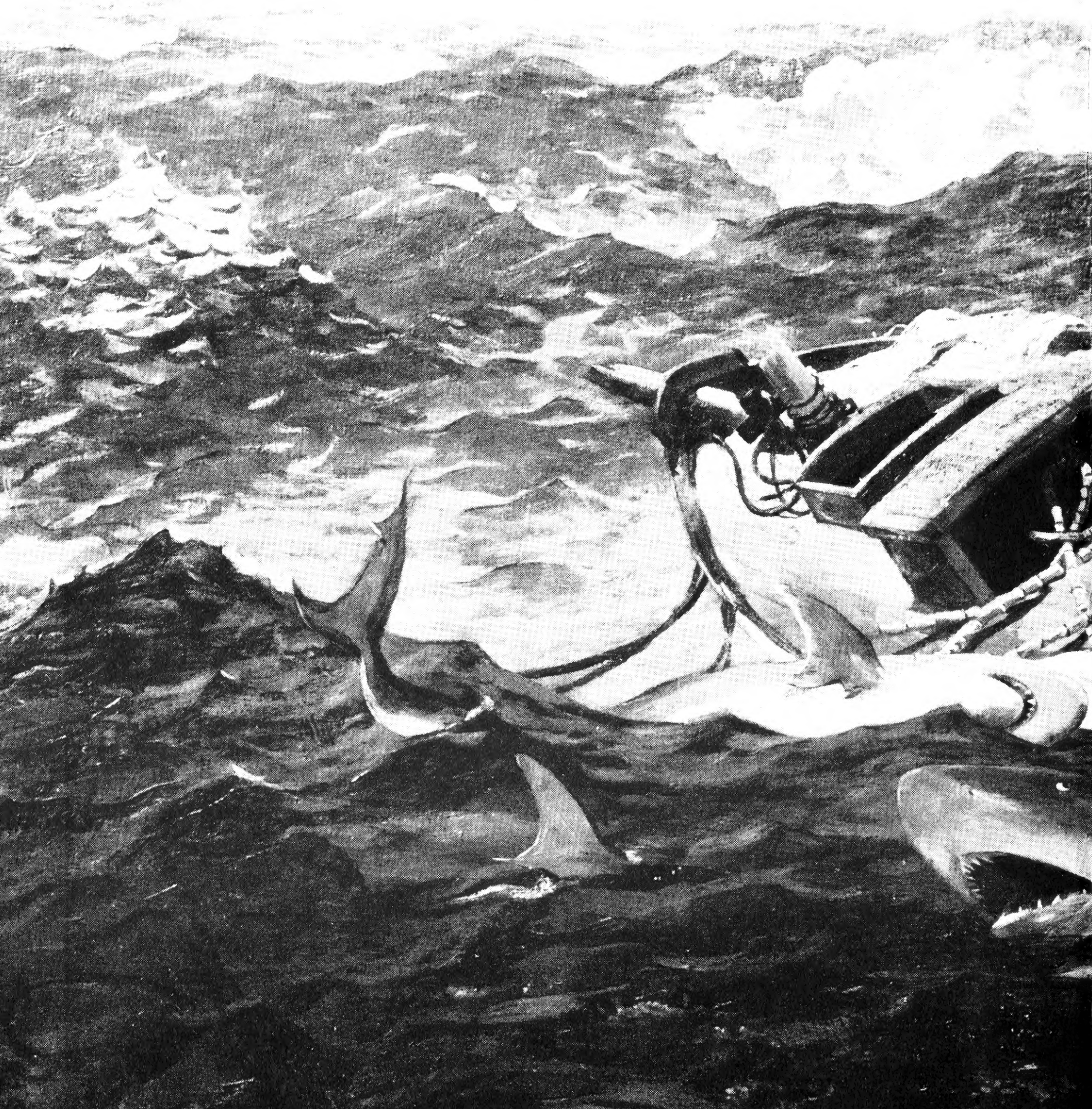
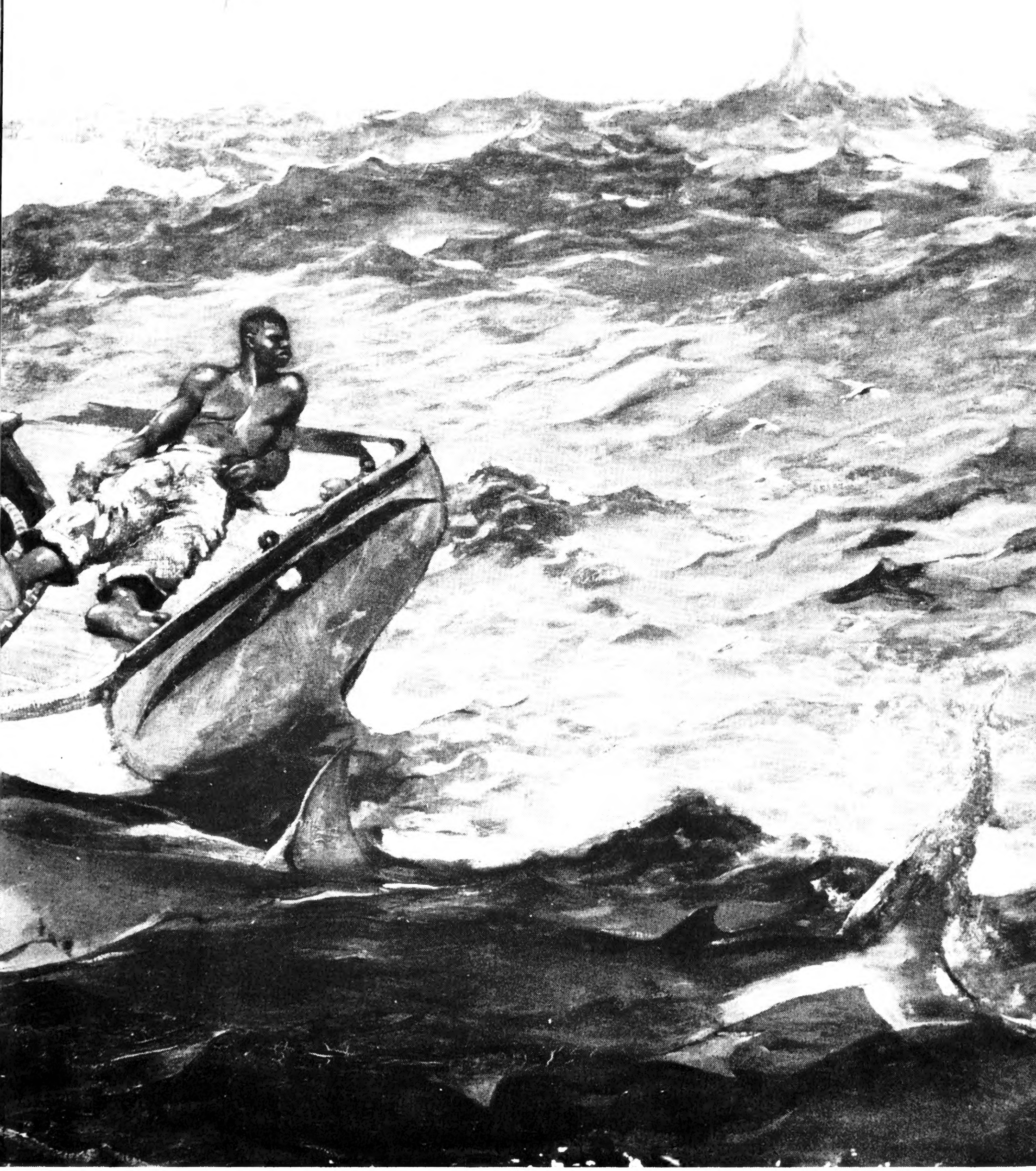
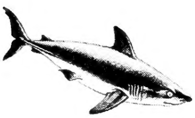


Sea Sharks



End leaf photo: Winslow Homer's "The Gulf Stream,"
The Metropolitan Museum of Art, Wolfe Fund, 1906

Title photo: Tom Allen
Opening sketches: Ronald D. Schwartz



Shadows in the Sea

Illustrated

Harold W. McCormick
and
Tom Allen
with
Captain William E. Young

CHILTON BOOK COMPANY
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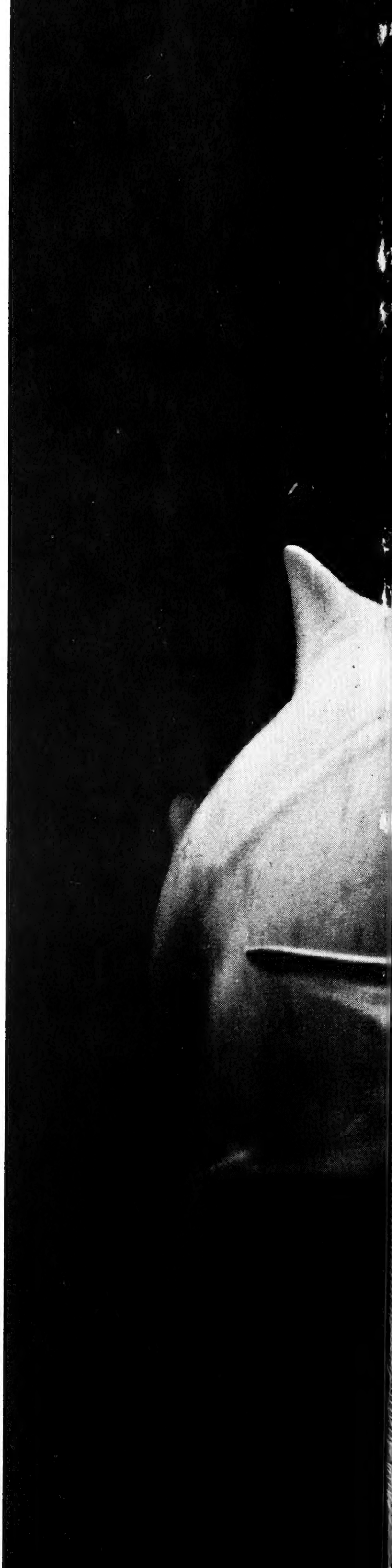

Shadows in the Sea

The Sharks, Skates and Rays

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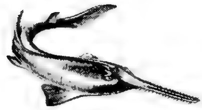
To

CAPTAIN WILLIAM E. YOUNG

1875–1962



Foreword

Captain Young and I for some years have been gathering material from all over the world about the Selachians—the Sharks, Skates, Rays, and their allies—of which there are more than 600 known species. We originally intended merely to up-date Captain Young's book "*Shark!! Shark!!*" (published by Gotham House in 1934, and now a collector's item), but, as the material ever expanded, it was decided that an entirely new book, covering a much broader field, was needed.

Material was collected from all over the world for many years. When Captain Young and I felt that the research was nearly completed, we called upon Tom Allen, an experienced newspaperman, to aid us in transforming the research material into a book. Tom and I continued the research up to (and beyond!) the completion of the manuscript. Tom also did further research and added new material in the course of writing the book.

In all scientific classifications, the Selachians are separated clearly from the Teleosteans, or Bony Fishes, and there are even leading ichthyologists who do not regard the former as fishes at all but rather as representing a separate and distinct *Class* of animal life.

Selachians are among the most adaptable and hardy forms of life on this planet and have survived longer hereupon than most. Among them are probably the most deliberately ferocious forms of life on earth. The Selachians are to be found from polar to equatorial seas; from shallow to abyssal waters; in salt, brackish, and fresh waters; and all over the world. Some have changed little, if at all, during millions of years. No one knows just how many kinds exist today, and scientific expeditions probing both the ocean depths and tropical jungle rivers continue to find new ones almost every year.

The behavior of sharks toward men is inexplicable and may possibly forever be a mystery. The more that they are observed, the less certain we seem to be as to just what motivates them. Even those considered most dangerous are known to have ignored men who were helpless in the water beside them. Other species, long considered to be harmless, have been reported to have attacked swimmers and divers without provocation. The United States of America and several other Governments besides have spent huge sums to try to develop an effective protection for men in shark-infested waters; yet, no foolproof repellent is known today.

Information on shark attacks upon men is now being gathered scientifically on a world-wide scale for the first time; but, until we know much more about the sharks themselves, and until an effective means of protection against their attacks has been developed, they will remain a constant threat to man whenever and wherever he enters waters in which they dwell. Some species of sharks appear to be more prone to attack humans than others, but just how many species should be classed as dangerous we do not know. The size of the individual fish is no indication of its aggressiveness, its viciousness, or its potential. The largest of the sharks—the mighty Whale shark and the great Basking shark—eat, primarily, plankton and very small fish, have tiny teeth, and are generally considered to be harmless.

The Skates are generally inoffensive creatures and the same may be said of the Rays. However, if molested or trodden upon unexpectedly, some of the latter may inflict painful and even mortal wounds with their "stings." Yet again, the largest of the Rays—the huge Manta or Devil-Fish—does not have a sting and is harmless. Both Skates and Rays are of world-wide distribution, but the Rays occur in both salt and fresh water, and some species of the latter are found thousands of miles from the oceans—almost to the headwaters of the Amazon and its tributaries, for instance. The Sawfishes, which form another group related to the Sharks, are also found in salt, brackish, and fresh water. Some of them in the Pacific and the Indian Oceans attain great size and are capable of severing a man with one swipe of their rostra—the great, flat, tooth-beset, bony structure that projects from their heads.

Man's age-old fear, hatred, and even worship of the Shark has prejudiced and limited the eating of not only *its* flesh but also that of all Selachians. Yet, they *are* eaten all over the world in all countries that border the sea, though usually under some trade name that disguises their true identity. Many species are excellent eating and they are almost all good food. Selachians are readily marketed in all the major sea and fishing ports of the world—New York, London, Barcelona, Marseilles, Hamburg, Madras, San Francisco, Melbourne, Tokyo, and so on. Perhaps you, too, have enjoyed an excellent fish dinner at some time or another and wondered at its fine flavor. It may well have been the flesh of some Selachian.

We would have liked to have presented in this book some reassuring and dependable prescription for avoiding shark attack. Unfortunately, there is none. We base this pessimistic conclusion on reviews of the circumstances of attacks around the world, selected samples of which are reported in this book.

At one point, we compiled a list of factors and conditions which seemingly would encourage a shark attack. It was a long list. We decided not to print it because, we realized, the list was based on *human* thinking —and not on whatever goes on in the brain of the shark.

The shark is unpredictable. If you venture into the shark's domain, you must calculate your own chances that a shark will not single you out. Your guess is as good as our advice would have been.

Our knowledge of the Selachians is really very limited and the authors of this book are most interested in gathering all further information possible about them, and from all parts of the world—reports of their behavior, both usual and unusual; their invasions of fresh waters; observations on their breeding habits; their migrations; utilization of them by man; methods of capturing them; rituals that concern them; and any other aspects of these remarkable animals. All information will be welcome. We are particularly interested in receiving reports of any Selachians from the Pacific and the Indian Oceans, and the seas and the rivers that are tributary to those oceans; also, from the rivers of Africa, Indonesia, and Central and South America. We will welcome anything that our readers may be kind enough to contribute, including sketches and photographs. (These should be addressed to Dr. Harold W. McCormick, 11 Riverside Drive, New York 23, New York.)

You may not realize the fact, but *you* may be the one to make the definitive observation on some point that has baffled the experts for many years!

Harold W. McCormick

Contents

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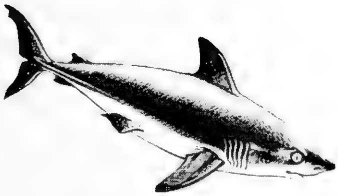
Part 1

Shark Against Man

Chapter 1

The Shadows Attack



Down the beach he ran, an impatient young man drawn to the cool and beckoning sea. He had arrived at the resort in Beach Haven, New Jersey, scarcely minutes before. And now—Saturday, July 1, 1916—Charles Van Sant was plunging into the surf.

He was 23 years old, and his life stretched before him as did the sea—invitingly, excitingly, seemingly without end. On his own horizon, and on the horizon of millions of other young men, there hung a cloud of war. On the horizon of the sea around him, there was not a cloud.

Behind him, on the beach, a holiday crowd was gathering. Soon his father and two sisters would be there. He had left them still in their shore-front suite, unpacking and settling themselves. They had been too slow for him. Time had been too slow for him. He had spent ages on the hot, jammed train that carried him across the breadth of New Jersey from the Van Sant home in Philadelphia to Long Beach Island, a narrow strip of land dotted with resorts like Beach Haven. Finally, the trip had ended. Charles rushed into the suite, hastily donned his bathing suit, threw on a robe, and rushed to the beach. As he dived in, he might have heard someone singing, "By the sea, by the sea, by the beautiful sea . . ." The sea was beautiful in Beach Haven that day.

Charles was a strong swimmer. With powerful strokes he pulled away from shore. He swam out about a hundred yards—far enough, he decided, for a first swim. Leisurely, reluctantly, he turned back toward shore, trying to prolong this serene and solitary communion with the sea. But he was not alone.

Directly behind him, knifing toward him straight and sure, was a gray shadow beneath a black fin that crested the water. They saw it from the beach. Bathers screamed, but the man did not hear their cries. Then, suddenly, they stood silent and motionless, frozen by the sight of the narrowing gap between Van Sant and the pursuing fin. He was still swimming excruciatingly slowly, unaware that he was the hunted in a deadly chase.

He was close to shore when the water churned and red foam billowed around him. At that moment Alexander Ott, a former U.S. Olympic team swimmer, dived into the sea and began to swim faster than he had ever swum before. As Ott reached the red blotch on the water, the gray shadow turned menacingly, then darted away for blue water, leaving Van Sant to the man who had come to save him.

Ott managed to get Van Sant to shore, and there, on the warm sand, Van Sant's life ebbed away. His legs had been horribly ravaged. He died that night from shock and loss of blood.

The gray shadow glided seaward, unseen and unheralded. No alarm was spread. No one could remember a shark ever having killed a swimmer before. Perhaps it had happened in the South Seas or in Australia. But never in New Jersey. And the experts said that there never had been an absolutely authenticated case of a shark attacking a swimmer anywhere in the world. Herman Oelrichs, a wealthy New York banker, had offered a $500 prize to anyone who could prove to him that any bather actually had been attacked by a shark anywhere north of Cape Hatteras. The prize had gone unclaimed for 30 years.

Only three years before, on August 26, 1913, a fisherman had caught a shark off Spring Lake, New Jersey, 45 miles up the coast from Beach Haven. When the shark was cut open, a woman's foot wearing a tan shoe and a knitted stocking was found in its stomach. But this gruesome discovery—like similar ones attested to down the years by numerous sailors and fishermen—was explained away: though sharks might devour bodies, never would a shark attack a live swimmer.

In Spring Lake on July 6, five days after Charles Van Sant was killed, more than 500 people were lounging or strolling on the beach. It was after lunch; the tide had ebbed. Relatively few swimmers were in the water. Children splashed at the water's edge. A few bathers stood in knee-deep water.

Life was elegant and tranquil at Spring Lake, one of the favorite resorts of society. The socially prominent of Philadelphia, New Jersey, and New York gathered there. Some lived in fabulous shore homes they liked to call cottages. Others stayed at the New Monmouth Hotel or the Essex and Sussex Hotel. Secretary of the Treasury William G. McAdoo, who was married to a daughter of President Wilson, was one of the leaders of Spring Lake society. New Jersey Governor James F. Fielder and former Governor John Franklin Fort spent most of their summers there. And hundreds of wealthy New Yorkers had fled to Spring Lake with their children that year to escape the infantile paralysis epidemic in New York City. Since June 10, 165 persons had died of the disease in the city. On July 5 alone, 24 deaths had been reported . . . And there were rumors that the epidemic was spreading to New Jersey. So the talk on that July 6th afternoon in Spring Lake was not about the new Allied offensive against the Huns or the neutrality policy of Wilson. It was not about Wilson's chances of reelection or Charles Evans Hughes' chances of defeating him. It was not about sharks, or the death of an obscure young man at a rather unfashionable beach resort 45 miles away five days before. Infantile paralysis dominated the conversations at Spring Lake just as it dominated the headlines in the New York City newspapers . . .

In the democratic sea, a bellboy was as good as a millionaire. Perhaps that was why Charles Bruder loved the sea. Charles was a bellboy at the Essex and Sussex Hotel and when he was not working could usually be found swimming. He was 28 years old, personable, and well liked by hotel guests, who considered him part of Spring Lake. Even people who had been coming to Spring Lake for much of their lives could not remember Spring Lake without him, for it was said that he had appeared there when he was 8 years old and had been working at various hotels every summer since. From the tips he earned he supported himself and his only known relative, his mother, who lived in Switzerland.

Bruder had the afternoon off on July 6th, and ebb tide or not, he was going swimming. He walked out through the surf, nodding and smiling at hotel guests he recognized. When the water reached his waist, he dived in and began to swim. He was soon beyond the life-lines. George White and Chris Anderson, the lifeguards on duty, did not call him back as they would have summoned most swimmers, for everybody knew that Charles Bruder was a strong swimmer.

A woman's scream shattered the air of Spring Lake. Instinctively, White and Anderson turned narrowed eyes seaward. Bruder had disappeared.

