JOHANNES

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CALIFORNIA

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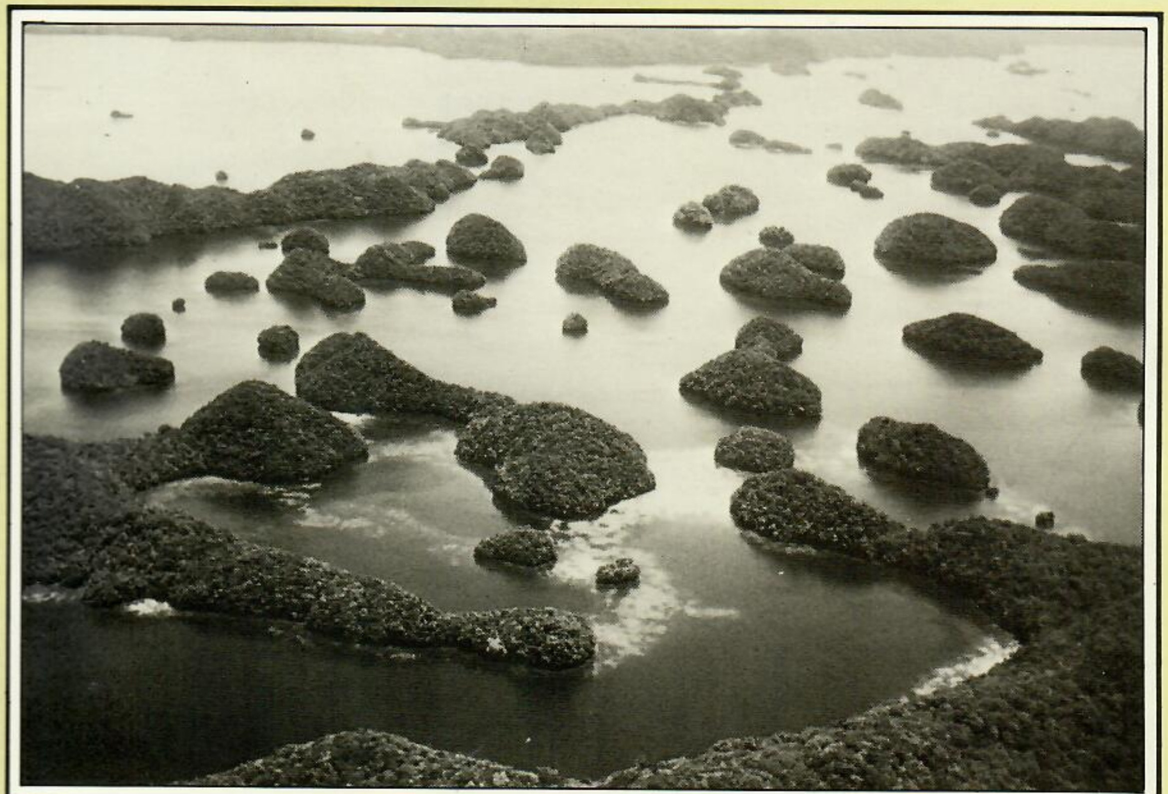
FISHING AND MARINE LORE IN THE



PALAU DISTRICT OF MICRONESIA

R. E. JOHANNES

WORDS OF THE LAGOON

Fishing and Marine Lore in the Palau District of Micronesia

by R. E. Johannes

Words of the Lagoon is an account of the pioneering work of a marine biologist to discover, test, and record the knowledge possessed by native fishermen of the Palau Islands of Micronesia.

"When Palauans fish, land-based protocol is suspended. Harsh criticism, or 'words of the lagoon,' *tekoi l'chei,* may be hurled by man or boy of any rank at anyone, chief included, whose efforts do not measure up on the fishing grounds. No one, irrespective of rank, may express offense at being scolded under such conditions." Robert Johannes lived for sixteen months among the outstanding fishermen of Palau and the South West Islands. They became his teachers and Palau's biologically diverse and abundant coral lagoons his classroom.

The Palauans' sophisticated knowledge of fish behavior and water conditions is reflected in their elegant strategies with hook, net, trap, and spear. The author describes the islanders' use of the lunar calendar as a reliable guide to the behavior of fish and their vulnerability to capture. The identity and behavior of some fish are also determined by observing the seabirds above them. Johannes learned the effective techniques used by native divers to attract fish, the utilitarian origins of the remarkable designs of Pacific Island fishhooks, and the pattern of the island current, familiar and important to the fishermen though previously unknown to oceanographers. A fascinating and well-documented account of his marine biological findings, *Words of the Lagoon* also conveys the

(continued on back flap)

human excitement of the author's interaction with his informants and his growing insight into their way of life.

The wealth of information Johannes was able to obtain is a tribute to the people who developed this specialized knowledge. The Palauans' sensitivity to marine ecology and their centuries-old use of conservation methods employed only recently by industrialized societies are meshed in the traditional values of the culture that gives a special place to "words of the lagoon." Through this book some of their wisdom and expertise is made available to Western science. The author analyzes its immediate practical importance for the effective utilization and management of tropical marine resources: specialists in marine fisheries biology and the ecology of coral reef environments will find much that is new to them in *Words of the Lagoon*. As a study of the culture and technology of a fishing people, this book will also be welcomed by anthropologists, geographers, and fishermen.

R.E. Johannes is currently Principal Research Scientist at Austrialia's Commonwealth Scientific and Industrial Research Organization, Division of Fisheries and Oceanography. He is the author of many articles on marine ecology, particularly the ecology of coral reefs.

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JOHANNE

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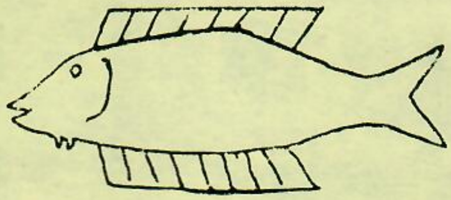

"[Johannes] presents the Palauans as competent field naturalists—as they rightfully are—rather than the more common treatment of dealing with the knowledge and logic of traditional societies as being an irrational approximation of the reality known by western science.

"[*Words of the Lagoon*] is crammed with odd and significant pieces of information that demonstrate the incredible sophistication of Palauan fishing knowledge. The material on lunar spawning cycles is excellent. When a biologist goes into the field and comes back with such fascinating information about fish, fishing, currents and seabirds, I find that to be very important."

—Bernard Nietschmann, Professor of Geography, University of California, Berkeley

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EPILOGUE

A culture is defined in part by the specialized knowledge it possesses. The extent to which this knowledge is retained is one measure of the strength of that culture. Today in Oceania knowledge about fishing, as well as farming, hunting, medicine, and navigation, is disappearing because younger members of island cultures are often no longer interested in mastering it. They judge it no longer useful. Why learn to fish well when nine-to-five jobs in air-conditioned offices beckon in the district center and there is an endless supply of fish in cans? Why learn to build a canoe and sail it when fiberglass boats and outboard motors can be bought and operated with little detailed preparation or knowledge? This disdain is reinforced by well-meaning educators, for the exclusion of traditional skills and knowledge from westernized school curricula in many developing countries amounts to a constant, tacit assertion that such things are not worth learning.

I have pointed out in this book and elsewhere (Johannes, 1978*a*, 1980) that traditional knowledge can be invaluable to Western scientists as an aid in conserving natural resources. Such an argument is not liable to motivate many young islanders to acquire it.

But there is another, more compelling reason for mastering it. Pacific island economies were traditionally self-sufficient. Detailed knowledge of the local environment and of ways to exploit it wisely was essential to this sufficiency. Today there is a heavy and growing reliance on imported technology, energy, and food. A rising influx of foreign aid, investment capital, and tourists in the past decade has according to technicians, but it was killed before I could be summoned to witness the event. But nowhere outside of Palau, including Hawaii, Yap, Ponape, Truk, Tarawa, Saipan, and western Malaysia, where I also interviewed fishermen, could I locate so much as a rumor that octopus have babies in trees.[5]

There are three possible explanations for this story: (1) it is true; (2) it is false, but Palauan fishermen (who are quite familiar with octopi) have periodically seen something that *seemed* to them to be an octopus having babies in a tree; and (3) I was deliberately and independently misled by a considerable number of fishermen, including Ngiraklang. I am unable to favor any of these possibilities; they all strike me as improbable.

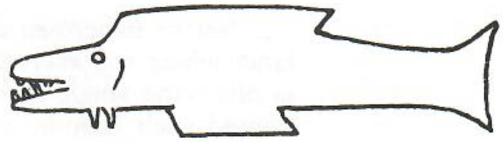
5. There is a story in Ponape that octopus sometimes enter the taro fields and climb into taro plants, but most Ponapeans I talked to treated this story simply as a legend. Palauan informants were quick to differentiate between actual observations and legends, but all of them were quite serious about the reality of the octopus story.

stimulated much recent planning and research focusing on the further expansion of island market economies. These efforts have been based on the assumption that the growth of the world economy, on which local market economies depend, will continue. The ominous international economic climate in which these words are being written makes this assumption seem dangerous indeed.

Pacific islanders are at the end of a long and expensive supply line that now delivers much of what they once obtained within their own islands. Their economic well-being is now at the mercy of alien decision makers and impersonal market forces centered thousands of miles away in foreign capitals and trade centers. When the world economy falters, tourism, foreign aid, and foreign investment are among the first things to be affected. Pacific islanders will thus be among the first to feel the impact of a global depression. And ultimately, their market economies will be among the hardest hit. If this occurs arguments between those who espoused rapid economic progress for the Pacific islands and those who wanted to preserve traditional island cultures will seem academic indeed.

The success of an involuntary return to greater self-sufficiency would hinge largely on the extent to which traditional knowledge—knowledge gained specifically to foster self-sufficiency—has been retained. A book such as this cannot preserve such knowledge in sufficient practical detail to serve the purpose. It must be retained within the culture as a matter of personal experience.

I am not arguing that islanders should suddenly, voluntarily reduce their participation in international market economies. But if they wish the option of doing so relatively painlessly, should the time come when they have no choice in the matter, then they must strive to preserve the traditional knowledge and skills that have served well for so many centuries.



PREFACE

Few people would claim to know as much about how to catch fish as a good full-time fisherman. When it comes to understanding fish behavior and the many environmental factors that help determine and predict it, marine biologists must often take a back seat. This is hardly surprising. There are hundreds of times as many fishermen today as there are marine biologists, and their forebears were plying their trade and passing on their accumulated knowledge tens of centuries before anyone heard of marine biology. What *is* surprising is how little effort has been made by scientists to search out and record this information.

Traditional native fishermen are especially rich sources of unrecorded knowledge. A modern commercial fisherman fifteen feet off the water in a rumbling trawler searches for his fish with machines. Isolated in his wheelhouse he perceives his prey as abstract shadows on an echo-sounder chart. The native fisherman searches with his eyes and ears. In shallow water he stalks fish at close range on foot. He pursues them in their own realm with goggles and spear. He knows the local currents intimately, for in his small, often motorless craft he must harness them when they are benign and avoid them when they are not. He is, in short, more in touch with his prey and their surroundings than his modern, mechanized counterpart. As Ommaney (1966) states, he "has forgotten more about how to catch the fishes of his particular bay or lagoon than we shall ever learn."

Native fishermen are particularly knowledgeable on small islands where seafood is the main source of animal protein and fishing is often the single most important male occupation. The waters around such islands, moreover, are generally influenced little by nutrient- and sediment-bearing terrestrial runoff. As a consequence they are typically very clear, affording fishermen with especially favorable conditions for observing the behavior of their prey. A particularly large reservoir of information about the sea and its inhabitants exists in the islands of the tropical Pacific because of their great number and the high biological diversity of their marine communities.

Pacific islanders' knowledge of fish behavior is, according to Ottino and Plessis (1972, p. 370), "of a stupefying richness, and at times of such precision that the corresponding poverty of our own conceptions makes inquiry very difficult." Gosline and Brock (1960, p. 1) state, "It is probable that the Hawaiians of Captain James Cook's time knew more about the fishes of their islands than is known today." Groves (1933–34, p. 432) said that, "as a result of his regular association with fish getting activities, the average male native [of Tabar Island, Bismarck Archipelago] has an amazing knowledge of the habits, type, and value for food purposes of the innumerable varieties of fish in the adjacent waters." Concerning Tahitians, Handy (1932, p. 77) wrote, "the native fisherman is possessed of a store of precise knowledge that may be truly characterized as a natural science," and Nordhoff (1930, p. 233) stated, "an accomplished fly fisherman in Europe or America does not carry in his head one-half the store of practical knowledge a bonito fisherman uses every day."

But despite such enthusiastic endorsements, very little serious effort has been made to collect and record this knowledge. Some anthropologists are well trained in biology and could carry out such research. But anthropologists interested in the ethnobiology of Oceania have focused largely on terrestrial ecosystems. This surprises me as a higher percentage of tradition is preserved in the Pacific islander's relations with his marine ecosystem than with his land (see, e.g., Danielsson, 1956). The terrestrial ecology of virtually every island in Oceania has been drastically altered by the introduction of foreign plants and animals and the extinction of indigenous ones (e.g., Fosberg, 1972). Marine communities have not undergone changes of comparable magnitude; there have been far fewer marine introductions and very few known marine extinctions.

To be sure, many pages have been written on Pacific island canoes and fishing implements and how they have been used to catch fish. But little has been written on why the islanders fish the way they do and what they know about their prey and its environment. This is probably because it is the nature of anthropology to focus mainly on people. Accordingly, when anthropologists study man-in-nature, the general form their queries take is usually, "how does this environment influence you?" rather than "what can we learn about this environment from you?" (There are some exceptions; e.g., Blurton Jones and Konner, 1976; Nelson, 1969).

