Melanesians and Polynesians, prior to their immigration into the island of Formosa . . . it is still an open question whether it is possible that a people other than the Indonesians were the bearers of the culture represented by the Hoabinhian axe-cord-impressed pottery occupation of Formosa. (1956, p. 384)

Malaya and Indonesia

As in the areas just discussed, the relevant culture history begins with the industry called the Bacson-Hoabinhian. According to Tweedie, this is the only Mesolithic culture that is extensively developed in Malaya

¹ Recent excavations in this area by Dr. P. I. Borisbovsky have served to verify earlier reports by Colani (1927). New Hoabinhian sites were also opened with results similar to hers (Solheim, 1963).

(1953, p. 10), while in Indonesia, van Heekeren places the Sampungan Bone Culture and certain flake blade industries also within the Mesolithic (1957, p. 67). As noted above, the Hoabinhian is characterized by the presence in the middens of an elongate pebble tool which may be chipped on one or both sides. In Malaya and Indo-China (Viet-Nam), the sites are usually located in interior regions, in caves, and normally associated with these caves are extensive shell middens (Tweedie, 1953, p. 15; van Heekeren, 1957, p. 67). Pounding and grinding stones, occasionally with pitted 'grips' and hematite are a common find in the middens. Other objects such as certain types of shell, cord-marked pottery, the so-called 'round axes,' and perforated animal teeth are also found, but their association with the Hoabinhian is open to question (Tweedie, 1953, p. 14).

Food remains from these inland sites are relatively constant. In most of them, the freshwater shells are fairly consistently Unionid shells, generally *Thiara variabilis*, while on the coast the marine shells *Meretrix meretrix* and *Ostrea* were the common forms. The Hoabinhian peoples were also good hunters and the remains of many animals are found in these middens.¹ Excavated sites containing Hoabinhian remains include Sai-Yok caves (Chin You-di, 1962) in Thailand, Bukit Chintamand in Malaya (Tweedie, 1936), the Karama River site in Celebes (Stein Callenfels, 1951), and the Guah Kepah site on the west coast of Malaya (Stein Callenfels, 1936). This last site consisted of three shell heaps chiefly of *Meretrix meretrix* and a few other types. Mammal remains were rare with a few tusks of boar (*Sus cristatus peninsularis* Miller) being found, as well as the canine tooth of an immature *Rhinoceros sp.* According to the excavator:

Far more common . . . were fish bones . . . belonging to the family Ariidae (sub-order Siluroidea), sluggish, littoral and estuarine fish. . . . From this fact, we conclude that although living on the sea beach, the human inhabitants of the shell heaps did not have deep water canoes and contented themselves with the fish they could catch in very shallow water. (Stein-Callenfels, 1936, p. 31)

Beads made from fish vertebrae were also found in all three mounds.

In addition to the Hoabinhian, van Heekeren also places two other industries in this same general time period: the Sampungan Bone Industry and the Toalean and related flake industries. The first of these industries was first found in Java and is known from at least 17 caves in that area (1957, p. 84). This industry consisted primarily of bone implements, including bone fishhooks which are rare, great quantities of red pigment (hematite), and various ornaments, including shell objects, perforated shells, and animal teeth (1957, p. 84). No pottery was known and the people apparently still lived on "edible molluscs and wild vegetables . . .

¹ Lists of these may be found in Tweedie (1953), and van Heekeren (1957).

[and] . . . they had become increasingly competent in hunting big and small game" (1957, p. 85). According to van Heekeren, this industry occupies a place intermediate between the Hoabinhian and the Neolithic in Indonesia.

The last industry which is included in the Indonesian Mesolithic is the Toalean and related flake and blade industries. The Toalean is all known primarily from southwestern Celebes where it was discovered and named by the Sarasins in 1902-03. It is known from 19 different caves and it appears that

. . . the people who introduced this culture lived mainly on edible fresh-water molluscs as well as from hunting small and big game, fishing, and gathering edible wild plants. (van Heekeren, 1957, p. 95).

Other than the Celebes area, similar flake industries are found in Java, Sumatra, Flores, Timor, Roti, and Borneo. Van Heekeren himself also discovered this industry in Java associated with the Sampungan Bone industry (1957, p. 104). This same site also contained some small 'Sumatraliths' and red hematite in the six layers of stratification. There were shell artifacts and "a marine deposit of shells and coral . . ." (1957, p. 104). There is no information on food remains. On the Lesser Sunda Islands of Roti and Timor this industry (blade and flake) has been found associated with molluscan shell but no vertebrate remains (1957, p. 107).

In addition to van Heekeren's general summary, the literature reports a number of sites which give indications of similar remains of food but in which the artifacts are of different types. For this reason these sites are usually placed in a Neolithic period. Very little is known of this period in either Malaya or Indonesia. According to an earlier reconstruction of the culture history of this area by Heine-Geldern (1932), the distinguishing feature of the Neolithic is the Quadrangular Adze. Associated with this adze type (and its variants)¹ is cord-marked pottery of a variety of forms (Tweedie, 1953, p. 18). References in the literature to midden remains are scanty and most of what is known is based on surface finds of artifacts, which have been summarized by van Heekeren (1957, pp. 120-26). A single radiocarbon date is known from Gua Harriman Cave from a level containing human remains, cord-marked pottery and a beaked adze (Williams-Hunt, 1952). This date is 3450 ± 150 years B.P. (ca. 1500 B.C.) (Radiocarbon Supplement, 2, 1960, p. 29).

A few of the published site reports do indicate that shellfish and animal remains are still found associated with pottery and polished stone tools. In Malaya, a series of rock-shelters and caves all report the finding of fresh-

¹ Beaked, shouldered, and stepped adzes.

water mussels, animal bone (generally pig, deer, some fish and turtle and perhaps cattle) associated with both polished and unpolished tools, hammers, and pottery (Evans, 1920a, 1920b, 1922; Collings, 1936; Tweedie, 1940). The finds from Niah Cave in Borneo have already been mentioned (see page 141).

Philippine Islands

Up to 1950, most of what was known about this area was based on the extensive researches of H. Otley Beyer. His two main publications included an outline of various provinces and islands and the archaeology conducted on them (Beyer, 1947), and an attempt to bring together all of the then available data from the Philippines and relate them to Oceania and the Asian and southeast Asian regions (Beyer, 1948). Other than brief mentions of the occurrence of shell heaps (1947, p. 268), neither of these works contains much in the way of data on the food remains found in the sites. Tools, pottery and other objects are recorded, and a tentative historical sequence with dates based upon artifact types is postulated. (1948, pp. 79-82)¹

A number of cave sites have recently been excavated in the Philippines which help to clarify some aspects of the subsistence activities of this area, at least for the early periods. In addition, a series of radiocarbon dates has been obtained which has enabled workers to implement Beyer's original chronology. These caves, located on Luzon (Fox and Evangelista, 1957a, 1958), Cagraray Island (Fox and Evangelista, 1957b), Masbate (Solheim, 1955), and Palawan (Fox, n.d.), all contained evidence of the use of freshwater and salt-water molluscs, as well as some animal remains, primarily pig and deer.

The earliest radiocarbon dates from these caves come from Tabon cave on Palawan Island, where a series of dates ranges from about 21,000—22,000 years ago (UCLA-283, UCLA-288, UCLA-285) to 9250 ± 250 years B.P. (UCLA-284). No evidence of the use of shells is found in this cave and Fox feels that their absence indicates that the shoreline at this period was much farther away than at present, too far for shells to be utilized as an everyday resource (n.d., p. 11).

Shells have been and continue to be a major source of protein for the Filipino people, notably people living near the coasts. Sea shells appear by the thousands in other Lipuun and Iwaig caves, some caves being at least fifteen to eighteen kilometers in distance from the coast. The flake tool industry at Duyong which is associated with a thick midden of sea and brackish water shells yielded a Radiocarbon 14 date of 7000 ± 250 years; a period within recent geologic times when the sea level and shore

¹ More recent chronologies have been offered by Evangelista (1963, p. 47) and Fox (n.d., fig. 1).

line had assumed approximately their present position. . . . There is no physical reason why shell would not have survived in association with the flake tool industries . . . it is far more likely that . . . the shore line was many kilometers away from the cave. (Fox, n.d., p. 10)

The date of 7000 ± 250 B.P. (ca. 5050 B.C.) for Duyong cave is the earliest evidence for the use of shellfish. Apparently no fish remains were found.

This use of shellfish is also found in sites that are later in date, and in the Bato Caves, radiocarbon dates of 2550 ± 200 (ca. 90 B.C.)¹ (M-728) and 2280 ± 250 (ca. 180 A.D.)² (M-727A; Radiocarbon Supplement, 1959, p. 196) are associated with the remains of sea and land shells but few animal bones (Fox and Evangelista, 1958, p. 120). A slightly earlier date from Batugan Caves on Masbate (Solheim, 1955) of 2710 ± 100 years B.P. (756 B.C.) does not have any midden remains reported, but a site from this same area which Solheim attributes to the Middle and Late Iron Age is said to contain fresh- and salt-water shells and the bones of pig and deer, but "no indications of fishing were found . . ." in any of the sites on Masbate" (Solheim, 1955, p. 49).

From this brief survey of the Philippine archaeology, we can see that the use of shellfish was and is relatively important as a source of protein. Fox believes shellfish gathering began around 7,000 years ago and continued to the present day. (Evidence from the other sites in this region tends to bear out this contention.) Absence of fish remains from these sites indicates a notable lack of interest of the inhabitants in fishing, which is also reflected in the scarcity of fishhooks. This situation is typical of Malaysia in general. From the data presented here it would seem that protein requirements were satisfied by a broad hunting and gathering effort utilizing local animals and riverine and sea shellfish.

Summary

From this brief survey of the literature of the east Asian mainland, Japan, southeast Asia and Malaysia, we can see that, with two exceptions, basically there seems to be a single orientation toward the utilization of natural resources. This involves land-oriented subsistence activities such as hunting, shellfish gathering, and the probable use of a wide variety of plant foods. One possible exception is the southeast coast of China where no substantial evidence of human occupation is found prior to the advent of the Corded Ware/chipped stone axe Stage (Chang, 1963, p. 77). What the food habits of this stage were is unknown. Agriculture arrived in this area with the next stage postulated by Chang, and from this point on, the

¹⁻² Corrective applied for modern shell sample ± 500 .

southeast coast was an area of combined cultivating, hunting, and fishing. (Chang, 1959, p. 81)¹

In the southwest, however, the environmental exploitation was apparently of the type found all over southeast Asia and Malaysia, that which has been called Hoabinhian after the characteristic implements found in many of the sites. These groups of people were apparently intensive collectors; intensive in the sense that a wide variety of foodstuffs, both plant and animal, were utilized. On the basis of the incomplete data, it is inferred that this adaptation continued on up to the present time through much of this region, being practiced along with agricultural techniques. In terms of our interests, the utilization of shellfish, both fresh- and salt-water types, seems to be of the most importance. Fish remains, although known from sites on the west coast of Malaya (Stein-Callenfels, 1936), Borneo (Medway, 1958), and the east coast of Sumatra (van Heekeren, 1957), are comparatively rare, as are artifacts, such as fishhooks or net sinkers, which would indicate that this aspect of the environment was being exploited. It is not quite clear whether the fish remains found are of riverine or marine origin, with the exception of the Guah Kepah site in Malaya, where estuarine types are noted. In Niah Cave the inference is that the fish bones were riverine,² although no specific identifications are given. The inland location of a site on the east coast of Sumatra excavated by Schürmann (van Heekeren, 1957, p. 71) makes one infer that the fish remains found there were also riverine.

This same pattern was also noted for the Philippine Islands where the gathering of shellfish has continued to be an important source of protein for the native peoples (Fox, n.d., p. 10). Here, too, there is considerably less emphasis on the taking of fish, if the archaeological remains are to be considered as at all indicative of the food interests of the inhabitants.

This seeming emphasis on shellfish may, in part, be related to the rising and falling of the sea level in this region through time, since many of the more maritime-oriented sites may be submerged on the relatively shallow coastal shelf found between a number of these areas. However, in view of the continuing presence of marine shells in most of these sites, it would seem that more evidence of marine fishing would also turn up as well. Undoubtedly much of this emphasis is being colored by the lack of archaeological research in many of the areas included in southeast Asia and

¹ This is the area from which Chang would derive the Malayo-Polynesians after the advent of agriculture in the Lungshanoid stage (1959, p. 92).