"He has upset!" the woman screamed. "The man in the red canoe is upset!"

Even as she screamed, White and Anderson were racing toward their boat. They knew that it was not the reflection of an over-turned canoe they saw, for even now the red blot was spreading, and in the midst of it, for one awful moment, Bruder's agonized face appeared, and he flung up a bloodied arm. The boat reached him. White leaned from the bow and held out an oar to Bruder. Somehow, he grasped it. They pulled him toward them. His face was sickeningly white and his eyes were shut. "Shark—shark got me—bit my legs off!" he gasped and, mercifully, fainted. White hauled him over the gunwale. His body was not heavy.

Mrs. George W. Childs, one of the principal envoys of Philadelphia society at Spring Lake, was standing on the private balcony outside her suite at the Essex and Sussex when she heard the screams from the beach. She turned to her maid and asked for her spyglass.

Below on the shore, she saw White and Anderson beaching their boat. She saw them hesitate to lay Bruder on the sand. From the crowd a woman darted forward and put down her linen coat, turning her eyes away as she did so. Several women fainted. Mrs. Childs, 74 years old and indomitable, did not faint. She went to the phone in her room, called the manager, and told him what she had seen. She also asked that her car be brought around. Three minutes later she was speeding to Deal Beach, some 5 miles north. Her niece took a plunge in the surf there every afternoon, and Mrs. Childs wanted to get to Deal Beach before the shark did.

Bruder was dead. The doctor called to tend him was treating the women who had fainted. At the Essex and Sussex, the telephone operator was ringing up every central switchboard from Point Pleasant to Atlantic Highlands. Within 12 minutes, swimmers were streaming ashore along 20 miles of New Jersey beaches.

But was it a shark? Was it true that man-eaters were prowling the shore of New Jersey? Hotel men, resort operators, summer colonists wanted to be told that it could not happen. They anxiously awaited the verdict of Colonel William Gray Schauffler, an eminent physician and Surgeon General of the New Jersey National Guard. He had examined Bruder within 15 minutes after he had been taken from the sea.

"There is not the slightest doubt," Colonel Schauffler reported, "that a man-eating shark inflicted the injuries. Bruder's right leg was frightfully torn and the bone bitten off half-way between the knee and ankle. The left foot was missing, as well as the lower end of the tibia and fibula. The leg bone was denuded of flesh from a point half-way below the knee. There was a deep gash above the left knee, which penetrated to the bone. On the right side of the abdomen, low down, a piece of flesh as big as a man's fist was missing."

That night, while hotel residents, at Mrs. Childs' suggestion, took up a collection for Bruder's mother, motorboats equipped with searchlights slipped out to sea in a futile hunt for the shark. Colonel Schauffler called a meeting of resort owners and town officials to discuss ways to make the beaches safe from sharks. Rifle-toting boatmen were hired to patrol the beaches. Fishermen volunteered to fish for the shark with great hooks, sturdy lines, and chunks of prime mutton, reportedly the best shark bait, donated by cooperative Spring Lake meat markets. "I am certain that the bathing beaches will be made safe within two or three days," Councilman D. H. Hill announced . . . No shark was caught, shot, or even seen.

The day Bruder was killed, 24 people died in New York City of polio, then called infantile paralysis. Bruder's death received far larger coverage in the New York papers. Such is the glamour and the terror of the shark!

Each resort town along the New Jersey coast went its own brave way. Atlantic City was more upset by a ban on bathing suits that exposed "the nether extremities" than by sharks, although some daring souls made an adventure out of the shark scare by contemptuously swimming beyond the end of the piers. At Asbury Park, with a flourish of publicity, a motorboat shark patrol was begun and workmen were set to enclosing the bathing area with "shark-proof" wire netting. A net was not necessary, according to a sea captain interviewed as a "shark authority." Sharks scared easily, he said. "The best thing to do when a shark comes along," he advised, "is to shout as loud as you can and splash the water with your hands and feet."

The Atlantic seemed alive with sharks and tales of sharks. At Spring Lake, a lifeguard told of battling a 12-foot shark with an oar some 50 feet offshore. At Bayonne, New Jersey, 20 boys were swimming off a yacht club float when they saw a shark. A policeman heard their cries and emptied his revolver at an ominous black fin. The shark, he said, fled to the open sea. In shallow water off Eldred's Bar near Rockaway Point in Brooklyn, eight men digging for sandworms saw a shark driving a school of weakfish toward shore. With eel-tongs, oars, spears and spades, they said, they slashed at it and killed it. All along the coast, shark vigilantes were firing their rifles at anything that looked big and moved in the sea.

Finally, out of this hysterical war on sharks, porpoises, and any other shadows in the sea, came the sobering voice of academic authority. Dr. John Treadwell Nichols, curator of the Department of Fishes in the American Museum of Natural History in New York, and Dr. Robert Cushman Murphy of the Brooklyn Museum, declared that there was very little danger that a shark would attack anyone. Dr. Frederick A. Lucas, director of the Museum of Natural History, added his agreement. No shark, he said, could snap off a man's leg "like a carrot." A shark's jaws were simply not powerful enough to do the kind of bodily damage Dr. Schauffler described, Dr. Lucas insisted.

The experts had spoken. The shark scare abated somewhat. New Jersey bathers believed that they could once more enter the water unafraid. But the shark panic had cost New Jersey resort owners an estimated $250,000 in lost tourist business. In some areas, bathing had fallen off more than 75 per cent. Six weeks of summer still remained, and, with plenty of hard work, the resort owners assured each other, the loss could be made up.

"Tiger sharks will hold but little terror for bathers in the waters hereabouts within a few days," the *New York Times* reported from Asbury Park on July 10th. "Today the final work was being rushed on the net protectors about the Asbury Park beaches, and in Ocean Grove the contractors who received the job of erecting steel nets began work. At Fourth Avenue, where the grounds had been enclosed by the steel nets, a record-breaking crowd of bathers enjoyed the surf."

The dispatch was not entirely optimistic, for it reported that a fishing boat had sighted four sharks 8 miles off Asbury Park. Another shark had been reported 200 yards off Bridgehampton, Long Island, by Esterbrook Carter, nephew of Charles E. Hughes, the Republican candidate for President. Carter, along with all other Republicans, was relieved to learn that Hughes had spent the day indoors, polishing his speech accepting the nomination.

Officials of the U.S. Bureau of Fisheries in Washington tried to dispel the fear of sharks *en masse*. A *single* shark, they theorized, was probably responsible for both fatal attacks. Because of a scarcity of food fish off the New Jersey shore, they said, this renegade shark may have been driven far inshore and, maddened by hunger, attacked Van Sant. Then, having acquired a taste for human flesh, it continued swimming near shore until its appetite was satiated by Bruder. It was a ghastly theory. In an apparent attempt to still renewed apprehension, U.S. Commissioner of Fisheries Hugh M. Smith hastily pointed out on July 9th that "The case is extremely unusual. I don't look for it to happen again. The fact that only two out of millions of bathers have been attacked in many years is evidence of the rarity of such instances." Again, the very best assurance—from an expert.

On a map, Matawan, New Jersey, appears to be an inland town. It is 11 miles west of the Atlantic Ocean and 2 miles south of Raritan Bay, a body of water that blends into the Lower Bay, gateway to the great port of New York. Matawan's only link to salt water is a tenuous one, a meandering tidal creek—barely a stream at high tide—that empties into Raritan Bay.

In the summer of 1916, as in countless summers before, Matawan boys spent every minute they could in Matawan Creek. The most popular swimming hole was at the old Propeller Wyckoff Dock, named after the tug-sized steamer *Wyckoff* which, years before, used to come up the creek with the tide to pick up farmers' produce and carry it to the New York market on the next tide. The dock had deteriorated into a dozen or so pilings that jutted close to one another along the edge of a dilapidated pier. Diving and jumping off the pier and the pilings was not adventurous enough for the boys who swam at Wyckoff Dock, so they usually played tag, hopping from piling to piling in pursuit of one another.

One day in early July, 1916, Rennie (for Rensselaer) Cartan, aged 14, was playing tag on the Wyckoff pilings. To escape an outreaching hand, Rennie dived into the creek. As his head and shoulders entered the murky water, he felt something like a strip of very coarse sandpaper grate along his stomach. He arched his body to the surface and stroked for the pier. His stomach was streaked with blood as he clambered up a piling and

At this spot in Matawan Creek, in Matawan, New Jersey, Lester Stilwell and Stanley Fisher were attacked by a shark. The pilings in the foreground served as diving platforms for Lester and other boys playing in the creek. The dilapidated wharf at the right was where the mortally wounded Fisher was brought ashore.

From a contemporary news photo

onto the dock. "Don't dive in any more!" he shouted to his companions. "There's a shark or something in there!"

No one paid much attention to Rennie, and, as a matter of fact, he ignored his own warning a few minutes later by diving into the creek. He was in a hurry to get home. It was much quicker to swim across the creek than to walk to the nearest bridge. (More than 40 years later, the scars from the sandpaper-like burn still on his stomach, Rensselaer Cartan would stand by the creek, and, shaking his head, say to one of the authors, "It might have been me. You know, it might have been me.")

On July 11th, in Belford, on Sandy Hook Bay, a few miles east of the mouth of Matawan Creek, Herman Tarnow, a fisherman, caught a 9-foot shark 120 feet out from the low-water mark. No one paid much attention to Herman Tarnow, either.

In the late morning of July 12th, Captain Thomas Cottrell, a retired sailor and part-time local fisherman, was walking along the new trolley drawbridge that crossed Matawan Creek about a mile and a half down creek from Wyckoff Dock. Eleven days had passed since Charles Van Sant had died at Beach Haven, 70 miles as a shark would swim, from Matawan. Six days had passed since Charles Bruder had died at Spring Lake, 25 miles as a shark would swim, from Matawan. Now, as Captain Cottrell walked across the bridge that hot, bright morning, he saw a dark gray shadow sweeping up the creek with the incoming tide. The shadow was moving swiftly. But the captain, a man who trusted his eyes, believed what he had seen. He shouted to two workmen on the bridge. They saw the shadow, too. They ran to a telephone and called John Mulsonn, a barber who was also Matawan's chief of police. Captain Cottrell ran the half mile to Matawan center. He tried to stop groups of boys who were heading for the creek. He toured Matawan's short and busy lower Main Street, shouting his warning to merchants and their customers. Everyone laughed at the idea of a shark in a shallow creek, only 35 feet across at its widest point. Chief Mulsonn did not even leave his barber shop. Captain Cottrell walked back toward the creek.

One of the shops Captain Cottrell stuck his head into on his futile trip up Main Street was Stanley Fisher's new dry-cleaning establishment. Stanley, one of Matawan's best-liked young men, had only recently started this business, which had shown no promise of making his fortune. As a sideline he was also taking orders for men's suits. He had made an unusual sale a few days before. A man had come in and bought a suit. Instead of paying cash for it, he had bought Stanley a $10,000 life insurance policy. Stanley, a blond-haired, 210-pound giant of a man, was taking a ribbing from his friends. He was, after all, only 24 years old; in the prime of life, they told him. What would he need with an insurance policy?

Stanley's father, Watson H. Fisher, had followed the sea most of his life and risen to Commodore of the Savannah Line. Now retired and well off, he was one of Matawan's leading citizens. If he had ever wished that his son might go to sea, he had kept the wish to himself. Some people in Matawan did say, though, that it was a shame a big, strong man like Stanley was running a dry-cleaning store instead of sailing the seas as his father had before him.

July 12th was a scorching, muggy day. The heat was nearly unbearable in Anderson's Saw Mill, where Lester Stilwell worked with his father, William Stilwell. By 2 o'clock, Lester had finished nailing up his last wooden box, a task he was especially good at, and, since he was only 12 years old, he was given the rest of the day off. He waved good-bye to his father, dashed out of the stifling mill, and headed for Wyckoff Dock with his pals—Johnson Cartan, Frank Clowes, Albert O'Hara, and Charles Van Brunt. Soon they were all splashing around in the creek. Most of them, like Lester, were not wearing bathing suits.

Albert O'Hara, aged 11, was near the dock, about to climb out of the water, when Lester yelled: "Watch me float, fellas!" Albert turned to look. Lester was so thin he usually had trouble floating. At that instant, something hard and slippery slammed Albert's right leg. He looked down and saw what looked like the sinuous tail of a huge fish. Charles

Van Brunt, 13, still in the water, saw it too. It was the biggest, blackest fish he had ever seen, and it was streaking for Lester Stilwell. Lester screamed. Charles saw the big black fish strike, its body suddenly twisting as it hit Lester, and Charles saw that the fish was not all black, for as it rolled it exposed a stark white belly and gleaming teeth. And Charles knew, to his everlasting horror, that he had seen a shark. In an instant, it all but closed its jaws about Lester's slim body and dragged him beneath the reddening waters of Matawan Creek. Lester had neither time nor life to scream again.

Lester's pals and other boys who had been swimming nearby scampered out of the water. Some ran into Fischer's bag factory at the creek and summoned workmen to Wyckoff Dock. Others ran up the steep dirt road from the creek and raced to the center of town. Now, where Captain Cottrell had walked, there was panic, and screaming, naked boys. Boys who had seen the shark were yelling, "Shark! Shark! A shark got Lester!" Along the shore by the dock, those who knew only that Lester Stilwell had gone under were calling his name: "Lester! Lester!" Out of this tumult somehow came the report that Lester, "a boy who took fits," had been seized by an attack and was drowning. All that the townspeople knew for sure was that a boy was in trouble at the creek, and men, women, and children began running there to help him. Among them was Stanley Fisher, who had ducked into the back of his dry-cleaning shop only long enough to put on a bathing suit.

"Remember what Captain Cottrell said," Mary Anderson, a Matawan teacher, shouted at Fisher as he ran. "It may have been a shark!"

Fisher stopped for a moment. "A shark? Here?" he asked. He looked immense as he stood there, towering above Mary Anderson. "I don't care," he said, as if finally answering some inner doubt. "I'm going after that boy."

Then, turning to his errand boy, 8-year-old Johnny Smith, who was standing nearby, Fisher said, "Take care of the store until I get back." And Fisher sprinted to the creek.

The son of Commodore Fisher took command at Matawan Creek. His quarterdeck was Wyckoff Dock, and his enemy was a shark. Some 200 townspeople, including Lester Stilwell's mother and father, lined the dock and nearer bank. Fisher soon had men in boats, poling for Lester's body. Someone brought a roll of chicken wire to the dock. Fisher ordered a couple of young men to get into a rowboat and string the chicken wire, weighed down with stones, along the bottom of the creek, downcreek from the dock, where the channel was about 20 feet wide. Fisher knew there was a deep spot, off the farther bank, directly opposite the dock. There, he believed, the shark was lurking with Lester's body. Fisher's plan was to flush out the shark, driving it into shallower water down-creek, where it would be trapped by the chicken-wire barrier. But the hastily strung fence only partially blocked the creek.

When this futile fence was completed, Fisher dived into the creek. Several men were in the water, diving to the bottom, feeling in the mud for Lester's body. Fisher swam alone to the deep spot. Arthur Smith, 51, a carpenter by trade and a hunter by avocation, was diving, too. On shore, his daughter was screaming to him: "Come back, Pa! Come back!" The task was for younger men. But Smith kept diving, defying the death that swam by him and, finally, touched him. (A day would come when Arthur Smith, half blind and almost deaf at 95, would sit hunched and feeble in an old house on the bank of Matawan Creek. Suddenly, at shouted mention of that awful day, he would spring forward in his chair and vividly recreate that moment when he felt the shark scrape his leg. At 95, he would still carry the scars and show them to one of the authors.)

Smith saw Fisher make two "overhangs"—powerful overhand strokes —and dive down, down . . .

Arthur S. Van Buskirk, a local deputy of the Monmouth County Detectives' Office, had just arrived at the creek. He was sitting on the forward deck of a small boat when he saw a thrashing in the water at the farther shore. Even as he looked, the water calmed and a rapidly widening red stain spread on the surface. Van Buskirk yelled at the other man in the boat to start the engine and, while it sputtered to life, Van Buskirk sculled toward the red stain, in the midst of which Stanley Fisher had suddenly appeared.

Fisher was facing the farther bank. The silent crowd at Wyckoff Dock could see only his broad back and shoulders. He was drawn up, half crouching in waist-deep water and he seemed to be tottering on one leg. The boat pulled up directly behind Fisher. Van Buskirk could see that Fisher was holding the bloody remnants of his right leg in both hands. Just as Fisher was about to pitch forward face first into the water, Van Buskirk reached out and pulled him into his arms. He could get Fisher only halfway out of the water. The boat backed out of the shoal water and, as it turned to head toward the dock, a gasp rippled through the crowd. Now they could see Fisher, breasting the water like a macabre figurehead on the prow of the boat. Enough of him was out of the water so that his terrible wound could be seen. From groin to kneecap the flesh was gone from his right leg. Several women fainted. Little Alfreda Matz, one of the many children on the dock, tried to look. But her father threw the tail of his suit coat across her eyes and hugged her face to his side. She thought, *A crocodile bit Mr. Fisher.*

A sound like a moan went up as the boat neared the dock, for Fisher almost slipped from Van Buskirk's grasp. Staring down at Fisher's leg—it was hardly more than a bone and that bore jagged scratches running lengthwise along it—Van Buskirk saw blood pulsating from a torn artery. There was a rope on the deck beneath him, and he thought of tying a tourniquet with one hand. His own weight and that of his burden combined to prevent him from getting the rope, and he almost lost his grip on Fisher as well. Just then, hands reached out from the dock and grabbed Fisher. He was still conscious. Gently, men placed Fisher on a stretcher improvised from planks and bore him to the Matawan railroad, about a quarter of a mile away. Each jolting step up the bank and along the track stabbed him with searing pain. Merciful unconsciousness awaited him, but he seemed to fight it off. There was something he very much wanted to say.

At the station, they placed him on a baggage car and waited for the next train. A doctor had been found. There was little he could do, other than to retard the flow of blood. Nearly three hours went by until the 5:06 train from Long Branch was flagged down. Even on the train, Fisher held on to consciousness. Not until 7:45 that night, as he was wheeled into the operating room at Monmouth Memorial Hospital, did he die. Before he died, he had said what he wanted to say: on the bottom of Matawan Creek, he had reached the body of Lester Stilwell and wrested it from the jaws of the shark.

While Fisher lay on the baggage car waiting for death and the 5:06, several men went to Asher P. Woolley's store and got dynamite to blow up the shark they believed to be still off Wyckoff Dock. The creek was cleared of boats. But, moments before the charge was to be set off, a motorboat hove into view from down-creek. Jacob R. Lefferts, a Matawan lawyer, was at the wheel. Lying on the bottom of the boat was a boy. His right leg was swathed in bloodied bandages. "A shark got him," Lefferts shouted, as he pulled in to shore. The boy was transferred to a car and speeded to St. Peter's Hospital in New Brunswick.

At first the boy would not give his name. He was afraid his mother would be angry at him. Soon he was identified as Joseph Dunn, aged 14. He had been swimming with his older brother, Michael, and several other boys off the dock of the New Jersey Clay Company brickyards about a half mile down Matawan Creek, near Keyport. Someone had run to the brickyards and told the boys about the shark. They were all in the water when the warning came, and they swam swiftly to the dock. Joseph Dunn, the youngest, was the last one out of the water. As he started up the ladder, something that felt like a big pair of scissors, he said, grabbed his right leg. ("I felt my leg going down the shark's throat," he said later. "I believe it would have swallowed me.")

Joseph screamed, and the older boys sprang to the ladder. Joseph kicked the water with his free leg. Michael Dunn and two others began a tug of war with the shark, ripping Joseph's flesh to save his life. For a moment or two, the shark hung on. Then, suddenly, Joseph was free. The shark had let go—and vanished. Its third victim in less than an hour had been snatched from death.

In St. Peter's Hospital, hope was high that Joseph Dunn's life would be saved, but saving his torn leg—slashed with tooth marks, a major tendon severed, muscles badly mangled—seemed hopeless. Dr. R. J. Faulkingham, on general surgical service at the hospital, was given the case.

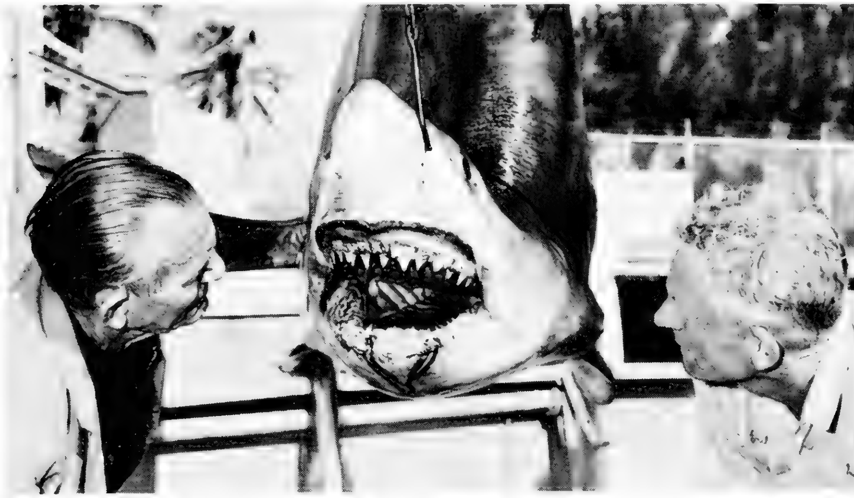
All that night and into the morning, Matawan Creek was the scene of an orgy of vengeance. Blast after blast of dynamite sent geysers of water and fish skyward. Hundreds of men lined both banks, armed with scythes, pitchforks, and old harpoons taken from living-room walls. By lantern light and by the first glimmer of dawn, men fired shotguns and pistols into the creek. At low tide, men waded into the water with knives—and even hammers.