The lack of interest shown by biologists in such knowledge has a different root. Natural scientists have routinely overlooked the practical knowledge possessed by artisans (e.g., Hanlon, 1979; Isaacs, 1976). It is one manifestation of the elitism and ethnocentrism that run deep in much of the Western scientific community. If unpublished notebooks containing the detailed observations of a long line of biologists and oceanographers were destroyed, we would be outraged. But when specialized knowledge won from the sea over centuries by formally unschooled but uniquely qualified observers—fishermen—is allowed to disappear as the westernization of their cultures proceeds, hardly anyone seems to care.

There seems to have been only one good published general study of Pacific island marine lore. It was written neither by a biologist nor an anthropologist, but by a writer, Charles Nordhoff, coauthor of *Mutiny on the Bounty*. Nordhoff fished extensively with Tahitians using their techniques and was a fine observer. His 1933 study of Tahitian offshore fishing has been called "a minor masterpiece stylistically and ethnographically," (Oliver, 1974, p. 284).

But offshore fishing involves only a few species of fish. Shallow coral reef and lagoon habitats, in contrast, yield several hundred species of edible marine animals, and this is where the expert native fisherman's knowledge, as Nordhoff acknowledged, is most awesome. "The time is ripe," he stated, "for some trained enthusiast to settle in these islands, learn the language, and devote four or five years to a complete account of fishing, inside and outside the reefs. Such a work would assume proportions almost encyclopaedic, and bring to light a mass of curious data."

The present work grew out of what is probably the first reasonably comprehensive attempt to carry out the kind of studies that Nordhoff called for forty years ago—to discover what Westerners can learn about tropical marine ecosystems and their resources by investigating the knowledge and actions of native fishermen and by observing their impact on these resources.

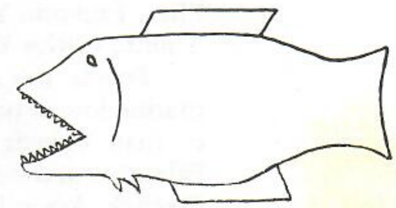
There are practical reasons for such studies, particularly in the tropics. Coral reef communities cover an estimated 230,000 square miles of shallow tropical sea bottom and appear to have a finfisheries potential of 6–7 million tons per year (Smith, 1978). This would be enough fish to feed the entire population of the United States at its current rate of fish consumption for about four years, and is equivalent to about 9 percent of the world's current commercial catch from the sea.

But this potential is not being realized. Many reef and lagoon fisheries appear to be heavily overexploited today, whereas many others are clearly underexploited. Scientific knowledge concerning these resources and their effective exploitation is meager. Moreover they present biologists with the most complex fisheries management problems in the world. There are far more species than in higher latitudes and the fisheries are not dominated by a few overwhelmingly important species as is the case in most temperate waters. Learning enough about the biology of the hundreds of species that contribute to the catch so as to manage their exploitation efficiently is an enormous undertaking. Even if tropical countries had the money, facilities, and trained scientists to carry on marine research programs of comparable strength to those in the richer countries of the temperate zone (an almost impossible dream for most of them in this century), it would take decades to amass enough information to manage the many important tropical marine species as efficiently as some shrimp, salmon, or halibut populations are managed in temperate waters today.

The kind of research described in this book offers a shortcut to some of the basic natural history data we need in order to understand these vast and valuable resources. Such information has to be quantified and blended with more sophisticated forms of biological research (e.g., population dynamics, behavior, physiology, genetics) before it can be put to optimum use, and this is no small matter. But I gained more new (to marine science) information during sixteen months of fieldwork using this approach than I had during the previous fifteen years using more conventional research techniques. This is because of my access to a store of unrecorded knowledge gathered by highly motivated observers over a period of centuries. This book, then, is really the work of uncounted individuals carried out over many generations.

For several years prior to this work I had been trying to deduce what sets the upper limits on the yield of fish to man in coral reef communities. Although coral reefs are among the most biologically productive communities on earth, their fish populations seem surprisingly vulnerable to overharvesting. I came to Palau with an ecological hypothesis to explain this. But after a few weeks I became aware of various political, cultural, and economic pressures impinging on fishing in such a way as to make my purely biological explanation seem quite simplistic. This provided me with an important reason for examining not just the marine biological factors that influence fishing, but the human behavior patterns as well.

Most of my past research was written in a technical style that made it nearly incomprehensible to all but colleagues. The present research seems of sufficient general interest that I am seeking a wider audience in this book. So I have tried to write in a style that will interest colleagues, yet is sufficiently free of technical jargon so as not to discourage the layperson with an interest in the sea. I have tried to convey some of the excitement and occasional perplexity I felt as the work progressed. These are important ingredients in research, but ones which editorial conventions force us to ignore in more technical writing. Certain material has been placed in appendices so the general reader can ignore it if he chooses. Some of the more specialized material arising from this research is treated in greater detail in several technical publications (Johannes, 1977, 1978a; 1978b; 1980).



ACKNOWLEDGMENTS

My exceptional debt to Ngiraklang, second chief of Ngeremlengui and one of Micronesia's finest native scholars, will become obvious as the reader progresses through this book. Patris Tachemaremacho, his father Patricio, and the rest of his family provided a cheerful, endlessly patient fount of information on Tobian fishing.

One of the problems faced by this neophyte interviewer was that of forgetting himself and asking long, rambling questions that sometimes taxed interpreters. April Olkeril translated such questions (and some almost equally rambling answers) with a skill and exactness that would put many professionals in the shade. Dale Jenkins flavored his interpreting with rich insight and winning cross-cultural humor. Beketat Maidraisau, Palau's first professional marine biologist, provided much firsthand knowledge.

Other informants and interpreters in Palau included: from Angaur; Mariek Remang, Moses Ngiramur and Abraham; from Peleliu; Mark Mabel, Ngcheed, Mikel Mad, Nobuo Ngiradechal, Ngirangesil, Uchau, and most importantly, Daelbai; from Koror; Omelau, Ucherbelau Orrukem, Bena Sakuma, Ulou Brobesong, Charlie Gibbons, Meruk Yalap, John Kochi, Alan Sied, Tewid Boisek, Mongami, Cisco Uludong, Nancy Wong, Ngiromelau, Captain Seong Yoon Ho; from Ngeremlengui; Blau Skebong, Fumio Kyota, Johanna Ongos, James Amboi Franz, Melemalt; from Ngiwal; Sichang, Temol, Ignacio; from Geklau and Ngerechelong; the groups of men I interviewed in the men's houses; from Ollei; Oshima, Omelau Chereomel, Kloulechad; from Airai; Singeo Techong; from

Kayangel; Chief Rdechor; from Tobi; Zacharias Saimer, Kalisto Elias, Faustino Yaitowak; from Sonsorol; Mariano Carlos, Bernardo Tubito, Carlos William, and Pacifico Bemar.

People too numerous to list aided me in the pursuit of the marine lore of other Micronesian islands. I am particularly indebted to Juan Cepeda and Frank Cushing in Guam; Margie and Sam Falanruw and Issac Figir in Yap; Mike McCoy, Richard Croft, Ioanis Pretrick, Adam LeBen, and Al Milliken in Ponape; Rich Howell and Mario Henry in Truk; Jack Villagomez in the Northern Marianas, Bill Puleloa, Mike Trevor, and Pat Bryan in Majuro, and Teekabu Tikai and Mikaere Tekanu in Tarawa.

Others who helped out include Tosh Paulis, Jim McVey, Ted Tansy, Roger Pflum, Torao Sato, Lu Eldredge, Emilie Johnston, Sakei Moriss, Ronn Ronck, Howard Yoshiura, Renee Heyum, Douglas Faulkner, Darrell Gray, Gunter Reuning, Douglas Vann, and Roland Force. Bob and Hera Owen provided much expert advice and unstinting friendship. John Bardach helped shield me from the manic exactions of American academia while I wrote.

Chris, my wife, went, in one month, from completing her doctorate to scrubbing clothes on a washboard with good humor and a sense of adventure. My five-year-old son, Greg, offered tactful words of encouragement when my spearfishing was going badly and it looked as if we would have to eat canned mackerel again.

Portions of the manuscript were critically reviewed by Ted Hobson, William McFarland, Beketat Madraisau, Demei Otobed, Yoshihiko Sinoto, Robert Randall, Peter Black, John Munro, Ron Thresher, David Gibson, Jorg Imberger, and Richard Barkeley. The entire manuscript was reviewed by Gene Helfman, Bob Owen, Bill Wiebe, Malcolm Gordon, Craig Severance, and John Bardach.

Karen Straus, Gene Helfman, Robert Iverson, Brian Court, and Masachi Yamaguchi provided photographs. Dave Wright drew the fish, Liz Jefferson and Liz Corbin did the other illustrations.

The illustrations that appear above the headings throughout the book display some of the drawings of the 127 types of fishes made by an unidentified Palauan for A. Kramer (c. 1929).

These acknowledgments cannot begin to repay the many kindnesses received from these people and others in Micronesia, the United States, and Australia who helped make this work possible.

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R. E. J.

CSIRO
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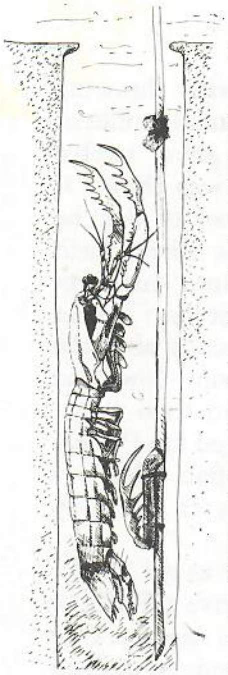


Using Marine Animals to Catch Marine Animals

When the skin of a sea cucumber, *Holothuria atra (choas)*, is rubbed it emits a red liquid containing a nerve toxin. It was used by Pacific islanders to kill fish in shallow pools at low tide.[5] Also, when introduced into an octopus lair it drove the occupant out into the open where it could be speared. In Palau the toxin was also employed to paralyze large edible sea anemones used as food. Once exposed to the substance the anemone would neither retract into its hole nor sting the fisherman as he dug it from the reef.

Mantis shrimps were lured to the tops of their burrows with bait, then snagged and dragged out with a device employing the claw (second maxilliped) of another member of the same species. This claw was lashed to a stick, and the bait was secured above it. When the device was lowered into the hole the claw folded up on itself. The shrimp moved up past the claw to get the bait. As the stick was pulled from the hole the claw opened like a partially open jacknife, its "blade" preventing the shrimp from retreating.

As elsewhere in Oceania fishhooks were made from the shells of hawksbill turtles (green turtle shell is too weak) and of various molluscs. Although no record exists of how these hooks were made, it is possible that they were shaped, as on some other Pacific islands, using coral files, and finished using the abrasive skin of rays.[6] Throwing spears were sometimes tipped with the spines of stingrays.

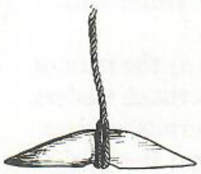
The Leaf Sweep

Using a rope festooned with leaves to herd and capture fish might sound as if it were guaranteed to fail. But the leaf sweep was used traditionally throughout much of Oceania, from Hawaii to Palau, because of its simplicity and effectiveness. It is an example of the island fisherman's use of applied fish psychology. Called *hukilau* in Hawaii and *ruul* in Palau, the device resembles a giant green Christmas tree garland. It has been all but superseded by nets in much of Oceania and I saw it being made and used in Palau only once.

Although fish can easily swim physically through or under a leaf sweep, it forms an effective psychological barrier for most species.

5. Whereas sea cucumbers were used traditionally in Oceania as a fish poison (e.g., Frey, 1951; Smith, 1947) biologists established their toxicity only in the 1950s. Some of the first research of this nature was carried out, coincidentally, in Palau by Yamanouchi (1955), who found *Holothuria atra* to be one of the most toxic species present. Abe (1938) also lists four plants that were used as fish poisons. As far as I could determine only one, *Derris elliptica*, is still used occasionally today. The Japanese imported this species, a more potent variety than the indigenous *Derris trifoliata*, and raised it commercially in Palau for the manufacture of insecticides. They also encouraged its use by Palauans to secure fish for them.

6. Ray skins were used until early in this century in Palau as an equivalent of sandpaper in smoothing canoes and wooden utensils.



sticks pointed at both ends and tied in the middle to the line. They were baited and deployed in such a way as to lie parallel to the fishing line. When a fish swallowed the bait and tension was applied to the line the gorge turned sideways and lodged in the stomach or throat. Although gorges are generally not as effective as well-made hooks, they coexisted with fishhooks in Palau because they were much easier to make. A good turtle shell hook took two or three days to make, whereas a gorge could be made in minutes. One Palauan in his nineties made for me some gorges like those he remembered having used in his youth.

Fish Weirs

Stone or wooden fish weirs were built on the reef flats to trap fish on receding tides. The maintenance of these structures required considerable labor. They have fallen into disrepair in this century, being replaced in function by the less labor-intensive *kesokes* net (see later in this chapter). In 1975 I heard of only one stone fish trap, near Geklau, which, although not maintained, still afforded a few fish occasionally to the owners. Vestiges of another, just north of the dock at Ngeremlengui, were visible in 1976. It had ceased to catch fish in the 1950s.

Modern Methods

Fishing, like many aspects of Palauan culture, has changed considerably in this century. Motor boats have almost completely replaced dugout canoes. Imported machine-made nylon nets have replaced locally made varieties. Fishing techniques have been modified and reduced in number. The elaborate religious rituals once used to placate the gods of weather and fishing have almost completely disappeared.