² "Fish, too, present little tool problem to the primitive hunter in this land of constantly changing river level. Rich catches may be made by operating simple weirs across tributary streams—opened with the flood and closed as the water falls. This method traps big fish rather than small." (Medway, 1958, p. 635)

the Malaysian archipelago. On the basis of what we do have, it appears to me that the utilization of the resources of the sea was only minimally developed during the periods of time when the migrations out into the Oceanic world are supposed to have begun.¹ If this area was the starting point for these migrations, then much of the development in the technology for exploiting the sea probably took place in the islands rather than in this 'homeland' area.

The second exception to this utilization of the sea occurs in the islands of Japan. Here we find that the use of the sea—in particular, marine shellfish gathering—began by at least 7000 B.C. (see Table 1) with the use of fish as a source of protein beginning by at least 2500 B.C. and perhaps earlier. At this time both inland and deep-water fish were being exploited for food (Groot and Sinoto, 1952). By Middle Jomon times the use of the fishhook had become common. It was in use prior to this period but was rare. These hooks were one-piece forms with plain and barbed points made of bone and antler. In the last stages of the Jomon, barbing became more elaborate and hooks with both shank and point barbs are known (Groot, 1951, p. 75, fig. 10b). The harpoon was also an important implement throughout Jomon times and tends to become more elaborate from Early to Late (Groot, 1951, figs. 1 and 8).

Melanesian Archaeology

Introduction

Prior to the end of World War II, very little archaeological work had been done in the Melanesian area. Since that period excavations have taken place in New Guinea,² New Caledonia, the Ile des Pins, and Fiji. With the exception of New Guinea, all of these areas are in the southern and easternmost part of Melanesia, and as a result leave much of the region unknown archaeologically.

New Caledonia, Fiji and the Ile des Pins all provide evidence of a utilization of the sea for food in the extensive middens that are found encircling the shorelines of these islands. Excavations conducted by Gifford in New Caledonia and Fiji as well as the work done by the Auckland University party in 1959–60 were primarily concerned with these seaside middens. On Fiji, Gifford excavated two sites, one on the east and one on the west

¹ Even Chang's archaeologically-validated reconstruction of the proto-Malay-Polynesian culture does not include items which would be associated with exploitation of maritime resources such as fishhooks or net sinkers (1959, p. 91), although he does note fishing and the use of canoes as characteristics (p. 90).

² The excavations recently completed by Bulmer are not being considered here since they are not applicable to the immediate problem of the utilization of the resources of the sea.

Fig. 10. Map of Micronesia and Melanesia

coasts. Both contained shells in the upper levels and fishbones in nearly all levels (Gifford, 1951, Tables 1-6). On New Caledonia eleven sites were sampled, most on the coastal fringes of the island—six on the west side and five on the east—and all of them (even the two sites which were a mile or more from the beach) contained varying amounts of fishbone, molluscs and other evidences of a utilization of the available sea resources. The site of St. Mauritz on the Ile des Pins contained shells, turtle and fishbone (Golson, 1962, p. 170); however, their excavation is still unpublished.¹ For this reason, this section will concentrate on Gifford's work from New Caledonia and Viti Levu in the Fijian Islands.

New Caledonia

The sites on New Caledonia were surveyed and excavated by Gifford and Shutler in 1952. Eleven of the many sites explored were actually excavated, and of these, seven were dated by radiocarbon (Gifford and Shutler, 1956, p. 89).

Though varying in date (A.D. 73 site 50, A.D. 1569 site 51), depth, composition and detail of artifactual assemblage, 10 of Gifford's 11 sites are characterized by the presence of the same general ceramic tradition. This consists in a great preponderance of undecorated sherds (93-97% by weight) and, on the evidence of rim pieces, of vessels with vertical sides and rounded lips. (Golson, 1962, p. 169)

The other site excavated by Gifford, Site 13, is rather distinct. It not only contains a distinctive pottery type but the radiocarbon dates, though inverted (846 B.C. $\pm$ 350 at the 24-30-inch level and 481 B.C. at the 30-36-inch level), are considerably earlier than dates for the remaining sites. On this basis Gifford feels that it is "... likely that this site was deserted in antiquity, perhaps before the time of Christ" (Gifford and Shutler, 1956, p. 89). In short, Site 13 represents a distinctive and earlier period of habitation on New Caledonia, while the remaining sites represent a rather long period of occupation on the island when apparently no great changes were occurring in the pottery types and the artifact complement.

Both fishbone and molluscan shell were found in all of the sites excavated, but the amount varied from site to site (Gifford and Shutler, 1956, Tables 1-12). According to Gifford, "molluscan shell was the most abundant material representing life forms in the kitchen middens. . . ." (Gifford and Shutler, 1956, p. 29) with 255 species being identified, most (222 species) being noted from the east coast.² Fishbone was also fairly abun-

¹ Except in cyclostyled form (Golson, 1962a).

² Although more difficult to handle since the figures are given in percentages of weight of the column samples, a glance at these tables indicates (with the exception of site 19) that the west coast sites produced higher percentages of shell than those from the east coast (Table 1, p. 21). Further evidence for this more intensive occupation is also given when one glances at the tables regarding artifacts (Tables 32-40), other bone than fishbone (Table 15, p. 36), and decapod shell (Table 18, p. 38).

dant in the excavations with slightly more than 175 grams per cubic foot being recovered from the sites. This figure varied considerably, however, from site to site.¹

Without exception, all of the fish remains identified from the sites belong to families and genera which are easily taken close inshore or on the reefs. None would involve more than the use of nets, traps, or spearing. Two species are apparently fresh or brackish water species: *Galaxias neo-caledonicus* Webber and Beaufort and *Terapon puta* Cuvier. Other than the sharks, the fish inhabiting the deepest waters are certain of the Serranidae family (Schultz, 1953). Even the species of shark might also be taken in shallow water, for according to Schultz, in other areas it is found in "shallow water on the reefs, where it can be observed with its back exposed and the black tips of its fins showing" (1953, p. 15). It is apparently a common inhabitant of the reefs and lagoons.

The Serranidae apparently were an important source of food for the inhabitants, being found in nearly all of the levels of Sites 26 and 20 (Gifford and Shutler, 1956, p. 35, Table 14). Their importance as a source of food is apparently widespread for on Rariora they were second only to the Scaridae (parrot fishes) as a food source (Harry, 1953, p. 71). The genera within this family inhabit both the reefs and the deeper parts of the offshore and lagoon waters, and, on Rariora, they were found in all of the ecological zones except the surge channels (Harry, 1953, p. 71).²

Fishhooks are scarce in the artifact materials from the sites. There were nine crude hooks of *Placostylus* shell, which is a land snail, recovered from the 11 sites. Six of these are from Site 19, a site which produced only 18 grams of fishbone. By contrast, Site 26, which had the most fishbone, produced a single hook in the top level. All of this would seem to indicate that fish and fishing with the hook did not loom large in the native diet.

Site 13, which is early in time, had very little fishbone in it except for the top six inches. However, the continuous presence of shell net sinkers in the midden to a depth of 48 inches (Gifford and Shutler, 1956, Table 32), does seem to indicate an interest in, and the use of, nets for the taking of fish. The amount of fishbone found in the upper layer may be the result of disturbance and represent relatively recent activity.³

¹ Site 6 had less than 2 grams per 1,791 cu. ft. of midden while site 26 had more than 4,400 grams in 1,053 cu. ft. of screened midden.

² More specific ecology for the various genera is given by Schultz (1953, p. 328 *passim*).

³ "On the surface and in the upper layers of all excavated sites fragments were found of objects of European manufacture, comprising metal, clay tobacco pipes, glass, chinaware, bricks, concrete. Also glass beads and sawed animal bones were encountered. These objects were on the surface or, where they had been ploughed or spaded under, a few inches deep." (Gifford and Shutler, 1956, p. 1)

and we must presume, as Gifford has, that "molluscs and, to less extent, decapods must have been the principal sources of protein" (Gifford and Shutler, 1956, p. 28).

Fiji

Thirty-nine sites were explored by Gifford on the island of Viti Levu in 1947 (1951, p. iii) and of these, two were excavated. Excavations at Navatu (Site 17) were conducted at two locations, A and B, and carried to a depth of 144 inches at Location B (Gifford, 1951, p. 198). At Vunda (Site 26), two locations were also excavated, the greatest depth here being 10½ feet at Location A (1951, p. 201, Diagram 5). According to Gifford,

The striking thing about both sites was the prevalence of shell in the upper layer and its scarcity or absence in the lower layers, except at location B of Site 17, where shell occurred down to a depth of 126 inches. Samples taken at 132, 138, and 144 in. at location B showed no shell. The deep occurrence of shell at location B is probably correlated in some way with its seaside situation. (1951, p. 202)

As in the New Caledonian sites, shellfish remains were found in all of the sites investigated (1951, p. 190) and fishbone was recovered from both excavated sites.¹ A total of 3,113.1 grams of fishbone was recovered from the sites with only 387.7 grams of this from Site 26, Location A (1951, p. 206). Location B, as noted above, produced most of the fishbone from Site 17 (1,525.4 grams to 1,200.0 grams from Location A). A total of 2,880 cu. ft. of midden was excavated (1951, p. 189); therefore, the total amount of fishbone in the sites averaged about 1.08 grams per cu. ft. This is slightly above the .75 grams per cu. ft. on New Caledonia, but

Whether this represents a true cultural difference in the use of fishes as food in Fiji and New Caledonia, or whether it is a fortuitous factor of excavation, or whether the reported practice of burning fishbones is the cause of the smaller New Caledonian yields are questions which we cannot answer with any assurance. (Gifford and Shutler, 1956, p. 28)

As with the New Caledonian sites, artifacts, with the exception of pottery, were scarce in the middens. Most of the sherds found were of plainware, but incised and relief decorated sherds were found in both sites with the abundance in Site 17. Incised decoration is a characteristic of "both the modern pottery and the excavated Late period pottery of Ra Province" (Gifford, 1951, p. 222), while the early pottery from the lowest levels of Site 17 was characterized by a wavy relief design found only at a few other sites on the surface. Subsequent radiocarbon dates for Site 17 confirmed the early date for this site inferred by Gifford on the basis of his stratigraphic analysis (1951, p. 235). No dates were obtained for Site 26.

¹ Only location B of Site 26 contained no fishbone, nor, for that matter, much of any kind of bone or shell.

A recent re-analysis by Green (1963) attempts to clarify the temporal situation that exists on Viti Levu. By subjecting Gifford's data to an intensive re-analysis and interpolating more of the historical data, the temporal significance of the sites was re-evaluated. One of Green's contributions is a clarification of the Middle period, showing that the continuum of occupation is much more consistent than Gifford's analysis would imply. Green also adds a hypothetical earlier period; a period of proto-Polynesian occupation prior to the excavated sequence, which he sees as becoming more and more Melanesian in its character as a result of influence from the south and west.

A brief summary of these redefined periods follows. After stating the case for a Middle period (already suggested by Gifford) and pointing out the difficulties created by Gifford's use of "shell middens as a distinctive attribute of the Late Horizon . . .," Green recommends abandoning this as a relevant criterion (1963, p. 236), for, as he later shows,

... the historical evidence makes it doubtful that the shell midden portions of Site 17A and Site 26 are contemporary, although the two may overlap in time. Second, the evidence of Site 17B clearly demonstrates that shell-fishing was practiced not only in the late period but throughout the sequence. Third, Middle period deposits for all three sites reveal evidence for shell middens and relief sherds with the underlying shell-less deposits break down at Site 26. It is not at all evident if one plots shell midden against incised pottery. In fact, given his two alternatives, concrete evidence is lacking that the use of shellfish was restricted to the Late population only, as Gifford implies; rather the presence or absence of shellfish seems to depend on the position of the site with respect to the coast and the use to which the portion of it excavated was put at various points in time. On the evidence available . . . one can only conclude that shell-fishing was practiced, without noticeable change in the species exploited at all three sites during the Middle period, at two sites during the Later period, at one site during the Early period. (1963, p. 237)

He then goes on to offer evidence for and discuss each of his proposed horizons. In Green's revision (1963, p. 240) the materials designated as Late at Site 17A by Gifford, probably the Mereke site, and those levels containing European materials constitute the Late Period. The approximate dates of this period are A.D. 1643 to A.D. 1840 (Green, 1963, p. 241).

The Middle period "extends back to the 11th century A.D." (Green, 1963, p. 41) with deposits of this period found in all three sites (17A, 17B, and 26). The base of the shell midden in 17A belongs here; the upper portion of Site 17B; and almost all of Site 26 belongs to this period (see Green, 1963, p. 251, chart, fig. 1). It is characterized by changes in the temper of the pottery as well as by the introduction later in the period of applique relief decoration. The use of shellfish continues throughout, and fishbone and mammal bones are also found.