The creek was soon laced with tangles of chicken wire and fishing nets. Newspaper reporters and photographers swarmed into Matawan, and one newspaper proclaimed that it had organized a shark-hunt—a boat loaded to the gunwales with men carrying rifles. Extra-large charges of dynamite were set off for the benefit of newsreel cameras. Stores in Matawan and Keyport ran out of explosives and ammunition. A special order was sent to Perth Amboy, New Jersey, for more.

"We've got a shark!" a man shouted here . . . then there. Reports came in with the tide: one shark, two sharks, three sharks, four sharks were trapped in Matawan Creek. With the outgoing tide went reports that shark after shark had escaped from Matawan Creek.

The only respite from the frenzy at the creek came when Matawan buried its dead. The boys who had been the last to see Lester Stilwell alive bore him to his grave. At the First Methodist Church on Main Street, Stanley Fisher's voice was missing from the choir that mourned him. But his memory would live on in the church. With the money from the new insurance policy he had so strangely acquired, Stanley's parents purchased a stained glass window—a landscape of Bethlehem. In the years to come, the rays of the setting sun would filter through the window as day's end came to the little town of Matawan.

At St. Peter's Hospital, Dr. Faulkingham was quietly, skillfully tending the wounds of Joseph Dunn. Newspapers had already reported that Joseph's leg would undoubtedly have to be amputated. But Dr. Faulkingham didn't have time to read the newspapers. He had sutured Joseph's severed tendon and ripped muscles, and a slow, uncertain recovery began. It would be 59 days before Joseph Dunn would walk out of St. Peter's Hospital, but walk he would, on two strong legs.



The savage triangular teeth of a Great White shark show plainly in this specimen, which is a small *Carcharodon carcharias.* No other shark has teeth like the Great White's. Note that it is not truly a "white" shark. The underbellies of virtually all sharks are white. The upper body of the Great White may vary from an oyster-shell white to deepening shades of gray. Courtesy, Miami Seaquarium

Six days after the attack, a shark was finally caught in Matawan Creek—by none other than Captain Cottrell. He was coming up the creek in his motorboat *Skud* with his son-in-law, Richard Lee, when, about 400 yards from the bay, not far from the bridge where he had first seen that lethal shadow, he saw a dorsal fin rise out of the water, then disappear. Swiftly, he and Lee let out several yards of gill net, weighted with lead at the bottom and strung with corks on the top. The net billowed out as the outgoing tide carried it down-creek. Both ends of the net were secured in the boat. By deft maneuvering, the Captain trapped the shark between boat and net. The shark struggled furiously but, foot by foot, the two men hauled in the net, which was to be the shark's shroud.

Using the hull of his boat as an anvil, Cottrell smashed the shark on the head again and again with a large mallet. When he was convinced the shark was dead, Cottrell hauled it ashore. It weighed 230 pounds and was almost exactly 7 feet long. He put it on exhibition in his fish shed, and nearly everyone in Matawan and Keyport lined up to see it as it lay on ice. They paid 10 cents each to view the "Terror of Matawan Creek."

In Bridgehampton, Long Island, scene of another shark scare, a fisherman caught a shark, rented a zinc-lined coffin from a local undertaker, and exhibited *his* shark for 5 cents a look.

Actually, the killer of Matawan Creek may have been caught two days after the attack. Michael Schleisser, a New Yorker who was one of the many shark-hunters prowling the local waters on July 14, was dragging a drift net behind his boat in hope of snagging a shark. He was in Raritan Bay, off South Amboy, New Jersey, less than 4 miles northwest of the mouth of Matawan Creek, when a large shark charged the net. Though quickly enmeshed, the 8½-foot shark fought savagely, snapping a jaw in which row upon row of teeth glistened menacingly. Schleisser, unaware that he had caught a shark of the most feared species in the sea, strained to haul the net closer to the boat, and clubbed the shark again and again. Although many other sharks were being hauled in and displayed by fishermen, Schleisser's shark *was* a killer. Had Schleisser slipped and tumbled into the net, he might have become another victim. For, when he finally subdued the shark, towed it into South Amboy, and ripped it open, he found 15 pounds of flesh and bones in its belly. One of the bones, 11 inches long, was identified as the shinbone of a boy. Another fragment appeared to be part of a human rib. There was no doubt that the shark had probably attacked and certainly eaten at least one human being.

Dr. Lucas of the Museum of Natural History, skeptical about local shark attacks only a few days before, personally identified the remains as human.

The shark itself was identified, too. It was a Great White shark (*Carcharodon carcharias*), feared as a man-eater in tropical waters but, until the period dealt with here, unreported along beaches as far north as New Jersey. Doctor Nichols, an expert who had joined with Doctors Murphy and Lucas in minimizing the possibility of shark attacks after the first two New Jersey killings, now joined with them in conceding the existence of dangerous sharks in northern Atlantic waters. They granted at least one man-eating shark, for Nichols and Murphy concluded that Schleisser's *Carcharodon carcharias* was probably responsible for all five attacks. Whether or not this conservative estimate was accurate, it is possible that there were many of these dangerous sharks in the waters at the time.

Schleisser, who had had some training as a taxidermist, mounted his shark and placed it on exhibit in a New York newspaper office. Later, "The Jaws of the New Jersey Man-Eater" wound up in the window of a Broadway fish shop.

The capture of the apparent killer did not stop the stories that were sweeping the Eastern seaboard. From Florida to Rhode Island came reports of sharks. Virtually every ship that came into New York carried a cargo of shark stories. Several hundred sharks were reported off Fire Island, Long Island, and possés were formed to track them down.

Theories abounded, too. One was that heavy cannonading in the North Sea had driven sharks across the Atlantic to more tranquil seas. Another theory held that sharks were feeding on swimmers because they had been deprived of their usual diet of refuse from passenger liners, whose sailings were being curtailed by another kind of shark, the U-boat. The European war also spawned the idea that sharks had been feasting so well on war dead floating down rivers into the sea that they had undergone a change of dietary habits. One *New York Times* letter-writer gravely calculated the figures: more than 12,500 war casualties had been gobbled up by sharks, he claimed.

By stoking their imaginations a little more, some of the theorists concluded that the ghoul-sharks of European waters had deserted their bountiful feeding grounds in the war zone for the far less ample larder offered by New Jersey bathing beaches.

Logic and reason fell victims to the shark scare. A neighbor of Teddy Roosevelt's said she saw a shark off the beach in Oyster Bay, Long Island, and called upon him to do something about it. A long-distance swimmer announced that he would brave the terrors of the lower bay of New York Harbor in a round trip from the Battery to Sandy Hook—in a wire basket. In the *New York Times*, America's leading woman swimmer, Annette Kellerman, advised bathers to dive under an onrushing shark. "As he is coming at you upside down," she explained, "you have a chance to get away, if the distance to shore or safety is not too far." A chorus girl rushed into print with the exciting news that she had escaped a shark by frightening it off with an impromptu ballet of splashes and kicks. Human sharks profiteered from "special swimming courses" to teach bathers how to outwit sharks. Arguments broke out over whether the shark attacks weren't rather the doings of giant turtles!

After losses estimated at $1,000,000 in canceled reservations, the mayors of 10 New Jersey resort towns met at Beach Haven, where the first shark attack had occurred, and pleaded for an end to the panic. They asked newspapers to refrain from publishing stories that "cause the public to believe the New Jersey seacoast is infested with sharks, whereas there are no more than in any other summer." The resort men thus went on record that there *were* sharks in their waters *every* summer!

The mayors' plea went unheard. Shark stories continued for a few more days to push news of the war and the infantile paralysis epidemic to secondary positions on newspaper front pages.

"Sharks are the undisputed masters of the Atlantic coast," one New York newspaper exclaimed. "The federal government yesterday abandoned its proposed campaign of extermination along the New Jersey beaches. The enemy was too numerous for the Coast Guard to tackle, it was said."

There was some truth in the story of the government's so-called surrender. The federal government had indeed declared war on sharks. A Coast Guard cutter had been dispatched to New Jersey to fight them. A congressman, predictably from New Jersey, had risen in Congress and asked for a $5,000 appropriation to launch a federal crusade against the shark.

And ultimately the strategy of the shark war was discussed at the highest possible level. At a time when Presidential worries included Pancho Villa's raids, a national election campaign, and possible U.S. participation in the World War, the President's Cabinet actually placed the subject of sharks on its agenda. After this Cabinet meeting, Secretary of the Treasury McAdoo announced that the Coast Guard had been ordered to do what it could, which eventually turned out to be nothing. Secretary of Commerce William C. Redfield stated that his Bureau of Fisheries had not yet discovered why the sharks had appeared. Later, the Bureau of Fisheries officially warned bathers to stay in shallow water, because there was no known way to get rid of sharks.

But already, as unexpectedly and as unpredictably as they had appeared, the sharks had disappeared and become, once more, merely shadows in the sea.

Why?

Why was the New Jersey coast the fateful rendezvous for four deaths by shark bite? Why had five shark attacks occurred in 12 days in an area where none had occurred before?

Why? (And why is the New Jersey coast still one of the most shark-ridden coasts in the northern latitudes?)

After the panic-mongers and the tale-spinners had left the stage, taking with them their bizarre theories about shark attacks, the scientific experts stepped forward to explain the 1916 attacks. The experts looked a bit embarrassed.

In April, 1916, three months before the attacks in New Jersey, Doctors Nichols, Murphy and Lucas (the three shark experts) had collaborated on an article on sharks in Long Island waters. Their paper, published in the highly respected *Brooklyn Museum Quarterly*, all but dismissed the possibility of a shark attack on a "living man."

"Probably few swimmers have actually met in him their fate," Nichols and Murphy wrote, "but doubtless many a poor drowned sailor has there found his final resting place." And, in a separate postscript, Lucas added his voice of authority:

"Cases of shark bite do now and then occur," Lucas conceded, "but there is a great difference between being attacked by a shark and being bitten by one, and the cases of shark bite are usually found to have been due to someone incautiously approaching a shark impounded or tangled in a net, or gasping on the shore. And, under such circumstances, almost any creature will bite."

Recalling the unclaimed $500 reward Herman Oelrichs had offered for proof of a shark attack north of Cape Hatteras, Lucas concluded: "That this reward was never claimed shows that there is practically no danger of any attack from a shark about our coasts."

In October, 1916, Nichols and Murphy were back in print again. In a cautious understatement, they noted that "the New Jersey accidents of July, 1916," had brought "the whole shark question before us in a new phase." After making the concession that four "living men" had indeed been killed by sharks, they wrote: "It must be admitted that deaths from shark bite within a short radius of New York City would seem to be one of those unaccountable happenings that take place from time to time to the confounding of savants and the justification of the wildest tradition."

After investigating the attacks and searching for clues to explain them, Lucas, Nichols, and Murphy confirmed that an unusual number of sharks had summered in New York–New Jersey waters. "The nearest I can come to accounting for the sudden preying of these fish," Lucas said, "is to say that this is a 'shark year.' " In line with this theory, Nichols and Murphy wrote:

"It is not impossible that this summer sharks really are with us in unprecedented force, and that we are experiencing an extraordinary shark migration, a movement comparable with the sporadic abundance during certain years of army worms, or jellyfishes, or western grasshoppers, or northern lemmings—movements that all have their source in overproduction and other little understood natural agencies."

Further indication that 1916 was a "shark year" comes from the records of a remarkable shark-watcher, Edwin Thorne, a member of the Board of Managers of the New York Zoological Society. Thorne's hobby was not only shark-watching but also shark-catching. Between the years 1911 and 1927, Thorne spent a total of 302 days looking for sharks in Long Island's Great South Bay, then and now a popular bathing and boating area. Great South Bay was also popular with sharks, Thorne discovered. For, in those 17 years, he sighted 1,799 sharks and killed 305 of them.

In 1916, he saw 277 sharks and killed 102. *In no other year did he see or kill as many*.

Nearly all the sharks Thorne killed were female Brown sharks (*Eulamia milberti*, formerly *Carcharinus milberti*), which had entered Great South Bay to spawn their litters of 6 to 13 young. (Like many species of shark, the Brown shark brings forth young alive.) Great South Bay was—and is—a "shark nursery," a sheltered spot where newly born sharks can begin their lives in relative tranquillity, one of many such nurseries that have been found all over the world and that are used by various species of sharks.

No Brown shark has ever been convicted of attacking a bather. An increase in the number of Brown sharks in New York waters would have had no direct connection with the New Jersey attacks. The indication, however, that more Brown sharks than usual were around in 1916 did raise the question of whether a population explosion in indigenous sharks somehow had brought about the appearance of a dangerous stranger, such as a Great White shark.

Besides the "shark year" theory, there was some speculation that hunger had driven sharks closer to shore. Because of unexplained shortages of normal food at sea, the sharks were said to be prowling the coasts, seeking new prey: and five times—or so the theory went—that had been man. This theory, of course, did not square with the assumption that a single shark had been responsible for all five attacks. But, even though human remains had been found in the Great White shark caught on July 14th, this was not irrefutable proof that the Great White had been the only one of its kind—or the only large and potentially dangerous shark—in New Jersey waters during that particular summer.

On a hot August afternoon in 1960, 44 summers after the New Jersey shark attacks of 1916, John Brodeur, a 24-year-old accountant, and Jean Filoramo, his 22-year-old fiancée, walked hand in hand into the surf off a beach at Sea Girt, New Jersey, barely 2 miles from Spring Lake, where Charles Bruder had been killed by a shark so long before.

In waist-deep water, John and Jean waited for a breaker that would carry them to shore. A glistening, frothing breaker bore down on them. Brodeur let it pass; he wanted a bigger one. As the breaker rolled past him, he thought he saw something black within it. He wondered idly for a moment what that something was.

Then, something—*that black something*—struck him from behind and seized his right leg. Brodeur kicked his left leg at the thing that was clamping an ever-tightening grip about his other leg. His left leg struck something hard and coarse. He twisted about and hit a black body with his left hand So rough was the surface of what he hit that it badly cut two of his fingers. The sea around him was red and he saw, floating to the surface, bits of red flesh torn from his leg.

Submerged by the next breaker. Brodeur lost consciousness. Miss Filoramo pulled him to the surface and screamed for help. Three men dashed into the surf and helped her carry him to the beach. Norman Porter, a former Marine major, ran to where Brodeur was being placed on the beach, grabbed a leather belt from a lifeguard, and wrapped it around Brodeur's thigh as a tourniquet.

The calf of his leg was hanging by a few shreds of flesh and muscle. One leg bone was crushed, the other was deeply gouged. By the time he reached a hospital, only a few minutes after he was carried to shore, he had lost an estimated 8 pints of blood. Eight days after he entered the hospital, Brodeur's mangled right leg was amputated at the knee. But he was lucky. He had survived a shark attack.

The sharks were off the New Jersey coast in the summer of 1962, just as they were every year. But when, one pleasant Sunday in August, a bather stumbled, bleeding, out of the water at the beach in Manasquan, the resort-minded police stubbornly insisted that "a big fish," not a s - - - k, had done the job.

The bather, Michael Roman, aged 24, was taken to Point Pleasant (N. J.) Hospital. The physician who stitched up Roman's left hand and left thigh said that an outline of teeth, forming an incomplete oval of 7½ by 9½ inches, was clearly visible on Roman's leg. Still, the official report persisted: "A big fish."

On Monday, Kendall H. Lee, City Manager of Asbury Park, a popular resort a few miles north of Manasquan, sent telegrams to newspapers in the area: PLEASE BE ADVISED OUR BATHING BEACHES ARE AND HAVE BEEN IN FULL OPERATION AND HAVE NOT BEEN SHUT DOWN AT ANY TIME . . . ASBURY PARK IS PROUD OF ITS LONG AND OUTSTANDING SAFETY RECORD.

Finally, on Tuesday, State Conservation Commissioner H. Mat Adams courageously faced the fact emblazoned on Michael Roman's left thigh. What had attacked Michael Roman, the commissioner solemnly announced, was a shark. It was a very special kind of shark, however, for, Adams pointed out, it had not engaged in a "vicious attack." He said that the shark had not closed its jaws. Rather, Roman had unknowingly put his arm into the shark's mouth up to his elbow. It almost seemed as if Roman was being blamed for attacking the shark!

What happened to John Brodeur that day in 1960; what happened to Charles Van Sant, to Charles Bruder, to Lester Stilwell, to Stanley Fisher, to Joseph Dunn; what happened down the years to so many—and yet, proportionately, to so few—bathers could happen on any warm day in any year at any beach on the East Coast, West Coast, or Gulf Coast of the continental United States. It could happen, too, on any day or night in any warm or temperate sea on earth, for the shark lives in them all. And there are many rivers and at least one fresh-water lake where it could also happen!

Rarely does it happen. The chances of being attacked by a shark, it is often said, are about as great as of being struck by lightning. Actually, there is no comparison between the rarity of death by shark bite and the frequency of death by lightning. In 1959, for instance, 183 persons were killed by lightning in the United States—and only 3 were known to have been killed by sharks. Australia is regarded as one of the most shark-infested countries in the world. Since 1919, there have been about 100 reported attacks on swimmers in Australia—less than three a year. And at one beach, even after three attacks took place, it was calculated that for each bather attacked by a shark, about 30 million bathers had suffered no more than sunburn. Of the swimmers who have enjoyed Florida waters in modern times, less than one out of every 5 million bathers has been attacked in any way by a shark.

But statistics cannot still the fear evoked by the sight of a dark dorsal fin or just an ominous shadow beneath the surface—or the panic loosed on beaches when an attack does occur.

Brodeur was attacked on August 21, 1960, and a mild panic began. Police of several New Jersey shore towns ordered the beaches closed. Lifeguards at New York City's teeming beaches were ordered to use "extreme alertness and caution" in watching not only for sharks but also for panic caused by baseless shark reports. (A New York Park Department spokesman explained that in past shark scares children had been trampled during the stampede out of the water.)

On August 24th, a man in 4½ feet of water 75 yards offshore in Bridgeport, Connecticut, was nipped on the left arm by a shark. The panic increased. Sharks were being reported—and, occasionally, caught—off beaches from Boston to Florida. Beach after beach was closed. In New York City, policemen armed with submachine guns manned six police launches, which, along with two helicopters, were assigned to special shark-patrol duty.

On August 30th, still in 1960, a man swimming 2 miles from shore at Ocean City, New Jersey—about 40 miles south of the scene of the Brodeur attack—was savaged by two or more sharks. His right leg was severely torn and his body slashed, but he managed to swim ashore. Eventually, he recovered without losing his leg.

The panic was really on now: 25,000 bathers were ordered out of the water after a shark was reported off New York City's Orchard Beach. (There were no reports of children being trampled.) Coney Island bathers scrambled ashore when policemen, firing rifles and submachine guns for the benefit of cameramen, inadvertently triggered a shark scare.

It was like 1916, with modern touches. Besides the submachine guns and the helicopters, a Navy blimp was put on shark-spotting duty, and Coast Guard cutters scoured the sea, directed to reported shark packs by radio.

The anxieties of bathers presumably were put to rest by the knowledge that nearly every modern weapon was being used against the shark. But few realized what a senseless war it was. For the seas abound in sharks.

Sharks menace popular bathing, boating, and water-sports areas all over the world—from the beaches of Australia, South Africa and California to the sun worshipers' meccas of Florida and the shores of Long Island. Between August 13th and October 13th, 1961, a total of 310 sharks were caught off the New Jersey and the Long Island coasts by agents of the U.S. Fish and Wildlife Service as part of a very limited study of predators of game fishes. The catch, according to Dr. Lionel A. Walford, director of Sandy Hook Marine Laboratory at Highlands, New Jersey, included six Great White sharks (*Carcharodon carcharias*), ranging in weight from 151 to 285 pounds.[1]

Florida, with its 1,277 miles of coastline, has at least 40 species of sharks within its waters, most of which are said to be harmless. But many a "harmless" shark inexplicably turns on man. One species, long dismissed as harmless, has, in very recent times, been accused of 14 known attacks.

Bathers have been scraped, maimed, or killed by small sharks, big sharks, and such bizarre shark relatives as the Sawfish, whose long snout is studded with thick and massive teeth, and the sting ray, whose tail is a whip that bears one or more venomous spines. It is impossible to classify precisely some sharks as harmless and some sharks as dangerous.