The classical cultural anthropologist might say that fishing today in Palau is a pale shadow of what it once was. But the biologist interested in what can be learned from Palauans concerning the biology of reef fish can learn much that was unknown to Palauans fifty years ago. For in Palau, as in many other Pacific islands, there was a recent period of several decades when old and new ways of fishing overlapped considerably, producing a degree of understanding of marine life that was probably never before equalled (and may not soon be equaled again).

While older Palauan fishermen were still teaching the young traditional fishing knowledge accumulated over centuries, modern technology was simultaneously expanding fishermen's horizons. Remote and seldom-visited fishing areas became within easy reach by motorboat. Much of what Palauans know today about fish outside the reef, for example, was first learned during this period. A number of common offshore species such as skipjack and yellowfin tuna are known today by Japanese names—a legacy of Palauan employment in Japanese fishing activities beyond the reef.

A revolution in the study of underwater life began at the turn of the century when diving goggles were imported by German traders to facilitate diving for pearl shell. In the late 1940s underwater spear-guns were also introduced. A few years later underwater flashlights became available, facilitating nighttime underwater spearfishing. This equipment enabled fishermen to exploit habitats and harvest species to which they had little previous access. Species that would not take hooks, or were too powerful, or distributed in waters too deep to be taken readily in nets, now became available. And a fisherman could now easily observe the fish he sought while he was actually submerged in the clear waters of their habitat. Even at night (when the behavior of many species changes radically) he could watch them at close quarters. Such developments led inevitably to a heightened understanding of fish behavior. As Ngiraklang stated, "We perhaps cannot name as many fishes as our forefathers, but the fishermen of my generation know more about their habits." (Why much of this information is being lost as Ngiraklang's generation passes will be discussed in later chapters.)

Today in Palau underwater "fishing guns" and stationary barrier nets are the two most productive and extensively used fishing devices. Gillnets, droplines, trolling lines, throwing spears, and portable fish traps account for most of the rest of the catch.

Stationary Barrier Nets

The traditional movable *ruul*, or leaf sweep, described earlier has given way almost completely within the past few years to an imported stationary barrier net called *kesokes*. In keeping with the shift from collective to individual labor that often follows Western contact in Oceania, it can be employed by a single individual, whereas the *ruul* requires many people to operate. It is usually several hundred yards long, from two to five feet deep and has a stretched mesh of from one to two and one-half inches. It is composed of detachable segments and its length can quickly be adjusted to particular needs by adding or subtracting segments.

At Ngeremlengui the net segments are placed on a bamboo raft, or *brer*, and poled out onto the reef flat. The segments are tied together and the net is set on the reef flat in a V shape on a falling spring tide. The orientation of the V is important; a good set requires that the fisherman know the regular pathways the fish take as they leave the reef flat for deeper water as the tide falls (see chapter 3). The apex of the *kesokes* usually lies in the deepest water in the area.

separate cord eight to twelve feet long, the free end of which terminates in a copper spike about the size of a pencil. This line or *iengel* is used for stringing fish as they are caught. The spike facilitates threading the line through the mouth, gills, or eyes of the fish. By dragging the fish behind him rather than tying them to his waist the diver is not only freer in his movements but is also less liable to be threatened by sharks attracted to his bleeding fish.

The bamboo float serves a second purpose. When a fish or a turtle is speared that is strong enough to break the line attaching the spear to the gunstock, or to drag and hold the diver down, he lets go of the stock. His prey swims off towing the gun, rope, and float, gradually exhausting its strength without putting undue strain on the cord attached to the spear. He retrieves prey and gear when the float pops up from beneath the surface signaling the end of the struggle—which may take an hour or more if a large turtle has been speared.

Sea turtles are usually speared in a front flipper. A turtle thus speared is forced to swim in circles (only the front flippers are used for propulsion in these species) and is unable to fight effectively. Fish are usually speared from one side, or from above and behind. The diver aims at or just behind the head; the spear holds better when imbedded in the bones of the skull. If the shot is perfect it hits the brain or severs the spinal cord just behind the brain and the fish dies instantly.

Divers exploit various behavioral traits of their prey. If a struggling jack or large surgeonfish is left on the spear, other members of the school from which it was shot will often crowd around it, providing easy targets for other spears. Rudderfishes, *Kyphosus cinerascens* and *K. vaigiensis* (*komud*) lose their customary wariness and will approach the diver and eat the partly digested algal fragments released when a spear penetrates the stomach of one of their school.

Sounds made by various reef fishes are sometimes employed by the underwater spearfisherman to locate or attract prey. Several species of angelfish bear the onomatopoetic Palauan name, *ngemngumk*. When said quickly with an emphasis on the vowels, the word reproduces the percussive grunting sound these fish make when alarmed. The squirrelfish, *Adioryx spinifer* (*desachel*) make a similar, although softer alarm sound. Both squirrelfish and angelfish often hide when alarmed, but these sounds advertise their presence and general location to the spearfisherman.

Some jacks are readily attracted to the fisherman if he makes a glottal grunting sound similar to the noise the fish themselves sometimes make by grinding their pharyngeal teeth (e.g., Moulton, 1958).[10] Some jacks are also attracted to a diver if he expels bubbles noisily from behind pursed lips as if blowing on a trumpet. (This technique worked very well for me with certain species, providing I was at or below the level of the fish in the water. The jacks would change course abruptly and swim straight toward my face, sometimes approaching so fast that I was unable to pull my long speargun back and take aim before the fish were at such close range that it was impossible to shoot.)

Some species, particularly rudderfish *(komud)* are said to become alarmed if a diver presents his face to them. This is believed to be a reaction either to the diver's eyes or to light glinting off his faceplate. In any event such species will often not allow the diver within spearing distance if he keeps looking at them. (Native divers in Papua New Guinea have made the same observation [Gaigo, 1977].) Accordingly the diver faces the bottom, peeking awkwardly upward occasionally to keep track of the fish's movements as he swims slowly toward it. (I was always too eager to watch the fish I was stalking to test this technique adequately.)

Palauans say that large barracuda, dogtooth tuna, or large jacks should never be speared head on. Sometimes these fish will charge straight ahead the instant the spear is fired and may inadvertently drive the butt of the spear into the diver. Most other injured fish, they say, generally flee down current. (This seems adaptive because the trail of blood left by an injured fish fleeing upstream would enable predators to trace it more easily.)

Octopus are highly valued as food and bait, and their well-known ability to camouflage themselves makes them hard to spot on the reef. Divers seeking octopus look for various signs of their presence. Piles of broken crab or clam shells often indicate the presence of an octopus burrow. As an octopus crawls along the bottom its suckers stick to pebbles and turn some of them over. Certain pink coralline algae that grow best at low light levels are often found growing on the bottom of such pebbles. A trail of pink pebbles is thus a sign that an octopus has passed.

If an octopus is too far back in its hole to be grabbed or speared, divers attempt to force it out. Moray eels are among octopus' worst enemies, and a dead moray thrust into an octopus lair often brings the occupant flying out. The neurotoxic secretion of a sea cucumber,

10. Beaglehole and Beaglehole (1938), Kayser (1936), and Bagnis et al. (1972) also mention the use of sounds by underwater spearfishermen to attract fish in other Pacific island groups. I heard accounts of one Palauan fisherman who coaxed groupers out of their caves and into shooting range by holding small pieces of coral rubble in his hand and grinding them together in front of the hole. An American witness said that the groupers came out aggressively as if defending their territory in response. I was not able to get this technique to work on the few occasions I tried it.

Very heavy spears were also once used from canoes to spear dugong (*mesekiu*), which abounded and were a staple food sixty years ago (Kramer, 1929). Today they are an endangered species, depleted as a consequence of the ease with which they can be chased and speared in an outboard motor boat. I saw only one during my stay.

The introduction of outboard motors has created new employments for the hand spear. Although spearing fish from motorboats is not economical—gasoline is too dear—Palauans love high powered boats and spear from them for sport. (Nowhere else in Micronesia is gasoline burned so freely for the sake of speed. Ngiraklang, at 79, took my breath away more than once with his *kamikaze* approach to boating. One day I crashed clear through the seat of his boat as a result of his full-throttle assault on some rough water.) A by-product of these activities are several interesting insights into the behavior of marine animals that can, with the advent of fast boats, be chased down and speared.

A modern Palauan spearman wears polarized sunglasses and searches for fish from the bow of his runabout. In one hand he holds the taut bow line to steady himself. His other hand holds a spear, tip down, shaft resting on his shoulder. His success depends not only on his accuracy but also on the maneuverability of the boat and the responsiveness of the driver. The spear tip is lifted to signal to the driver that fish have been sighted. The shifting course the boat must take in the chase is telegraphed to the driver by pointing the spear. A number of fish, such as large wrasse, parrotfish, or snappers, sometimes "hole up" when pursued, taking refuge within a coral patch. The driver circles several times to discourage the fish from leaving its refuge. The spearman then dons mask and snorkle and moves in on the fish underwater. The head of the fish offers the best target. Palauans have found that hiding fish tend to rest with their heads facing into the current. The diver approaches the hole with this in mind.

In pursuing turtles speed has replaced stealth. The canoe fisherman paddled slowly and quietly up to a turtle hoping to get close enough to throw his spear before being heard or seen. Today's spearfishermen approach turtles at top speed. Hawksbills and small green turtles tend to head straight for deep water. Consequently they are approached, if possible, from deeper water so that they will have to

Divers in Palau and elsewhere swear that fish will allow unarmed divers to approach closer than divers carrying a spear. That is my impression too. Whether species that sleep habitually in shallow water "learn" to sleep in deeper water soon after being exposed to heavy night-time underwater spearfishing or whether their altered behavior is entirely the result of natural selection is not obvious.

run toward the boat. Hawksbills seem to have less stamina than greens and tend to give up quickly, making them comparatively easy targets. Larger green turtles often run a short distance, then circle the boat, apparently trying to confuse the pursuers. Eventually they either come up for air or seek shelter, in either case rendering them easy targets.

Some fishermen maintain that, more often than not, fish will run toward the sun when chased across a sand flat. When this happens they are hard to see in the glare and the driver tries to maneuver so as to put the boat between sun and prey.

Large barracudas are not chased by the prudent; several fishermen have had expensive damage inflicted on their boats by the teeth of a large barracuda that turned and charged its pursuers.

Milkfish, *Chanos chanos (mesekelat),* "the strongest fish in Palau," provide challenging sport. When a school is sighted feeding on a shallow sand flat, it flees, taking a swift erratic course. Schooling functions to confuse predators, including man, by making it difficult to focus easily on a single target. Visually isolating an individual fish for long in a fast-moving school of milkfish is virtually impossible. And the chance of hitting a fish by throwing blindly into the school is very poor. So the hunters set out to separate a single fish from the school.

As shouting fishermen and alarmed fish careen across the reef flat the school eventually splits up. The boat follows the smaller group. This group in turn may split. Once again the pursuers chase the smaller group. Sooner or later a single fish will take off alone. The pursuers have now isolated their target.

After several minutes the lone fish slows down abruptly. Simultaneously it changes color, from silver to gunmetal blue. This appears to be a manifestation of stress; it is also seen in sick or roughly handled milkfish in the laboratory (Nash, pers. comm.). When this happens the spearman gets ready for his throw. But occasionally, before he can release the spear, the path of the fleeing fish and that of a school of milkfish will intersect. In this case the fish joins the school and accelerates to match the speed of its startled brethren. But its fate is generally sealed now, for it cannot hide among the school. Its much darker color marks it unmistakably and the hunters pursue it without difficulty.

Soon it slows down once again. Eventually it will turn slightly sideways for a moment, thereby presenting a larger target. At this instant the spearfisherman raises his spear and drops the bow line so that he can extend his other hand to sight the spear along it. His feet are wide apart bracing him against the gunwales. His knees are slightly bent. He does not lead the fish with his throw as a shooter

The stomachs of some of these species are completely empty prior to spawning. (Cessation of feeding prior to spawning has also been observed in a variety of temperate zone fishes [e.g., Iles, 1974; Shul'man, 1974].) But they nonetheless often take baited hooks or lures just as nonfeeding salmon do on spawning runs (e.g., Boyd et al., 1898). And they begin to feed voraciously immediately after spawning, according to fishermen.

As described later in this chapter, other factors associated with new and full moons influence fishing success. But fishermen maintained, and my observations confirmed, that spawning aggregations were the major source of big catches around new and full moons. (Rabbitfishes are an important exception. Two species that are very important to fishermen in some parts of Palau spawn and are caught in particularly large numbers beginning several days after the new moon [see appendix A].) There is thus correspondence in Palau with geographer Cordell's (1974) suggestion that among artisanal fishermen in coastal Brazil a lunar-tide system of determining fishing strategy has been perfected as a consequence of spawning periodicity.

Learning and committing to memory the timing and location of these aggregations is an essential part of becoming a good fisherman in Palau. And many of the older fishermen retain the formidable memories characteristic of preliterate peoples, despite their exposure to written languages since Japanese times. As a consequence some of them are remarkable repositories of knowledge about lunar spawning aggregations.

By examining the gonads of various species through the lunar month and by visiting the sites of reported spawning aggregations I found that the information provided by Palauan fishermen was highly reliable. Among those species that I investigated only one, the milkfish, *mesekelat* (*Chanos chanos*), failed to aggregate with ripe gonads at the time and place predicted by the fishermen—a puzzle that is described in appendix A along with a species-by-species account of other reported lunar spawning rhythms and aggregations.

Although lunar reproductive rhythms are apparently rare among strictly terrestrial animals, some land crabs return to the sea on a pronounced lunar cycle to release their eggs. The best known example of this among Palauans is *Cardisoma hirtipes (rekung el beab).* This fist-sized crab lives in holes in the forest floor, coming out at night to feed. This routine is interrupted beginning several days before the full moon, mainly during the months of the southwest monsoon. Females with eggs abandon their holes and set out on a mass migration toward the sea. At this time women and children collect sacks full of them with ease as they cross the roads of Angaur and Peleliu. At dusk, starting about two days before the full moon, the crabs emerge from the edge of the forest and move warily down sand beaches to the edge of the water.