The Early period,

... radiocarbon-dated between the first century B.C. and the 8th to 11th century A.D., remains defined approximately as before. The principal deposit is the non-shell layers at Site 17A. . . . The evidence for the use of shell-fish in this period is all from Site 17B. Here shell was present down to a depth of 126 inches which is quite sufficient to conclude that these people used shell-fish in their diet, although to what extent it is impossible to infer. (Green, 1963, p. 244)

On the basis of data from as yet unexcavated sites at Sigatoka (Gifford's sites 20 and 21), Green goes on to postulate a proto-Polynesian period preceding the sequence just discussed. Other data, admittedly scanty, are also marshalled to bolster this case. Of interest here is the imputing of the use of shellfish to this earlier horizon¹ with its implications for the importance of shellfish gathering throughout Fijian prehistory.

If we use Green's sequence and attempt to refigure the data offered by Gifford in Tables 1 to 6 (1951, pp. 204-209), as is suggested by Green (1963, p. 236), we arrive at some interesting conclusions about the use of shellfish and fish.² The figures on the following chart seem to indicate that the use of fish was gradually decreasing from the Early Period to the Late. Since no figures are given for the weight of shellfish in the various sites, we are unable to determine whether or not there was an increase or

TABLE 3.—Recomputed Midden Constituents of Sites on Viti Levu, Fiji Islands.—

These and the following figures have been computed from Gifford's tables.

	Fishbone		Shellfish	Other Bone	
	Weight (grams)	Weight (cu. ft.)	Avg. percent per sample	Weight (grams)	Weight (cu. ft.)
Late	574.1	0.67	14.4	2146.3	2.51
Middle	958.9	1.47	12.1	1701.3	1.10
Early	1580.1	2.65	13.8	1097.0	1.21

a decrease in their weight. From the ethnographic data and from Gifford's statement that the reefs are searched six days a week for shellfish, one must assume that they were, and continued to be, an important part of the Fijian diet.

If we compute the average percentages of the shellfish per sample from Tables 1 and 2 (Gifford, 1951, p. 204), we see that the percentages remain

¹ This is done by equating Sites 20 and 21 (which are shell mounds) with Site 17 which has produced a date of 46 B.C. All these sites contain the wavy relief pottery which is associated with this early date.

² Green's revision (1963) has the shell layers of 17A in the Late Period; Site 26 and the upper half of Site 17B in the Middle Period; the Early Period is made up of the lower edge of the shell midden in 17A plus the non-shell layers (the division here is fuzzy and computed from the column samples: only those levels with greater than one percent were included in the Late Period; those with less than one percent were included in the Early Period) and the lower half of Site 17B.

fairly constant for all periods.¹ Tables 4 and 6 (1951, pp. 207, 209) give the data from the sites in regard to other bone in the middens. These figures, when recomputed, indicate that the use of other sources of protein rises from the Early Period to the Late. The figures for the Late Period undoubtedly reflect the introduction of European species such as the deer and goat, perhaps even the pig. A large amount of the bone included fire-blackened human bones and we must assume that man provided much of the protein in the Early and Middle periods (1951, p. 208, Table 10). Turtle was also a protein source in the early periods.

If the remains from these sites represent a valid sample of what was occurring in terms of changes in the subsistence activities of the native peoples, it may be that the decline in fishing—which is indicated by the relative proportion of fishbone in the middens—reflects an increasing utilization of agriculture as the main source of food. The importance of agriculture during the ethnographic present would tend to substantiate this theory.

Archaeologically recovered implements which could provide some information as to the sources of food are also limited in the sites. A single fishhook from Site 17A (24–30 inches) is the only indication of their use. Unlike New Caledonia, the sites did not produce any net sinkers. Implements which might be interpreted as being associated with tree or root crops, such as the single shell breadfruit peeler-scraper which is a modern example, are also lacking in the excavations. Five specimens were also recovered from the surface of Sites 20 and 21 (Gifford, 1951, p. 220).

The fishbones collected by Gifford were identified and reported on by Fowler (1955). He was able to identify “upward of 20 determinable species and several genera for which the specific identifications are not clear, or not available” (Fowler, 1955, p. 2). All species were of kinds available at the present time and Fowler declined to make any very general conclusions.

Site 17A produced most of the fish remains (Location A, 1,200 grams; Location B, 1,525.4 grams). Gifford attributes 17B's greater output to the seaside location (1951, p. 206). Only a single specimen of fish was identified for Location B that was not found elsewhere: *Lycondotia* sp., an eel. About six of the genera appear in nearly every level (in which remains

¹ The column on shellfish remains is computed on the same basis as the previous data. These are average approximations and are the best that could be deduced from the data given, but should be used with caution. They are offered to show the possibility that the use of shellfish probably remained relatively constant throughout Fijian prehistory.

are found) and must be indicative of the importance of these particular fish to the inhabitants.¹

The species found in Site 26 were no different from those from Site 17 and indicate that the aboriginal inhabitants of the Fiji Islands depended, as now, upon the more easily gathered reef and inshore varieties of fish; fish that could be taken by the relatively simple expedients of trapping or netting or poisoning the reef pools.

Summary

From all of the foregoing, we can see that although the middens of sites in New Caledonia and Fiji produce abundant evidence of the utilization of the resources of the sea, there is some evidence of a decline in the utilization of fish. Fishbone, molluscan shell, and the remains of decapods have all been found. On the other hand, very little can be deduced from the artifacts found as to the specific means of obtaining these foods. It may be assumed that shellfish gathering would not require more than a search along the reefs or in the lagoons for good beds. Decapods are generally found in the same zones. A few species may require diving into deeper water—the tridacna, for example—but most are found in relatively shallow water.

Fishing equipment (primarily fishhooks) is notably lacking in the site remains, and those that are found are generally simple one-piece hooks of *Placostylus* shell (New Caledonia). The single example from Fiji is said to be the shank of a central Solomons Island type. This latter came from the Late materials in Site 17A (Gifford, 1951, p. 220) or, according to Green, the Middle period (1963, p. 244). Unlike New Caledonia, Fiji produced no shell net sinkers.

In considering the artifacts and the midden remains we can see, I think, that shellfish gathering and the taking of fish were important throughout most of the occupation of the sites. On Fiji apparently the taking of fish may have been more important in the Early periods than in the Late ones. If so, it may indicate a greater and greater reliance on other sources of protein—a turning away from the abundant fish which are reported from this region. In addition, there is little evidence for the use of hooks, and this lack continues up to the ethnographic present. This would seem to indicate that the taking of fish occurred with other technological devices, and the hook, or at least the one-piece bait hook used for sub-surface fishing, has never been an important factor. On the other

¹ These include the following: *Cataphracti*(?) (6–66 inches); *Diodon* sp. (6–102 inches); *Lethrinus* sp. (6–72 inches); *Lutjanus* sp. (6–54 inches); *Scarus* sp. (6–108 inches); *Serranus* sp. (7–72 inches); and *Tetradon* sp. (6–78 inches). These are the snappers, a close inshore fish (Fowler, 1928, p. 7), the groupers or sea basses, parrot and puffer fish, and the porcupine fish. All are reef fish with a circumtropical distribution (Fowler, 1928).

hand, the use of mollusks has remained fairly constant throughout the occupation of this region and has remained a prime source of protein for the native peoples.

Micronesian Archaeology

Introduction

Like most of the Pacific region, the archaeological investigation of this area of the Pacific is only beginning. Other than random, generally unreported digging carried out by collectors, travellers, and others in times past, archaeological excavation in Micronesia has generally occurred since World War II.¹ The first large scale excavations were undertaken by Hans Horbostel in the southern Marianas in the 1920's under the auspices of the Bishop Museum. The results of his work, with the exception of his archaeological collections (Thompson, 1932), are largely unpublished. Hornbostel made a number of excavations, primarily on Guam, and his large collection of artifacts is now in the Bishop Museum.² This work and report is the most extensive digging undertaken in all of Micronesia prior to the end of World War II, with the possible exception of work by the Japanese unknown to me.

At the period just at the end of World War II, Osborne, Carpenter, and Smith undertook some excavations on Guam. The results of those explorations have been written up but are unpublished to date (Osborne, n.d.). These are primarily a survey and tests of some of the then known sites. A small collection of the artifacts is in the Robert Lowie Museum, as well as one in the Rochester Museum. Another survey was conducted by Reed (1952) and was primarily concerned with the preservation of sites on Guam. No excavations were conducted.

Marianas Islands

The works of Spoehr (1957) and Gifford (1959) are the most fully reported excavations of sites within the Micronesian area since World War II. Spoehr made extensive excavations on the islands of Saipan and Tinian, and a brief survey of Rota. Two of his sites produced carbon dates, one of considerable antiquity from Chalan Piao (1527 B.C.±250 years). In addition, Spoehr was able to demonstrate that more than one level of occupation was to be found on the islands, with the earlier levels characterized by prone burials and a hard reddish ware called Marianas Red

¹ Prior to this time, digging and collecting had occurred at Ponape (Christian, 1899, p. 133; Matsumura, 1918; Hambruch, 1936), and in the southern Marianas (Thompson, 1932).

² A smaller collection is in the M. H. De Young Memorial Museum in San Francisco (on loan to California Academy of Sciences).

ware (1957, p. 174), as well as a few stone and shell adzes. The later phase, the Latte phase (Spoehr, 1957, p. 171), was characterized by the presence of stone house pilings called *latte* and the pottery of the later horizons called Marianas Plain, Trilled, Cordmarked, and Fine Line Incised, as well as various stone tools, shell ornaments, fishing equipment, etc. Within the Late period Spoehr was able to demonstrate further temporal differences based on a pottery seriation of rim shapes of Marianas Plain ware. On this basis a tentative temporal sequence of the sites was constructed. The basic temporal distinction found between Marianas Plain ware and the Marianas Red ware was later verified by separate excavations carried out by Father Pellett on the island of Tinian at the House of Taga Site (Pellett and Spoehr, 1961).

In addition to the artifacts, Spoehr recovered midden remains which included shellfish,¹ animal bone, and fishbone. Thirty-seven genera of shell are listed (52 species). The largest number of species found from a single site are the 24 from Objan; the smallest number are the 8 species listed for Chalan Kija. The other midden remains were relatively few and the relevant paragraphs are quoted

Unworked animal bones, including remains of dogs and pigs, were found in the excavations. The Chamorros at the time of discovery were reported to be without either dogs or pigs, which is highly unusual for an Oceanic people. Unfortunately, all the dog and pig finds listed below occurred less than six inches below the surface, so the probability that these may represent modern intrusions cannot be excluded.

Specimens and Provenience—Humerus, tibia, radius, fragment of scapula, astragalus, and tooth of young pig (Objan, Level 1, Saipan); fragment of pig tusk (Chalan Piao, surface, Saipan); femur of young carnivore, probably a dog (Objan, Level 1, Saipan); canine tooth of dog (Laulau Rock Shelter, Level 1, Saipan); vertebra of seal (Blue 1, Level 1, Tinian); three fragments of turtle plastron (Objan, Level 4, Saipan). . . .

Most of the remains of fish found in the excavations were teeth, mandibles, and maxillas of parrot fish. According to Loren P. Woods, Curator of Fishes at Chicago Natural History Museum, at least three species of *Callydon* are represented, but they are so fragmentary that specific identification is not possible. Parrot fish teeth may well have been used as cutting and scratching tools. Provenience of parrot fish bones: Objan (XX' profile, Levels 2, 4, 5); Blue I (Levels 1-5).

Vertebra of marlin (*Makaira*) were found at Objan (Level 1) and one tip of the spear of what is probably *Makaira* was also found at Objan (Level 6). A fragment of the ramus of a sparid, probably *Monotaxis*, was found at Laulau House A (Level 1). The hypural vertebra of a scombid, a tuna, or possibly a young sailfish were found at Objan (XX' profile). A tooth plate of the spiny puffer *Diodon*, probably *hispidus*, was recovered from Level 6 at Taga. In addition, a miscellaneous collection of fish vertebrae, too fragmentary to be identified, was found at virtually all the excavated

¹ A table of unworked shells found in the excavated sites is given in Spoehr, 1957, pp. 162-63.

sites. A large deposit of fish scales was found at the very bottom of Test A, Blue I. (Spoehr, 1957, p. 164)

Although the midden remains are few, some ideas about them may be tentatively advanced. The absence of pig, dog, and, apparently, the chicken from all but the top levels of the sites would seem to indicate that these animals were relatively unimportant as sources of food in the prehistoric period. A single fragment of turtle plastron came from the lower levels of Objan. The presence of marlin remains in the uppermost and middle levels of the occupation of the Objan site is also important, for it indicates that this pelagic species was probably taken throughout the Latte occupation of the site.¹ The other fish remains indicate that reef species (esp. *Callydon* and *Diodon*) were also taken and used for food. There is very little that can be said about the shellfish remains, since no data are given other than their presence or absence from the sites. It is significant, I think, that they are noted in all of the sites, and fishbone "was found at virtually all of the excavated sites" (Spoehr, 1957, p. 165). This indicates a continued reliance on these resources throughout the Latte period.² The absence of the pig and dog at the time of historic contact would seem to allow us to infer that mollusks and fish were probably the most important source of protein in the native diet.