But there is one shark that ranks above all others as a killer and that is the Great White shark. Even after the attacks in 1916, when the Great White was captured off New Jersey, U.S. Commissioner of Fisheries Hugh M. Smith said, "It must be regarded as comparatively inoffensive in our waters." The Great White was then thought to be a tropical shark. We know today, though, that it often cruises as far north as Nova Scotia. The Great White is also described as a pelagic (oceanic) shark, but it makes excursions into bathing areas. And monstrous specimens have been taken not far from such areas. A 3,000-pound, 16-foot Great White, for instance, was harpooned a few miles off Amagansett Beach on Long Island in 1960.

In 1950, the California Bureau of Marine Fisheries published a guide to sharks found in that state's waters. The guide said that the Great White was "uncommon at best in our waters, and, *since it rarely comes inshore*, it is a negligible hazard to California swimmers." [*Italics added.*]

One day in October, 1955, a shark appeared near two skin-divers swimming not far from shore off La Jolla, California. The divers were not attacked and the incident probably would not have been investigated

[1] Other species caught in the Fish and Wildlife survey: 124 Sandbars (*Eulamia milberti*), weighing 8 to 348 pounds; 77 Duskys (*Carcharhinus obscurus*), 12 to 590 pounds; 52 Smooth Dogfish (*Mustelus canis*), 1½ to 18 pounds; 29 Tigers (*Galeocerdo cuvieri*), 29 to 1,100 pounds; 9 Hammerheads (*Sphyrna zygaena* and *Sphyrna diplana*), 24 to 225 pounds; 6 Makos (*Isurus oxyrinchus*), 220 to 320 pounds; 1 Sand (*Carcharias taurus*), 250 pounds, and a 650-pound Thresher (*Alopias vulpinus*). Six sharks were lost before they could be positively identified.

except for a quirk of geography. The shark had chosen to appear right off the pier at the Scripps Institution of Oceanography—and an ichthyology student was there to identify it as a Great White shark. The next day, a Scripps specialist in sharks, Arthur O. Flechsig, was at the pier. He baited a hook and caught the shark. It got away before Flechsig and his two companions could land it. But it had attacked their boat not far from the pier and left behind proof of identification as reliable as a fingerprint: two teeth embedded in the gouged bottom of the skiff. One of the most positive means of identifying a shark is by its teeth. There was no doubt that the teeth in Flechsig's boat belonged to a Great White.

Within two weeks, nine Great Whites had been caught in the area.

Shark attacks had been rare in California coastal waters up to 1955, when the Great Whites suddenly appeared. Besides two cases of swimmers being brushed by sharks, there were on record only three known attacks, one of which in Monterey Bay, on December 7, 1952, was fatal. But in 1955, California's shark-attack pattern changed drastically: two reports of minor injuries from encounters with sharks off Venice Beach . . . a grapple between a surfboarder and a shark off Santa Monica . . . a vicious attack upon a SCUBA diver by a 3-foot shark . . . the astonishing escape of a spear-fisherman who had been seized by a shark but suffered only a scratched foot. The spear-fisherman had been diving in Monterey Bay. He wore a black rubber diving suit and rubber swim fins. The shark grabbed him by the ankles, ripped both "ankles" off the diver's rubber suit, tore off his right swim fin and a heavy wool sock, and bit through his left swim fin. The fisherman identified the shark as a Great White.

There was one report of a non-fatal attack in California in 1956. Then in 1957, one eerie encounter with a shark was reported. Peter Savino and Daniel Hogan were swimming beyond the breakers of Morro Bay, near San Luis Obispo. Savino became tired and Hogan began towing him toward shore. A shark appeared, nudged Savino and slashed his arm, apparently by rubbing him with its sandpaper hide. "I have blood on my arms! We'd better get out of here!" Savino yelled to Hogan. They began swimming separately. Hogan turned a moment later to see whether Savino was all right. Savino had disappeared, without an outcry, and was never seen again.

In 1959, California again experienced a Year of the Shark. On May 7th, a swimmer was killed by a shark practically within the shadow of Golden Gate Bridge. And, on June 14th, there almost certainly was another Great White shark off La Jolla, but this time the shark was not caught. Instead, it caught a man.

Robert Pamperin, a husky, 33-year-old aircraft engineer, was diving for abalone about 50 yards off La Jolla with another skin-diver, Tom Lehrer. Suddenly, Pamperin rose high out of the water. His skin-diver face-plate had been torn off. He screamed once.

"I was swimming about fifteen feet from Bob," Lehrer said later. "I heard him calling, 'Help me! Help me!'

"I swam over to him. He was thrashing in the water, and I could tell he was fighting something underneath . . ."

In the next instant, Pamperin went under. Lehrer peered underwater through his face-place. The water, though bloodied, was remarkably clear, and he saw his friend's body in the jaws of a shark.

"It had a white belly and I could see its jaws and jagged teeth," Lehrer said. "I wasn't able to do anything more. So I swam to shore to warn the other swimmers."

Before 1959 ended, there were three more attacks in California—a spear-fisherman whose left leg was slashed by a Hammerhead shark 300 yards from where Pamperin had been devoured; a swimmer whose left arm was raked from wrist to elbow by a shark off Malibu; and a skin-diver who lived to tell how (what he presumed to be) a Great White shark bit down on one of his rubber swim fins, "shook me like a dog shakes a bone," and then released him, unharmed.

Public officials in California talked of somehow finding a way to stop the sharks. Swimmers and skin-divers sought an explanation for the attacks and the presence of Great Whites in California waters. Oceanographers said that there had been a rise in water temperatures off the coast of California in recent years. But no one really knew why the sharks had come, why bathers had been attacked—or even how many had been attacked. For, when a man goes for a long ocean swim and never returns, or when men go out fishing in a small boat and only the boat is found . . . what was their fate? Captain Charles Hardy, chief of San Diego lifeguards, remarked after Pamperin's death that three persons had disappeared in the area during the previous three months, and that their bodies had never been found. Were they, too, victims of sharks?

Eight days after Pamperin was killed, a 12½-foot shark was caught off Catalina Island, about 60 miles north of La Jolla. In its belly was found a man's watch, too badly deteriorated to be identified. It could not have been Pamperin's, for he wore no jewelry when he went on his last abalone hunt. But whose watch was it? Had a man lost it at sea and, as it fell to the bottom, had its gleam lured a curious shark? Or had a man been wearing it?

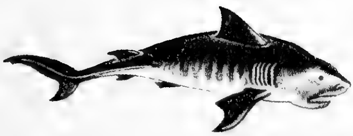
When the southern summer began in Australia in November of 1961, the warm weather ushered in another tragic "Year of the Shark." Fishermen and bathers began reporting the sighting of more offshore sharks than had been seen in recent memory. This time, there was no mystery about what had lured the shark packs. Heavy rains and floods had swept countless fish down the rivers and into the sea along much of Australia's coast.

At many beach resorts, shark patrols were doubled, and swimmers were continually warned against swimming alone or venturing out too far. Along the coasts of Victoria and New South Wales, at least 15 Gray Nurse and White Pointer sharks were killed.

But, in mid-December, a 22-year-old man was attacked off the Queensland coast. His left leg was mauled, and he died within a week. Then, on December 28th, an 18-year-old girl and her 24-year-old boy friend went swimming at Mackay, Queensland. They were standing in about 2½ feet of water about 12 feet from shore when a shark knocked down the girl. In three savage attacks, the shark ripped off one of the girl's arms and part of the other and slashed her right thigh. Her companion desperately beat the shark with his fists. His right hand suddenly gushed blood. By this time, a third bather came to their aid, and the shark disappeared. Forty-eight hours later, the girl died.

Chapter 2

More Shadows Attack



The hazardous creatures of the sea are many, but there is one that man fears above all others: the ominous, stealthy shadow—The Shark.

The fear of sharks is older than the recorded history of man, for tales of terrible encounters between sharks and men go back to prehistoric times. In recorded history the Greek poet, Leonidas of Tarentum, told of Tharsys, a sponge diver, who was being pulled into a boat when a shark attacked him, tearing away the lower portions of his body. Tharsys' companions took his remains to shore, and thus, the poet wryly noted, Tharsys was buried "both on land and in the sea."

Since the time Europeans first sailed the open sea, they carried back to port tales of fearsome fishes—"cruell devourers, the ravenous *tiburon*," man-eating monsters. They were sharks. Yet, skeptics ashore doubted the tales, and the doubts grew as sea voyages became more commonplace. By relatively modern times, the skeptics were insisting that no adequate proof existed to show that sharks truly attacked living men.

In 1916, when the first New Jersey shark attack occurred, the skeptics were shaken, but they still clung to their claims. Even after five successive attacks in New Jersey waters that summer, alleged experts held out against the belief that a shark, unprovoked, would devour a living man. The evidence occasionally found in the bellies of sharks, they said, proved only that sharks would eat bodies, and this was really no proof that the persons were alive when the sharks found them. This was and is a perfectly valid statement.

Ten years after the New Jersey attacks, a businessman named Louis J. Crossette announced that he was going to start a shark fishery in the Caribbean. He wasn't worried. "Sharks do not eat human beings," he explained. "The shark is one of the worst cowards in the sea." Crossette pointed out that no less an authority than William Beebe, the famed underwater explorer, also scoffed at stories of shark attacks.

Beebe, in his bathysphere at the bottom of the ocean, had peered through the thick windows and had seen sharks. He had observed them close at hand while in a bathing suit and diving helmet, in fairly shallow water. None had menaced him. He had also, he said, talked to men in the tropics who had encountered sharks. And, Beebe said, he had come away unconvinced that the shark was a man-eater. Once, he recounted, he had asked the head of the pearl-diving industry in Ceylon if sharks bit men.

"Why, yes," the head pearl diver replied. "We lose many men. They go down, disappear, and we see blood coming to the top of the water."

"Now, tell me," Beebe said, "as one man of science to another, did you ever know a shark to bite a man?"

The way Beebe told the story, the head diver grinned sheepishly and answered: "No, but the tourists like to hear such stories, so we tell them what they want to know."

With well-known experts like Beebe around, the reality of the five New Jersey shark attacks could not compete with the unreality of ignoring the facts of the shark menace. Telling people what they wanted to hear, many alleged experts said that no one need fear the shark. "Where are the records to prove shark attacks?" the experts said. "What is there to rely on besides sailors' yarns?"

The record was there, if anyone bothered to look at it. There was, for instance, the *Indian Medical Gazette* of April 1, 1881, in which a surgeon routinely reported that "more than 20 persons have been severely bitten by sharks this year. Almost all were fatal." And there were on record in 1926 at least four well-documented shark attack reports in the archives of the United States Navy.

Apparently, these Navy records were not consulted by those who refused to believe that sharks would attack men. It seems likely, though, that the following report by a Navy surgeon would have converted any non-believer:

The U.S.S. *Dale*, at the time of the accident, was anchored in Canacao Bay, P. I. About 5 p.m., May 31, 1917, E. E., water tender, attached to the U.S.S. *Dale*, started out for a long swim, accompanied by one of his shipmates. E. E. was an excellent swimmer and, after a time, his companion, becoming tired and not wishing to go further, left him and he continued to swim alone in the direction of the open bay.

About 5:45 p.m., a seaman on the U.S.S. *Monterey* happened to notice E. E., who was then some 200 yards from the ship, fall suddenly on his back and then give two or three violent strokes in the water. At the same time, the observer saw a shark in close proximity to the bather.

It was not hard to conjecture that some accident had occurred, and a boat was rapidly lowered and rushed to the vicinity where the man had last been seen. The body was recovered, but it was evident from the extensiveness of the wound that the man was dead. He was then taken to the morgue of the United States Naval Hospital, Canacao, P. I.

Nearly the entire abdominal cavity had been torn away. Indeed, the wound extended from the ensiform cartilage nearly to the brim of the pelvis. Laterally, from the right mid-axillary line to the left mid-axillary line. The stomach, the small and large intestine, with the exception of a few feet, most of the liver and bladder, half of the left kidney and all of the large abdominal blood vessels were removed . . . A portion of the ribs had been taken out with the nicety of a costotome. Some of the skin along the edges of the wound was in ribbons and bore the imprint of the monster's teeth.

E. E. was of large stature. He was about 5 feet, 11 inches tall and weighed approximately 200 pounds. No doubt if he had been of much smaller dimensions the force of the attack might have been sufficient to have cut his body in two.

If indisputable medical reports such as that one had gained circulation, the question of whether or not sharks attack men would have been settled long ago!

The first documented study of shark attacks in U.S. waters did not come until 1935, when E. Milby Burton, director of the Charleston (South Carolina) Museum, reported,

Authentic published records of persons having been bitten by sharks while in bathing along the Atlantic coast north of Florida are rare . . . Yet, within the last decade, off the coast of South Carolina, there have been several well-authenticated cases of fierce attacks upon bathers.

Burton examined hospital records, interviewed victims, and talked to the doctors who had treated them. The first attack Burton documented occurred on July 16th, 1933, when Miss Emma G. Megginson was standing in the surf at Folly Island, which lies south of Charleston harbor and faces on the Atlantic. The water was about up to Miss Megginson's waist. Her younger brother was in the water with her, and, when she felt something pinch the calf of her left leg, she thought it was her brother trying to frighten her.

But a moment later, her right leg was seized savagely, and blood tinged the water around her. She staggered ashore and was taken to the Roper Hospital in Charleston, where 30 stitches were needed to close the wounds imprinted by the jaws of a shark.

Five days later, Drayton Hastie, aged 15, was swimming at the north end of Morris Island, at the mouth of Charleston Harbor. The attack on Miss Megginson, and the almost simultaneous capture of an 8-foot Cub shark, had made everyone around Charleston shark conscious. So, when Drayton saw what he thought was a dorsal fin of a shark far up on the shore from where he was swimming, he was momentarily frightened. He concluded, though, that he had excitedly identified a choppy wave as a fin.

Just to play it safe, however, Drayton waded to shore and sat down in about 3 feet of water in a place where the beach sloped gradually

Three hundred yards off the shore of North Bondi, Australia, two surf-boarders freeze in terror as the dorsal fin of a shark cuts through the water close to them. The shark circled the youths for 40 minutes before a boat chased it out to sea. (This unbelievable picture has been double-checked for accuracy. It was taken by Sydney *Daily Telegraph* photographer John Askew.) United Press International Photo

to a drop-off some 6 feet from shore. "I was almost certain," he said later, "that in such shallow water I would be safe from anything large enough to bite."

Drayton was thus sitting in shallow water when . . . "I felt a swerve of water, which was immediately followed by an impact which brought me to my senses. Something clamped down on my right leg. I was aware of a tearing pain up and down my leg, and that I was being pulled outward by something which seemed to have the power of a horse. Looking down, I saw, amid the foam and splashing, the head of a large shark with my knee in its mouth, shaking it as a puppy would shake a stick in attempting to take it away from someone. Through natural instinct, I started kicking frantically with my unharmed leg, in order to free myself. I freed my right leg, only to have the monster bite me on my left one.

"All this time I had been pulling myself up on the beach backwards with my hands and kicking at the rough head of the shark, which seemed to me as solid as Gibraltar.

"Although to you this may seem long and strung out," Drayton told Burton, "it must have all happened in a space of ten seconds . . . Some people said I had been bitten by everything from crabs up to whales . . . I still have a perfect design of a shark's mouth around my knee, measuring ten inches across. This confirms the statement of my friend who was standing on the bank and who said that the shark was easily eight feet long."

Drayton Hastie recovered. Possibly confirming his story, within a week after the attack, an 8-foot Cub shark (*Carcharhinus leucas*) was caught less than a hundred yards from the scene of the previous attack. It may well have been the same culprit.

A little more than a month after the attacks on Miss Megginson and Drayton Hastie, Kenneth Layton and a friend were swimming at Pawley's Island, about 75 miles north of Charleston. They were far from shore, although the water they were in was only about 4 feet deep. Suddenly, a man on the beach shouted: "Shark! Shark!"

Layton heard the warning at about the same instant he saw what had inspired it: a large dorsal fin about 50 yards away from him and bearing toward him fast. Layton and his friend frantically began swimming toward shore. But the shark veered and seemed to be trying to cut the swimmers off before they could reach shallow water. It did not attack immediately. Almost as if it were toying with the swimmers, or singling one of them out, it held off until the swimmers were in waist-deep water. Then, in a flash of movement, the shark struck Layton, seizing his right heel and ankle. Courageous friends splashed through the sea to his side, and, by sheer tugging, pulled him from the shark's jaws. The shark disappeared. Several tendons of his right ankle were severed, but Layton survived—and eventually regained use of his crippled foot.

These were not the first shark attacks South Carolina had known. In 1924, for instance, a man was attacked by "a large fish" while standing near the shore of Folly Island. More than 100 stitches were taken in wounds in his left leg. Two months after the attack, he went back to the hospital, complaining about intense pains in his left knee. The knee was operated upon, and a remnant of a tooth was removed. The tooth was immediately mis-identified as a barracuda's. This, presumably, relieved people around Folly Island, for, when faced with some seemingly incontestable piece of evidence proving an attack, the believer in the benevolence of the shark always somehow finds solace in blaming a creature other than a shark. (When Burton was assembling his evidence of South Carolina shark attacks, he had the tooth-from-the-knee clue examined by two ichthyologists who positively identified it as having come from the jaw of a shark!)

Competent research such as Burton's could have turned up numerous shark attacks along United States coasts. But the public, to the delight of concessionaires and chambers of commerce in coastal resort towns, asked for no revelations about shark attacks. They preferred to continue to ignore the shark.

Skepticism about shark attacks persisted up to the advent of World

The mass feeding habit of sharks is shown here. The seas are frothing from the frenzied thrashings of sharks in search of food. This is the most perilous situation a man in the water can face. The photo was taken during the Navy's wartime experiments to develop a shark repellent. The sharks are feeding on trash fish dumped overboard by a shrimp boat off Mayport, Florida. The sharks here were tentatively identified as Small Black-Tipped sharks (*Carcharhinus limbatus*). U.S. Navy Photo

War II. When the war began, neither sailors nor ocean-spanning pilots were prepared for what awaited them if they were cast into shark-infested waters.

On the very day of the Japanese attack on Pearl Harbor, half a world away sharks were attacking, too. A British warship was torpedoed in the South Atlantic on that day. As survivors swam to life-rafts, a pack of sharks appeared among them. Man after man was attacked. The blood triggered a frenzy, and the sharks went mad with hunger-lust. The men lucky enough to reach the rafts fought off emboldened sharks with paddles. When the survivors were rescued five days later, weary, terrified men were still wielding paddles, and sharks were still claiming victims. Of the 450 men aboard, 170 survived. How many were killed by the torpedoing, how many drowned—and how many were devoured by sharks—will never be known.

Nor will it be known how many victims sharks claimed in other wartime disasters, such as the torpedoing of the troopship *Nova Scotia* at night off Delagoa Bay, southeast Africa just north of Durban, or the sinking of the cruiser *Indianapolis* by a Japanese submarine in the Philippines.

A thousand men were lost in the *Nova Scotia* tragedy. Next morning, when rescue ships arrived, they found numerous corpses in lifejackets. The lifejackets had saved the men from drowning. But their dead bodies were legless. Nothing could have saved the men from the hordes of sharks that swarmed the sea.

In the sinking of the *Indianapolis*, 316 men survived and 883 died, most of them in the water, awaiting a bungled rescue that did not come for four long torturous days. The number of men killed by sharks is not known. Many of the men who survived bore shark bites. And 88 of the bodies recovered had been mutilated by sharks.

Despite the earlier known shark attacks, U.S. survival manuals published at the start of the war dismissed the shark as "slow-moving, cowardly, and easily frightened off by splashing." The shark was described as "a wary fish, suspicious of noise, movement, unfamiliar forms. This trait alone would restrain a shark from attacking a swimming person." The shark described in the survival manual appeared to be a creature akin to the cowardly lion in *The Wizard of Oz*, and the recommendations for fighting off a shark read like something out of a fairy tale. After "striking him on his tender, vulnerable nose, in the eye, or knifing the more vital gills," the manual writers bravely advised, "swim out of the line of his charge, grab a pectoral fin as he goes by, and ride with him as long as you can hold your breath."—Probably the silliest armchair advice that could be offered.

But this was only the beginning. "If you can attach yourself to him," the manual went on, "the shark may lose his viciousness and become his usual cowardly self. If you have a knife, cut the shark's belly open. By opening the shark's belly, you let water inside; this will kill him almost instantly."—More absolute nonsense.

A reader of the manual, who did manage to survive a shark attack despite the book's advice, told how he pounded his unloaded .45 pistol on an attacking shark's "vulnerable nose" and "soft" belly. "He turned over then," the pilot reported, "and I started to pound him on the top of his head. He was as hard as steel there, and I later discovered I'd partially flattened the little steel eyelet on the butt of the gun, where the lanyard is attached."

Life-raft occupants were also attacked, and what happened to some of them was certainly not covered in the survival manual. "Late in the afternoon," a man who lived through 17 days on a life-raft recounted, "a shark about four feet long struck at the raft, and, going right over my shoulder, slid into the raft. It took a bite out of C——. One of the men and myself caught the shark by the tail and pulled him out of the raft. C—— became delirious and died about four hours later."

In the South Pacific, potential shark victims did their own field research. Some rescued airmen claimed sharks could be driven off by sea-marker dye, a brilliant yellow preparation used to stain the water to facilitate rescue; others complained that sharks were attracted by the dye. Many men put their faith in water-purifying tablets, the theory being that the chlorine in the tablets repelled sharks.