I watched this phenomenon in June 1977 as the full moon rose on a quiet night off Honeymoon Beach on Peleliu. Hundreds of crabs were moving quietly out of the underbrush and down the sand. My approaching movements, though careful, sent them scurrying back to shelter. As I settled down they once again began this strange march toward their original home. When a crab reached the water's edge it walked into the oncoming waves. The instant it touched the water it began to act as if oblivious to human activity, even seeming to ignore the bright light I shone on it. The first incoming wave generally knocked it over. Quickly righting itself as the wave receded, it dug its rear walking legs into the sand, braced itself for the next wave, and elevated the front end of its body. As the next wave washed over it the crab flapped its abdomen and shook its pincers vigorously up and down in unison, actions that shook loose the larvae that had just hatched from the embryos carried beneath its abdomen. The larvae were all released in a dark stream during the advance and retreat of two waves. The crab then moved back onto the beach, having spent just a few seconds in the water. It immediately regained its customary wariness and moved up the beach and back into the forest.

The temporary loss of caution by land crabs while releasing their larvae is similar to the stupor of spawning reef fishes. (One wonders whether this phenomenon has contributed to the widespread belief in "moon madness.") It is also characteristic of a number of other species of land crabs in Palau (Gene Helfman, pers. comm.). In such situations the animals are very vulnerable to predation—the crabs far from their normal shelter, the fish packed densely on spawning grounds and often besieged by sharks and other predators (e.g., Helfrich and Allen, 1975). If either fish or crab fled from predators at this time reproduction would be disrupted. Reproductive stupor may thus be a "flight override" mechanism that ensures that the aggregations will complete their reproductive act successfully even though some individuals will be lost to predators. Sea turtles, though threatened when mating by fishermen and sharks, and when laying eggs by turtle hunters, also seem oblivious to predators at these times (e.g., McCoy 1974), perhaps for the same reason. Reproductive stupor does not appear to occur among smaller reef fish species that spawn in small groups and stay close to shelter to which they retreat quickly if approached (Johannes, 1978b).

The lunar rhythm of larval release in the land crab, *Cardisoma hirtipes*, was first described in the biological literature in 1971, for the Ryukyu Islands south of Japan (Shokita, 1971). But it is clear from accounts of travellers and anthropologists that the phenomenon is widespread and well known among the peoples of Oceania and was recorded by Westerners more than ninety years ago. Land crabs have been reported migrating to the water's edge on a lunar cycle (usually around the full moon) in Samoa (Pritchard, 1866), Fiji (Woodworth, 1903, 1907), Guam (Amesbury, pers. comm.; Safford, 1905), New Britain (Brown, 1910), Kosrae (Kusaie [Sarfert, 1919]), the Solomon Islands (Ivens, 1927), Tahiti (Stimson, 1928), the Cook Islands (Beaglehole and Beaglehole, 1938), Ponape (Bascom, 1946), Ifaluk (Bates and Abbott, 1958), and Satawal (McCoy, pers. comm.). The same phenomenon also occurs on Tobi, Yap, and Truk according to fishermen I interviewed on those islands. On Lamotrek Atoll the traditional name of the second day after the full moon means "shoo," referring to the belief that the moon shoos the land crabs back into their holes after several days spent on and near the beach (Clifton, pers. comm.). According to Trukese fishermen the traditional Trukese name for the night of the full moon is *bonung aro*, meaning "night of laying eggs," referring specifically to the lunar rhythm of the land crab.

By releasing their larvae at the peak of the highest spring tides land crabs maximize the offshore flushing and dispersal of their larvae, thereby reducing their loss to the numerous predators who live in shallow reef waters. Releasing the larvae at night when visibility is low further reduces their vulnerability to predators. Similarly green and hawksbill turtles lay their eggs at night. The eggs are covered and hidden from predators before daybreak. Many species of reef fish also spawn at or after dusk according to Palauan fishermen; often fish caught late in the afternoon from a spawning aggregation will be ripe, whereas those caught early the next morning are found to be spent.

But why are full moon spring tides apparently more suitable than new moon spring tides for these reproductive migrations? Certainly the migrating crabs and their larvae would be less visible to predators during the dark nights around the time of the new moon. The answer may lie in the need for some kind of compass during the crabs' reproductive migrations, particularly if they live some distance from the water. On Peleliu some crabs appear to move as much as a kilometer from their burrows through dense underbrush on reproductive migrations and are quite selective about the locations along the beaches at which they release their larvae. In some localities this species may live several kilometers from the sea (Minei, 1966).

Some decapod crustaceans can use the moon as a light compass (see review by Creutzberg, 1975). Schöne's (1963) work suggests that the crab, *Talitrus saltator*, orients specifically to polarized moonlight. Waterman and Horch (1966) discovered that a Florida member of the same genus as Palau's *rekung el beab* can detect polarized light. This species (later found to be *Cardisoma guanhumi*; T. Waterman, pers. comm.) also makes reproductive migrations that peak around the time of the full moon (Gifford, 1962).

These observations are all consistent with the possibility that *Cardisoma hirtipes* release their larvae around the time of the full moon, rather than the new moon, because moonlight (or perhaps specifically polarized moonlight) provides a celestial compass that guides them to and from the particular beaches on which they shed their larvae. The moon is not only brightest around the time of the full moon, but, in contrast to other portions of the lunar cycle, is also visible throughout the night.

Seasonal Rhythms

Not far from the equator, and bathed throughout the year by waters of almost uniform temperature, Palau experiences little of the annual weather cycles we associate with the seasons in the temperate zone. The direction of the prevailing winds changes with the seasons, but temperature, humidity, rainfall, and day length are relatively constant. The physical environment thus provides only subtle clues to the seasons. Nevertheless it is clear that life responds to these cues. Seasonal reproductive cycles are everywhere and obvious. Trees blossom[3] and birds nest according to regular seasonal rhythms well-known to Palauan villagers (e.g., Klee, 1972), and every season brings predictable changes around the reefs and lagoons.

Seasonal environmental rhythms are charted traditionally in Palau, as in the rest of Oceania, using a calendar based on the lunar month.[4] Although lunar spawners lay their eggs during the same portion of the lunar month year after year, their spawning dates wander all over the Gregorian month. For example, the *kotikw*, *Gerres oblongus*, begins to lay its eggs every year on the new moon of the first month of *ongos* (Palauan New Year's Day). But if we date the event according to the Gregorian calendar it lays them somewhere in October or November with a twenty-nine-day range from year to year. In the context of fishing in Palau it can thus be seen that a lunar calendar is more useful than the Gregorian calendar. The older men are familiar with the Gregorian calendar. But they use it mainly for such things as keeping appointments with younger

3. Seasonal variation in plant growth is not limited to the land. Kanda (1944) lists nine species of benthic marine algae that exhibit distinct seasonal periodicity in Palauan waters. Ngiraklang noted that seagrasses near Ngeremlengui bloomed mainly in March and April. In April of both 1976 and 1977 I observed several square miles of floating tufts of *Hormothamnion* sp., a benthic, nitrogen-fixing blue-green algae of the shallow reef, along the southeast coast of Babeldaob.

4. Hidikata (1942) first described Palau's traditional calendar. Klee (1972) has redescribed the Palauan system of time reckoning in considerable detail.

TABLE 3. Preferred Lunar Phases, Tidal Stages, and Seasons for Fishing at Ngeremlengui*

	Best Lunar Stage	Best Tidal Stage	Best Season
KESOKES			
Daytime	Around new and full moons	Last hours of falling spring tides	April–September
Nighttime	Around new and full moons	Last hours of falling spring tides	October–March
UNDERWATER SPEARFISHING			
Daytime	Around the second and fourth quarters	Neap tides. Water calmest at slack tide, clearest during early stages of incoming tide	October–March
Nighttime	More productive than daytime. 23rd to 30th, 1st to 6th (dark nights)	Easier when tide is low	October–March
DROPLINE FISHING			
Daytime	Around 2nd and 4th quarters	Around slack and early part of incoming tide	October–March
Nighttime	23rd to 30th, 1st to 6th (dark nights)	Hard to generalize (see text)	October–March
TROLLING			
Daytime	Hard to generalize (see text)	Rising tide	October–March
Nighttime	Moonlit portions of 7th to 22nd		October–March
REEF GLEANING			
Daytime	Around new and full moons	Spring low tides	April–September
PORTABLE TRAPS	no preferred time		
CAST NETTING	The best lunar phase, tidal stage, and season vary with the species being sought.		

*Superimposed on these determinants of good fishing are the spawning rhythms and diurnal migrations of the fish.

tion pathways coincide with those of tidal migrations described above. Other pathways are restricted to the reef flat and have no vertical component.

A number of biologists, most notably Edmund Hobson, have described similar twilight movements in other coral reef communities: "This activity involves movements that occur consistently in certain locations . . . specific routes are followed, in which certain species stream continuously past a given point in long drawn-out processions over a period of several minutes" (Hobson, 1972*a*, p. 720). He says elsewhere: "Even species that are solitary when their activity is confined to a limited area will join with others of their kind when migrating" (Hobson, 1973, p. 367).

Turtle Rhythms

Hawksbill and green turtles are still common in Palauan waters, even though they have been heavily fished. Nevertheless, say fishermen, their numbers and average size have decreased noticeably. Hawksbills nest in Palau, particularly in the Seventy Islands area, where they crawl ashore at night to lay their eggs in the sand. (A few green turtles nest on small islands north of Babeldaob and on Peleliu, but the major nesting sites in the Palau district are Helen Reef and Merir, small uninhabited islands south of the Palau archipelago.) Until the Seventy Islands were declared a marine reserve a few years ago, fishermen came to harvest hawksbill eggs for food and the adults for their shells, which were made into "women's money" and jewelry. In recent years Palauans have learned that the strong-smelling meat of the hawksbill becomes palatable when it is boiled several times, changing the water each time. Consequently the flesh is not wasted as it once was.

The nesting season of hawksbills in Palau stretches from June to January, with a peak, according to fishermen, in July and August. Like turtle fishermen throughout the tropics, Palauans are familiar with the fact that female turtles lay their eggs several times per season and individuals will usually return in the evening on a high tide to the same stretch of beach for each laying. It has been suggested that turtle egg harvesters probably originally discovered these facts by noting that individual turtles with distinguishing marks, such as scars, returned to the same beach to lay their eggs at regular intervals (Carr, 1972).

This may well be true, but Palauan legend records a more entertaining (and not entirely implausible) version of how the discovery was first made in Palau. Long ago during the time of the gods a young man and a girl fell in love. As the distance between their home islands was great they decided to rendezvous on Ngemelis Island which lay between them. They first met on the night of the new moon. When they awoke in the morning the girl could not find her grass skirt, and was forced to make a makeshift skirt from palm fronds. Before parting, the lovers agreed to meet again fifteen days later on the following full moon.

They arrived on the appointed evening, and as they lay by the beach they saw by the light of the full moon a turtle crawling toward them. Fragments of a grass skirt were entangled around one flipper. It was then that they deduced the fifteen-day egg-laying cycle of the hawksbill and the fact that individuals nest repeatedly on the same beach. (This could have been, inadvertently, the world's first remembered marine tag-and-recapture experiment!)

Palauans state that more turtles lay their eggs around new and full moons (that is, on spring tides) than at other times, although some egg-laying occurs throughout the lunar month. Turtle biologist D. C. Drummond similarly observes (personal communication) that more green turtles beach at Heron Island, Great Barrier Reef, on spring tides than at other times. He points out that as these turtles have an egg-laying cycle of about two weeks, and as they can delay laying in the presence of unsuitable conditions (such as insufficient water over the reef flat at high tide to facilitate their reaching the beach), a tendency for egg laying to synchronize with spring tides is not unreasonable. Hocart (1929) reported that turtles in Fiji lay their eggs largely around the full moon. As nesting there presumably also occurs at approximately two-week intervals, laying peaks therefore should also occur around the time of the new moon.

Palauans have taken the ability to predict when a turtle will return to its nesting beach two steps further. They have learned that by examining the eggs they can deduce how long ago they were laid. And if the eggs are less than fifteen days old they can estimate how many days will elapse before the parent returns to lay the next batch.

An egg, when laid, is rubbery and flesh-colored. But the shell begins immediately to calcify and harden. Calcification begins as a white disc that gradually enlarges and spreads over the entire shell. Up until the sixth day after the eggs have been laid, the experienced turtle hunter can estimate their age by the size of the calcified region. After the sixth day an egg must be peeled open and the size and state of the developing embryo used to determine the age of a nest. By the fifteenth day, for example, the umbilical cord is clearly visible. Using a piece of twine the fisherman ties a number of knots equal to the calculated number of nights that will elapse before the turtle will return to lay its next batch of eggs. By removing one knot each day he knows when it is time to intercept the turtle on its return to the beach.

This technique is not perfect because the fifteen-day egg-laying cycle is only approximate; the female may return on the fourteenth, or more rarely the sixteenth day. In addition, according to fishermen, the embryos do not develop at exactly the same rate, growing more slowly in shaded or overly moist nests or in rainy weather. (Too much fresh water collecting in the nest is liable to cause the eggs to rot, they say. Roots growing around the eggs will hinder the escape of hatchlings.[12]) Solomon Islanders apparently used similar criteria to determine when turtles would return to lay their next batch of eggs (Hocart, 1929).