Fishing equipment is known from excavations in the southern Marianas. Both Hornbostel (Thompson, 1932) and Spoehr record the finding of fishhooks: these are simple one-piece hooks and apparently a single specimen of a composite hook shank. In addition, gorges and sinkers of various types are recorded. Thompson records the finding of over 100 fishing implements from this area: 38 hooks, 33 gorges (mostly right-angled), and 43 sinkers. Spoehr's excavation produced basically the same types of objects, with the exception of the composite hook, but fewer in number.³ These hooks are J-shaped one-piece hooks with a grooved shank for securing the line (1957, p. 159, fig. 85).

Yap

This island was the third of Gifford's Pacific expeditions and was chosen by him because of its geographical position "near the western edge of Micronesia," making it important for understanding the prehistory of Oceania, "for it lies in the path of the eastward movement of

¹ Spoehr has characterized this site as unknown in the length of its occupation, but ranging from a pre-Latte period to historical time (1957, p. 170).

² Little is known of the resources of the pre-Latte phase. Sea urchin spines, bone, and shells are known from the earliest levels of occupation (Pellett and Spoehr, 1961, p. 324).

³ 11 sinkers, 3 hooks, 5 gorges.

peoples from Malaysia into Micronesia and Polynesia" (Gifford and Gifford, 1949, p. 149). As with his previous work in New Caledonia and Fiji, a number of sites were investigated and of these, five of the most promising were excavated: three on the east coast (Pemrang, Ruuway, and Walgom) and two on the west coast (Boldanig-Wolom and Penin). A number of carbon dates and the evidence from the stratigraphy of the pottery indicate that probably more than one period of occupation occurred. The earliest levels (as indicated at Boldanig-Wolom and Pemrang) contain a type of pottery that has been identified as Marianas Plainware (Gifford and Gifford, 1959, p. 179), while the later levels contain a laminated ware that is identical with the type made in historic times. The stratigraphy is not clear-cut, however, since some of the sherds found could apparently be classified as either laminated or unlaminated (Gifford and Gifford, 1959, p. 179).

Other artifacts than pottery included shell adzes, knives, taro peelers, paring knives, scrapers, and various ornaments, all of shell. Gifford notes that shell tools preponderate over stone and feels that this "would seem to suggest that the Yapese ancestors arrived with a tradition of shell implements (1959, p. 185). One bone artifact, a single surface find of a stone adze, and a few other stone objects complete the artifact complement. No fishing equipment of any kind was found in any of the sites investigated, with the possible exception of some *Arca scapha* and *Cardium mindanense* shells which could be used as net sinkers. Gifford's Yapese crew, however, denied that they were used in this way (1959, p. 192). This absence of fishing equipment is somewhat strange in view of the relatively large amount of fishbone—an average of more than two grams per cubic foot—found in the sites (1959, p. 162).

Zoological specimens were also recovered in the excavations. According to Gifford (1959, p. 162), the only "domestic animal before the coming of Europeans seems to have been the chicken . . . [and] rats and flying foxes were apparently the only mammals in Yap." Fish bones and mollusks were also important, the latter being the most abundant life forms encountered in the excavations, with fish bones being the most abundant of the vertebrate remains (1959, p. 162). Only the site at Wolgom (where a taboo apparently forbade the eating of fish) did not produce some fish remains. The largest amounts of bone came from the site at Pemrang and the cookhouse site at Ruuway. Although the total weight of molluscan shell is not given, the samples had weights which ranged in size from none at all up to 307 grams per sample (57 per cent of a 540-

gram sample).¹ A comparison of the use of fish and mollusks (based on their respective weights in the middens) indicates that the Yapese used slightly less shellfish overall and slightly more fish than either the Fijians or the New Caledonians (Gifford and Gifford, 1959, pp. 161-62).

All of the species of fish which have been identified are common reef species. They are found throughout the occupation of the sites, indicating that both fish and mollusks were important from the earliest period of which we have evidence to the latest. The absence of fishing equipment is more puzzling and would seem to indicate that fishing with the use of fishhooks was not as important in the early periods as it was to become by the time of European contact when hooks made of turtle shell and other materials are recorded (Müller, 1917, pp. 72-73; Anell, 1955, pp. 92-93, fig. 4, nos. 17-19). The presence of turtle shell in the lowest levels of the earliest site at Pemrang (Gifford and Gifford, 1959, p. 162) is an indication that preservation is not a factor in their absence. It must be assumed that fishing was done with nets, traps, and non-preservable equipment.

Summary

From this it can be seen that the data from Micronesia, though scanty and primarily confined to the western part, do indicate some slight differences in the utilization of the sea on Yap and in the Marianas. These differences are centered primarily on the presence of fishing equipment in the Marianas and its absence on Yap, as well as indications that fishing outside the limits of the reef may have occurred in the Marianas but apparently did not at Yap.²

Unfortunately, the data do not allow us to compare the amount of fishbone or molluscan shell in the two areas. However, the figures cited by the Giffords (1959, pp. 161-62) do suggest that fish and fishing were more important to the Yapese than they apparently were to either the New Caledonians or the Fijians.³ Apparently correlated with this is a

¹ It is impossible to translate this figure into weight per cubic foot, since the sample size is not indicated in any of the three reports where this sampling technique is utilized. If we can assume that the sample size was 4" x 4" x 6", then a cubic foot of midden produced up to better than five thousand grams of shell. The average was, of course, much less than this, somewhere around 500 grams per cubic foot.

² The remains of *Makaira*, a deep-water sailfish, were found in the middle and upper levels of the Objan site and may indicate that fishing outside the reef in relatively deep water was carried on. No comparable species are noted for Yap.

³ "A comparison of the occurrence of molluscan shell in samples of mound materials from . . . Fiji, New Caledonia, and Yap is interesting. The averages for the . . . regions, in terms of percentages of total weight, are as follows: . . . Fiji 13 per cent . . . New Caledonia 9 per cent . . . Yap 4 per cent . . ." (1959, p. 161).

"The 1809 cubic feet of deposit yielded 4,053.3 gm. of fish remains, averaging more than 2 gm. per cubic foot. A comparison of these figures with the data from Viti Levu (slightly more than 1 gm. of fish remains per cu. ft. of deposit) and New Caledonia (about $\frac{3}{4}$ gm. per cu. ft.) indicates that the Yapese depended more than the Fijians and New Caledonians on fish for food." (1959, p. 162)

drop in the amount of shell remains found in the Yapese middens.¹ This is the reverse of the proportions of shell and fishbone in the middens of Melanesia. This pattern of increasing amount of fishbone and decreasing amounts of molluscan shell in midden analysis has been noted for California shell middens (Reinman, 1964), and also occurs in middens on Okinawa (Meighan, personal communication). Assuming that the total exploitation of resources has remained relatively constant, this relationship in the proportions of molluscan shell and fishbone in the samples would indicate that fish and fishing were more important to the Micronesians than the Melanesians.²

Polynesian Archaeology

Introduction

Perhaps the best known area in Oceania, both ethnographically and archaeologically, is Polynesia. Much of the early interest in this area stems from the efforts of the Bernice P. Bishop Museum (founded in 1889) and its sponsorship of many of the early explorations of the various island groups for the purposes of collecting data for that institution. The result of these explorations was a series of publications, beginning with an eight-volume catalog of the Museum's collections prepared by Wm. T. Brigham in 1892-93, and continuing to the present day. Many of these early investigations concerned with the archaeology of the islands were basically surveys of the ruins of surface structures.

Prior to World War II, archaeology involving the actual excavation of sites was rarely done. Instances are known from Hawaii (McAllister, 1933b, pp. 13-18), Tonga (McKern, 1929), and New Zealand (Downes, 1932; Teviotdale, 1932, 1937, 1938, 1939; Fairfield, 1933; Lockerbie, 1940). Many of these reports not only describe the artifacts recovered but also indicate the presence or absence of stratigraphy and often include identifications of shellfish (Lockerbie, 1940, p. 407).

Since World War II Polynesia, like the rest of Oceania, has seen a spurt in archaeological activity. Recent work in the Hawaiian Islands (Emory, Bonk and Sinoto, 1959; Emory and Sinoto, 1961; Radiocarbon Supplement, 1963), the Marquesas (Suggs, 1961), the Society Islands

¹ In part this may result from the Yapese women's apparent lack of interest in shellfish gathering (Gifford and Gifford, 1959, p. 161).

² This is not to assert that fishing and the use of fish as a food source were necessarily replacing the use of shellfish, but that, as suggested earlier in our discussion of fishhooks, fishing—especially with hooks—indicates an increasingly greater exploitation of the potential resources of this particular aspect of the environment. This increase in the total amount of food available would therefore be expected to be reflected in the midden remains. Unfortunately, no hooks come from the Yapese sites, while in the Marianas hooks are present but no data for the amounts of shellfish and fish remains.

(Green, 1961; Emory, 1963), Tonga and Samoa (Golson, 1962), Easter Island (Heyerdahl, 1961), and in New Zealand (Adkin, 1948, 1950; Lock-
erbie, 1953; Trotter, 1955; Duff, 1956; Golson, 1959; and others) has
resulted in many new ideas and theories about the Polynesians and their
prehistory.

Society Islands

Work by Emory and Sinoto in 1963 uncovered burials on the island of
Maupiti. Associated with these were fishhooks said to have "coincided
in their specialized forms with those of the Moa Hunters of Wairan in the
South Island of New Zealand" (Emory, 1963, p. 96), and with those from
a site on Fanning Island (Emory and Sinoto, 1964, p. 152). Trolling hook
points and a single one-piece pearl shell hook were also found and exhibit
relationships with other early sites in Polynesia (1964, p. 152).

Hawaii

In 1959 Emory, Bonk, and Sinoto published a monograph in which the
archaeology of the Hawaiian Islands was reviewed (1959, pp. 3-7). To
date, 33 sites have been scientifically excavated: Kauai (1), Oahu (4),
Molokai (8), Lanai (1), Kahoolawe (1), and Hawaii (18). This publica-
tion is primarily concerned with fishhooks and fishing equipment and none
of the excavations are described. Since 1959, Emory has also excavated a
site on the island of Maui for which a carbon date of 200 ± 150 B.P.
(1757 A.D.: M-1184) has been obtained, but the work is undescribed
(Radiocarbon Supplement, 1962, 4, p. 201).

The second monograph in the series¹ was concerned with "the excava-
tion of four natural shelters on Oahu . . ." (Emory and Sinoto, 1961, p. 3),
and gives us our first relatively complete data on the sites. After the intro-
duction, each of the four shelters is covered and the contents of the midden
are described and artifacts noted. Only two of the excavations offer us a
statistical analysis of the midden content² and for Kuliouou and Makani-
olu shelters the amounts of midden refuse in selected squares of the excava-
tion are presented. Of the four sites, two were apparently fishermen's
shelters (Kuliouou and Hanauma shelters), while Makaniolu and Kaweki-
u were not so used (Emory and Sinoto, 1961, p. 53). Nevertheless, all four
shelters produced ample evidence of a utilization of shellfish, fish, pig, dog
and chicken.

¹ This series is entitled *Hawaiian Archeology*. Volume 1 was subtitled *Fishhooks*
(1959) and the second volume was *Oahu Excavations* (1961).

² Shellfish are identified, but no fish remains are.

Tables 1 (p. 17) and 2 (p. 28) in Emory and Sinoto's 1961 text give the analysis of the midden samples. Table 1 is on Kuliouou Shelter.¹ The remains of fish, shellfish, crustacea, animal and bird bone all were found. With the exception of animal bone, all were found in every level.² Fishbone remains were not identified, so inferences about the species cannot be made. The weight of the fish remains is about 3.1 grams per cubic foot of midden in the sample. Table 2 for Makaniolu shelter, on the other hand, indicates that 18.9 grams of fishbone for each cubic foot of midden of sample was recovered there.³ In Kiliouou shelter there is considerably more shell per cubic foot of midden than either fishbone or animal bone. On the other hand, Makaniolu shelter contained relatively few shells, and the weight of animal and fishbone exceeded the shell weight (Emory and Sinoto, 1961, Table 2, p. 28).