At least two cases were recorded in which the survival manuals themselves were used to shoo away sharks. An airman downed in the Yellow Sea had nothing to do but pass the time reading a booklet attached to his lifejacket. After reading the booklet, *Survival at Sea*, he tore it up and threw the pieces in the water. A shark that had been following the airman's dinghy darted after the paper and never bothered the airman again.

Over the South Pacific, five men bailed out of a crippled plane. They had no life-raft, and, as they trod water together in their lifejackets, sharks began circling around them. The airmen tried to drive off the sharks by kicking at them. Then, in disgust, they tore up two survival manuals and tossed the pieces away. The sharks left the men and swam off to examine the manuals. A short while later, the men were rescued. What happened to the sharks after digesting the message in the manuals is not known.

Dr. George A. Llano, an Air Force research specialist, and an internationally known student of shark attack, himself a life-raft survivor, gathered these reports in an exhaustive study of airmen who ditched their planes or who were shot down over the sea during the war. He examined the reports of 2,500 victims of wartime sea survival experiences. Surprisingly, only 38 reports mentioned actual contacts with sharks. But, as Llano grimly remarked, "When sharks are successful, they leave no evidence, and the number of missing airmen who may have succumbed to them cannot be estimated."

Llano told of one Navy officer who survived a shark attack during the 12 hours he floated in the water off Guadalcanal after his destroyer was sunk. At dawn, he said, he was floating in the water when he felt something "tickling his left foot."

"Slightly startled," his account reads, "I . . . held it up. It was gushing blood . . . I peered into the water . . . not ten feet away was the glistening, brown back of a great fish . . . swimming away. The real fear did not hit me until I saw him turn and head back toward me. He didn't rush . . . but, breaking the surface of the water, came in a steady direct line. I kicked and splashed tremendously, and this time he veered off me . . . went off about twenty feet and swam back and forth. Then he turned . . . and came from the same angle toward my left . . . When he was almost upon me I thrashed out . . . brought my fist down on his nose . . . again and again. He was thrust down about two feet . . . (he) swam off and waited. I discovered that he had torn off a piece of my left hand. Then . . . again at the same angle to my left . . . I managed to hit him on the eyes, the nose. The flesh was torn from my left arm . . . At intervals of ten or fifteen minutes he would ease off from his slow swimming and bear directly toward me, coming in at my left. Only twice did he go beneath me. Helpless against this type of attack, I feared it most, but because I was so nearly flat on top of the water, he seemed unable to get at me from below . . . The big toe on my left foot was dangling. A piece of my right heel was gone. My left elbow, hand and calf were torn. If he did not actually sink his teeth into me, his rough hide would scrape great pieces off my skin. The salt water stanched the flow of blood somewhat and I was not conscious of great pain."

(Though by now the shark had bitten his thigh, exposing the bone, the officer was more concerned with attracting the attention of a ship that was going by. He waved frantically. The ship spotted him and sped to his rescue scant seconds before he would surely have been devoured. Sailors aboard the ship began firing rifles at the shark to drive it away.)

"A terrible fear of being shot to death in the water when rescue was so near swept over me," the officer later told his rescuers. "I screamed and pleaded and cried for them to stop. The shark was so close. They would hit me first."

Llano discovered that every shark encounter produced an apparently unique pattern of behavior, by both the shark and the man who faced it. A pilot swimming toward an island after being downed in the southwest Pacific told of seeing four sharks come within 25 yards of him. He ignored them. "I made up my mind not to get panicky, but to keep plugging along until I got there, or the sharks got me," he said. He made it, unmolested by the sharks.

Another pilot who parachuted into Philippine waters was shadowed by four sharks. As long as he kicked at them, they did not bother him. When he stopped to rest, one of them would make a pass at him. In one of these lunges, a shark grazed his legs. Even though blood colored the water around him, he was not attacked again. After eight hours in the water, he was picked up by a destroyer.

"Men have spent hours in the water among sharks without being touched, and in view of the evidence some of the escapes seem little short of miraculous," Llano reported. "The one feature all accounts illustrate is the fact that, though clothing cannot be depended on to prevent attack, sharks are more apt to bite a bare than a clothed body."

The wartime experiences recounted to Llano and other researchers in the Air Force and the Navy provided science with some new information about shark behavior—and showed the absurdities of some old beliefs about sharks. But man still has a lot to learn.

Anyone who read of a shark attack, then went to the beach, felt a slight chill when the thought of a shark passed through his mind. The very terror of the shark, however, often suppresses reason. Shock, horror, revulsion, grief, panic, fright—these are the typical ingredients of a shark-attack story. They are ingredients that rarely produce a cool, analytical report of what actually happened.

After an attack, if the victim is dead and the body is recovered, it may still bear some evidence. Pathologists may find some clues: a tooth, or a crescent of wounds that will indict a certain species of shark. If the victim lives, he may babble an incoherent story, or, as has happened several times, he may be able to recount, vividly, exactly what happened—but only during those few awful seconds when his life or death hung on the whim of a shark.

"All I remember about the actual accident," one victim said, "was that there was a movement on the surface and my left hand had disappeared in a shark's mouth . . . I closed my right hand and hit upward on the end of his nose . . . The fish obligingly opened his mouth and disappeared. I had not seen him come, nor did I see him go—even though we were only a foot or two apart."

The man who told this story, Philip C. Diez of Honolulu, was attacked off the Island of Molokai in Hawaii in 1956. He was hauled aboard a nearby boat and taken to shore, where prompt medical attention saved his mangled arm. To Diez, the attack was as sudden and as inexplicable as a bolt of lightning searing a sunny summer sky.

Rarely are there calm, competent witnesses who have seen the whole terrible tableau of an attack and have had the necessary background to interpret soberly what their shocked eyes have seen. There is on record, however, at least one such accumulation of eyewitness testimony about an attack. From this testimony has come a thorough study of a shark attack. But for this detailed report, a young man had to die, and several brave men had to risk death.

The victim was Barry Wilson, aged 17, who was attacked by a shark off Pacific Grove, California, about 2 o'clock in the afternoon of December 7th, 1952.

Barry's ordeal with a shark began, like many another, with a scream.

His cry was heard simultaneously by his friend, Brookner Brady, Jr., aged 15, who was swimming close by, and John C. Bassford, who was sitting on a rise directly above the beach. Bassford, assistant manager of the Monterey (California) office of the Metropolitan Life Insurance Company, and an experienced skin-diver, was 30 yards from Barry when he heard the scream. Bassford saw the actual attack. An instant before Barry screamed, Bassford noticed that the youth seemed to be frantically scanning the water around him. Then, as Barry's face was transfixed in terror, a large shark appeared directly in front of him. While Bassford shouted a warning to Barry's companion, the shark struck Barry. Bassford saw Barry's body thrust straight out of the water up to about his thighs.

Barry pushed both his hands against the shark, trying to free himself. But he fell sideways, still clutched by the shark, and was pulled under. Blood gushed upward and spread on the surface, forming a circle about 6 feet in diameter. Barry suddenly bobbed to the surface in the middle of the circle, screamed again, and began beating the water with his hands.

Now the shark appeared again, part of its back showing above the surface. It swept past Barry, then returned—and finally disappeared. Whether it struck Barry again, Bassford didn't know.

Although he had seen the attack, 15-year-old Brookner Brady would not leave his friend. He swam 50 feet to Barry's side and began towing him to shore.

Meanwhile, four members of the Sea Otter Club, a skin-divers' group, swam out to Barry and Brookner. Three of the Sea Otters were trained investigators: Sergeant Earl Stanley of the 63rd Military Police Platoon stationed at nearby Fort Ord; Robert Shaw of the 313th Criminal Investigation Detachment at Fort Ord; and Frank M. Ambrosio of the California State Highway Patrol. The fourth Sea Otter was John L. Poskus, a mathematics and physics teacher at Monterey High School.

The four rescuers brought with them a large inner tube which they managed to get around Barry's body and up under his limp arms. As they struggled in the water with the bulky tube, Barry suddenly lunged forward. Startled, Shaw looked around to see who had pushed Barry so violently. Shaw saw a shark, just as it turned away, and he realized what had pushed Barry. The shark had not given up its victim.

Shaw and Ambrosio clung to opposite sides of the inner tube, pushing it, while Poskus pulled it with a nylon rope he had attached to it. Stanley kept to the back of the tube, supporting Barry's head to keep it from falling backward into the water.

Through rough seas, the men headed for a small breakwater pier. It was a slow, arduous journey that lasted more than 20 minutes. And during those 20 long minutes, the shark constantly hovered close by the rescuers and the victim they had snatched from it. Again and again—usually when the men stopped to prop Barry's slipping body back into the tube—the shark appeared. That is all it did. Appear. Never did it strike at Barry. Never did it make a feint. The men said its movements were slow, deliberate, almost leisurely.

Somewhere during that nightmare, Barry died. He was dead when a waiting physician examined him the moment his body was carried up to the pier. The lower part of his right buttock and nearly all of the back of his right leg from the thigh almost to the knee was ripped away. His left leg bore deep slashes.

By careful examination of the wounds—and by interviewing the rescuers, who had been able to observe the shark closely, ichthyologists concluded that the killer had been a Great White, 12 to 13 feet long. Rolf L. Bolin, an ichthyologist from Hopkins Marine Station in Pacific Grove, deduced that Barry had been bitten at least four times.

"The corroboratory evidence of the witnesses," Bolin reported, "indicates the sequence: first, on the lower left leg from behind, which strike wounded and startled him; second, on the medial surface of the right thigh, when the shark approached him from in front, and, passing partially between his legs, lifted him high out of the water; third, on the upper left leg from the back and side, when Wilson struck in desperation at the water, and, finally, on the back and side of the right thigh, while he was being placed in the tube and when he was undoubtedly already dead."

The attack took place in water about 30 feet deep. The water temperature, which had been slowly falling from about 56° to 55°F. for about a week, was hovering at around 55° at the time of the attack. A heavy surf, reaching to heights of about 8 feet, was running, and the water was somewhat murky—because of dirt washed into the sea by rain the night before and a heavy concentration of plankton. Visibility was limited to about 6 to 8 feet underwater. The day was partly cloudy.

Those were the factual ingredients of the attack. Is there, somewhere among them, an answer to the riddle of why sharks attack men?

If there is an answer to the riddle, it is certainly hidden in the sequence of events that trigger an attack—the conditions in the water, the reaction of the swimmer, the responses of the shark to a complex series of causes and effects. But so many factors seem to be involved that no simple equation can be set up. With what is known about sharks today, no one can honestly say that a certain set of conditions will or will not produce a shark attack. Only one categorical statement can be made about sharks: they are unpredictable.

Captain Cousteau, who has become one of the world's outstanding authorities on life beneath the sea, and has survived many confrontations with sharks, says in his famous book, *The Silent World:*[1] "From the data, covering over a hundred encounters with many varieties, I can offer two conclusions: the better acquainted we become with sharks, the less we know them; and one can never tell what a shark is going to do."

Dr. Gilbert Doukan, a doctor of medicine, and a pioneer in underwater hunting, exploration, and photography, is only a trifle more optimistic. Perhaps, he writes in his *The World Beneath the Waves,*[2] the day will come when we will "know which sharks are the 'good' ones, and which are the ones whose aggressive and dangerous nature makes it advisable to give them a wide berth."

But he adds: "Unfortunately, however, by the time we have succeeded, in the bluish immensity of the water, in recognizing to which type a shark belongs, it may be too late. There are no charitable beings dwelling in the depths of the tropical waters who will considerately erect, in the appropriate regions, notices saying, 'Beware of the sharks.' "

The enigma of the shark is not left unchallenged. Scientists of shark-menaced shores from Florida to Australia are seeking to unravel the mystery. It is frustrating work. The typical dangerous shark is large, difficult to handle, and not designed for laboratory study. It often languishes in captivity, and whatever secrets of behavior it may reveal in a tank or a pen are muted by its apathy in imprisonment.

With patience and skill, however, scientists are managing today to keep sharks in captivity and study them. Dr. Eugenie Clark is testing the behavior and the intelligence of large sharks of several species at the Cape Haze Marine Laboratory on Siesta Key, Florida. Recently, Dr. Clark delivered 37 Tiger shark pups by cesarean section. One survived. Thanks to constant, almost maternal care, the shark pup lived for three and a half months while Dr. Clark scrupulously observed it. She hoped to learn when the shark reached maturity—an elementary fact, but one that is not positively known, so scant is our knowledge of sharks.

One morning Dr. Clark checked her shark pen and found the pup dead. It was killed, she believes, not by natural causes or by another shark, but by a vandal who sneaked into the laboratory compound, somehow caught the little shark, and beat it over the head.

With the aid of an anesthetic known as M.S. 222, sharks can be captured and subdued, experimented on or examined—and then returned to the sea, unharmed. The anesthetic can knock out a 400-pound shark in 1 minute or less. It is merely squirted into the mouth of the shark

[1] Jacques Yves Cousteau, *The Silent World* (New York: Harper, 1953).

[2] Dr. Gilbert Doukan, *The World Beneath the Waves* (New York: John de Graff, 1957).

Dr. Eugenie Clark holds a 34-inch Tiger shark (*Galeocerdo cuvieri*), last of a litter of 37 born at the Cape Haze Marine Laboratory at Sarasota, Florida. The pup was apparently killed by a vandal. Dr. Clark had hoped that the sharks would live long enough to reach maturity and perhaps provide clues to the Tiger shark's ravenous eating habits. Wide World Photo

(the spiracles of a ray) or sprayed over the gill slits. A simple water pistol can be used. The anesthetic has been used extensively in recent experiments on sharks under conditions as close as possible to their normal environment.

Research has not usually been encouraged in areas sensitive to publicity about shark attacks. In 1958, however, the Sarasota County Chamber of Commerce requested the Florida State Board of Conservation to "determine as many facts as possible about sharks in Florida waters, their potential (statistical) danger to bathers and what measures or recommendations for precautionary measures seemed advisable."

The Chamber's unprecedented request was not inspired by a sudden academic interest in ichthyology. In the summer of 1958, four shark attacks occurred within five weeks along a 60-mile stretch of beach between Sarasota and Sanibel Island on the lower west coast of Florida.

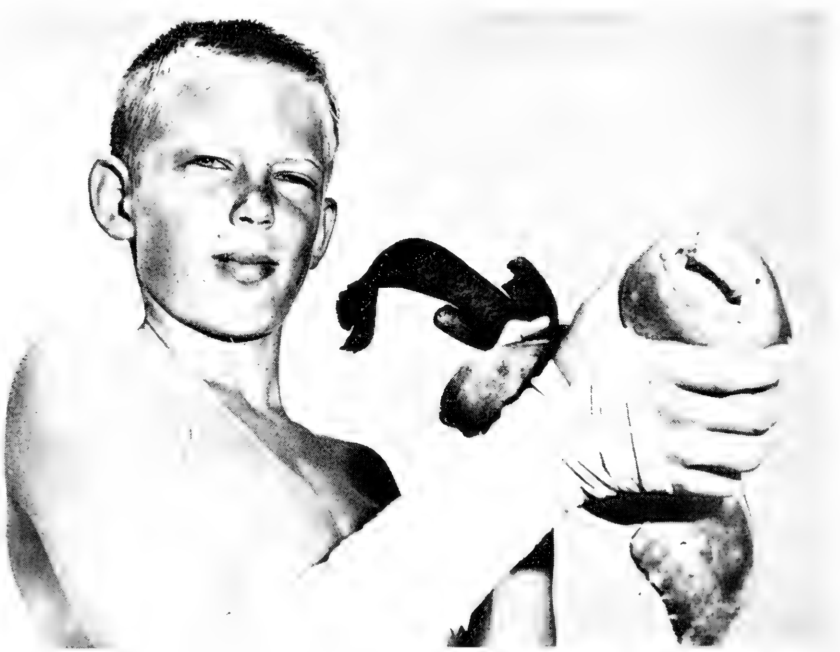
On June 24th, Frank A. Mahala, aged 17, was walking toward shore in 2½ feet of murky water at Turtle Beach on Siesta Key. He was about 10 feet from shore when, coming from behind, a shark grabbed his left leg. Mahala said he did not feel any sensation in his wounded leg. He thought he had been bitten only once. Actually, he had several wounds. This insensitivity to pain is typical in shark bites.* He was dragged to shore by relatives and taken to a hospital, where it was found that his left foot and leg were severely injured by what the attending physician described as teeth "shaped like the teeth of a heavy saw." The physician believed, from the nature of the wounds, that the shark had taken the youth's entire foot in its mouth, but had not been quite strong enough to bite through it. Mahala recovered.

On June 26th, Eric N. Cockerill, aged 59, was wading in water about 3 feet deep on a sand bar some 30 feet from shore off Sanibel Island. Cockerill said that he felt a sharp pain in his right foot and realized that he had put it right into the mouth of a shark. He yanked his foot out of the water and saw the shark's jaws still locked around it. The shark let go and disappeared. Cockerill limped ashore, and eventually recovered the use of his foot. From Cockerill's description of the shark and from the pattern of the wounds, it was concluded that a "harmless" Nurse shark, about 7 feet long, had attacked him.

On July 2nd, again at Siesta Key, Jon Hamlin, aged 22, was skin-diving about 10 feet from shore. He saw a "harmless" Nurse shark lying amid some rocks on the bottom. Hamlin grabbed the 5½-foot shark by the tail with both hands and started making his way toward shore. Suddenly, the shark twisted and sank its teeth into the inner part of Hamlin's left leg, just below the knee. Hamlin immediately released his grip, and so did the shark, which rapidly swam away. Hamlin recovered.

The fourth attack occurred on July 27th, 9 miles north of where Frank Mahala had been attacked on June 24th. Douglas Lawton, an 8½-

* The authors have no explanation as to why some sharks can bite sizeable chunks of flesh from victims without apparently causing pain. This phenomenon is reported frequently in case histories of shark attacks.



Thirteen-year-old King Scherer displays a 28-inch Nurse shark (*Ginglymostoma cirratum*) which ripped his arm when he tried to grab its tail while he was skin-diving off Delray Beach, Florida. Despite the wound, he towed the shark to shore. Nurse sharks have long been classified as "harmless," despite the fact that they have often viciously, though not fatally, attacked swimmers. United Press International Photo

year-old aspiring skin-diver, was playing with his 12-year-old brother in about 3 feet of water 10 feet from shore. He and his brother were wearing green face masks and green flippers. They were alone in the water. The boys' father and mother, an uncle and an aunt, were sitting near the water's edge.

No one saw the shark glide into the water near the boys. When Douglas screamed and was pulled under, his brother rushed to him, and, in rapidly reddening water, supported his brother's head. Douglas' parents, aunt, and uncle ran into the shallow water. They saw the shark striking again and again at Douglas' left leg. So shallow was the water that the shark's head, clamped to the boy's thigh, broke the surface. Douglas struck at the shark with his left hand. Slashed by the shark's teeth, his hand began to bleed. The boy's father pulled the shark by the tail, trying desperately to tear it from his son. Douglas' uncle held the boy by the shoulders and tugged against the shark. Douglas' brother was scratched, apparently by the shark's hide, as he held his brother's body. Unable to wrest Douglas from his family's grasp, and partially exposed in the shallow water, the shark floundered, then slithered into deeper water and vanished.

A tourniquet was applied to Douglas' ravaged left leg. He was taken to a hospital, where his leg was amputated above the knee.

Dr. Clark, whose marine laboratory was nearby, studied the four attacks. She interviewed victims, witnesses, and attending physicians. She showed them pictures of various species of shark. She decided that a Tiger shark had been the attacker. And, after discovering a sand bar off the attack site, she reconstructed what she believed to be the events leading up to the attack.

"It is possible," she said, "that the shark swam over the sand bar earlier in the day and then found itself trapped in the channel as the tide became lower; or it may have swum into the channel from either of the passes at the ends of Longboat Key. The victim and his brother were the only people in the water at the time and the shark might easily have detected the vibrations made by the boys slapping their foot flippers at the surface of the water.

"The victim's feet and ankles were not as deeply tanned as the rest of his legs, as he usually wore shoes and socks when playing in the sun. It seems possible that the shark, attracted by the vibrations made by the flippers, saw the pale lower portion of the boy's leg and struck at that point, first causing the large wound on the foot [the victim's left flipper was lost, presumably during the attack]."

Her criminological study of the four cases led her to another possibility. "The shark which attacked Frank Mahala on June 24, 9 miles south," Dr. Clark said, "could conceivably have been the same species and possibly the same individual shark. The latter is considered doubtful, but . . . this could be an explanation for the unusual occurrence of these two unprovoked attacks so close together in time and location in an area where no similar attack had been reported in 38 years."

The theory that a solitary, malevolent shark may be responsible for a series of adjacent attacks has been proposed by Dr. V. M. Coppleson, the Australian surgeon who has made a lifelong study of shark attacks in his home waters. Dr. Coppleson, who named these reputed marauders "rogue sharks," suggests in his book, *Shark Attack*,[3] that the "rogue" is "a killer which, having experienced the deadly sport of killing or mauling a human, goes in search of similar game." He said the shark with a taste for human flesh is comparable to the man-eating lions and tigers which especially seek out only humans for prey.