A second observation allows the turtler to distinguish between an individual turtle's first clutch of eggs for the year, its last clutch, and intermediate layings. The eggs at the bottom of the first clutch are small, elongate, have little yolk, and seldom hatch. There are few misshapen eggs in the intermediate clutches. In the last clutch the eggs on *top* of the clutch are small and misshapen. It is as if the reproductive machinery of the turtle is a little rusty early in the season and falters once again just before it shuts down at the end of the season, producing inferior eggs in both instances.[13] Apparently the Polynesians of the Tuamotus are also aware of this phenomenon; Emory (1975, p. 217) states, "the last eggs to be laid were smaller than the others and were called *teke titi*. When such eggs were observed it was a sign that the turtle would not come ashore again that season."

Among a few Palauans a curious belief exists that the number of eggs in a nest will reveal how soon the female will return to nest again. Eighty-four eggs would mean four days, eighty-seven eggs would mean seven days and so forth. This notion can also be found among the natives of Truk (LeBar, 1952), the Tokelaus (Beaglehole and Beaglehole, 1938), and Tuamotus (Danielsson, 1956).

Turtles feed mostly during the night, early morning, and late afternoon. Often around midday they move into the lagoon and sleep on the bottom for two or three hours. The hawksbill generally sleeps in a crevice or cave in the reef; the green turtle more often chooses a sandy bottom, under an overhanging coral or rock. Both species also sleep during part of the night, hawksbills generally sleeping longer than green turtles. Both have customary sleeping places with which Palauans are familiar. The animals are easy to catch here because they are almost oblivious to disturbance. Palauans say a person who is hard to wake up *bad el wel*—"sleeps like a turtle."

12. For a more detailed account of the various hazards faced by turtle eggs according to Palauan fishermen, see Helfman (1968).

13. The first and last eggs laid by certain geckoes during their reproductive lives are similarly small and misshapen (Falanruw, pers. comm.).

In the village of Ollei it was customary to allow certain species of fish, particularly the rabbitfish, *Siganus canaliculatus* (*meas*), to mass on the spawning grounds for at least one day before pursuing them, thereby allowing a portion of them to spawn. Early in this century a chief in the village of Ngiwal similarly forbade catching some species of fish while they were spawning. (The vulnerability of spawning fish to Palauan fishermen is described in chapter 3.) These customs, like many others, were discontinued as a result of the disruptions of World War II.

An unusual conservation measure was once practiced in northeast Babeldaob. A type of herring, *Herklotsichthys punctata*, or *mekebud*, occurred in dense shoals at certain times of the year (Kramer, 1929). Jacks, particularly *Caranx melampygus* (*oruidl*), patrolled these shoals, often driving them into very shallow water. Frequently the *mekebud* would be driven right up onto shore in their efforts to escape[5] and here the people could readily gather them. Sometimes the *oruidl* also beached themselves as they chased their prey. Here, one might guess, was a double windfall as *oruidl* were also a favored food fish. It was the law, however, that stranded *oruidl* must be returned to the water so that in the future they might drive more *mekebud* ashore. (A similar traditional law exists in the Marshall Islands and is still in effect on Likiep Atoll according to Marshallese fishermen.)

The god of the small island of Ngerur, north of Babeldaob, owned the island's turtles. Consequently no turtle could be caught while on the island and no turtle eggs could be dug. In some other areas Palauans were not supposed to kill a nesting turtle until after it had laid several batches of eggs or until it had reached the water after nesting. When turtle eggs were harvested it was the law in certain parts of Palau that some had to be left to hatch.

The Impact of the Twentieth Century

Traditionally a Palauan's needs and wants were satisfied almost exclusively from within his internally regulated subsistence economy. He lived in a state of what Sahlins (1974) has described as "subsistence affluence." Because economic enterprise, according to Useem (1945, p. 570), "rated low in the scale of values, the accumulation of physical goods had no effect on a person's status, sense of security, or standard of living." And, as in much of Oceania, the Palauan worker had control of his own economic means. Sahlins

5. Palauan children sometimes catch *mekebud* by jumping from an overhanging mangrove branch into the midst of a school. The startled fish leap into the air and some of them land on the bank where the children scoop them up.

(1974) notes that this circumstance rules out elevating one's self through controlling the production of others, as is done in most industrial societies. "The political game," he states, "has to be played out on levels above production, with tokens such as food and other finished goods; then, usually the best move, as well as the most coveted right of property, is to give the stuff away."[6]

In accordance with this principle the traditional Palauan fisherman seldom sold his fish; he generally gave them away.[7] "To have is to share," is a traditional Palauan saying (Force, 1976). Ultimately some of the products of the recipients' labor were tendered in return.[8] Village social and economic life were in this way intimately entwined. One impact of foreign cultures on Palau has been to erode this system.

Japanese colonists imported a variety of trade goods and set up stores to provide Palauans with the incentive to work for them (e.g., Yanaihara, 1940). This planted the seeds of a new economic order, subsequently nurtured by the United States, whereby goods are seldom shared, but rather bought and sold.[9] The fisherman began to sell some of his fish to the Japanese in order to obtain the money to purchase these attractive new commodities. In order to catch enough fish to continue, in addition, to supply the needs of his village he had to fish harder. But among the newly imported goods were excellent nets, motorized boats, and a host of other items that made his fishing easier. The creation of export markets (e.g., Japan for trochus shell, Asia for sea cucumbers, and later, during the U.S. administration, Guam for reef fish) expanded his opportunities for earning money.

At first the reefs withstood his increased harvesting pressure because motorboats facilitated fishing in more distant areas seldom exploited in the days of dugout canoes and chronic warfare. But eventually his catches began to drop while imported inflation occasioned by Palau's increasing participation in external markets caused operating expenses to climb. Increasingly he found himself forced to compete with his fellow fishermen for money and thus for fish. He abandoned the leaf sweep, which employed a dozen or more

6. It is sometimes assumed that giving away the fruits of one's labor in a communal society is less egocentric than selling them in a capitalistic society. Such is not necessarily the case, as Sahlins clearly points out in this passage. Palauans do not generally strike the observer as being particularly altruistic.

7. There was some sale of certain highly valued marine animals, such as dugongs, by villages in whose waters they were found, to unendowed villages (Kubary, 1895).

8. One consequence of this traditional mode of distribution in Palau is that older Palauans often refuse to believe that there can be places in the world where people go without food simply for lack of money.

9. Unlike many Pacific islanders Palauans had a traditional form of money, but it was used mainly for ceremonial transactions (e.g., Force, 1976).

investing it—in projects that often bore no relation to the welfare of one's fellow Palauans. The chiefs became increasingly troubled by the actions of the elected members but could do little about it. The U.S. administration dealt primarily with elected members and tended to ignore the chiefs, who "were accorded courtesy, but little more" (McKnight, 1972).

Meanwhile, Trust Territory conservation laws, which the old people welcomed, were being widely ignored. Dynamite was used to catch fish, thereby destroying reef habitat on which the fish depended for food and shelter. Dugongs, which were totally protected and on the Endangered Species List after being hunted almost to extinction, were still killed surreptitiously. Undersized and out-of-season turtles and their eggs were openly harvested. Small mesh nets captured very young fish.

Trust Territory conservation personnel had little incentive to enforce the few conservation laws on the books. Their lives were sometimes threatened when they did. The chief conservationist had a spear thrown at him one night through his dining room window. Moreover when violators were caught they could depend on very lenient treatment if they had a relative with influence in the government—and almost everyone did; the Palauan extended family extends very far indeed. The chiefs had no legal right to enforce Trust Territory conservation laws and their informal attempts to support them[17] were not always respected. One chief told me that when he tried to reprimand a man for taking an undersized turtle the man replied that the laws governing the taking of turtles were Trust Territory laws and none of his concern.

Those few traditional conservation customs that had survived, such as reef and lagoon tenure, were taken more seriously by potential transgressors. If one was caught breaking a traditional law, punishment was fairly certain and often rather severe by contemporary American standards. "I'm not scared of the court, but I'm scared of the Palauan custom," was a phrase I heard often. "When you are punished Palauan style you are really punished!" But most traditional conservation laws lived only in the memories of a few old men.

Ngiraklang was one of a number of chiefs I talked to who deplored the decline of the conservation ethic. One evening I asked him what he would like to do to rescue Palau's deteriorating environment. "Nothing," he said rather grimly. His answer perplexed me. So a few days later I asked the question again, phrasing it

17. Not *all* the chiefs were concerned. A few helped throw the dynamite and dig the turtle eggs.

differently. "Suppose you were king of all Palau and could make and enforce any laws you wanted to. Would you make any changes to help protect Palau's natural resources?" This time my question elicited a long and thoughtful answer. After he had finished I asked why he had been so negative when I had brought up the subject earlier. "Today we were imagining, and I was the king of Palau," he said. "If there were such a king, he could do something. I can do nothing. I know for I have tried."

He went on to describe how for a number of years he had been a member of the Palau legislature. He had repeatedly introduced conservation legislation but it was never brought to the floor. Every year, for example, he tried to establish laws to control hunting of the diminishing Micronesian pigeon. Ever since guns replaced blowguns among Palauan hunters, pigeon populations had been shrinking. But the younger men who dominated the legislature were not interested in conservation; either it interfered with their pleasure or with their business. So Ngiraklang finally gave up.

A Renaissance, Perhaps

In the mid-1970s a new generation of Palauans began to make themselves heard. The environmental awareness that mushroomed in the West in the late 1960s was spreading to Micronesia. "We have an entirely different point of view than most of our legislators," one Palauan in his late twenties told me. He continued:

> They were trained to think of our traditions and culture as backward and to think of progress just in terms of money. But we who have recently returned from schooling abroad have learned of the consequences of unplanned economic development, and have begun to realize that our traditions and our culture retain considerable value. That does not mean that we want to shut out the rest of the world. That is impossible. But if we accept technological progress uncritically it could mean the end of our culture and the destruction of the environment in our small islands.

A new awareness was testing the Palauan "conviction that new ways do not mean the dissolution of Palau Society" (Useem, 1955, p. 132).

Ecology became part of the high school curriculum in the 1970s. The results soon became visible. In 1976 teachers and students at Koror High School sponsored a panel discussion on whether Palauans should support plans to develop a giant international oil storage and transfer depot amidst Palau's reefs. A prominent Palauan businessman-politician, who strongly favored the superport but who, it appeared, wanted to seem impartial, addressed the students. If they wanted to be fishermen like their fathers, he said, then he would be

On Tobi, unlike Palau, there are no forests, streams, lakes, or mangrove swamps. Thus there are no jungle fowl, freshwater fish and shrimp, fruitbats, or mangrove crabs. (A single stray crocodile reached the island a few years ago and was speared and eaten.) A narrow fringing reef provides the only significant source of animal protein other than the open ocean. Such shallow coral reef communities may, when intensely harvested, yield as much as twelve metric tons of fish and shellfish per square kilometer (Hill, 1978).[2] Because Tobi's reef occupies an area of about one and a quarter kilometers, its maximum annual yield of seafood would probably amount to no more than about fifteen metric tons. Shared by 986 people, this would have allowed each an average of only about thirty-six grams of flesh or about ten grams (about one-third ounce) of protein per person.[3] The reef therefore could not have been the sole source of animal protein. (Curiously Tobians did not eat a variety of easily harvested reef invertebrates [e.g., sea cucumbers, sea anemones, sipunculids, starfish] eaten by Palauans and other Pacific islanders.) It can thus be seen why Tobians have depended heavily on the waters beyond the reef for their catch. Of forty-one Tobian fishing methods listed by Black (1968), thirty-three involved fishing beyond the outer reef crest.

So steeply does the bottom fall away as a canoe pulls past the breakers on Tobi's reef that within seconds only blue water can be seen beneath. A trip of a few hundred meters takes a fisherman from his house to the open-ocean fishing grounds where he seeks tuna, dolphinfish, rainbow runners, wahoo, marlin, sailfish, barracuda, flying fish, and sharks.

Until recently the fishermen of Tobi also sailed periodically to Helen Reef, a tiny uninhabited atoll thirty-nine miles to the east, in order to get turtles and giant clams.[4] According to informants these clams (*Tridacna*) were once common on Tobi's reefs but were virtually exterminated by overharvesting. (A single large giant clam was discovered on Tobi in forty feet of water in 1968.)

2. This value is much higher than other published yields calculated for reef fisheries (e.g., Stevenson and Marshall, 1974). This is because the other estimates relate only to commerical catches, whereas Hill (1978) measured yields on Samoan reefs that were heavily gleaned on a subsistence basis for small invertebrates and fish as well as the larger commerical type specimens—in other words, reefs harvested with similar intensity to Tobi's.

3. This figure is calculated assuming fresh reef fish average 27 percent protein (Murai et al., 1958).

4. The Tobian name for this atoll is *Hocharihie*, "Island of the Giant Clams." Sadly this lovely place, containing the most beautiful reefs I have ever seen, has been one of

Learning to Fish

Traditionally Tobian boys went through long and rigorous training before mastering all the fishing techniques to which they could legitimately aspire, generally reaching middle age before having a chance of being considered a *marusetih* or master fisherman. At seven or eight years of age they would begin their fishing careers. Fishhooks were too precious, prior to the introduction of metal, to be entrusted to neophytes. Consequently a young boy's fishing gear consisted only of a very fine line. A loop was tied on the end, in the middle of which a piece of hermit crab was suspended as bait. Gathering on the reef flat at low tide the boys used these simple devices to noose small fish in tidepools. A small unidentified jack was especially sought after; the rough lateral keel on its tail helped prevent the noose from slipping off it. The boys were restricted to this kind of fishing for three or four years. Fishing at such close range to the fish, they learned much about the behavior of different species.

In the meantime they were taught how to make fishhooks out of shell or bone. Only after they could make them well—a demanding operation (see Chapter 9)—were they allowed to use them. Their training continued in a series of steps involving the use of poles, hooks, and lines on foot in shallow reef waters. The final stage in this period, when the boys had reached late adolescence, involved learning how to cast out beyond the reef crest to catch larger fish living on the outer reef slope. This was the first time the boys engaged in a fishing technique routinely used by adult fishermen.