The artifact material contains a large portion of fishing equipment. Tools directly related to fishing, including sinkers, files for the manufacture of fishhooks, hook blanks, and fishhooks and gorges, comprised more than 30 per cent of the artifact complement.⁴ Better than 10 per cent of these artifacts were fishhooks. This interest in fishing, inferred from the artifacts related to it, is true of the whole Hawaiian chain.⁵

Since very little else has been published on the midden materials, we cannot make comparisons between sites. Most of the published material

¹ "Squares D6 and D7 were selected for a detailed analysis of floor content. Unfortunately, the amount of material at 6-inch levels was probably subnormal because of a large boulder which intruded. . . . Charcoal . . . yielded a radiocarbon date of A.D. 1004 plus or minus 180 years (Chicago C550). Charcoal gathered between 18 and 24 inches in D7 gave a radiocarbon date of only A.D. 1739 plus or minus 150 years, or a maximum age of A.D. 1589 (Michigan M564). This indicates a rapid rate of deposition in the last few centuries." (Emory and Sinoto, 1961, p. 15)

² The dog seems to have been present throughout the shelter's history despite its absence in the samples (Emory and Sinoto, 1961, p. 17).

³ This despite the classification of Makaniolu as primarily a non-fishing shelter. Better preservation is undoubtedly a factor in the overall figures. Both sites are rock shelters and we must assume that preservation of remains would be greater than in an open site. These weights are considerably above those for either Micronesia or Melanesia, indicating an average of about 6 grams per cu. ft. of midden.

⁴ The following have been included in the computation: 95 hooks, 21 hook blanks, 7 gorges, 140 files and saws, 6 octopus hook sinkers, 2 cowry shell lures, 6 line sinkers and 6 line and net floats. In addition, fragments of fishing nets were recovered from Kiliouou Shelter. The total artifact number was 937 objects and of these 283 were directly relatable to fishing equipment.

⁵ Based on figures from the earlier publication which deals with fishhooks only, and "is a classification and description of 4,159 fishhook specimens from the 33 excavations shown on the map . . . [of the Hawaiian Islands]" (Emory, 1959, p. 3). This is slightly more than 126 hooks per site, and illustrates one of the differences among site remains in Polynesia and other areas. The large number of hooks recovered from the sites indicates widespread interest on the part of the Polynesian in fishing and the resources of the sea, prior to the advent of Europeans.

relates to fishhooks, and both Emory (1959) and Sinoto (1962) have published site seriations based on hook and head form.¹

In summary, in the Hawaiian chain the remains of fishhooks and other fishing equipment, and the presence of fishbone and shellfish in the middens are evidence of the persistence of the use of the sea as a means of subsistence from the earliest periods known. Undoubtedly, more archaeological effort, especially in midden analysis, will enable much sharper conclusions to be made about the specifics of particular local adaptations. It should be clear, however, that the sea and especially fishing, was of great importance as a source of protein.

New Zealand

At the other end of the Polynesian triangle is New Zealand. Perhaps more digging has been done here than in any other area of Polynesia, but despite this there are apparently no published accounts of an analysis of midden constituents which can provide us with statistical data on the frequency and weight of food remains. Many of the reports contain an enumeration of the remains—often in the form of a list beginning with the most prevalent kinds to the least so²—but these cannot be used except to make statements about the presence or absence of shellfish in the diet.

A recent summary of the prehistory of the area was made by Golson (1959) which incorporates much of an earlier work by Duff (1956). Golson distinguishes two phases in New Zealand's prehistory: (1) the Archaic phase (dated to around 1200–1350 A.D. but probably beginning somewhat earlier), and (2) the Classic Maori phase. Drawing heavily upon Duff's earlier publication dealing with the Moa-hunters, Golson distinguishes between the two phases in terms of what is presently known of the artifact assemblage of each, and the inferences that may be drawn about the two phases from these assemblages.

More is common to the phases differentiated than would appear from the trait lists themselves since these have concentrated on the more distinctive items. Thus the use of the earth oven and the possession of the dog are attested for both. In the trait

¹ The earliest types of two-piece hooks show notched points and come from a dated site in Hawaii and are dated from A.D. 124 to about A.D. 1230 (Emory, Bonk, and Sinoto, 1959, p. 43). The later types have knobbed points and begin about 1230 A.D. and continue up to contact as the most popular form. Apparently the one-piece hooks show considerably less change in their form (Emory, Bonk, and Sinoto, see fig. 24, p. 42) on Hawaii. On the other hand, Sinoto, using the head form of one-piece hooks was able to demonstrate changes in the preference of the line attachment over time for a number of sites (notched heads decreased in popularity over time and knobbed heads increased in popularity) (Sinoto, 1962, p. 164). It also partially verifies the early date for Site H1 on Hawaii of 124 A.D. and indicates that the use of hooks has been consistent for at least this period of time in the Hawaiian archipelago.

² This evaluation is often a visual one, made by the excavator, rather than on the basis of excavated samples.

lists themselves the following implements are referable with certainty to both phases: needles, bone awls, tatooing chisels, round sectioned woodworking chisels, bird spears, *unbarbed one-piece fishhooks with incurved point, barracouta points* and cloak pins, *though neither of the last two is common in the Archaic.* (*Italics mine*; Golson, 1959, p. 62)

There is as yet no evidence for the presence of agriculture in the Archaic. Duff feels that the location of the camps (near the seaside at the mouth of a river) "makes it certain that they (the Moa-hunters) had no cultivated food; of domesticated animals they possessed only the dog whose bones are plentiful in the middens" (1956, p. 11). Golson (1959, p. 44) objects to this as indefensible since many of the sites used by Duff to reach this conclusion are outside the limits of agriculture or in marginal regions, as well as the fact that most of the tools utilized in Polynesian agriculture are wood and would not be preserved.

Very real differences do exist in the two phases, however: the absence of weapons of the *patu* type in the Archaic, changes in the adze types, changes in the types of ornaments, and changes in the fishing gear (Golson, 1959, p. 63). These latter changes include:

- (a) the appearance of the barb on some one-piece bait hooks;
- (b) the appearance of—or at least a tremendous growth in popularity of—the composite¹ bait hook with barbed point;
- (c) the replacement of the minnow lure hook, in the North Island, by the *kahawai* lure² (Golson, 1959, p. 62).

The new elements found in the Classic phase have Polynesian or general Oceanic relatives, except for those said to be unique to New Zealand (1959, p. 63). The fishing implements are seen to be part of the developments that took place in Polynesia rather than elsewhere, except for the *kahawai* lure which is apparently an indigenous development in the North Island (1959, p. 64).

In summary, the New Zealand evidence indicates that the sea was a gradually increasing factor in the economy. Although no published accounts of food remains in stratigraphic context were found, a number of accounts list the types of food remains so common to these sites. In early sites in the south island,

the Moa-hunter's diet consisted principally of moa flesh, with some seal, whale, fish, and bush and shore birds. Few shell-fish were eaten . . . [and] plant foods were no doubt consumed. . . . (Lockerbie, 1959, p. 82)

By A.D. 1450, the Moa was becoming less plentiful . . . and greater quantities of fish and shell-fish were being consumed. . . . By A.D. 1660, the moa had become very

¹ Called a simple hook, compound form on basis of function by Anell (1955, p. 110).

² The *kahawai* lure is a spinner hook with a lure of paua (*Halotis*) shell inlaid on a wooden back or shank and having a barbed point.

scarce . . . the moa hunter's diet consisting principally of shell-fish, fish, seal and small birds. (Lockerbie, 1959, p. 84)

On the North Island, shell middens which contain, in many cases, stone and obsidian, fishhooks, fish and bird bones (occasionally), and other kinds of shell, bone and stone artifacts are also well known (Adkin, 1948, p. 44), and we must assume that the adaptation was similar to that on the South Island, including the association of man and the Moa. During the later stages of the Archaic phase presumably the reliance on the sea for food increased as the Moa decreased, and continued, into the Classic Maori phase. The increase in hook varieties and numbers also suggests that there was more concentration on fishing.

Easter Island

Like New Zealand, Easter Island has been the subject of relatively recent archaeological investigation, but to date no detailed analysis of the middens of any of the habitation sites has been published. The recent work by the Norwegian Archaeological Expedition (Heyerdahl, *et al.*, 1961), notes the presence of fishing equipment in the habitation sites (Section II: Dwelling sites) and the presence of shellfish and fish remains in the middens. Two habitation caves investigated by C. Smith were found to contain two cultural horizons with the upper and later horizon containing shank barbed fishhooks, whereas the lower and earlier level contained unbarbed simple fishhooks. In addition:

The refuse indicates a diet of fish, shellfish, sea birds, and possibly human flesh throughout the occupation of the site, no wild or cultivated plant remains were preserved. The chicken may be present, but no bones identifiable as pig or sheep were found. (Heyerdahl *et al.*, 1961, p. 269)

Other excavations also produced evidence of the use of the sea as a source of food (see Heyerdahl *et al.*, 1961, Section II, pp. 257-338).

Fishhooks were a small but persistent part of the artifact complement excavated from these sites. In the two habitation caves excavated by Smith they formed slightly more than one percent of the artifacts in one cave (O-hae cave, Table 2, p. 270) and slightly less than five percent in the other (Puapau cave, Table 1, p. 270). At the Maunga Auhepa House site they made up less than one percent of the total, and at the Tupa of Hiramoko done by William Mulloy, they made up slightly more than six percent of the artifact total (table on page 327). From this latter site the faunal remains were also identified and different species in each of two levels given without any indication of relative amounts to be found in those levels:

The midden deposits also included a number of bones of mammals, fishes, and birds, as well as a variety of mollusks. The fish, bird, and some mammal bones were identi-

fied. Other mammal bones as well as the mollusks remain unidentified.

Human, pig, and sheep bones were present in the Upper Level, and human bones in the lower. The only identifiable bird bones were domestic fowl, *Gallus gallus*, which occurred in both levels. Among fish bones present in the Upper Level were *Serranidae*—close to *Acanthistius* or *Trachypoma*, *Labridae*, *Ostraciidae*, and Balastoid fish—probably *Monacanthidae*, *Serranidae*. In the Lower Level were *Serranidae* probably *Trachypoma macracanthum*, *Serranidae*, *Labridae*, Balastoid fish probably *Balistidae*, probably *Holocentridae*, probably *Belonidae*, *Scorpaenidae*, *Holocentridae*, probably *Charachrinidae*, and shark" (Heyerdahl *et al.*, 1961, p. 327).

From these facts it can be seen that, with the possible exception of the sharks and *Serranidae*, all of the identifiable groups recovered are shore and reef dwelling species; none is pelagic. This would seem to indicate that fishing was confined to inshore areas rather than the open sea at the period that these sites were occupied. That fishing was of somewhat lesser importance here than elsewhere in Polynesia is also suggested by the lesser numbers of fishhooks found in the middens.¹

The Marquesas

Excavations in the Marquesas Islands were carried out by Shapiro and Suggs in 1956 and 1957–58 (Suggs, 1961, p. 5). The results of this work have been thoroughly reported by Suggs (1961), who has interpreted the Marquesan occupation sequence as having a number of periods. These range in date from 150 B.C. (Settlement Period) up through the Historic period (beginning in 1790 A.D.). The beginning date for the Settlement Period is based on radiocarbon dates obtained for NHaa 1 (2080±150 to 1910±180 years prior to 1956), while the period name comes from the fact that no other material found seems to be as early as that from this site. Suggs places this site in his Settlement Period and believes

that the site is one of the first to be occupied on Nuku Hiva: indeed it may have been settled by some of the discoverers of the archipelago. (1961, p. 174)

These settlers originated in Western Polynesia and they carried with them a material culture characterized by a preponderance of Western Polynesian and Melanesian traits . . . [which may] . . . actually be remnants from a common early Melanesian Polynesian heritage. (1961, p. 180)

Remains of pig, dog and chicken from NHaa 1 indicate "that the Marquesans brought these animals with them in their migration from the west . . ." (1961, p. 195). In addition, the remains of fish and shellfish were also found in all of the coastal sites, further evidence of a reliance on the sea for part of their subsistence.

¹ Surface collecting produced additional specimens of stone (3 complete, 20 fragments, and 14 unfinished hooks), and bone (33 complete and fragmentary hooks—22 of these one piece—and 1 incomplete hook) fishhooks, for a total of 83 hooks; 12 of which were from the excavation. Figures taken from Heyerdahl *et al.*, 1961, p. 417 and p. 427.