Dr. Coppleson once dramatically demonstrated his "rogue shark"

[3] V. M. Coppleson, *Shark Attack* (Sydney, Australia: Angus & Robertson, Ltd., 1959).

theory in Australia. After reading a newspaper report that dogs were being attacked by sharks in George's River near Sydney, Coppleson suspected that a rogue shark was in the area. He became convinced when a 13-year-old boy was killed by a shark at North Brighton Beach, not far from George's River. The fatal attack occurred on January 23rd, 1940. That day Coppleson wrote a letter to the *Sydney Morning Herald*, warning that a man-eating shark was in the area and might strike again. Eleven days after his letter was published, a man was killed by a shark 400 yards from the scene of the first attack.

Several cases may give weight to the rogue-shark theory. The five attacks in New Jersey in 1916 conceivably could have been the work of a single shark. In 1931, three persons were attacked—two of them fatally—within nine days in the waters around Havana, and a solitary shark was blamed. Probably the most damning indictment of a rogue shark occurred in 1899 in Port Said, the bustling seaport at the Mediterranean end of the Suez Canal.

Dr. William Bryce Orme, the port medical officer, reported that about 8:30 on the morning of August 8th, 1899, a 13-year-old Arab boy was brought into the hospital. He had been bitten by a shark. An hour later, a 19-year-old boy was brought in, an arm and a hand torn by a shark. At 11:30 A.M., a 9-year-old boy was admitted. Part of his back had been ripped away by a shark. "None was bathing at the same place or the same time," Dr. Orme reported. "Many people have expressed the opinion it must have been one shark which bit all three boys and I think this very likely."

Although it is possible that a single shark may be responsible for more than one attack within a short period of time or within a short span of coast, the rogue-shark theory cannot explain all shark attacks. In fact, nothing seems to!

Every apparent key to the *why* of shark attacks unlocks one part of the mystery only to reveal another. Conditions that seem to trigger some attacks do not trigger others. Every statement advanced to cover a number of attacks has to be jettisoned when exception after exception is found to it. Here are three categorical statements often made about shark attacks—and here are the inevitable contradictions:

Only large sharks attack men: On February 10th, 1955, while on the bottom of Trinidad Bay, near Trinidad, California, John Adams, a professional diver, was attacked by a hitherto "harmless" Leopard shark (*Triakis semifasciata*). It was 3 feet long. This is but one of several cases of small sharks attacking men.

Sluggish, bottom-dwelling sharks do not attack men: Two of the Florida attacks mentioned earlier were made by Nurse sharks (not to be confused with the Australian Gray Nurse), sluggish, bottom-dwelling sharks that have been described for years as "harmless." Nurse sharks are known to be responsible for several other attacks, especially on skin-divers. A similar, reputedly inoffensive shark, the Wobbegong of Australia, lost its benign reputation after biting off the foot of a fisherman who apparently stepped on it. Admittedly, these "attacks" are nothing of the sort in actuality, any more than is the lashing strike of a disturbed sting ray. They are classified as "provoked attacks."

Sharks do not attack when the water temperature is below 65 or 70 degrees: The fatal attack on Barry Wilson off Pacific Grove, California, occurred in water whose temperature was 55°. On May 7th, 1959, a Great White mauled 18-year-old Albert Kogler while he was swimming about 50 yards off Bakers Beach, near the Golden Gate Bridge in San Francisco. Kogler's left arm was nearly ripped off. His courageous companion, Shirley O'Neill, also 18, swam to his side and tugged him to shore, where, 90 minutes later, he died. Within three hours after the attack, the temperature of the water was taken at the attack site. It was 55°.

Another device that is used in attempting to explain shark attacks is "*The List*." This sets down exactly how many species of sharks are dangerous. Sometimes "*The List*" has 8 names, sometimes 13. A currently favorite number, used by the list-makers who are playing it safe, is 28.

The reader will not find "*The List*" in this book. For one reason, no one knows how many species of sharks there are, let alone how many species are "dangerous." For another, many species are so similar that even an ichthyologist cannot distinguish between them unless he has one stretched out dead in his laboratory and can count the teeth, measure the distance between dorsal fins, and ponder other anatomical quiddities. Few swimmers, seeing a shark lurking in the water, will be able to identify it correctly. Of the numerous attacks studied by scientists, only 5 per cent have yielded enough information on which to base an identification of the attacker. So "*The List*" is invariably drawn up on the basis of inadequate information.

"In general, good advice about sharks seems to be not to trust any of them," a Florida ichthyologist says, and good advice it is. The International Oceanographic Foundation's assessment is: "All sharks are potentially dangerous. Some sharks, shorter than 4 feet, are not so dangerous as the longer and larger ones, but one should beware of any shark, just to make sure."

Concerned over the lack of dependable information on shark behavior and the scarcity of facts about shark attacks, scientists from 34 nations met at Tulane University in New Orleans in April of 1958. The conference, sponsored by the American Institute of Biological Sciences, led to the creation of the Shark Research Panel (SRP). The SRP, affiliated with the Institute's Hydrobiology Committee, is supported by the Office of Naval Research, Cornell University, and the Smithsonian Institution. Members of the SRP are Dr. Perry W. Gilbert, Cornell University zoologist, who is chairman of the panel; Dr. Stewart Springer, Chief of the Exploratory Fishing and Gear Research Branch of the U.S. Fish and Wildlife Service; Dr. Leonard P. Schultz, curator of fishes for the Smithsonian Institution; Dr. Eugenie Clark, Cape Haze Marine Laboratory, Placida, Florida; Dr. Sidney R. Galler, Office of Naval Research; Dr. Robert W. Hiatt, University of Hawaii; Dr. James Snodgrass, Scripps Institution of Oceanography, La Jolla, California; and F. G. Wood, Jr., Marineland Research Laboratory, St. Augustine, Florida.

The SRP maintains a *Shark Attack File*, a permanent, elaborately cross-indexed record of attacks from all over the world. When an attack is reported anywhere, the SRP moves swiftly to obtain all available information. A physician in the area is asked to help, or one of the many ichthyologists cooperating with the Panel goes to the scene. If the victim survives, he is asked to fill out a detailed questionnaire. Whether he lives or dies, witnesses, policemen, hospital attendants, his physician, and his relatives are interviewed.

The questionnaire and the interviews seek such information as the depth, the temperature, and the condition of the water; the time of the attack and what the weather was like; the color of the victim's clothing or bathing suit, and the color of his or her skin; the kind of shark and who identified it; the nature and treatment of the wounds; and how both the victim and the shark behaved before, during, and after the attack.

From the answers to these questions, from the study of the circumstances surrounding attacks, and from research into shark behavior, the SRP hopes to find enough evidence to settle several theories about what triggers an attack. High on the list of suspected causes of many attacks is the presence of blood.

One moment the sea is empty of sharks. Then, a ship sinks or a plane crashes, and human blood, perhaps only in minute quantities, mingles with the sea. Suddenly, like wraiths instantly embodied, sharks appear. They circle warily. They hesitate to come close. Then one finds prey. Then another. Finally, the shark pack churns the water in a frenzy of feeding. Seemingly maddened by the intoxicating scent of more and more blood, the sharks gorge on any prey—*including each other*.

Fishermen have seen such sights whenever shark packs attack a school of fish or a bleeding whale. When survivors of a ship or a plane disaster are the victims, the massacre may be so thorough that there is no one left to tell the tale.

But from the lips of some survivors has come testimony to show that many men have leaped from sinking ships only to die in the jaws of sharks. When the troop transport *Cape San Juan*, torpedoed by a Japanese submarine, went down in the South Pacific during World War II, 1,429 men were aboard. The merchantman *Edwin T. Meredith* saved 448, and even during the rescue operation, great schools of sharks were still savaging the life-rafts and their occupants. A member of the *Meredith* crew later told what he had seen and heard: "Time after time, I heard soldiers scream as the sharks swept them off the rafts. Sometimes the sharks attacked survivors who were being hauled to the *Meredith* with life ropes." A soldier who survived the torment etched one stark vignette from the hours of horror: "I was sitting on the edge of a raft talking to my buddy in the darkness. I looked away for a moment, and when I turned back, he wasn't there any more. A shark got him."

The water need not be extensively bloodied to attract sharks. A drop of blood seems capable of alerting sharks to a potential feast. In the exhaustive investigation of the previously mentioned attack on Barry Wilson in California, scientists learned that just before the youth entered the water a veteran diver noticed that Barry's body bore several fresh scratches, inflicted when he skinned himself on a rock. The older man warned Barry that the infinitesimal amount of blood oozing from the scratches could attract sharks. Ignoring the warning, Barry dived into the water, and a few minutes later he was seized by a shark.

In another case, a skin-diver wearing an aqualung was swimming near the bottom when his nose began bleeding. Some of the blood was draining into his mouth and entering the exhaust tube of the aqualung, sending out a stream of blood-tainted bubbles. A small shark, apparently aiming for the source of the alluring blood, twice struck at the skin-diver's head and face, then darted away. The skin-diver was only slightly injured.

So sensitive is the shark's perception of blood in the water that Dr. Schultz of the SRP believes it is possible that a woman bather may be in more danger of a shark attack when she is menstruating.

The presence of fish blood or struggling fish is a well-known shark attractant. Most often skin divers report the loss of the fish that they have captured. Some, less lucky, attract the sharks to themselves. On August 19th, 1962, a fisherman named Hans Fix was standing in waist-deep water off Padre Island, a thin strip of land that extends along most of the Texas Gulf Coast. Fix had a string of fish dangling from his belt. A shark, undoubtedly lured by the fish, rushed at Fix. In seconds, the shark bit the fisherman's right leg three times, nearly severing it. Thirty minutes later, Fix died in a hospital.

When a single shark swoops into a group of persons, usually, it seems, one victim is selected, and the shark pursues that one, ignoring other persons nearby. On May 19th, 1960, four teen-agers were clustered around an inflated inner tube about 150 yards off Hidden Beach, 6 miles southeast of Santa Cruz, California. They were members of a high school sophomore class who had earned a day off as a bonus for selling the largest number of school yearbooks.

Playing around the tube were Nick Buak, aged 16; Larry Cronin, 15; Tessie Lettunich, 15; and Suzanne Theriot, 16. "Larry and Suzanne were swimming around the tube, and Nick and I were in it," Tessie later reported. "Suzanne screamed that something was on her leg. Larry grabbed her arm and Nick told me to pull my feet up onto the tube. I saw the blood, and the fin sticking out of the water. We started kicking, and Larry, holding Suzanne, clung to the tube."

At this point, another swimmer, Edward Cassel, aged 17, reached the tube and helped get Suzanne ashore. Her left leg, which was later amputated, was mangled. But the shark had not touched any of her companions. (Similarly, none of the rescuers of Barry Wilson was touched by the lurking shark that followed them as they got him to shore.)

A macabre tale of a shark's persistence in singling out a victim came out of World War II. An Esso tanker was fired upon and then torpedoed by a German U-boat. Two members of a Navy gun crew aboard the tanker were shot down at their battle stations when the U-boat shelled the tanker. After the vessel was torpedoed and the order given to abandon ship, a heroic seaman, Charles D. Richardson, dragged the two wounded men to the railing and dropped them over the side. Then he dived in after them.

Richardson got one man on his back and told the other to cling to his neck. With his double burden, Richardson began struggling through the oil-coated water toward a lifeboat. He heard the man on his back moan and felt him begin to slip. Richardson turned to see a shark pulling at the man on his back.

While the second wounded man still clung to his neck, Richardson pulled a knife and slashed at the shark, trying to drive it away. But the shark kept gnawing at the man on Richardson's back, as if determined on him alone for its victim. Ignoring Richardson and the second wounded man, the shark kept on tugging. The shark got its man. Richardson did save the other man, and they reached outstretched hands in the lifeboat. The valiant seaman later received the Maritime Commission's Merchant Marine Distinguished Service Medal for his heroism.

In several Australian shark-attack cases, the strange pattern has been the same—a single victim selected from several bathers; an attack on him alone; his rescuers untouched.

The theory has naturally arisen that the rescuers of an attack victim are somehow themselves immune from attack. But this theory has been demolished by careful Shark Research Panel investigations. Dr. Schultz reports: "Our records indicate that of 68 individuals who have gone to the aid of a victim of shark attack, 12, or 17.7 per cent, have been attacked. Hence, anyone going to the aid of a person being attacked is definitely placing himself in a dangerous situation."

Are there no clues to what causes an attack? Is there no theory that will stand up under scientific scrutiny?

Two factors that trigger attacks seem to be established beyond question:

Blood, even greatly diluted and in small quantities, definitely attracts sharks. So does vomit, offal, garbage, and carrion.

The behavior of an injured or inexperienced swimmer—irregular, frantic motions, panic—can set off a kind of signal that may embolden an approaching shark to attack. The behavior of the swimmer may suggest to the shark that something wounded is in the water and this attracts the shark just as would a fish writhing on a hook.

Perhaps the very chemistry of the body sets off this signal. When the senses of the human body detect a threat—such as a loitering shark—what is usually called "fear" manifests itself in a series of swift, involuntary activities within the body. Epinephrine (also know as adrenalin) is secreted by the adrenal gland to step up the heart beat and raise the blood pressure, thus increasing the flow of blood to muscles the body may have to use to fight the threat its senses have detected. The blood vessels of the stomach, the intestines, and other internal organs suddenly constrict to lessen the flow of blood so that more will be available to the muscles. The liver pulses with new, fear-inspired activity, converting glycogen into sugar to provide more fuel for the muscles. The pupils of the eyes dilate to increase the field of vision. The body trembles. Goose pimples erupt on the flesh. Cold perspiration breaks out on the brow. The body seems coated with cold sweat. The mouth goes dry. These manifestations of fear occur because the body's chemical machinery is unbalancing the normal, orderly functions as it works at full throttle, preparing for an emergency. The body may emit a subtle (chemical) "aura" of fear. And it *may* be this which lures the shark on some occasions.

The list of conditions that may bring about a shark attack is seemingly endless: refuse strewn into the sea from sewers, abattoirs, and factories . . . the shark-trailed schools of migrating fish . . . seaquakes and storms that disrupt the delicate balance of marine ecology, sending sharks foraging for new feeding grounds, perhaps closer to shore—and swimmers! Anything unusual, such as the impact of a plane plunging into the sea or the mass of sounds transmitted through the sea when a ship sinks, appears to attract sharks, and may trigger attacks.

But the conditions that lure sharks do *not* always of themselves trigger an attack; the effect of them may be, curiously, the opposite. The famed shark expert, E. W. Gudger, noted, for example: "At Key West, I have seen boys diving for pennies off the old Mallory Line dock, while 200 yards away, a dead horse drifting out with the tide was surrounded by four or five 10-foot Tiger sharks bucking and surging, trying to tear it apart so that they could eat it. The point is plain—the Tigers preferred dead horse to live boy."

A man adrift at sea, far from land, never knows, however, when or whether a shark will be drawn to him. Two Air Force men parachuted into the Atlantic about 200 miles east of Savannah, Georgia, one night in 1953. The men, Sergeant Larry C. Graybill and Airman Second Class James B. Henderson, kept afloat by their lifejackets, lashed themselves together back to back. They floated for 22 hours until they were rescued. And for most of those hours, they fought off sharks.

"I remembered something I had read—if you hit them on the snout, they take off. It worked," Henderson said.

Graybill was not so lucky. "Something rushed by me," he recounted. "I felt one hand in a mouth, so I took a poke at him to get loose."

Graybill's hands were both cut and scraped by the sharks. Henderson's forearms were raw with Portuguese men-of-war stings. Their blood in the water should have doomed them to the jaws of gore-crazed sharks. But no such mob-feeding frenzy occurred. Once more, sharks showed how unpredictable they could be.

The greatest number of shark-attack victims have died during marine disasters. More people were killed by sharks in several World War II ship sinkings than were killed close to shore in all of recorded history. But, of those killed near shore, most have been in areas "where bathers are most thickly congregated," a Shark Research Panel report points out. However, it is thought that the danger is far greater in some of the open seas, and the proportion of attacks *all over the world* bears this out.

Also, men have drifted for long periods in warm seas without seeing a shark or any other fish. We simply know nothing valid of shark, or even of fish migrations in any true scientific sense.

How does a shark select one out of many bathers? What attracts a shark to one man or one woman? Is the attack only a wild, random raid? Or is the shark truly selective about its victim?

Assuming that the shark is somehow selective, the list of possible attack-triggering factors is again a long one. A glittering ring, a flashing piece of jewelry, or a shiny brass beach-locker tag worn on wrist or ankle may lure a curious shark, just as dazzling manufactured fish lures are supposed to attract game fish. The color or pattern of a swimmer's bathing suit may be the lure.

Because so many attacks occur near the beach in shallow water, the theory has arisen that some attacks may unfold in this way:

Some distance from shore, while the bather is swimming in deep water, he is spotted by a shark, which silently glides near and sees a strange creature of fair size. Still curious, but cautious, the shark lurks unseen. As the bather makes for shore, the shark follows. Then, when the bather's feet touch bottom and he begins to wade in, to the shark's eyes it looks as if the strange, large creature it has been following has disappeared, and in its place are two smaller, slow-moving, inoffensive creatures that seem incapable of hostility—the bather's legs. Instinctively, the shark charges them. But, as it does, the bather kicks and thrashes the water. Other bathers rush to his aid, churning the water still more. No cod or sea turtle ever acted this way, so the shark, confounded and frustrated by this unfamiliar behavior of prey, hastily withdraws.

This is only a theory. Scientists who have been studying sharks and shark attacks are not satisfied that any explanation can be made authoritatively for anything a shark does or does not do. We simply do not know enough about sharks or shark attacks. A clue is picked up here, another there. In one case, there is blood in the water and, though sharks are present, they do not attack the swimmer. In another case, there are no apparent conditions for bringing on an attack, yet an attack takes place. The paradoxes appear in attack after attack.

Until the Shark Research Panel began its study, the facts about attacks throughout the world had never been analyzed so thoroughly. Now, finally, for the first time, an unprecedented world-wide analysis is being undertaken.

Searching through old medical journals, ships' logs, hospital and physicians' records, and newspaper files from all over the world, the SRP has tracked down information on 1,251 attacks that go back as far as the year 1580. Out of this accumulation of facts has come an analysis of 790 shark attacks which the SRP felt were well enough documented to warrant study. The facts about the attacks were then reduced to these statistics:

Of the 790 attacks, 599 were unprovoked. Of individuals attacked, 408 died and 390 recovered. (Many records are incomplete; the total number of persons attacked is not known.)

Most attacks (75.4 per cent) in Australian, North American, and African waters occurred in summer months. But in equatorial waters, attacks occurred equally in all months. This means that the so-called shark-attack season is nothing more than the human swimming season, whenever that happens to be.

Most individual attacks (62.2 per cent) occurred within 300 feet of shore.

Most (70.2 per cent) occurred within five feet of the surface; 24.9 per cent of the victims were in water more than knee-deep and no more than shoulder-deep when attacked.

Most persons (63.3 per cent) were swimming or floating on the surface when attacked; 20.8 per cent had been wading; 19 per cent had been spear-fishing or carrying fish; 10.3 per cent had been standing close to where fish were being caught, or near swimming fish, just prior to the attack.

While 38.2 per cent of the attacks occurred while persons were alone in the water, 24.8 per cent had companions less than 10 feet away; 15.8 per cent were 10 feet or more from companions; 21.2 per cent were within a few feet of one other person.

Most attacks (94.3 per cent) occurred during daylight hours.

The fact that 5.7 per cent of the attacks occurred at night does not mean that a romantic moonlight swim is safer than a daylight dip. Actually, the statistics tend to show a quite opposite picture when they are interpreted. Most people swim during the daytime. Certainly, the number of nighttime swimmers is far less than 5 per cent of the number of daylight swimmers. Thus, proportionately, more nighttime swimmers are attacked than daylight swimmers. Nighttime is feeding time for many species of shark. In the tropics, knowledgeable natives usually will not enter the water at night, though they may swim unconcernedly during the day, even when sharks are present. In Cuba, fishermen catch *Tiburon de Noche*, the Night shark (*Hypoprion signatus*), in relatively shallow depths, only after the sun has gone down. In the Caribbean, the Tiger shark is said to appear rarely near the surface during the daytime. The nocturnal feeding pattern begins when, in darkness, plankton rises. Small fish rise to feed upon the plankton. Bigger fish follow the small fish up—and last in the eat-and-be-eaten line comes the hungering shark.

"Weather and other physical factors do not appear to be especially significant in triggering shark attacks," says Dr. Schultz, author of the SRP shark-attack report. "For example, the number of attacks when the sky is clear and the number when the sky is cloudy are about equal.

"We have no evidence that a peculiar color of clothes or shade of skin is an important factor in stimulating sharks to attack. Bright, shiny objects, or contrasting light and dark objects, do attract the attention of sharks. However, our data are too scanty and unreliable at present to suggest significant conclusions about physical factors."