This traditional training schedule exists today in attenuated form. Young boys are encouraged to fish on the reef for small fish but the procedure is less rigid than it used to be. Baited hooks are used because metal hooks are now cheap and expendable. Otherwise boys go through the same general progression as their ancestors, but in a much shorter time. As on most tropical Pacific islands, there were numerous onerous fishing taboos and protocols, often of a religious

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the subjects of systematic pillage by Okinawan, Taiwanese, and Korean fishermen. These men have ravaged reefs from the Marshall Islands through western Micronesia and all the way to Australia's Great Barrier Reef in their search for giant clams. In addition to decimating the atoll's giant clam populations (Bryan and McConnell, 1976), a party of Korean fishermen recently devastated rookeries of several species of sea birds in their quest for food and cut down most of the islet's palm trees, rather than climbing them, to get the coconuts.

Helen Reef and Merir, another uninhabitated island in the South West Islands, are the most important green turtle nesting sites anywhere within U.S. jurisdiction (Pritchard, 1977). Unfortunately a small number of Palauans habitually harvest turtles illegally during visits of the government supply vessel to Helen Reef. South West Islanders resent these intrusions—illegal according to both traditional and modern laws—but cannot stop them; the Palauan government has simply ignored complaints concerning these activities.

nature, that had to be learned by apprentice fishermen. But with the introduction of Christianity many of these practices ceased (Black, 1977). Today boys are sometimes allowed to fish beyond the reef as soon as they are physically capable of doing so, due to a shortage of manpower. Depending on their fathers' judgment of their physical maturity and strength, boys from thirteen to sixteen are now crewing on the large canoes and trolling for tuna or netting flying fish. After a year or two of instruction by older male relatives the boys start going out with friends and brothers.

In theory no Tobian can master all traditional fishing techniques, for some are considered private property. (Virtually the only things that are owned outright among the communal Tobians are nonmaterial. These include not only fishing techniques but also certain songs and medicines.) As a general rule the more difficult a technique, the fewer people that own it. A boy gaining his initial access to a one-man canoe is told by his father which of the techniques he may legitimately use. Once having mastered these techniques he is drawn to those belonging to others and he proceeds to try to "steal" them. (This is the Tobian term and refers to acquisition of a technique by covert observation.) Arguments concerning this practice are frequent. Serious confrontations are avoided, however, by directing accusations and retorts back and forth from a distance and over an extended period of time through a chain of intermediaries.

Such ownership practices have eroded among South West Islanders in Koror; many of their techniques are inapplicable in the lagoon fishing areas to which they have easy access. Only once during my interviews in Koror did a man explain politely that he could not answer my question because the relevant knowledge was a family secret.

Traditional Marine Conservation

Secrecy probably functions as a conservation measure; if the knowledge needed to exploit a particular area or species is restricted, the likelihood of overexploitation is lessened (e.g., Forman, 1967). (Conversely the "stealing" of a method helps reduce the risk of it being lost if its legitimate owner dies without heirs.) A variety of other South West Island customs also functioned to conserve certain species. Some of these practices were imbedded in ritual and it is impossible today to determine whether or not they were originally intended as conservation measures.

Octopus, for example, could not be eaten on Tobi except by the elderly. Octopus make excellent bait but are not abundant around Tobi. Was this restriction set forth originally in order to maintain the bait supply? Today Tobians no longer remember. A variety of other species were taboo to part of the population or during part of the year. Still other edible species were forbidden to all at all times. Such complete prohibitions *appear* not to have been erected as conservation measures as their effect seems functionally equivalent to exterminating the species in question. However we cannot assume that when survival was at stake Tobians did not set aside such taboos.

Some South West Island customs were clearly designed with practical conservation in mind. As described earlier, seabirds help fishermen find fish. In a conscious effort to conserve the populations of these birds it was forbidden on Sonsorol to eat them except during the nesting season when they were very abundant. The use of fish poisons was also restricted to certain special occasions on Tobi and Sonsorol because it killed too many juvenile fish, thus reducing the future supply.

Although turtles were never abundant around Tobi within living memory (see also Holden, 1836), their numbers seem to have decreased even further in recent years. Several years ago it was decided at a meeting that turtle eggs (a great delicacy) would no longer be eaten, so there would be more turtles to eat in the future. Anyone who violated the new law would be fined. A person finding a nest of turtle eggs reported it to the magistrate who immediately fenced the site to keep the hatchlings safe from cats. When the eggs hatched (the time can be predicted to within a day or two) the hatchlings were not allowed to make their dangerous trek across the beach and reef to the open sea. To the apparent frustration of the many seabirds that gathered at the first sign of hatching, the hatchlings were gathered up. They were kept in a large bucket and fed finely chopped fish. When they were judged big enough to have a good chance of surviving they were ferried by canoe out to the open sea and released.[5] (Unfortunately, a new crop of teenage boys not in on the original decision began eating all the eggs they could find recently.) A similar conservation measure was introduced at about the same time on Sonsorol.

FISHING METHODS

Several dozen different fishing methods are used in the South West Islands. Trolling for large pelagic fish and dipnetting flying fish by torchlight are by far the most important methods in terms of

5. The extent to which turtles depend on their trip across the beach and reef in order to "imprint" on their birthplace and find it again at egg-laying time is unknown. If this trip is an important part of the imprinting process then these efforts at conserving turtles may, in fact, deplete them even further.

On the upstream end of an island the current divides and is directed past the island on either side. Shoreward of the point where the current divides is an area of still, calm water with almost no current which Tobians call the *suriyout*.[1] Two narrow streams of turbulent water called *arm* extend downstream from the sides of the island, paralleling the prevailing current. Five to forty meters wide, each *arm* is sufficiently rough so that crossing it in a canoe can be hazardous. It was an *arm* that we had passed through near Sonsorol. These twin currents usually increase in width and decrease in turbulence with distance from the island. They extend downstream for a variable distance, sometimes to a point from which the island can no longer be seen, gradually curving toward each other. Ultimately they converge, creating an area of exceptionally rough water, called *hapitsetse*.[2] (If such a convergence can be found near Pulo Anna, fishermen there were unaware of it, although their description of the currents around their island coincided with those described for Tobi and Sonsorol in other details. Tobians said their *hapitsetse* disappears when the currents are weak.)

Leading back from the *hapitsetse* toward the island is a kind of backwash, or reverse current, running between the two *arm*. Patris explained it like this: "You know when you throw out a cigarette behind your canoe when you are sailing? Sometimes instead of being left behind it is sucked forward toward the stern. The same thing happens in the current directly behind Tobi. After we have been fishing downstream from the island we ride back to it easily on this current." Like fishermen, he said, turtles also tend to beach on the downstream side of the island, riding this backwash toward shore.

The wake current system as a whole is known on Tobi as the *hasetiho*. What did physical oceanographers have to say about such a current system, I wondered. Consulting the literature when I returned

1. Although parts of this chapter are based on information from Sonsorol, Tobian terminology is used throughout for the sake of clarity. Although inhabitants of the South West Islands all speak the same language, each island has a distinctive dialect. For example, *suriyout* is referred to as *doriyout* in the Sonsorolese dialect.

2. According to Mariano, a Japanese fisherman living on Sonsorol before World War II once approached the *hapitsetse* too closely in his canoe and was swept into a whirlpool. While clinging to the bow of his upended canoe as it revolved, he was spotted by a Sonsorolese fisherman who paddled his canoe as near as he dared. As the other man swung by he leaped from his canoe and grabbed the bow of his rescuer's boat. The Sonsorolese man back-paddled as hard as he could and the two men made it to safety.

Marine biologist John Miller (1973) described dye studies downstream of the islet of Molokini in Hawaii, the results of which indicated the existence of a pair of currents which converge in a manner similar to *arm*. Because of the exceptional turbulence at this spot, it is known to local boaters as The Washing Machine (Gene Helfman, pers. comm.).

to the United States I learned that they had reported two basic types of wakes downstream of oceanic islands (figure 4). One consists of a trail of more or less random turbulence. The other, called a von Karman vortex street, consists of a trail of eddies. The eddies form near both lateral edges of an island, enlarge as they drift downstream, and are shed laterally, first from one side of the wake, then from the other in a regular sequence. Neither of these wake types corresponded to what South West Island fishermen had described to me.

If no such current pattern existed, why had informants from islands separated by more than 100 miles of open sea been so uniform and explicit in their accounts of it, even possessing special words in their dialects for its features? Later, in a recently published thesis in anthropology, I found additional evidence for its existence. Fishermen from Linungan Island in the southern Philippines had

FIGURE 4. Current patterns caused by an obstruction such as an island in a prevailing current. (a) von Karman vortex trail; (b) Random turbulence; (c) Stable eddy pair.

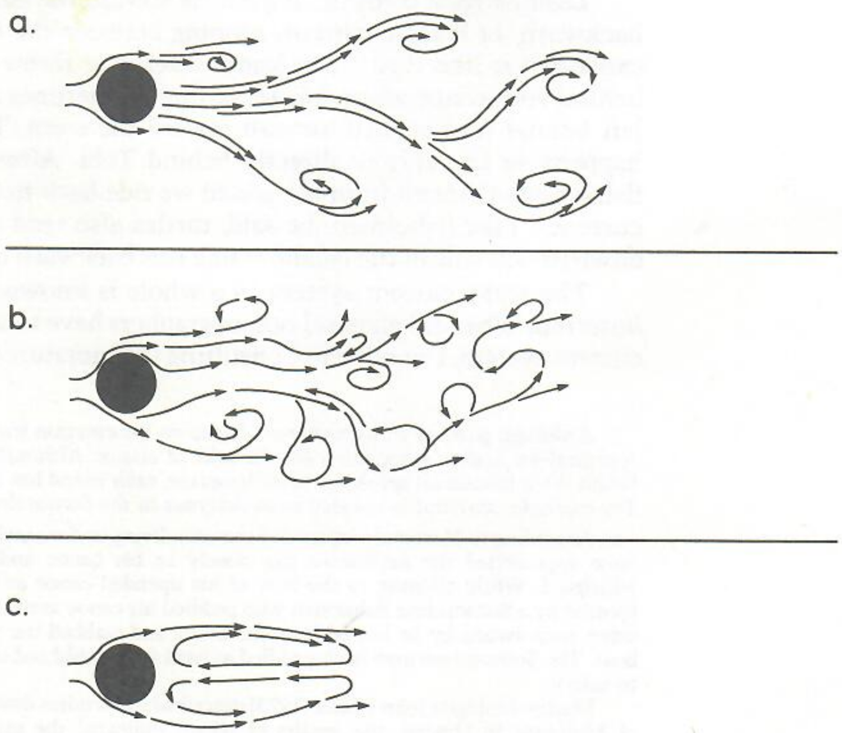


TABLE 5. Seasonal Changes in Weather, Wave, Current, and Fishing Conditions around Tobi.

Month / Approx. Tobian Equivalent	January / Tahebor	February / Yahemaus	March / Tumuch	April / Masichik	May / Masirap	June / Tauta	July / Tukumar (Tirotamau)	August / Huh	September / Ur	October / Erir (Yoruyoru)	November / Mar	December / Iich
WINDS AND WEATHER	Northeasterly, weak		Easterly or no wind, thunder	Easterly, weak, clear			Easterly, or no wind, rain, thunder		Northwesterly, moderate, dry			
CURRENTS	Southeast, weakening	South, weak	Southwest, very weak	Currents weak and unstable, direction often changing with the tide			South to east strengthening	South to east, strong				
WAVE STATE	Diminishing	Low						Picking up	High			
SKIPJACK & YELLOWFIN TUNA	Mostly large yellowfin, feeding on squid and flying fish	Small yellowfin mixed with skipjack move offshore before dawn, spread out all around Tobi in shallow water, returning in early evening eating small fish					Remain in *Suriyout* during day eating small fish, move offshore at night; Best tuna fishing season		Mostly large yellowfin, feeding on squid and flying fish			
JUVENILE REEF FISH		Particularly abundant		Abundant								
FLYING FISH AND NEEDLEFISH								Abundant, eggs appear in September. Spawning from October through June				
WAHOO			Very abundant, with eggs			Abundant						
GREEN TURTLES (Helen Reef)	Mating starts			Egg-laying. Numbers of eggs laid per nest decreases as the nesting season progresses, from 100-150 in April to around 70 in October								No turtles
SEABIRDS			Nesting: Brown noddy, black noddy, white tern						Lesser frigate birds common; no nesting (nests on Sonsorol)			
DRIFTING LOGS							Some logs		Best log months			

Island fishermen. They seemed as interested in this glimpse of the larger pattern as I was in the details of the local circulation they had taught me.

Fishermen of all three islands noted that in some years the prevailing currents behave atypically. For example, in Tobi the direction of the current occasionally shifts systematically counterclockwise for several months. Oceanographic observations in this region confirm that current patterns differ appreciably from the norm in some years (e.g., Inanami, 1941).

Prevailing currents around Tobi are weakest from April through February. Pelagic juvenile reef fish are also most abundant around the island during this time. (The apparent connection between these two phenomena is discussed in Chapter 3.) Tobians are particularly aware of seasonal changes in abundance of juvenile reef fish because of their importance as food for tuna. Few schools of small, surface-feeding tuna, and few seabirds, are present from September through January. The return to Tobi waters of large numbers of tuna and seabirds beginning in late February is believed by fishermen to be linked to the increased availability of pelagic juvenile reef fish. Egg-bearing *yar* or wahoo (*Acanthocybium solandri*) are also more abundant around all three South West Islands (and Palau) in the spring.