As with other Polynesian sites, fishhooks were a prominent part of the remains recovered from the coastal sites. In all, over 250 one-piece and composite hooks of various types were recovered from the excavations, most being made from pearl shell (1961, p. 86). Suggs also notes that

. . . the maritime-oriented Marquesans apparently failed to produce as many hooks as their Hawaiian relatives. . . in the Marquesas . . . extensive digging is necessary to amass a sample. The quantity of fish remains, however, indicates much fishing. (1961, p. 86)

His explanation for this is that either most of the hooks were made of wood and hence not preserved or that net fishing was more important in pre-historic times than it was at the time of contact; he leans to the latter view (1961, p. 86). He feels that the hooks closely resemble the Hawaiian and New Zealand hooks in some categories, but in general, “. . . there seems to be a greater-than-chance disparity between the total hook collections from those islands on the one hand and the Marquesas on the other” (1961, p. 89). One difference is the absence of two-piece bait hooks, which are common in other Polynesian collections, from the Marquesan material.

In summary, Suggs feels that the Marquesas were settled from Western Polynesia by a group carrying a number of Melanesian traits, which may be part of a common Polynesian-Melanesian culture, and that the site NHaa 1 fairly represents the culture at this early period. At this time, fishing and gathering of shellfish were important sources of food but the early tradition of hook fishing gradually gave way to a greater use of nets as the main catching device (1961, p. 86). Hook fishing remained part of the total picture, however.

Unfortunately, no data are given as to the kinds of fish remains in the various sites, the amount of midden excavated, or the total number of artifacts recovered. Nevertheless, it is apparent that the Marquesans, like other Polynesian peoples, were fishermen, and fishing formed an important source of protein.

Summary

Archaeological research in Polynesia indicates that the sea and its resources have always played an important part in the food-getting behavior of the settlers of this area. Almost all of the midden sites excavated to date contain both shellfish and fish, as well as fishing equipment comprised primarily of fishhooks of various kinds. Areas where these excavations have been carried out are Tonga and Samoa, New Zealand, the Hawaiian Islands, the Marquesas, Easter Island, and the Society Islands. Despite the relatively large number of excavations, only in the Hawaiian Islands do we have any published data on the midden remains which enable us

to evaluate the degree to which the various types of sea food resources were used. For two Hawaiian sites, an average of six grams of fishbone per cubic foot of midden was recovered (297.4 grams of fishbone in 49.5 cubic feet of midden), a figure that is somewhat higher than that found for middens in Micronesia or Melanesia. None of the reports identifies the species of fish found except for a single instance from Easter Island.

Perhaps the most significant characteristic—and the one best authenticated—is the abundance of fishhooks which are found in the archaeological sites of Polynesia. This is coupled with a general increase in the closely-allied equipment used for fishing, such as stone net and line sinkers, lure sinkers, files for use in the manufacture of fishhooks, as well as the many unfinished specimens of hooks. Whether or not this is an indication of greater efficiency in exploiting this aspect of their environment remains to be determined; however, it does indicate that in this region (excluding western Polynesia) the emphasis on fishing, especially with hooks, was greater than in other areas of Oceania.

In the western area—primarily Tonga and Samoa—we have a region within Polynesia in which fishhooks are relatively scarce, especially the simple hooks. Those we do have indicate an interest in surface fishing¹ and are known only from ethnographic collections.² As in Yap, in Micronesia and the Melanesian islands, this would seem to indicate that angling in general was of less interest prehistorically than after contact. The relatively complete lack of one- and two-piece simple hooks seems to indicate that subsurface fishing was never important in this area.

¹ Mostly compound spinner hooks, no one-piece or compound bait hooks.

² None has been excavated to date; however, a single specimen of a one-piece hook was "picked up from an eroded seabank in 1957" (Golson, 1962, p. 175) on Tonga.

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THE USE OF THE SEA IN OCEANIA

Introduction

In the preceding pages we have attempted to gather together the available data on the utilization of the resources of the sea by the peoples of Oceania. On the basis of the hypothesis that population movements were from the Asian mainland out into the Oceanic world, it was expected that evidence of increasing adaptation to the sea and marine resources as a result of increasingly restrictive possibilities for land-oriented subsistence activities would be found. The archaeological and ethnographic evidence for the use of the fishhook, the greater amount of fishing equipment in the archaeological sites the gradually increasing amounts of fish remains in the middens, as well as the increasing emphasis on fishing as an economic activity in the eastern and northern areas of Oceania tend to bear out our expectations.

Both ethnographic and archaeological literature were consulted to evaluate the methods employed in exploiting the sea and to determine the presence or absence of categories of maritime resources in the various island groups. Ethnographic data were surveyed for statements as to the part fishing played in the lives of the natives, as well as for data on the types of fishing equipment utilized. Archaeological data were reviewed for the analysis of midden remains, such as shellfish, fish, sea mammals, and turtle, and the relative amounts of these remains were taken to be an indication of the use of these resources. In addition, artifacts related to fishing, especially the fishhook but also sinkers of shell and stone, net weights, hook blanks, and other evidences of fishing equipment, were considered in order to differentiate two aspects of the exploitation of the sea which, from a technological point of view, seem important: surface fishing and sub-surface fishing.

The use of the fishhook as a normal part of the food quest has been interpreted as evidence for a more complete exploitation of the potential of the sea, and, within this class of objects, the simple one- and two-piece hook has been taken as an indication of the use of the sub-surface waters of the sea. Thus, when hooks, both simple and compound, are utilized

in addition to other kinds of fishing equipment, the potential returns with their use should be much greater than when they are not used.¹

Use of the Marine Environment

By the time of European contact it should be apparent that the use of the sea and its resources was important to most groups which had access to the coastal waters of nearly all of the occupied islands. Many kinds of shellfish and fish were utilized to supplement that part of the diet derived from other sources. Relatively large fish such as sharks, the *Ruvettus*, and schooling types like the bonito, were important in many areas. In addition to these larger types of the open and deep sea, a great number of smaller reef-dwelling fish were also used. Sea mammals such as the dugong, seal, and the occasional stranded whale, turtle, and porpoise were also taken and utilized. In general, fishing was man's work. Combing the reef flats and gathering shellfish was left to the women and young children. Community drives and fish poisonings, however, often found men, women and children working together to provide the fish needed for a feast or ceremonial affair.

The techniques employed in the taking of fish, shellfish, sea mammals and turtle appear to be, with few exceptions, nearly universal in their distribution in Oceania at the time of contact. These were: hand gathering of shellfish and small fish, spearing, netting, trapping (with a number of trap types), and angling with different kinds of hooks. The most important differences to be found in the ethnographic accounts were in the sporadic use of the harpoon, the absence of the use of the net in Torres Straits and among the Kawai peoples of New Guinea, and in the category of angling; few or no fishhooks (and the techniques associated with them) are used in some areas of Melanesia and Polynesia. Anell's intensive study of the ethnographic data on various forms of fishing equipment indicates that there is a rather sharp division between the Melanesian-Malaysian area, on the one hand, and the Micronesian-Polynesian region, on the other, in terms of the distribution of the fishing implements he investigated. The implements of the former area appear to have come from Southeast Asia while those of the latter area apparently originated in the Northeast Asian-Japanese culture area (1955, p. 247). An analysis

¹ This is not to be taken to mean that in actual returns, in any given area, the use of hooks and other devices will always yield more fish. For some areas, the potential is recognized to be much greater, and the actual returns from these well-endowed regions can be greater even without the use of fishhooks than that from a less well-endowed area being fully exploited. The advantage conveyed by a variety of equipment including fishhooks is that there is a greater degree of flexibility in the technology of this aspect of the economy, hence, a broader range of responses possible to changing conditions in the marine environment, as well as a broader utilization of the total environmental possibilities.

of the archaeological literature indicates that this dichotomy has general validity even in the prehistoric periods. Differences in the archaeological remains are noted in the apparent use and emphasis placed on marine resources in the mainland Asiatic and western Oceanic islands from that found in the southern and eastern regions. The most obvious difference in the technologies is in the category of fishhooks; hooks are scarce or unknown in the former regions and relatively common in the latter.

As the evidence now stands, with due allowances for the large and crucial gaps in the archaeological data, the Asian mainland and much of Malaysia provide few clues to anything but a hunting and gathering economy in the early periods. Of the scarce radiocarbon dates, the earliest are from Tabon and Duyong Caves in the Philippines and Niah Cave in Borneo. At this early time period, these localities represent the easternmost areas of settlement of the Asian land mass. The lowering of the sea level would have joined Borneo and Palawan to the Asian mainland as part of the Sunda Shelf since this pattern continues to the ethnographic present with decreasing emphasis on hunting and gathering as the result of increasing reliance upon horticulture. The gathering of shellfish and other products from the sea continues to be an important source of protein, and it is not until much later that some coastal groups became active sea fishers (see Dew, 1891; Brown, 1935; Firth, 1946).¹ The emphasis in this area at this later period appears to be upon netting and trapping, although there is some use of the metal fishhook. Classifications of the fishing gear and techniques for fishing clearly show the wide variety of implements and techniques associated with netting and trapping (Kesteven, 1949; Umali, 1950). The archaeological evidence, though by no means complete, indicates little or no sea fishing in this region. Only in Japan and on the Southeast China mainland is there evidence of a relatively great use of the sea as a food resource. In both these regions the remains of shellfish, fish, and fishing equipment are found.

The next area in which we have evidence for utilization of the sea is in eastern Melanesia on the islands of New Caledonia and Fiji, the western Polynesian islands of Tonga and Samoa, and the western Micronesian islands of Yap and the Marianas. In this area, according to the ethnographic data, the use of the fishhook is sporadically recorded, and is known from all of the islands mentioned. Not all categories of hooks are known from each group, however. Archaeologically, fishhooks are found only in New Caledonia, Fiji, and the Marianas Islands. None have

¹ According to Anell, to the best of his knowledge "no archaeological find of pre-metal hooks have been made in . . ." Indonesia and Southeast Asia (1955, p. 242).

been recorded as yet from western Polynesia.¹ The fishhooks from New Caledonia and Fiji are found in contexts which date them post-1000 A.D. and probably later. Other fishing equipment includes shell net sinkers from New Caledonia (Gifford and Shutler, 1956, p. 63), and stone octopus and net sinkers from Samoa (Green, 1964, p. 46). Only in the Marianas Islands of these island groups are there indications that fishing with the hook was of importance, and here, fishhooks, sinkers, and fish remains have all been recovered from the middens.

The middens in all of the islands and island groups mentioned above contain remains of fish and shellfish, which are evidence that fishing was supplying part of the protein requirements of the inhabitants. But in these middens on most of the groups the absence of remains of fishing equipment leaves the methods employed an open question. The lack of hooks archaeologically and ethnographically in all but the Marianas Islands would seem to indicate that techniques involving the use of hook and line were historically of little importance here. In this case, we must assume that the bulk of the fishing was done with nets, traps, and other surface-oriented equipment. The lack of deep sea species of fish in the midden remains from these areas (again, with the exception of the Marianas Islands) is a further argument against the use of offshore and sub-surface fishing techniques. Relative to each other, decreasing proportions of shellfish remains and increasing proportions of fishbone in the sites has been interpreted as indicating an increasing interest through time in the taking of fish for food.

In the rest of Polynesia the archaeological evidence indicates that fishing was an important part of the economic picture. Varying numbers and types of fishhooks are found in nearly all of the known sites, and Anell's work indicates that the ethnographic distribution of hooks is similar to that presented by the archaeology. Thus, simple hooks are well known except for the western Polynesian areas while the bonito spinner, apparently a unique Oceanic type, is unknown archaeologically and ethnographically in the southern Polynesian islands (Rapa, Easter, Manga-ruva, etc.). The distribution of wooden hooks (shark and ruvettus) is known only from ethnographic data. In addition, the remains of shellfish and fish in the middens also indicates a greater use of fish in the larger proportions of fishbone to shellfish than seen in the Melanesian and Micronesian sites.

On the basis of the implement distribution Anell has argued that Polynesian and Micronesian fishing implements are distinct from those found in Melanesia.

¹ With the exception of the single specimen noted by Golson (1962, p. 175).

The Melanesian implements did not occur in Polynesia in pre-European times. When they are found in westernmost Micronesia this is apparently due to late Indonesian influence. The Polynesian tackle on the other hand is often sporadically instanced from eastern Melanesia, introduced from Micronesia or West Polynesia. As a matter of fact, there exists, as regards the fishing implements, a very distinct border between the Melanesian and Polynesian culture and as an illustration of this one may mention that whereas most of the Melanesian tackle occur in the Solomons, the fishing equipment on the neighbouring Polynesian outliers is quite Polynesian (1955, p. 247).