Consider the question of color preference, for instance. Given a choice between a light-colored lure and a dark-colored one, a shark *seems* more attracted to the light one. Captain Young has stated that sharks apparently are lured more by the carcass of a white horse rather than that of a dark one. Dark-skinned native divers in tropical waters cover up

A shark attack on a fishing boat in the Parramatta River in Australia is illustrated in an old Sydney newspaper. Shark attacks on boats are often provable by irrefutable evidence: teeth marks and sometimes teeth themselves, left in the damaged hull.

From an old print

the soles of their feet with black sandals before they dive beneath the surface. Greek sponge divers hide the palms of their hands in the armpits of their black suits when a shark appears near them.

One of the most dramatic examples of a shark's apparent preference for white objects occurred in Nova Scotia in the summer of 1953. The episode took place off Fourchu on the southeastern coast of Cape Breton Island. Numerous fishing dories dotted the sea. One dory, about 12 feet long, was painted white, and this one was haunted for several days by a huge shark. Many fishermen in the area saw the eerie drama—the white dory would put to sea, and, soon, trailing behind it, appeared a dorsal fin. Finally, on July 9th, as the dory was sailing alone, the shark suddenly charged it, smashing an 8-inch hole in the bottom of the boat.

Both occupants of the boat were thrown into the sea. One man drowned. The other held onto the boat and remained in the water for hours until he was rescued. Neither he nor his companion was molested by the shark. (The companion's drowning was incidental to the attack. As far as is known, the shark did not go after his body.) A tooth found imbedded in the smashed boat was later identified as that of a Great White. William C. Shroeder, of the Museum of Comparative Zoology and the Woods Hole Oceanographic Institution, made the identification. Shroeder, an outstanding authority on sharks, estimated that the tooth had come from a Great White 12 feet long and weighing 1,100 to 1,200 pounds. The Great White, one of the most dangerous species, certainly could have devoured either or both men, yet it appears that the target of its voracity was the only *white* dory in the area.

If white attracts sharks, however, it would seem that the chances of survival are slim for the amazing Japanese *ama*, or "sea woman," who dives for pearls wearing a white jacket, a white skirt, and a white hood. These women believe that white *repels* sharks and jellyfish. Sometimes the women—and girls, for many an *ama* is a mere teen-ager—wear brightly colored garments, and wrap white towels around their long, jet-black hair. Their only equipment is a pair of goggles, a container for their catch, and a hooked iron knife to pry the *akoya*, the pearl-producing oysters, from rocks some 40 feet below the surface. They are ever on the alert for sharks, but, even in their gleaming white costumes, they are rarely attacked.

The claim that dark-skinned swimmers are immune to shark-attack has proved to be a fallacy many times and in many parts of the world. In the Torres Strait between New Guinea and Australia, for instance, when pearling was a major occupation for natives, attacks averaged three a year. A medical report on the attack experiences of Torres Strait divers noted that "a diver rarely fails to see at least one shark during any day." Sometimes, the shark attacked. After recounting several attacks and near-attacks, the medical report said: "These facts dispel a popular misconception that a shark will not attack a human being with colored skin . . . Actually more natives are attacked on the Australian coast each year than whites."

One Torres Strait pearl diver, a black-skinned native named Iona Asai, was diving in 12 feet of water one day when a Tiger shark charged him. The shark dived down on Iona, and an instant later Iona's head was in the shark's mouth. What happened next can best be told by Iona, for, incredibly, he lived to tell this story:

"When I turned I saw the shark six feet away from me. He opened his mouth. Already I have no chance of escape from him. Then he came and bite me on the head. He felt it was too strong so he swallow my head and put his teeth around my neck. Then he bite me.

"When I felt his teeth go into my flesh, I put my hands around his head and squeeze his eyes until he let go me and I make for the boat. The captain pulled me into the boat and I fainted. They get some medicines from Jervis Island school-teacher."

It took more than medicines to repair Iona, whose story, incidentally, is thoroughly documented by hospital records and photographs. Nearly 200 stitches were needed to sew up the two rows of teeth marks around

Iona Asai, a pearl diver in the Torres Strait between New Guinea and Australia, lived to tell the tale—and show the scars—after a shark seized his head within its jaws.
Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

his neck and jaws. Three weeks after he left the hospital, a small abscess developed on his neck. When the abscess was drained, in it was found one last bit of proof of Iona's tale: the tooth of a Tiger shark. Iona, aged 38 at the time of the attack in 1937, had been wounded by a shark 19 years before. He was aptly named, for *Iona* is the native version of one of their heroes of the Christian Bible, *Jonah*.

The Shark Research Panel's quest for a solution to the mystery of shark attacks is leading down many trails. Water temperature, for instance, once seemed a likely factor in attacks, and the SRP did establish the fact that sharks attack most frequently in waters warmer than about 65°F. (Some experiments have shown that certain sharks seem to lose their appetites when the temperature drops to the low 60's.)

When the coastal waters in temperate seas warm, the temperature change is often a harbinger of large, voracious sharks, roving from their tropical home waters. The sharks arrive in their new pastures just as these same seas are teeming with migrating fish—plus waders, swimmers, boatmen, water-skiers, spear-fishermen, and surfboarders. Great Whites, formerly reputed to be tropical, have been caught and spotted so often outside of the tropics in recent years that some ichthyologists believe that the sea's most dreaded sharks have become regular summer visitors to waters as far north as Nova Scotia.

There has been one known fatal shark attack in New England waters, and it was almost certainly the work of a Great White. The victim was a 16-year-old Massachusetts boy, Joseph Troy, Jr., who was swimming on July 25th, 1936, about 150 yards off Hollywood Beach, just above

Mattapoisett Harbor in Buzzards Bay, Massachusetts, when a shark suddenly seized his left leg and pulled him under. A courageous companion, Walter W. Stiles, who was 10 feet away, swam to the youth's aid. When Troy, pummeling the shark with his hands, broke the surface, Stiles was at his side. The shark released Troy, but remained nearby in the bloody water while Stiles supported the youth and managed to get him into a boat. The shark did not charge Troy again, nor did it attempt to molest Stiles. Troy died in a hospital five hours after the attack.

The tropical sharks that are appearing in temperate waters are probably following food–fishes deviating from normal haunts because of temperature shifts. Gradual, imperceptible changes in the temperature of the sea are apparently breaking down the arbitrary boundaries that once marked off the habitats of tropical, subtropical, and temperate marine life.

There is now ample evidence that the seas are getting warmer, probably as the result of an apparently global climatic change which can be perceived only by studying accurate, long-kept records. A recent U.S. Fish and Wildlife Service report showed, for instance, that the January sea temperatures near New Haven, Connecticut, have increased three to four degrees Fahrenheit since 1780; winter sea temperatures off Boothbay Harbor, Maine, have gone up by about two degrees since 1930.

At the same time, man has been venturing into colder waters. As Dr. Schultz points out in the SRP shark-attack report: "Divers with swim suits do enter colder waters, and three attacks have occurred in waters of 55 degrees along the California coast. We believe the area of the world in which shark attacks occur will be extended as more and more divers enter the domain of the predaceous sharks in temperate and subtemperate latitudes."

Because of the relatively few attacks on skin-divers, many divers seem to believe that they have a kind of immunity from attack. Some divers have become so contemptuous of the shark that they ride sharks or hang onto their tails. The Shark Research Panel has issued a stern warning that those who cavort with sharks have chosen deadly playmates.

"It would seem unnecessary," the SRP's Dr. Gilbert says, "to tell people not to grab the tail of a shark or to try to ride one. Yet, strangely, it is not. There are skin-diving clubs in California whose qualifications for membership require that you first must ride a shark. This we discourage."

The spear-fishermen in the underwater fraternity often unwittingly act as human shark lures. A spear-fisherman kills a fish. The water around him becomes laced with fresh blood. And when a shark flashes toward the exquisitely alluring scent of blood, it will usually charge toward the scent with a lust for any food in sight. Often the shark will snatch the catch off the spearman's weapon, or, as has happened, right off the line he has strung the fish on and tied around his waist.

Sometimes, rushing past the speared fish, the shark selects for its meal the spearman himself. Leniord Higgins, an Australian spearman, was towing a large catch of fish one day on a line 15 feet long. This is a safety measure, for the belief is that a shark will grab the fish and, while it is devouring the fish, the man can drop the line and get out of the water.

But the shark that found Higgins that day ignored the catch and rushed for him, hitting him with such force that, wedged in the shark's maw, he was carried 6 feet beneath the surface. Higgins screamed. The shark let him go, and disappeared as silently as he had appeared. An 18-inch wound ripped in his body, Higgins struggled to shore. He survived. He was not eaten, he believed, because the shark lunged for him so avidly that Higgins' body was jammed, edgewise, deep into the shark's mouth, and the shark was unable to snap its jaws shut.

The shark itself has become the prey for skin-divers who seek out and fight it as big-game hunters track down and kill the lion and tiger.

Two Australian spear-fishermen use what they call a "death needle" for their shark hunting. The men, Benn Cropp and Ron Taylor, claim to have killed as many as 50 sharks in a week-end with their needles, which are loaded with strychnine nitrate.

"We shot and killed all types of shark—Blue Pointers, Gray Nurses, Hammerheads, Tigers, and Whalers," Cropp said in an interview. "Once the needle struck, it was curtains for them."

The needle filled with the strychnine nitrate is attached to the point of a spear-gun projectile in such a way that, when the spear enters the shark, the needle forces the poison deeper into the prey's body. The men said that the poison could kill a shark in 30 seconds.

Another shark hunter is Scott Slaughter, a former commercial spear-fisherman who became a Navy frogman. Slaughter's shark-killing career began off Key West, Florida, where he was spear-fishing for snappers and groupers. With a big snapper writhing on the end of his spear, Slaughter started for the surface. Suddenly, a shark swished across his legs, darted for the speared fish, and ripped off all but its head. Then still hungry, the shark whirled toward Slaughter.

The shark charged just as Slaughter reached the surface, near his boat. Like a fencer, he thrust his spear toward the shark. It gobbled down the last morsel of the snapper as Slaughter clambered into the boat. Moments later, he jumped into the water again. In one hand he held his spear, on which was impaled a 40-pound grouper he had caught previously. In his other hand was a metal tube about 6 feet long.

Using the grouper as a lure, Slaughter brought the shark closer to him and, as the shark's teeth sank into the fish, Slaughter plunged the tube down on the shark's head, directly over its tiny brain. There was a muffled explosion, and a hole as big as a man's fist appeared on the shark's head. The shark was dead.

Slaughter's weapon was a "powerhead," a lethal device attached to the end of the tube. The powerhead is a length of hollowed steel cylinder consisting of a chamber for a 12-gauge shotgun shell and a firing mechanism. The cylinder is plugged with petroleum jelly to seal it from the water. In firing the shell, the powerhead is jammed directly against the shark's head. The thrust drives the end of the shell against a firing pin, which detonates the shell. A massed charge of No. 8 shot is propelled through the petroleum jelly seal and right into the shark; it meets no resistance from water, for its passage is directly from the cylinder to the shark. The charge smashes into the shark's brain, usually killing it instantly.

If Slaughter misses the brain, he blows a hole in the side of the shark, but the gaping wound hardly slows down the shark. Bullets fired from the surface at sharks beneath the surface are deflected by the water and, even if they penetrate the shark's hide, they do not have the destructive power of the massive shotgun shell charge. With the powerhead, Slaughter says he has killed more than 100 sharks, including Hammerheads and Great Whites.

Armed with powerheads like his, more and more underwater hunters are tracking down what they see as the ultimate game—and they are exposing themselves to the ultimate danger. Yet, even when they are stalking the shark, even when they are attacking it, the hunters have rarely been charged by their prey. These experiences have led many skin-divers and spear-fishermen to insist that the shark is a timid creature, whose ferocity has been vastly overrated.

Then comes a day like August 15th, 1959. On that day, James C. Neal, SCUBA diving about 7 miles off Panama City, Florida, followed a guide cable down to rocks on the bottom. He was never seen again. All that was found was his bloody, tooth-marked clothing and gear. . . . "Sharks are one of the sea's greatest dangers," a veteran Ceylon skin-diver says, "because they are more a potential than an actual danger to a diver, which leads to a disregard for them that can be fatal."

Michael Lerner, president of the International Game Fish Association, adds his voice of caution: "We feel that fishermen, boatmen, swimmers and skin-divers are becoming increasingly careless about the danger of attack by sharks and barracuda, owing partly to the fact that several recent published reports have tended to discount the ferocity of those fishes. It may be true, especially of sharks, that certain species do not appear dangerous in some locations. But it also is a proven fact that some of those 'harmless' breeds have attacked, wounded, even killed human beings in other areas."

The foolhardy diver who has become contemptuous of sharks, because those he has met retreated from him, insists that sharks are cowardly. The wise diver who has had the same kind of experience with shy sharks says merely that sharks are unpredictable, for he knows that, in his next confrontation, it may be he that flees, or attempts to flee.

There is absolutely no way of knowing what a shark will do when it encounters a swimmer—or a boat. Boats and rafts have been bumped, bitten, smashed, capsized—even *boarded* by sharks. There are several well-documented cases of sharks leaping into small craft where, thrashing their tails and gnashing their teeth, they have been as dangerous and difficult to subdue as they are in the water.

Natives of the Gilbert Islands ordinarily fear only one kind of shark —the *rokea*—and it is feared because of its vicious attacks on canoes and the men in them. If a fisherman is hauling in a tuna, say, and it comes up half-eaten, he will cut the line to give the rest of the fish to the *rokea*, a deep sea shark. Otherwise, the *rokea* will come after it. Unfortunately, its scientific name is unknown, but it is *not* the Tiger shark (*Galeocerdo*) which the natives know well, and of which they are only normally cautious.

Superstition? Sir Arthur Grimble, a former British administrator in the Gilberts, in his book, *We Chose the Islands*,[4] gives an eye-witness account of just such an incident.

"We heard a thud and a crack from a craft not sixty yards off," he wrote. "As we looked up, there came another thud; a vast tail had frothed from the water and slammed the canoe's side. A second later, the whole fish leapt, and there was a third smashing blow. We saw the hull cave in and start sinking. The *rokea* leapt again, and one of the two fishermen on board was swept off the foundering deck by that frightful tail. We saw him butchered as we raced to rescue the other man . . . The survivor, a boy of seventeen, confessed with tears that he was to blame; he had whipped a bonito aboard as a *rokea* was after it. The demon's attack followed in the very next instant."

Dr. Coppleson estimates that as many people in Australia are injured by sharks "bumping" them or their surfboards as are injured by being bitten. Why sharks bump into surfboards or boats is not known. One theory is that they are curious, and somehow satisfy their curiosity by charging the object.

One of the more curious shark-boarding incidents on record occurred

[4] Sir Arthur Grimble, *We Chose the Islands* (New York: Morrow, 1952).

in Australia. Three amateur fishermen were in a 16-foot dinghy off Seaholme, Victoria. For one of the fishermen, Doug Miller, it had not been a pleasant day. A violent attack of seasickness had left him a wretched man. Miller had collapsed in the bottom of the boat, wondering why he had ever taken up the miserable pastime of fishing, when . . . but let him tell it:

"One minute I was lying there, wishing I was dead. I felt terrible. Suddenly, I heard a scream and a yell and an eight-and-a-half-foot Gray Nurse landed fair on top of me. For a second, I didn't know what it was. Then I knew and nearly blacked out. I fought to get to my feet, and as soon as I did I was knocked down by its tail. Three times I stood up and three times I landed back on the bottom of the boat. I felt like going overboard, but I couldn't leave the other two."

After making the most rapid recovery from seasickness ever recorded, Miller sprang to the aid of the other two fishermen, and together they finally vanquished the shark by beating it over the head with the boat's tiller.

To dive from a boat at sea or even in harbor is possibly to invite shark attack, and similarly a possible danger is the sport of being towed in the water by a moving ship. When a man is being towed he may look, to a shark at least, like a fish. In 1959 alone, the SRP reported 12 unprovoked "contacts," including boats, life-rafts—and water-skiers. Twelve similar incidents were reported in 1960. Sharks attacked four boats in 1961, according to a SRP report issued in June, 1962. In one case, the report said, "a dinghy with two occupants was used as a toy by a school of sharks which swirled it around and around."

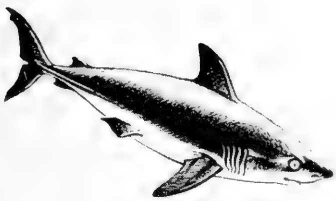
"Our data reveal," the SRP also says, "that it is dangerous to dive off piers, boats and ships at anchor in shark-infested bays and lagoons, for we have several records of divers who were attacked under such circumstances the moment they entered the water."

The Shark Research Panel's report on shark attacks in 1961 says that sharks made 30 unprovoked attacks on humans during 1961, injuring 31 persons, 6 of them fatally. The attacks listed were in waters off both coasts of the United States, off Hawaii and other Pacific islands, Bermuda, Australia, South and East Africa, the Philippines, in the Mediterranean Sea and the Persian Gulf, and 150 miles up the Limpopo River in East Africa. Though the attacks span a large part of the world, none is listed from South or Central America, the East Indies, or other coasts of Southeast Asia. Dangerous sharks are known to be plentiful in these areas, and attacks are known to occur, but most of the sharks' deeds go unrecorded.

Part 2

Man Against Shark

Chapter 3



Captain Shark-Killer

The boy was 10 years old on that summer's day. A friendly fisherman had taken the boy out to sea with him, and now the boat was sailing over the rippling forests of kelp that cover the ocean floor at La Jolla, California. Fascinated by the silent, shimmering beauty that swept before him as he stared down through the clear water, the boy at first didn't hear the fisherman's call.

"Bill!" the fisherman shouted again. "Quick! Look over the other side!" The boy darted to the other side of the boat and looked over the gunwale. There, gliding through the kelp a few feet below the surface, was a long, sinuous fish that looked like a graceful shadow amid the tendrils of kelp. The fish was as long as the 20-foot boat. "That's a shark, Bill," the fisherman said. Again, the boy didn't hear. For he was once more enthralled by a look at beauty. But this was a beauty of strength and boldness, and wrapped in that beauty, unseen, was a thing of terror.

William Young, in 1885, had seen his first shark. In the many years that were to follow, in the many places where he would pursue the shark, William Young would never forget that shadow in the kelp beds of La Jolla . . .

In 1900, Bill Young and his brother Herb sailed away from their home in California. Lured by a lust for adventure and fortune, they shipped aboard a two-masted schooner bound for the Hawaiian Islands. They found work there, but it was not exactly adventurous. They signed a contract to haul to sea the garbage of the city of Honolulu. This was the humble beginning of what would be a prosperous waterfront business. It was also the beginning of Bill Young's lifelong passion for catching sharks.

The refuse from the city dump frequently included the carcasses of horses. Whenever these carcasses were hauled to sea and dumped, hordes of sharks would suddenly appear. In their frenzy to devour the offal, the sharks would turn the waters into a maelstrom of blood and snapping jaws.

This was not beauty. This was the shark with its grandeur stripped away. So, there in the bloody seas off Honolulu, an older, wiser William Young saw the other aspect of the shark, the thing of terror beneath the beauty. But the terror did not repel him, as it had repelled so many men before him. Instead, it challenged him. He was seized by a desire to conquer the shark, to learn its ways, to hunt it down. The shark became his Moby Dick, an ageless, dreaded, murderous demon spawned of legend and fact. It could be attacked, but never destroyed; studied, but never understood; captured, but never tamed.

On the waterfront of Honolulu, where sailors spun their tales of sharks, and in native huts, where squatting Kanakas retold their myths of the *mano*, Young learned about the shark. And, in the blood-frothed waters of the shark orgies upon the carrion, Young killed sharks. He became known first as "Sharky Bill," a nickname that carried a trace of disdain for this man who seemed always to be asking about sharks, listening to shark stories, or talking about sharks. Soon, though, as stories about his prowess as a shark-killer circulated in the islands, he earned a title that was bestowed in awesome respect. They called him *Kane Mano*, "The Shark Hunter."

Before he killed his last shark—at the age of 70—Captain William Young had hunted sharks from Honolulu to Australia, from Florida to French Somaliland. At the age of 87, he could look back on 60 years of shark hunting—years in which he killed 100,000 sharks, often at the rate of 20 or 30 a day. At 87, he was still *Kane Mano:* "In *Kon-Tiki,* a book by a good friend of mine, Thor Heyerdahl, he told of catching sharks by the tail with his hand. I've never tried that game before, but I'm sure I can do it, even at 87."[1]

The log of *Kane Mano* has many entries. It spans many years and many seas. It recounts the lives—and deaths—of many sharks. Most of all, it tells the many adventures of a unique man. Here are some leaves from it:

When one hears the word *shark*, a powerful mental image is generated of a cold-blooded rover of the deep, its huge mouth filled with razor-sharp teeth, swimming ceaselessly night and day in search of anything that might fall into the cavernous maw and stay the gnawing hunger which drives the rapacious fish relentlessly on his way. A terrible creature, afraid of nothing. The savage fury with which he attacks, the rage of his thrashing when caught, his brutal insensibility to injury and pain—all well merit the name of *Afreet*, symbol of all that is terrible and monstrous in Arabian superstition.