Mackerel tuna (kawa kawa) and dogtooth tuna remain near the islands at all times according to fishermen. But yellowfin tuna, skipjack tuna, and a large needlefish all make predictable daily migrations to and from the waters near the islands, and these migrations vary in character with the season. During January and early February at Tobi, for example, skipjack, yellowfin, and needlefish move offshore after midnight and return by mid-to late afternoon. Skipjack move offshore and return earlier than yellowfin. Needlefish tend to leave and return earlier than either of the tunas. The phase of the moon reportedly has some influence on the timing of these movements; fish are said to leave the island later during the dark nights around the new moon and return later.

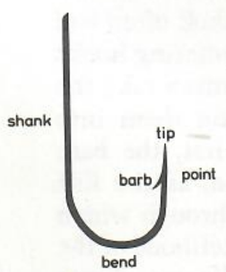
These daily migrations take tuna and needlefish from the calm waters of the *suriyout* along the *arm* in the direction of the *hapitsetse*. Seabirds leaving the island at dawn to hunt for the small fish that the tuna drive to the surface also generally fly off in this direction. Both birds and fish also generally return from this direction.

From February through June the tuna move offshore before dawn and are found during the day spread out near the surface all around the island. During this period of weak prevailing currents around Tobi, the schools of small fishes on which the tuna feed are also spread out around the island. When the prevailing current picks

(1856, p. 133). Of Tahitian hooks Wilson (1759, p. 386) said, "notwithstanding the form which to us appears most clumsy and crude, they will succeed, when we with our best hooks cannot." "In my opinion the Polynesian incurved hook . . . is mechanically superior to hooks of our kind," said Nordhoff (1928, p. 44). "The old Hawaiian fishermen caught more with these peculiar hooks than they could with the more dangerous looking hooks of the foreigner," stated Brigham (1903, p. 8).

Adding to this testimony are numerous reports that Pacific islanders had little use for metal fishhooks of European design, reshaping them and often removing the barb. Ellis (1859, p. 150), for example, claimed that the Tahitian fisherman "would rather have a wrought iron nail three or four inches long, or a piece of iron wire of the size, and make a hook according to his own mind than have the best European-made hook that could be given to him." Even a relatively fragile pearl shell hook was considered "much better than any made in Europe," Ellis stated.

An examination of Tobian fishhooks helps explain these conflicting accounts. Of the thirteen basic hook patterns in use on Tobi, the invention of all but one appears to predate the introduction of metal to Oceania. And when the older Tobian fisherman does come into the possession of an imported hook, he sometimes modifies it strongly before use, just as his ancestors did in the nineteenth century.[2]



The feature of many Pacific island hooks that most often perplexes the Westerner is the strongly in-curved point. The tip, instead of pointing upward, points inward toward the shank, or even downward (figure 5 and plate 21). Western fishermen unfamiliar with such hooks instinctively doubt their effectiveness. When noted American angler Harlan Major first saw one, for example, he was skeptical that "it would catch—to say nothing of hold—any fish" (Major, 1939, p. 52). But the design is intentional and the hook highly effective when employed properly. Called a rotating hook,[3] it is used under conditions where it is difficult to set the hook by jerking the line sharply when a fish bites. Such conditions occur when dropline fishing either in deep water or in strong currents. In either case water currents cause the line to "belly," or curve, rather than hanging straight down. Jerking the line tends simply to straighten it somewhat and little of the energy applied is transferred to the hook.

2. According to Holden (1836), Tobian fishermen could not be induced to use the European hooks his crew gave them "till they had heated them and altered their form."

3. Nordhoff (1930) learned how these hooks functioned and appears to have been the first writer to use the term "rotating" to describe them.

The fisherman allows a fish that has taken the bait under these conditions to swim with it for a time. As the fish swims away from the fisherman and roughly parallel to the line, the hook is usually pulled to the corner of the jaw. When this happens the point catches on the flesh of the inner edge of the upper jawbone and serves as a pivot point for the hook. Increasing tension on the line meanwhile causes the shank to compress a portion of the upper jaw (figure 5a). As line tension causes the hook to pivot, the jaw is squeezed between point and shaft and forced through the gape of the hook into the bend (figure 5b). This releases the pressure of the shank on it and causes the compressed portion of the jaw to expand to its normal dimensions. The incurved point now holds the fish on the hook; the diameter of the flesh and bone contained within the bend is now greater than the width of the gape of the hook. The jaw would have to be compressed once again in order to slip back out through the gape. There is no simple means by which the struggling fish can bring to bear the appropriate pressure to accomplish this. As the fish turns more or less at right angles to the line to fight the increasing pressure, the hook rotates in the jaw, forcing the point completely through it (figure 5c). The line is generally attached to the inner side of the shank to favor this rotating motion.[4]

Because turtle shell hooks were somewhat flexible the gape would widen slightly when a fish pulled against the line, making escape somewhat easier than is now the case with metal hooks. Consequently Tobian rotating hooks made of turtle shell often had barbs to offset this tendency. Tobian stainless steel rotating hooks have no barbs. Tobians, like other Pacific islanders, often take the barbs off manufactured metal hooks when reshaping them into rotating hooks. There are three reasons for this. First, the barb reduces the ease of penetration of the point. Second, as the fish fights, the barb tends to tear at and widen the hole through which the hook penetrates the jaw, thereby increasing the likelihood of the hook pulling out. Third, the barb constitutes an impediment when a fisherman unhooks his fish. Rotating hooks hold fish very well without a barb. In fact one disadvantage of a rotating hook is that it is so difficult to unhook, even when unbarbed, that it often has to be cut out of the fish (see also Kawaguchi, 1974).

The greater the slack in the line the less control the fisherman has over the fish, and the greater the need for a hook that will hold a fish securely in the absence of tension. Most rotating hooks on Tobi are therefore made in two different models depending on the depth at

4. Nordhoff (1930) made the same observation with regard to Tahitian line attachments.

which they are to be used. Although both models are basically deep water hooks, the model with the point closest to the shaft is used in the deepest water when the belly in the line will be greatest and the line slackest. A variable compromise is thus made between the speed and ease with which a fish can be hooked (faster and easier when the gape is wide) and the likelihood of retaining the fish on the hook (greater when the gape is narrow). Deep water fish are worth the extra time and care involved in hooking them. The deeper Tobians fish, the larger, on the average, are the fish they catch.[5] They fish to depths of more than 600 feet.

Also influencing the fisherman's choice of the particular type of rotating hooks to use is the number of sharks in the vicinity. When sharks prove troublesome, a hook with a wider gape is used. Fish escape more easily from such a hook but they hook up faster. This reduces the time they must be played and during which they make easy targets for sharks.

The range of compromise between the speed and the secureness with which a fish can be hooked is further extended by another basic fishhook type, the "jabbing" hook. This is a shallow water hook used with a taut line in trolling, shallow dropline fishing, and pole fishing and is of the general design most familiar to Westerners. There is little if any inward curve to the point and the gape is generally greater than that of a rotating hook. A fisherman jerks a taut line to set this hook. Only the barb, if it is present, plus sustained tension on the line, prevents a fish from throwing a jabbing hook. And as the hole in the jaw created by such a hook becomes enlarged during the struggle, the barb holds the fish progressively less securely. The fisherman must thus land the fish as quickly as possible.

Whether a jabbing hook is used with or without a barb often depends on how fast the fish are biting. Tuna in a school feeding at the surface often bite voraciously. But the school usually dives after a few minutes, so as little time as possible must be wasted unhooking fish. In this kind of fishing the fisherman's skill is measured largely by the speed with which he lands and unhooks fish and gets his hook back into the water. Concerning similar fishing in Tahiti, Nordhoff (1930, p. 215) states:

> The skill of a bonito-fisherman may be judged from an inspection of his hooks. A green hand uses long points, very sharp, to ensure landing every fish that strikes. The expert uses short, blunt points, just sharp enough to lift the fish out of the water before they drop out of the jaw.

5. An increase in mean size of fish with depth has often been noted by biologists (Helfman, 1968), but no one as yet has come up with a generally accepted explanation for this trend.

> While the beginner is landing a dozen bonito, many of which must be disengaged from the hook by hand, the adept will have pulled out of the water fifty fish and landed forty-five of them without touching the hook.

Under such conditions many Pacific island tuna fishermen, including Tobians, traditionally used barbless hooks, as do tuna pole fishermen of countries throughout the world today.

A barbless hook has the added advantage of penetrating the fish's mouth faster and with less resistance. Barbless jabbing hooks are also used in the South West Islands for pole fishing on the reef; a fish has little time to struggle and escape before being yanked from the water when hooked under these conditions. The same hook type is used for shallow dropline fishing when the fish are biting rapidly and, as in the case of fishing for surface-feeding tuna, speed of unhooking is important. Much line fishing is done at night on Tobi. The ease with which an unbarbed jabbing hook can be removed from a fish is also an advantage on a moonless night when the fisherman cannot see clearly what he is doing.

There are nine basic types of Tobian jabbing hooks. All are for use in shallow water. As with rotating hooks several of these types come in two different models. Once again the model with the point closer to the shaft is used with a slacker line than the other model with a wider gape. But whereas the point is curved inward to bring it closer to the shaft in a rotating hook, the shank is bent to bring it closer to the point in a jabbing hook. The straight-shanked version is used for trolling close to the canoe—a situation in which the line is almost always straight. Bent-shanked jabbing hooks are used in trolling with a long line and for shallow dropline fishing—situations in which the line is more curved and the tension more variable.

Until recently only the subjective impressions of Pacific island fishermen and their European converts could be used to support the contention that incurved hooks are superior to those with straight points. But recent trials conducted in the Caribbean (Kawaguchi, 1974), in Scandinavia (Hamre cited in Hurum, 1977), and in Great Britain (Forster, 1973) have demonstrated that in dropline fishing incurved hooks catch more fish.

The incurved points of rotating hooks also render them less liable to hook up on the bottom—an important feature when dropline fishing over coral-studded bottoms. Before the arrival of metal, rotating hooks had an additional advantage over jabbing hooks. Bone or shell hooks could not be jerked as hard as metal hooks for fear of breaking them. Therefore a hook that imbedded itself in a fish's mouth when only a gentle pull was exerted on the line was valuable even in shallow water, particularly when large fish were being sought.

would break such shell hooks, wooden hooks of the same design were used to catch them. The shrub *Pemphis acidula*, which has very hard wood (Stone, 1970), was used for this purpose in the Tuamotus. This plant is very common and widespread throughout the coastal tropical Pacific and it is probable that it grows on Tobi. But unlike many Pacific islanders, Tobians do not appear to have used wood for making fishhooks.

Another unusual Tobian hook is called *man tanante. Man* means "being" or "person." *Tanante* is a corruption of the name Ternate, an island about 300 miles southwest of Tobi in the Moluccas. The hook name commemorates a man from Ternate who accidentally drifted in his canoe to Tobi many generations ago and introduced the design.

The design is unusual among metal hooks in that the shaft is scarcely longer than the point. I was not able to understand the functional aspects of its design, but was told that it is the Tobians' most versatile hook, and is therefore used in instances where the fisherman is unsure as to what kind of fish he is liable to catch. Once he determines which fish are biting he often switches to a hook more specific to that fish.

Traditional Pacific island fishhooks clearly suffer in comparison with Western hooks in some regards. Metal hooks have greater tensile strength. Metal and shell hooks of the same style are therefore of somewhat different shapes and proportions. Shell hooks are usually thicker throughout. Jabbing shell hooks are also often reinforced at their weakest point—the bend—with a kind of triangular keel, particularly if they were to be used on a lure for trolling for large fish. Shell hooks also tend to have shorter shanks than comparable metal hooks because of the greater likelihood of a fish biting through or snapping a long shank.

Because the manufacture of shell hooks was so time-consuming, they were treated with great care. On Tobi if a grouper ran into a hole in the reef with a hook, the line was not broken off and the hook sacrificed as it usually is today. Instead steady tension was kept on the line until the grouper finally emerged—sometimes as much as an hour later. If a hook got snagged on a coral, a rock was attached to a second line, hooked on the fishing line, and slid down it. A little slack was let out in the fishing line so that the rock weight would pull on the hook from below, thereby sometimes unsnagging it in situations where an upward pull was of no avail.

Despite the labor involved in making turtle shell hooks and the fact that Tobians have had enough metal to make metal fishhooks since before the turn of the century, they did not abandon the use of turtle shell hooks completely until the late 1930s. One advantage of the latter, according to Patris, is that many fish seem not to like the taste of metal. Once they throw a metal hook they are not soon likely to bite again. Bone or shell hooks, however, apparently taste "natural"; a fish is more likely to bite again on such hooks if not hooked the first time.

A device that operated much like a primitive bow drill (plates 22, 23) was used to cut hooks from turtle shell. (Unlike some Pacific islanders Tobians never used heat to mold their turtle shell hooks.) Instructed by the older men, Patris made one of these instruments for me—probably the first to be made in the South West Islands in many decades. The size of the hooks being cut could be varied by using an adjustable wooden wedge lashed between the cutting teeth and the pivot tooth. The drill was rotated gently and repeatedly to cut through the shell. The hook was then finished using a file made from coral and "sandpaper" made from the abrasive skin of the nurse shark.

Some turtle shell trolling hooks not only had a barb in the conventional position near the tip, but also a barb facing it, projecting from the shank. These hooks were used when one man trolled with two lines. Although the second barb made it harder to hook a fish, it made it easier to hold a hooked fish on an unattended line while the fisherman played a fish on his other line. Occasionally a second barb was placed facing outward near the tip for the same purpose. Paired barbs were never used on rotating hooks.