Others have also considered the differences in this aspect of Polynesian culture as showing affiliation with the Northeast Asian area (Skinner, 1957; Heyerdahl, 1961; Parsonson, 1962). The distinct archaeological distribution of fishhooks in these two broad areas also suggests a more northerly and easterly origin and distribution of hook-fishing techniques. Further, if our distinction between the usage of surface and sub-surface areas as distinct zones of exploitation has any validity, then it also suggests that there was a greater exploitation of the potential of the marine environment in the Polynesian and northern Micronesian area.

The relationship between the use of fish and shellfish as food sources is also of interest in this context and should be further tested for validity in the field. In this paper, the relative proportions of each have been interpreted as indicating increasing and/or decreasing reliance upon the sea as a food source. From a technological point of view the gathering of shellfish requires little, if anything, in the way of equipment. It is the simplest and easiest form of maritime exploitation, and was probably the first historically. Since there are few technological requirements, it may be carried out relatively consistently as a supplement to other methods of subsistence.

In contrast, fishing, even without the use of boats, requires considerable technological know-how. Varied equipment and a knowledge of the habitat and habits of the quarry are necessary. Because of these technological requirements it is felt that an increased proportion of fishbone in the midden remains is indicative of increased activity in this sphere and increased interest in fishing as an occupation. That is, once the utilization of the sea had begun, increasing interest in it as a food source would have been generated as its reliability (less subject to natural disasters than land-oriented subsistence activities) would have been recognized. Once this potential was seen, the bulk of the improvements, from a technological point of view, must have been in the direction of securing fish rather than shellfish. The probable greater returns in weight and nutritional value¹

¹ See the article by Catala (1957, Table 15) for additional data on the amount of protein, calories, and fats per unit of weight in fish and shellfish.

must also have been a factor which helped to increase the effort employed in obtaining fish. In addition, it is probable that fish are less subject to overexploitation with primitive techniques than shellfish. The recognition of these factors involved the investment of more and more time in fishing as an occupation. It is at this point of increasing time, interest, and technological competence, when fishing stopped being simply an adjunct to the diet and became a focus of concern, that we have applied the concept of 'focus' to explain the increasing innovations that resulted.

The introduction and development of the fishhook into this sphere of activity further increased this process of innovation. It has already been pointed out that the use of the fishhook is an addition to other types of equipment which the primitive fisherman had at his disposal. The simple fact of additional equipment for this exploitation is part of the reason for considering its use as being indicative of fuller exploitation of the sea. Basically, however, it is its exploitation of the sub-surface regions of the sea that is the important factor. In addition, it is our unproven belief that many kinds of fish are types that can best (or perhaps only) be exploited by the use of the hook. Most of these are varieties found in the sub-surface zone. These would include many of the larger varieties of the Serranids and Carangids, as well as *Ruvettus* and *Promethichthys*. Some evidence for the effectiveness of angling as opposed to netting for certain types of fish has already been mentioned, and if this evidence is indicative, then it suggests that the larger fish may be more effectively taken with hook and line than with other types of gear.¹ The ability to exploit deeper waters, and so to take not only the larger fish but also fish outside the effective range of surface-oriented equipment, probably provided the impetus for making angling an important part of the sea-food quest. The subsequent amount of experimentation with baits, lure qualities, hook forms, angling depths, and other technological questions, must also have contributed greatly to and reflected the interest in fishing as a food-getting activity.

The result of this postulated cycle of activity, from an archaeological point of view, would be an increase in the artifacts associated with fishing, as well as an increase in the relative proportions of fish remains found in the middens of sites in these areas. Again, this is not to say that fishing supplanted shellfish gathering as an economic activity, but rather, that fishing became relatively more important. In all probability shellfish gathering continued to provide part of the dietary needs of the inhabitants; this was probably especially true in areas where the men engaged pri-

¹ This would be especially true of primitive gear since many of the modern mechanical aids to handling and hauling the heavy nets would not be available.

marily in horticulture and fished only as a dietary supplement. However, as more and more of the maritime subsistence activity came to be centered on fishing, it is to be expected that the relative proportion of fish to shellfish would show an increase of fish in the diet. This should also be reflected in the midden samples. The archaeologist is justified, I believe, in interpreting these changing relationships in terms of adaptation, provided the samples so interpreted are of sufficient time depth and are representative of the total subsistence activities of the group or groups under investigation.

The Fishhook in an Archaeological Context

Whether the hook was introduced into Oceania by migration or diffusion remains an unanswered question.¹ Regardless of how it occurred, its appearance resulted in an enlargement of the area of the marine habitat that could now be exploited for food, and by the time of European contact, fishing with the wide variety of techniques and equipment was a fully developed art and a major contributor to the subsistence of the inhabitants of the various island groups. The present evidence suggests that the introduction and subsequent development of the fishhook took place in the north, probably from the direction of Japan (Anell, 1955, p. 247). One possibility is a spread southward through the Bonin and Volcano Islands to the Marianas, then eastward through the Carolines to eastern and central Polynesia, thus bypassing Melanesia and western Polynesia. Another is a direct introduction to Hawaii and the rest of eastern Polynesia from the Japanese Islands.

Factors bearing on this problem are the following: the similarity of fishhook types in Polynesia and Japan,² the early date of the hooks in an archaeological context from Japan, where they are known prior to 2500 B.C.; and the fact that they are known archaeologically only from the northern areas of Oceania namely, Japan, the Marianas, the central Carolines, and eastern Polynesia.³ All of these factors may be adduced to show that their dispersal and development were confined to the northern and eastern Pacific regions.

¹ On the basis of the present evidence the introduction of the fishhook into Oceania seems more likely than its gradual development locally in response to increasing experimentation with fish and fishing. This does, however, remain a possibility.

² See Munro (1908), Groot (1951), Emory, Bonk, and Sinoto (1959), and Kidder (1959) for illustrations of the parallels in hook forms between Japan and Hawaii. The persistence of these hook types is also illustrated from Hawaii where the same forms are found from Early to Late in the sequence (Emory, Bonk, and Sinoto, 1959, p. 42, fig. 24).

³ The hooks from New Caledonia and Fiji are an exception.

The time of the introduction of the fishhook is also a matter of speculation. The earliest ones in the Pacific region come from Japan and California,¹ but in Oceania proper the earliest hooks, more than 2,000 years old, are apparently from the easternmost regions. Both Hawaii and the Marquesas Islands have produced hooks in a dated and sequential context that are as early or earlier than presently found anywhere else in Oceania.

The fact that no hooks are known from the Chalan Piao site on Saipan, which has a date of 1527 ± 250 years B.C., indicates an introduction into the Mariana Islands some time after this period. On the other hand, the presence of two-piece bait hooks, and the spinner hook in the earliest levels of the sites on Hawaii — types that probably developed en route to this area — argues for an introduction prior to the beginning of the Christian era. A date of about 1000 B.C. does not seem unreasonable on the basis of the above data. Further, the similarities of hook forms in the early Hawaii and Late Jomon sites can also be adduced as evidence for dispersal after the advent of this period of Japanese prehistory: 2000–250 B.C.

Fishhooks: Their Uses and Zones of Importance

Since fishhook remains are an important class of objects to the Pacific archaeologist, the kinds of hooks employed by the fisherman and the zones and levels they exploit are a necessary consideration. In the lagoon and the offshore areas fishhooks are employed in both the surface and sub-surface zones. A single form of lure hook, the Oceanic spinner, exploits the surface feeding habits of certain fish, while bait hooks of various kinds are used for bottom and midwater feeders. Within the latter group are a variety of hooks made of different materials and of different sizes and forms. Some appear rather generalized in their usage, being designed for the taking of a great variety of fish, while others, such as the shark and the ruvettus hook, were made with a specific type of fish in mind. The latter hook is the classic Oceanic example of a type designed for relatively deep water fishing. Its quarry is normally found ranging in depth from 80 to 400

¹ The resemblances between the California and Oceanic hooks apply primarily to the round shell-hooks. Anell explains these resemblances as being due to an early migration from northeast Asia, south to Japan and eastward across the Bering Strait, down the west coast of America (1955, p. 244). On the other hand, Meighan has recently suggested that if a historical connection exists between these two areas, the diffusion may have been from California to Oceania (1962, p. 4). This is based on the finding of shell-hooks in sites dated 4790 ± 90 years ago on Santa Rosa Island, California (Orr, 1962, p. 4). In discussing this, Heizer maintains that if this transference did occur, it may "not have been by human carriers or drift canoes, but could have been by live fish carrying hooks in their mouths" (Jennings and Norbeck, 1964, p. 124, footnote). He then cites a number of pelagic fish with a sufficient range to have carried the hooks from one area to another.

fathoms (Gudger, 1927, p. 331). Other forms and sizes of bait hooks are generally not used at these great depths but are designed to exploit intermediate levels, well below the relatively shallow areas of surface oriented equipment.

The most diverse class of hooks, the one- and two-piece bait hooks, may also be specialized to some degree toward different ecological zones, and further distinctions in the areas exploited and/or the kinds and sizes of fish taken by these hooks may ultimately be warranted. Although we are here entering an area of speculation, there is some evidence suggesting that perhaps the different shapes and sizes of this class of hooks has some significance in terms of the kind and size of the fish taken and do not just represent idiosyncratic behavior on the part of the makers. In addition to the differences in size and shape, the method of binding the line to the hook shank may also be significant. This latter difference is essentially the difference in the operation of our metal 'jabbing' hook and the Oceanic 'rotating' hook. In the European hooks, the line is affixed to the hook through an eye, while the Oceanic hook has the line bound to the inner portion of the shank in such a way as to cause the hook to rotate when tension is applied to the line. A paper by Nordhoff on the offshore fishing of the Society Islands describes the difference and notes that

... when the fisherman using a European hook 'gets a bite' he strikes to set the point and barb in the fish's mouth. With the native hook, on the other hand, one must never strike; a steady gentle tension is kept on the line and the fish allowed to hook itself. The pull of the line, leading from the inner head of the shank and causing the hook to revolve, sets the point deeper and deeper in the fish's jaw. (1930, p. 156)

As yet, we know too little about functional differences among the Oceanic hooks. A recent archaeological classification of hook types from Hawaii (Emory, Bonk and Sinoto, 1959) uses the terms 'jabbing' and 'rotating' to make distinctions between two hook forms, one an open, U-shaped hook and the other more or less circular with incurved point. Whether or not these terms are applicable to the way in which the hook is used is not clear from the classification. To the best of my knowledge, it is not known whether any Oceanic hooks were ever bound at any point other than to the inner head of the shank. On the other hand, Nordhoff's description implies a correlation between barbing and the method of fastening the line to the hook shank.

Actual tests of the various hook forms by investigators are relatively rare and the evidence for a functional differentiation of hook types is correspondingly scanty. A single series of tests suggests that one group of one-piece bait hooks, the circular shell hook, may have functioned best in a particular area of the sub-surface layer and against particular types of fish. Robinson (1942) caught 14 fish with hooks which he made from fresh

Haliotis shell. These were taken off the islands of Catalina and Anacapa just off the California coast and on the mainland at Point Mugu. He used a hand line and sinker and baited the hooks in the Oceanic way, leaving the point and the shank on the hook uncovered. Robinson found that

Species caught were mostly bottom-feeding varieties: rockfish, kelp bass, California halibut, sheepshead, and sculpin. With the small hook . . . I caught perch and a small kingfish. I found that every fish caught had worked the thin tissues at the side of its mouth through the clearance between the point and shank of the hook and that the pull of the line then rotated the hook and caused the point to slide through. A steady tension is kept on the line and the fish given time to hook itself. (1942, p. 63)

He also notes that once caught the fish has little chance to escape, and that it is this latter factor that strongly recommends the use of the circular hook. In addition, this experimental observation was verified by native Hawaiian fishermen who noted that "the white man's barbed hook will often slip or tear out of the flesh of soft-mouthed fish" (1942, p. 64). Another, and perhaps equally important advantage of the circular or incurved hook, is that it is less likely to be fouled on the bottom, since the point tip very closely approaches the shank leaving little room for it to hook obstructions and debris.

In this case, the results of the experiment indicate the effectiveness of the circular shell fishhook in taking soft-mouthed varieties of fish in this particular rocky-bottom and kelp-bed habitat. Other fishhook forms may also function best against specific groups of fish or in relatively limited segments of the habitat. If so, it is worth investigating whether or not the U- and V-shaped, one- and two-piece fishhooks are similarly oriented. A great deal more experimentation with these hooks needs to be carried out by the archaeologist before we can go much further with these ideas.

My own feeling is that the area of present speculation with potentially the greatest significance is that which explores the relationship between fishhook size and the range of the catch size. Since a major concern is the question of what the catch means in terms of food for the native population, some indication of the existence of a range of weight that could be correlated with the differences in hook form and size would be of great value in answering this question. A recent analysis of the fishhooks found archaeologically in the Hawaiian Islands indicates that statistically the points of the two-piece hooks tend to cluster around distinct sizes (Emory, Bonk and Sinoto, 1959, p. 16). According to the authors,

The points of two-piece hooks, on the basis of height alone, clearly fall into two distinct functional types. (1959, p. 18)

One-piece hooks show less variation. Unbarbed jabbing and rotating hooks of bone show a similar size range and mean length of the shank

(1959, p. 15, fig. 8). The subtype of barbed, rotating hooks, however, seems to show "a distribution norm of its own in terms of size" (1959, p. 14), but the sample was not large enough to make a test of this evaluation. The inference seems to be that the material is the governing factor, for the statement is made that "hooks made of bird bone, turtle shell, dog teeth, and metal each have their own appropriate sizes and proportions" (1959, p. 16). Table 1 (1959, p. 14) suggests, on the other hand, that the materials may not have been the sole factor, for among the jabbing hooks, those of bone and pearl shell have similar average shank lengths. The differences between the barbed and unbarbed forms also appear to be more distinct than those between the kinds of material from which they are made.

The available materials from which the fishhooks were constructed undoubtedly played a part in the ultimate hook size. But the fact that one-piece hooks of different sizes were made of the same materials and one-piece hooks of the same size from different materials suggests that the makers had an idea of the size of hook needed for the job envisioned, and that materials were selected to meet these needs. If we can assume that the size of the hook bears some relationship to the size of the fish which can be taken on it, this may be interpreted as an indication that the makers were producing hooks for fish of different sizes.

All of this implies a considerable knowledge of fish and fishing on the part of the Oceanic fisherman. As with the modern fisherman, he relied on his own experience, his inherited knowledge of the fish, the conditions of the sea and weather, and the skills he developed as a fisherman. According to Buck, the Hawaiian fisherman "knew the use of various types of hooks for different kinds of fish and the kind of bait best for each" (1957, p. 286). Further, the fisherman had to "know the character of the bottom of the sea both within and beyond the reef" and for him the sea was a "marine garden and was cultivated as assiduously as any area of dry land" (1957, p. 285). For the archaeologist who must work with the material remains of this knowledge and effort, the methods and techniques of the Oceanic fisherman need to become the basis for his inferential statements about this aspect of Oceanic economy. With this kind of knowledge, our statements about the material remains need no longer be simply confined to discussing the morphological characteristics of the various items, but we can view them in a functioning context. At this time we cannot be precise about some of the relationships I have discussed here; perhaps this will never be possible. These relationships comprise a potential but untouched area of investigation for the archaeologist.

In addition, considerably more information is needed on the ecological zonation of fish, especially those that frequent the offshore zones. Indications from the work of fish biologists on and within the confines of the island reefs are that fish do tend to exploit certain zones within the total environment. According to Harry's ichthyological survey of Raroia, the various marine zones into which he divided the atoll "are as clearly delimited ecologically as they are physically" (1953, p. 21). If this is true of the fauna on and near the reef, it may also be true of that in the deeper offshore region. Knowledge of this type can be of great help to the archaeologist in interpreting how island technology exploits these zones.

The Fishhook as an Adaptive Device

The addition of the fishhook to the technology of the fisherman, and the consequent greater potential exploitation of the marine environment enable the islanders to cope more successfully with this aspect of their economy, and to adjust to changes in the marine ecological conditions. Angling is not only additive in the sense that it increases the potential possibility for making a catch, but it also represents an alternative means of procuring a return from the sea. For example, on the high islands of the Hawaiian chain, during the rainy winter season, the inshore region was frequently covered with mud and silt as a result of outwash from the land. This made fishing in this zone impossible, and according to Buck, under these conditions, deep sea fishing outside the reefs became the only alternative (1957, p. 286). Other disturbances to the inshore region, such as occur in the typhoon season, often result in these areas being rendered temporarily unproductive as a result of wind and wave action. On the low atolls, much of the land productivity may also be made unusable at this time as a result of salt inundation. It is during these extreme periods that alternative methods of procuring food must have become very important. Fishing outside the heavily disturbed zones in the sub-surface levels of the sea would seem to be just such an alternative.

Ethnohistorical and ethnographic data also suggest that the inshore and lagoon regions, as well as specific kinds of fish, were subject to over-exploitation periodically from constant fishing and shellfish gathering. Occasionally they were tabooed until the fish and other sea foods had time to re-establish themselves. In Melanesia, for example, are found references without explanation to the tabooing of foods and fishing grounds (Gunn, 1914, p. 213; Fox, C. E., 1924, p. 297; Ivens, 1927, p. 253; Bogesi, 1948, p. 218). That conservation of the food supply was one of the reasons for so doing is indicated by Ivens who says that fishing grounds were tabooed "with a view to the increase of the fish there. . . ." (1930, p. 238). In Polynesia, the use of the taboo as a means of preventing the overex-

plotation of fishing resources was also well known: Hawaii (Bishop, 1940, p. 41; Buck, 1957, p. 357; Titcomb, 1952, p. 13), Tahiti (Wilson, 1799, p. 323), Easter Island (Metreaux, 1940, p. 173), Mangareva (Buck, 1938, p. 302), Pukapuka (Beaglehole, 1938, p. 33), Mangaia (Buck, 1934, p. 118), Manihiki and Rakahanga (Buck, 1932a, p. 91), and Tonga (Mariner, 1818, 1, p. 112). Similar uses must have been found in Micronesia as well, but references to conservation are scarce. Burrows and Spiro do note that on Ifaluk, in times of scarcity, the population was admonished by their chiefs to "only eat a little" of the scarce food (1953, p. 188). Perhaps the best statement on the conservation of sea resources is quoted by Titcomb about the rules found in the Ka'u district of the island of Hawaii

There was never a time when all fishing was tabu. When inshore fishing was tabu, deep sea fishing (lawai'a-o-kai-uli) was permitted, and vice versa. Summer was the time when fish were most abundant and therefore the permitted time for inshore fishing. Salt was gathered at this time, also, and large quantities of fish were dried. Inland crops were tilled, and supplies from the higher lands procured. In winter, deep sea fishing was permitted, and the sweet potatoes that grew in large patches near the shore were cultivated. A tabu for the inshore fishing covered also all the growths in that area, the seaweeds, and shellfish as well as the fish. (1952, p. 14)

The importance of knowing alternative methods of procuring fish under this system is fairly obvious.

Conservation of Sea Foods

Methods of conservation other than alternating the area of usage were also practiced in the Oceanic area. Fish ponds and traps are widely used to maintain a fish or turtle crop until needed or until they reach the desired size. The references to the raising of some kinds of fish in fresh and salt water ponds are numerous and come from eastern Melanesia in the Loyalty group (Hadfield, 1920, p. 90) and the Lau group in Fiji (Thompson, 1940, pp. 136, 141-42) and throughout much of Polynesia. In this latter area they are best known from the Hawaiian Islands (Ellis, 1831, 1, p. 138; Bennett, 1931, p. 24; Coulter, 1931, p. 9; McAllister, 1933, p. 28; Titcomb, 1952, p. 6). They are also found on Tongareva (Buck, 1932b, p. 107), Tahiti (Henry, 1928, p. 281), and Pukapuka (Beaglehole, 1938, p. 33). On New Zealand, Adkin reports that eels were stored in ponds (1948, p. 19), and Buck notes that on Mangareva turtles were stored in ponds, but "fish ponds for breeding fish were unknown" (1938, p. 300). According to Landtman, shellfish and crabs were also kept alive by the people of the Kawai Delta by being covered with mud in baskets (1927, p. 145). In addition to ponds, taro fields also provided an area in which shrimp and small fish were kept.

Preservation methods were also known and applied as a means of making the food supply somewhat independent of (1) the vagaries of the weather which might prevent the use of the sea for fishing; (2) the movements and natural cycles of fish breeding, and (3) the movements of the more important schooling fish. Basically, three methods were used: sun drying, smoking, and salting. Sun drying involved splitting or stringing the fish and exposing them to the sun on racks or stones until they were sufficiently dried to keep. Frequently they were cooked prior to drying. This method was said to preserve them for as little as a few days to as long as a month. On Pukapuka (Beaglehole, 1938, p. 105) and in the Tokelaus (MacGregor, 1937, p. 150) they are said to last indefinitely after cooking and sun drying. In Hawaii, according to Titcomb, there were two stages and hence two kinds of dried fish: partly dried for keeping a short time and well dried for keeping a long time (1952, p. 22).

Smoking was another method of preserving part of a good catch of fish. The fish were generally split and placed on racks above a small fire. After a few days of smoking they are said to keep from one month (Burrows, 1936, p. 138) to several months (Thompson, 1859, p. 153). The use of smoking as a means of preserving the fish is particularly widespread and was noted by Wilson in the Palaus (Keate, 1788, p. 190), on Ifalik (Bates and Abbott, 1958, p. 74), New Guinea (Held, 1957, p. 345), the Nicobar Islands (Man, n.d., p. 114), the Solomons (Blackwood, 1935, p. 286), and on Futuna (Burrows, 1936, p. 138). In the Torres Straits, pieces of dugong meat "are smoked making a fairly good bacon. . . ." (Haddon, 1912, p. 137).

The use of salt to preserve fish was also practiced in Oceania, especially in Polynesia. Captain Cook makes several references to this practice among the Hawaiians shortly after their discovery in 1778 (Cook, 6, 1821, p. 216). According to Titcomb, in Hawaii fish were salted to varying degrees and the process took from a few hours to around three days, depending on the size of the fish (1952, p. 23). Salt was rubbed into the fish or the fish was allowed to soak in a salt brine. Sun drying was frequently combined with this. Large pieces of fish were cut up, gashed and rubbed with salt, allowed to soak in brine for a few days, and then sun dried. Fish so treated kept for two or three years in a dry place (Titcomb, 1952, p. 23). Combinations of salting, soaking in brine, and sun drying were also used on Tubuai (Aitken, 1930, p. 42) and New Zealand (Thompson, 1859, p. 153), and are now in use on Tonga (Vaea and Straatmans, 1954, p. 214), and in both the Gilbert and Ellice Islands (Turbott, 1950, p. 349).

These scattered references suggest that the knowledge of preservation techniques, especially in the islands of Polynesia, was adequate and capable of providing for the keeping of excess amounts of sea foods. This skill, the recognition of the need for conservation of the resources through alternating the areas exploited, and the raising of fish through a system of ponding, all indicate a considerable appreciation for and concern with this aspect of the economy.

Angling with the fishhook appears to have been an important feature of this more successful use of the sea by Oceanic peoples. It may be, as has been asserted for the California islands by Meighan (1962, p. 4), that the use of the fishhook is an indication of a primary dependence on fishing as an economic activity. Although archaeology is only beginning in the Pacific Islands and many areas have yet to be investigated, work already done suggests that many of the Oceanic areas did not make use of the hook as part of their technology. In others, only the simplest and most rudimentary forms were known. Reviewing the distribution of the present evidence for the use of the maritime environment seems to indicate an increasing usage of its products from Southeast Asia through the Melanesian area and into Polynesia. The fishhook appears not to have been part of the early use of the sea in Oceania but a relatively late arrival which was generally confined to the northern and eastern regions.

In Polynesia the fishhook is a fairly common artifact in most sites and in the Hawaiian and Marquesan Islands it was used from the earliest known periods. In some instances, fishing equipment comprises nearly a quarter of the artifact total, and, of this, fishhooks make up as much as 10 percent.¹ This relatively large proportion of fishing equipment makes an understanding of how the marine environment was utilized an important consideration for archaeological interpretation. In addition to the morphological characteristics of the remains the following characteristics and considerations are important: a knowledge of the possible areas of differential usage of the sea; the importance of different types of fishing equipment, and where and how it was used; the possibility of fishhooks being a marker of this differential use; and what all this means in terms of productivity to the native peoples. The answers should enable the archaeologist to make more precise interpretations of the role of fishing in the Oceanic economy.

¹ These figures were computed from artifact totals given by Emory and Sinoto for sites on Oahu, Hawaiian Islands (1961).

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