Superimposed on the thirteen basic Tobian hook designs (appendix C) are many intergradations in style, some with special names. In addition there are other subtle variations on these designs, all of which are considered by their makers to be of functional rather than stylistic significance. I was often unable to perceive these variations when examining the hooks, nor did I clearly understand their significance when it was explained to me.

If I had had more time and opportunity to fish with the Tobians so as to test all these designs and their variations thoroughly, I have no doubt that this chapter would be much longer. Nevertheless this brief survey makes it clear that we can go beyond Reinman's statement that "perhaps" different shapes and sizes of Oceanic fishhooks had "some" significance beyond the whims of their makers. Fishhooks of the South West Islands have been skillfully designed to take into account the size of the fish being sought, their mouth size and shape, their biting characteristics, the toughness of their mouths, the depth at which they are being sought, the strength of the current, and the presence or absence of troublesome sharks. The ease with which different types snag up on the bottom is also taken into consideration. A varying compromise in design is made between the ease with which a hook can be set in a fish and the speed with which it can be shaken loose by the fish or removed once the fish is landed.

But, lest it be concluded from this account that the design and use of fishhooks has achieved the status of an exact science in the South West Islands, it should be added that there remains plenty of latitude for difference of opinion among the fishermen as to what hook to use for a particular purpose and how best to form it.

Those who maintained that Pacific island hooks were crude and ineffective were misled by the strange shape of the rotating hooks; it is not intuitively obvious that such hooks are very effective if used properly. O'Connell, a castaway on Ponape, provides an example of this misunderstanding. Rejecting the "rude tortoise shell hooks" of the natives, he made some "very tolerable" hooks from the ramrods of muskets preserved from the wreck of his ship. "But it was necessary," he related, "to keep the line taut, as there being no barb, the fish would otherwise escape" (O'Connell, 1836, p. 112). Had he copied the design of the rotating turtle shell hooks he saw, and sought instructions from Ponapeans in their use, he would not have been inconvenienced by the lack of a barb.

Those, in turn, who maintained that the islanders' hooks (by which they meant rotating hooks) were superior to Western jabbing hooks were oversimplifying. Rotating hooks were indeed better in design (although of lesser tensile strength) than typical Western jabbing hooks for those types of fishing involving slack lines. But the jabbing hook, native both to Europe and the Pacific islands, is a useful and versatile hook provided that it is used when fishing with a taut line in shallow water.

Contrary to the impression that is given by the early literature, it is unlikely that the islanders always modified the shapes of European hooks before using them. They probably did so only when the type of fish or style of fishing for which they were intended required it.

Lines, Leaders, and Lures

Today South West islanders still fish often with lines they make themselves out of sennet (coconut husk fiber) or the inner bark of *Hibiscus tilaceus*. One observer noted in 1898 that Tobian sennet "was twisted in various thicknesses so prettily and with such regularity that a European cordmaker would have gained credit by it" (Eilers, 1936). But good sennet rope is more than pretty. It is not only strong but also exceptionally resistant to decomposition. Heavy deep-water fishing lines of sennet are valued more highly by their Tobian owners than commercial line and often last for several generations.

Tobians recount that on recovering sennet and nylon fishing line from caches made during World War II they discovered that the nylon lines had deteriorated badly whereas the sennet line was unaltered. One of the latter coils is still in use today. Kayser (1936) notes similarly that coconut fiber left by accident for twenty-two years in a "slime pool" on Nauru was still in good shape when recovered.

Seidel (1905) described Tobian hibiscus fishing lines as "the best of their kind to be had without machines." Because the supply of fiber hibiscus is not as great as that of coconut fiber, hibiscus is used only for shorter, thinner lines. For deep trolling several meters below the surface, hibiscus is preferred because it is less buoyant than coconut fiber. Owing to its greater strength it is also used in preference to coconut fiber for making leaders. Leaders must be strong yet thin so as to be inconspicuous to an approaching fish.

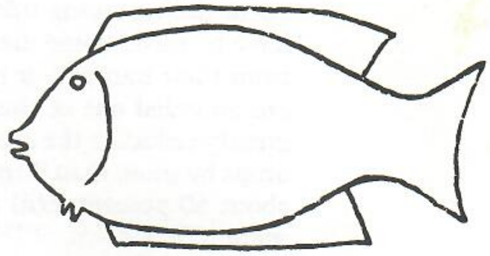
The ends of the shanks of Tobian turtle shell fishhooks were unique in that they were forked and, according to Beasley (1928), provided "a more practical method of attaching the snood (leader) than is in use in any other locality." Today the shanks of stainless steel hooks usually terminate in an open loop. The leader is attached first with a slip knot, then with two or more half-hitches running down the shaft, then with a final half-hitch in the loop, over the slip knot. Because the loop is not closed the line can be quickly loosened and slipped off in order to change hooks but will not slip off when a fish is hooked.

Wire leader is sometimes used today when fish with sharp teeth, such as sharks or barracuda, are being sought. Patris pointed out to me that there is a disadvantage to this arrangement. The attachment of the rather stiff metal leader to the line provides a second pivot point (the first one being where the leader is attached to the hook), allowing the fish greater flexibility in its struggles to escape. I showed him a piece of flexible braided metal leader I had recently bought and he pronounced it an improvement over the stiff wire leader with which he was familiar.

As on many other Pacific islands, trolling lures were made from various types of shell and coral adorned with feathers (figure 6). Whereas modern research has shown clearly that colors are perceived by some fishes and that some exhibit color preferences when feeding (e.g., Ginetz and Larkin, 1973; Wagner and Wolf, 1974), the claims of some Pacific islanders that subtle differences in the coloration of tuna lures make big differences in their effectiveness is not wholly convincing. Much has been written, for example, about the importance of shading in pearl shell tuna lures (e.g., Buck, 1932; Nordhoff, 1930). But Tobians say that except when tuna are feeding on squid, when a reddish-brown lure is preferred, tuna show little color preference.

The experiences of Palauans and of marine biologists tend to support this testimony. Today when feathers are torn by fish from worn commercial tuna lures, Palauans customarily replace them with skirts cut from plastic shopping bags. The color of the skirts may be white, grey, pink, purple, green, or blue with varying amounts of black print. Palauans express little preference for one color over another and state that the fish seem similarly undiscriminating. Ommaney (1966) experimented in the Indian Ocean with trolling lures made of bone, shuttlecock, feathers, plastic strips, rope yarns, metal foil, metal spoons, blobs of lead, and tops of cigarette cartons. "But," he states, "we never really found that one sort of lure was decisively better than any other. When the fishing was good any kind of lure would do as well as any other." In tank experiments Hsiao and Tester (1955) showed that to kawa kawa (mackerel tuna), *Euthynnus affinis*, yellow, red, black, white, and combination lures were almost equally attractive, although there may have been a slight preference for white.

FIGURE 6. Tobian trolling lure, for smaller, near-reef species such as jacks. The body is made of red gorgonian coral decorated with chicken feathers. Over the feathers one scale of a large parrotfish is tied in order to minimize the damage done by the teeth of a struggling fish. The hook is made from turtle shell. The lashings and leader are made from *Hibiscus* fiber.



APPENDIX C

TOBIAN FISHHOOKS

English hook terminology is explained on page 113.

JABBING HOOKS

Suheriong

- Point facing upward and outward. Shank straight or almost straight.
- Used on trolling lures for tuna and for shallow dropline fishing.
- In dropline fishing with this hook the line must be jerked before the fish turns with the bait in its mouth.
- Hooks in the top of the jaw.

Yawariyet

- As with the *suheriong*, the point faces upward and outward and the shank is almost straight. But the width of the bend is less than that of the *suheriong*. This results in it being a little harder to hook a fish successfully than with a *suheriong*, but it is easier to hold the fish once hooked because of the longer point and the decreased distance between shank and point. This distance is occasionally reduced further by bending the shank toward the point.
- Designed for fish which bite aggressively, such as tuna, rainbow runners, and jacks.
- Hooks in the top of the jaw.

Hapi Sereh

- Short straight point facing upward or slightly outward.
- A versatile shallow water hook, used on trolling lures for tuna, for pole fishing on the reef, and, with a weight, for shallow dropline fishing.
- Good for large-mouthed fish.
- The fish should be allowed to turn before striking when dropline fishing.
- Hooks up badly on the bottom.

Sangi

- Named after a village in Halmahera, Moluccas, from where it was reportedly introduced centuries ago by a fisherman who was blown off course and drifted to Tobi.
- Narrow, U-shaped bend, long, straight point directed very slightly outward from shank. Shank straight or gently curved.
- Used with shell lures for tuna, and in smaller sizes with feathers for small-mouthed squirrelfish (e.g., *Holocentrus* sp.) and other small-mouthed fishes. Trolled slowly.

Fotomahech

- Similar in shape to *sangi*, but with wider bend, and point directed slightly inward. Shank occasionally bent inward when used in trolling with the lure some distance from the canoe.
- Used with feather lure in slow trolling for tuna, and in smaller sizes for wide-mouthed fish, such as most squirrelfish. Also used in shallow dropline fishing.
- The fish should be allowed to turn with the hook in its mouth before striking.
- Large fish tended to bend the point of the turtle shell version outward, allowing them to escape.
- The fish must be allowed to turn away with the hook in its mouth before striking.
- Hooks in the side of the mouth.

Man Tanante

- Shank and point are one continuous curve. Shank often very short. Point directed toward top of shank.
- Most versatile shallow water dropline and reef pole fishing hook, used when "you don't know what you are going to catch."
- The fish should be allowed to turn before striking.
- Hooks in the side of the mouth.

Fichifichino'o

- The name means "bent like a palm leaflet midrib." When the latter is bent the stiff core breaks, creating a sharp angle rather than a smooth bend. The hook has three (or occasionally four) such angular bends in it. The point faces the top of the shank.
- Used for trolling with a lure, and with a weight for shallow dropline fishing.
- Less liable to break under the strain of a fish than other turtle shell hooks. Less liable to bend than other metal hooks. Small hooks of this design can effectively hook large fish.
- The fish should be allowed to turn with the bait in its mouth before striking.
- Hooks in the side of the mouth.

ROTATING HOOKS

Metch

- The name is derived from the Tobian name for cone shells, and refers to the spiral groove on the crown of the shell; the lower shank, bend, and point form a spiral.
- Strongly curved point facing inwards (shallower water version) or downwards (deeper water version).
- Used with a weight in dropline fishing for large-mouthed fish such as grouper. This is the hook of choice when fishing very deep.
- The fish must be allowed to run with the hook and then retrieved while keeping steady moderate tension on the line (see page 114).

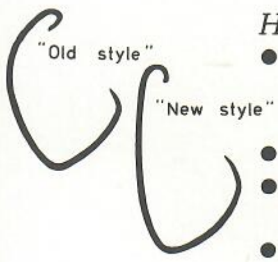
Fahum

- Bend almost circular.
- A deep water dropline hook used for fish with smaller mouths (e.g., lethrinids) than those sought with a *metch*.
- As many as five may be baited and attached to a single line at intervals.
- Used without a weight (a rock is tied loosely to the line to take the hook down, then shaken loose with a jerk).
- The hooking technique is intermediate between that used for a conventional rotating hook and a jabbing hook (see chap. 9). The fish is played gently for a while until the hook sets itself lightly. Then the line is jerked hard to set the hook more firmly.

Ramatiho

- Similar in shape to *fahum*, but point does not approach the shank so closely and the shank has more inward curvature.
- Used for dropline fishing in fairly deep water.
- The bait is placed on the hook loosely to allow maximum penetration; when a fish bites the bait usually slides up the shank.
- Used for groupers and also for fish that suck the bait in and out of their mouths cautiously; the wide bend makes the hook hard to spit out.
- Always hooks in the jaws, not in the lips; good for fish with easily torn lips.
- A strong fish is liable to bend this hook and escape.

FONG HOOKS



Haufong

- Straight point. Shank straight or angled inward for use in deeper water. Point, except for *fong*, leaning outward from shank. Made only of metal.
- Used for dropline fishing.
- Good for most small-mouthed carnivorous fish, but specifically designed for catching triggerfish (see p. 117, 118).
- A small piece of bait, which just covers the *fong*, is used.

Ramaributs

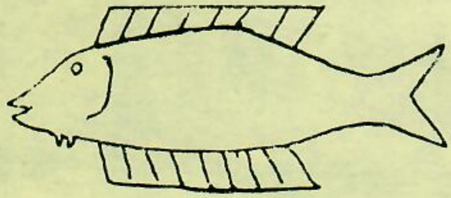
- Shank straight, or angled inward for use in deeper water. Point, limb except for *fong*, leaning outward from shank. Turtle shell version has both barb and *fong*.
- Used in dropline fishing in shallow to moderately deep (eighty fathoms) water for tuna and "slow-biting" fish. Used with a weight. Live or dead goatfish often used for bait.
- The *fong*, in addition to helping keep the bait (and the fish) on the line, causes the hook to perform like a rotating hook (see p. 113). The fish is allowed to swim with the bait, then retrieved with a steady pull.
- A strong fish is liable to snap off the *fong*.

Ramasu

- Similar in shape to *haufong*, but the fong is longer and the bait is placed below rather than around it.
- In the past, before the invention of the *haufong*, this hook was used for triggerfish. It is seldom used today.

JOHANNE

WORD
OF THE
LAGOO



"[Johannes] presents the Palauans as competent field naturalists—as they rightfully are—rather than the more common treatment of dealing with the knowledge and logic of traditional societies as being an irrational approximation of the reality known by western science.

"[*Words of the Lagoon*] is crammed with odd and significant pieces of information that demonstrate the incredible sophistication of Palauan fishing knowledge. The material on lunar spawning cycles is excellent. When a biologist goes into the field and comes back with such fascinating information about fish, fishing, currents and seabirds, I find that to be very important."

—Bernard Nietschmann, Professor of Geography, University of California, Berkeley

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