The shark is this, but I have found him to be a thing of endless paradoxes, too—sinister enigma, which one time may kill a man and another time flee from a man as if in fear; a cunning adversary which may trick a fisherman one day and a loutish brute which may blunder into a net another day; a creature of consummate grace and a beast of loathsome habits.

[1] Though he lived to see this book written, Captain Young died before it was published. Death came to *Kane Mano* on October 31, 1962.

I have known the shark in many seas, but I do not know the shark. No one does. After having hunted him, killed him and found uses for his products throughout the world, I do feel qualified to talk about him. (I know that a shark should properly be addressed as *it*, but to me the shark will always be a *he*, for he has as much character and personality as any man I have ever met.)

As I sit here in my snug harbor in Miami, writing my Log of time past, the memories of thousands of sharks parade through my mind. Most of them are dead. Some may still be alive, for no one knows for sure the lifespan of a shark. Others live in a curious way: in the sharkskin shoes I wear; in the mementoes that surround me—the dried gaping jaws, the thousands of teeth I have fashioned into jewelry to sell to tourists; the film I once made; in my book, *Shark! Shark!*[2], published decades ago; and now these leaves from my shark-hunting Log:

HONOLULU

This is where it all began, where the shark and I first met in combat. The Islands were quiet then, and life was simple. It was 1900, and Pearl Harbor was not yet a name that would live in infamy. Sailing vessels filled the harbor, and one motorboat, a 22-footer with a 4-horsepower gasoline engine, chugged around. That boat, the *Billy*, the first motorboat to enter Pearl Harbor, belonged to my brother Herb and me. (I still have a piece of the red-white-and-blue ribbon that was stretched across the harbor the day it opened.)

Soon we were prospering. We bought several other boats for a variety of jobs—diving and salvage work, running passengers from ships to shore, carrying pilots, customs officials and immigration inspectors to incoming ships. We had come a long way from those first days when all Young Brothers, Ltd., did was haul garbage out to sea.

And always there were sharks. "*Mano! Mano!*—Shark! Shark!" the Kanakas would call as they spotted the sharks circling around ships in the offshore anchorage awaiting the free meals the ship provided when garbage was thrown overboard. Often the clear water was alive with hungry sharks.

As I watched the shark-swirled waters one day from the deck of my boat, I was seized by a sudden, overpowering desire to catch a shark.

I told one of the English-speaking Kanakas aboard that I wanted to catch a shark. "*Mano?*" he asked, looking at me curiously. "Yes, *mano*," I replied. The Kanaka disappeared in the direction of the galley and soon returned with a big piece of salt pork, a stout line and a great hook. He was jabbering excitedly. "*Hana paa mano*—we'll catch a shark! He is much *wikj wikj kau kau haole*—he will eat a white man, very, very quick! *Pilau*—rotten—he is no good!"

He and another Kanaka dropped the baited hook over the side. The moment it struck the water it was seized. *Mano* was hooked! One of the boys borrowed a meat hook from the cook, got into a small boat alongside and hooked the shark through the mouth. The line was run through a boat davit and hauled up. The boat falls shivered as the shark thrashed at the end of the line. Quickly

[2] William E. Young, with Horace S. Mazet, *Shark! Shark! The Thirty-Year Odyssey of a Pioneer Shark Hunter* (New York: Gotham House, 1934).

another line was secured around his tail. Now the shark hung suspended within reach of the rail.

Swish! The glint of a big knife caught my eye as a native hacked off the shark's tail. The rest of the boys aboard danced around shouting curses at the mutilated enemy. Suddenly, the falls were slacked off, the boy in the boat cut the hook from the mouth and the shark was free—free to die a cruel death. For, if he were not immediately devoured by other sharks, he would soon weaken from loss of blood and die. This one died at the jaws of other sharks. Killed by shark and man, by hunger and vengeance.

Even then, I wondered if there could be some commercial use for sharks. The thought faded away; I had more pressing business there in the islands with our various shipping enterprises. But the thought—and the persistent desire to catch sharks—never left me.

It was off Honolulu one day that I saw the biggest shark in the sea, the Whale shark. It was about 35 feet long, and it seemed to be suspended in the water, no more than 2 fathoms below the surface, right next to our small boat. I could see its checkerboard skin so clearly I felt I could almost lean out of the boat and touch it.

The presence of our boat did not disturb this huge, sluggish shark. But my brother and I were practically holding our breath while we decided how to take him. We were determined to bring him in. Then, both of us realized at almost the same moment the awful truth. We had left port without a harpoon! We didn't have so much as a marlin spike aboard. So we just drifted there and after a while the biggest shark I have ever seen slowly swam out of my sight. Once again, the old adage held true: the biggest ones always get away.

My curiosity about sharks and my frequent harpoonings of sharks that attacked the dead horses we hauled to sea eventually led to a sideline for Young Brothers, Ltd.—shark hunting.

A shark hunt usually began with a phone call to our boathouse. "Hello, Young Brothers? Is Bill there—Sharky Bill. Well, tell him there's a party at the hotel who wants to go shark fishing."

When I got a call such as that, I would telephone the Humane Society and offer to take a condemned horse off their hands.

The shark hunt begins. The poor old horse is led to the end of the wharf and put out of its misery. It tumbles into the water at the end of a stout line. The fishing party arrives from the hotel and boards the boat. The fishermen look anxiously at a crewman honing a harpoon.

Not far out of the harbor one of the boys slits the carcass up the belly. Soon the water is saturated with the blood and scent of fresh-killed prey. We stop the boat. The fishermen are tense, not quite sure what is going to happen next. We tell them to keep quiet. They don't utter a sound. All that can be heard is the sound of the waves lapping at the sides of the boat. The sea is still, except for the bobbing body of the horse.

I can see, far off, a shadow in the water, zig-zagging ever closer to the surface and a black triangular fin cuts the water above it. Now it is the fin that is zig-zagging. It circles the carcass. A couple of times. A head appears forward of the fin and a cold, expressionless eye can be seen. It is the eye of a shark.

The shark, quite suddenly, is gone. No shadow. No fin. Nothing. The sea is deserted—at least by life. For the dead horse still floats there, awaiting its fate.

In twenty minutes or so, the shark is back. This time four or five other sharks accompany him. They prowl about, slowly circling closer and closer to the carcass. Occasionally, they nose it. But they seem hesitant, cautious.

If this were a white horse they would have attacked it long ago. But a dark horse does not quickly arouse the shark's hunger.

Suddenly, they strike! The first shark bites a huge piece of flesh from the corpse's neck. Then the second darts in for a bite. Then the third. The water is swirling now with hungry, rapacious sharks bathed in the blood of their prey. A gleaming skeleton is rapidly appearing where moments before there was the outline of a horse. Slowly, steadily, I draw the line attached to the horse closer and closer to the boat. Oblivious to the boat—and the gaping amateur fishermen aboard her—the sharks follow the corpse, still feeding on it savagely.

I hand the line to one of the boys and turn my attention to the fishermen.

"Here," I tell one of them, "hold the harpoon like this. Then strike down into the neck or gill of the biggest one. And don't fall overboard!"

The fisherman grasps the harpoon tightly with one hand—and with his other hand holds onto the gunwale. He is visibly shaking, he looks as if he is getting seasick, and he cannot tear his wide-open eyes from the seething water. So close is the orgy of feasting that blood-flecked spray occasionally showers the fisherman.

"All right," I shout to the harpoon-holder. "Take that big one—the one that is biting right now!"

The fisherman pales—and freezes.

"You, you take it, Captain," he says in a quavering voice. "I don't think I—Here, I might miss—"

I take the harpoon and hurl it. The iron strikes home into the forebody of the biggest shark! Immediately, he spews forth all he has eaten. Instantly, this is devoured by the other sharks. They will turn on him next, so he thrashes a moment, and then sounds.

Away goes the boat, towed by the wounded shark. Five minutes, he tows. The scene of the bloody feast is far behind us. Ten minutes, he tows. The fishermen look worried. They wonder how long this can go on.

I feel the line. It gives the jerks that signal the fact that the shark is rolling—and thus done for. Too weak to pull against the line, he can only twist over and over, trying to get loose, but only winding the line about his body.

I begin to pull in the line, keeping a steady pressure on it. The wet slack comes in, fathom after fathom. Then, out of the sea, his great jaws still gnashing, his arrogant eye still seeing, comes the shark, a 12-footer, vanquished but unyielding.

Swiftly, he is hooked through the mouth as he is drawn alongside the boat. He is securely held now, but he is thrashing, beating the water with his tail and drenching us with spray. We get a line around his tail and make it fast to a stern cleat. A sharp thrust from a whale-spade through the brain finishes him. The harpoon and hook are cut loose, and, with our first catch under our belt, we go after his companions.

They are still attacking what is left of the corpse, snapping scraps from it and dashing after any piece which is torn away.

We get another one, with a harpoon through the gill. There is no fight in this one, stabbed in a vital spot. He is quickly brought alongside and dispatched with the whale-spade.

We return home with our two trophies in close tow. The fishermen try to look casual as we pull up to the wharf. One of them is nonchalantly wiping shark's blood from a harpoon. They try to look modest. But they can't help swaggering a bit as they walk off the boat. After all, they just caught two sharks, didn't they?

And so it went. Day after day, we killed sharks. Except for the Chinese merchants who magically appeared on the wharf and hacked off the shark's fins for shark fin soup, no one seemed to have any use for the sharks, however. I am by nature a thrifty man, and I brooded about this waste. Wasn't there some commercial use for sharks? Couldn't a use be found for their incredibly tough hide? Wouldn't their huge livers give up oil as medically valuable as cod liver oil?

No one in the Islands had the answers. Though people talked a lot about sharks there, few knew very much about them.

I remember one day I caught a beautiful Tiger shark who was carrying 42 young. I packed her and the babies in an ice-lined trough and exhibited the whole family at the fair in Waikiki. I charged ten cents admission (collecting $1,500 in a week, incidentally), and, as the viewers filed past, I answered their questions. One of the visitors was a physician. He looked the Tiger and her pups over very carefully, and then called me aside.

"I'll tell you something about that mother Tiger shark that you don't know," he said.

"All right, Doctor," I replied, "what is it? I know where to find them and catch them, but you can probably tell me something else."

"Here," he said, pointing to the Tiger's mouth, "see this thin membrane running around the jaw over the teeth? You don't know what that's for, do you?"

"No," I honestly replied.

"You're a good fisherman, all right, but fishermen don't learn much about anatomy. As a matter of fact, this membrane is such an oddity, you won't find out anything about it in a textbook. But I happen to know that is where the Tiger shark nurses her young."

"Nurses her young!" I exclaimed. "You mean to tell me that you think . . ."

"Think?" he interrupted. "I *know*. The baby Tigers are born alive–you know that; you've seen them. Well, inside of the Tiger shark, when they want to feed, the babies come forward to this membrane and get their food by nursing at this membrane. It has to be the answer, Captain. After all, there is no placenta connecting the young to the mother. So obviously they live in a free state inside her, and . . ."

I let him spin his ridiculous theory, but I wasn't listening. It simply amazed me how little was known about the shark, even by so-called scientists.

It was not until 1920, however, that I had an opportunity to satisfy my curiosity about commercial uses for sharks. And I was to devote my life to this venture.

I left the islands in 1920 for a change of scene in the States. Footloose, restless for a challenging job, I wound up in New York City. I was walking up Broadway one day when I happened to glance in a shoe store window. I saw a pair of shoes with *sharkskin* tips! I all but ran into the store to find out about the shoes.

The sharkskin trail eventually led from the shoe store to Newark, New Jersey, where the Ocean Leather Company headquarters were. They were pioneering in the manufacture of shark hides. Shark-catching stations were being set up in Florida and North Carolina, I was told. And, before you could say "Jack Shark," I was on my way to one of the stations.

In the years to come, I would journey throughout the world in search of sharks. This would be my job, my vocation, my way of life.

At each way station in this world-wide pursuit of the shark, I would have adventures and I would learn more and more about the wily shark.

I have put down, in the pages that follow, some of my adventures among the *mano*.

Big Pine Key, Florida

I've been convinced for years that sharks are man-eaters. The natives in the Pacific, the old-time seafarers and many of my friends hereabouts believe it. But the unbelievers—most of whom have never seen blue water, let alone a shark—demand proof. I got them their proof today.

Walter Johnston—he calls himself Pete the Shark—and I have been catching shark here and skinning them for their hides. We've been doing pretty well. We go out in the morning, make a catch, and then come in to skin them at the end of the day.

Today, while skinning a 12-foot Brown shark, I noticed an odd protuberance on the stomach wall, so I slit the lining a bit. The round end of a bone came out. I grasped it with one hand and cut a little more so I could pull it out.

It was what was left of a human right arm and hand.

The arm was in a good state of preservation, indicating that it had been in the shark only a short time. The palm of the hand and fingertips were wrinkled, as they would be in life if immersed for a long time in water. I concluded it was the hand of a man who had not engaged in manual toil. It bore neither rings nor tattoos. The arm to the elbow was not mangled, but from the elbow to the shoulder joint all the flesh had been torn away. I knew I had to search the shark more thoroughly to see if there were any more clues to this poor devil's identity. I carefully probed and found six fragments of flesh—and a piece of blue serge cloth, about 12 by 18 inches, apparently ripped from a man's coat.

I photographed my gruesome find, and Pete amputated the hand and put it in a glass of alcohol.

I called the coroner at Key West. While he was on his way to Big Pine Key, I made some inquiries and learned that a plane had gone down the day before about 20 miles from Key West. A man named Atkins was reported missing. He had a blue serge coat on when he was last seen alive.

San Juan, Puerto Rico

Two years ago, I found a hand in the belly of a shark. Yesterday the hand came back to haunt me.

I had come here on a little vacation from shark-hunting. On the steamer on the way over, I was chatting with a man and his wife at dinner, and, as it usually does with me, the conversation soon turned to sharks. I showed the couple a few of the shark's teeth I usually carry to illustrate my stories about the shark's rapacity. The inevitable question—"Will a shark really eat a man?"—came up. I replied with the certainty I have held for the past two years. But the man persisted in his questioning. "How do you know?" he asked. "What makes you so sure?"

I told him that I had grisly proof not particularly suited for the dinner table. "It is a photograph," I said, "and not a very pretty one." He insisted on seeing the photograph. Finally, somewhat disgusted with the man's macabre curiosity, I took out the photo and showed it to him. He took one look at it and gasped, "So you're the man who found him!"

"Found who?" I asked, not immediately remembering the name of the victim whose arm I had discovered.

"Edwin Atkins!" my dinner companion replied. "The widow of that poor fellow is marrying my best friend."

Later, I learned the whole story of the tragedy. Edwin F. Atkins, Jr., his wife, their two young sons, Edwin, 5, and David, 3; a nurse and a governess had all boarded a two-motored seaplane, the *Columbus*, in Key West. They were bound for Havana, along with another passenger, a New York banker and broker named Otto Abrahams. Also aboard the plane were a pilot and a mechanic.

About 20 miles from Key West, the plane's starboard motor began to miss. The pilot, C. W. Miller, spotted a ferryboat and decided to try to land the plane near it. The day was calm, but the seas were surging.

As Miller brought the plane in, a wave nearly 20 feet high struck the plane's pontoons and hurled it upward. The plane plunged downward into the swells and smashed nose-first into the sea. As it struck the surface, another huge wave hit the plane and spun it around.

The impact tossed the passengers out of their seats. Mr. and Mrs. Atkins had been holding the children on their laps. When the plane crashed, the children were hurled from their parents' arms and were never seen again. Atkins tried to make his way back to the cabin, but Abrahams, realizing the children were surely dead, grabbed Atkins and managed to get him out of the water-filled plane and onto a wing. The governess, Grace McDonald, also clambered out on the violently bobbing wing.

The ferryboat, *H.M. Flagler*, meanwhile, was speeding toward the downed plane. Despite the mountainous seas, the *Flagler*'s skipper, Captain John Albury, launched a lifeboat, which fought its way toward the now rapidly sinking plane.

As the lifeboat neared the plane, a wave suddenly erupted and threw Miss McDonald off the wing. Passengers aboard the *Flagler*, lining the rail to see the drama, screamed as Miss McDonald vanished beneath the sea.

The lifeboat came alongside the plane at last. Seamen snatched the survivors out of the wreckage. They saved Mrs. Atkins, the pilot, the mechanic, the nurse and Abrahams. But Atkins, his two sons and Miss McDonald were lost.

Had Atkins been alive when the shark found him? I don't know. I do believe, however, that more than one shark got Atkins, dead or alive. Since no other remains were found in the shark I caught, I assume that several sharks attacked the body. And I assume that the other victims met the same awful fate.

The Brown shark, by the way, is listed by some so-called experts as a "harmless" shark.

TRINIDAD

The hand again.

I was in the smoking-room of an island steamer going from St. Thomas to Trinidad. Again, I had struck up a conversation with a fellow passenger. Again, we had started talking about sharks. Again, the question, "Will a shark eat a man?" Again, the persistent pleas to see the picture. And again, I showed it.

It was then that my companion told me that he had been a boyhood chum of Edwin Atkins.

I should destroy the photograph, I guess. It almost seems to be cursed. Yet, in thinking it over, I believe I will continue to show it when a skeptic demands proof of the claim that sharks eat men. In that way, perhaps, it will serve as a vividly grim reminder to beware of sharks.

FERNADINA, FLORIDA

Pete the Shark says he can smell sharks when they're around, and sometimes I think he actually can. In fact, I have wondered a couple of times if Pete isn't part shark himself.

I had figured out a new way of netting sharks by allowing a net to drift along vertically with the tide, instead of securing it at the bottom with anchors. We went out today to try the new technique because Pete said he had smelled sharks.

We set out the net, and we didn't have long to wait to see how well the drifting net idea worked. Minutes after we set the net adrift the nearest buoy disappeared.

We hauled in a big Tiger shark. Even before we had him killed and stowed aboard, another buoy disappeared. We pulled in the net again and found a big Tiger thrashing in it.

Again, and again, for four back-breaking hours we let out the net and hauled it in, each time landing a shark.

Frequently, we netted a batch of skates and rays. We cut them up and left them in the net, providing a bloody bait for the next shark which happened along. There is no better scent to be had.

The sharks kept striking the net and we kept pulling them in. When the thirty-sixth shark had been hauled into the 20-foot boat, there was barely 3 inches of freeboard left. A fair-sized wave would have swamped the boat and sent Pete and me spilling into some obviously sharky waters.

We hailed a nearby shrimp boat which took us in tow. But we had such a load that water poured in through two small holes in the sternboard, where a bumper formerly had been secured. Not a stick or a plug of any kind was in the boat. I couldn't let that great catch go to the bottom, though, so I did what that boy at the dike did, only more so. I stuck my two thumbs into the holes. We made it to shore safely.

Our catch weighed 9,985 pounds.

NANTUCKET, MASSACHUSETTS

Captain Ernie Schuetz and I are catching about 350 sharks a month, right off this summer colony where people are swimming without realizing that thousands of sharks are swimming here, too. These sharks aren't after bathers, though. Not as long as there are great schools of menhaden about.

And most of the sharks we are catching are not dangerous. Because I knew this, I got careless the other day. You should never get careless around sharks, even the "harmless" ones.

We had caught an 8-foot Sand shark on a hand line. The Sand shark isn't exactly harmless, but it isn't exactly ferocious, either. You just have to be watchful when you handle one. And I wasn't.

When we brought him alongside the boat, I clubbed him across the snout and swung him inboard with the block and tackle. He dropped down on the deck, apparently dead. (That blow on the snout does it–usually.) I wanted to move him forward a bit because he was in the way of the wheel. I started tugging him by his head while Ernie pushed him from the back. Suddenly, the shark gave a convulsive flop. His jaws yawned open and, somehow, he seemed to lunge forward. I leaped backward, lost my balance and fell. As I lay there, stunned on the deck, I could see the sky spinning above me, for I was flat on my back, and I could feel the shark's jaws slowly closing on my left leg.

I sat up. I just froze there, watching the shark's upper jaw descend over my leg like a jagged curtain.

At that moment, the shark died. Only the pinpoints of his teeth penetrated my skin. I was covered with cold sweat, and as I looked at my leg with its dim crescent of tiny pricks, I could hardly believe it was still intact.

Everything had happened in only a few seconds. Ernie was already prying the shark's jaws apart and gently lifting my leg from the maw.

Shark bites were no novelty to Captain Ernie. He told me once about the time he was working a ship out of Nassau. The *Una*, a small Bahamas steamer bound for her home port at Turks Island, hit a coral reef.

"She had about 75 laborers aboard," Ernie recalled, "and when that little ship hit the reef, there wasn't much time for many of them to get into the life-boats, or even on the life-rafts. Lots of them–God only knows how many–were dumped into the water and kept afloat by grabbing at whatever bobbed by.

"There wasn't much panic, though. That is, not until one of the passengers on a raft tumbled off and disappeared. Just one word was all he yelled: *Shark!*

"All of a sudden, the sea was alive with those monsters from hell! They smashed into the rafts, overturning them and throwing screaming men into the sea. One of them even half-leaped out of the water and pulled a man right off a raft.

"Men tried to beat the sharks off with oars. The oars broke over their heads—or a shark would grab an oar in his teeth and splinter it as if it was a toothpick.

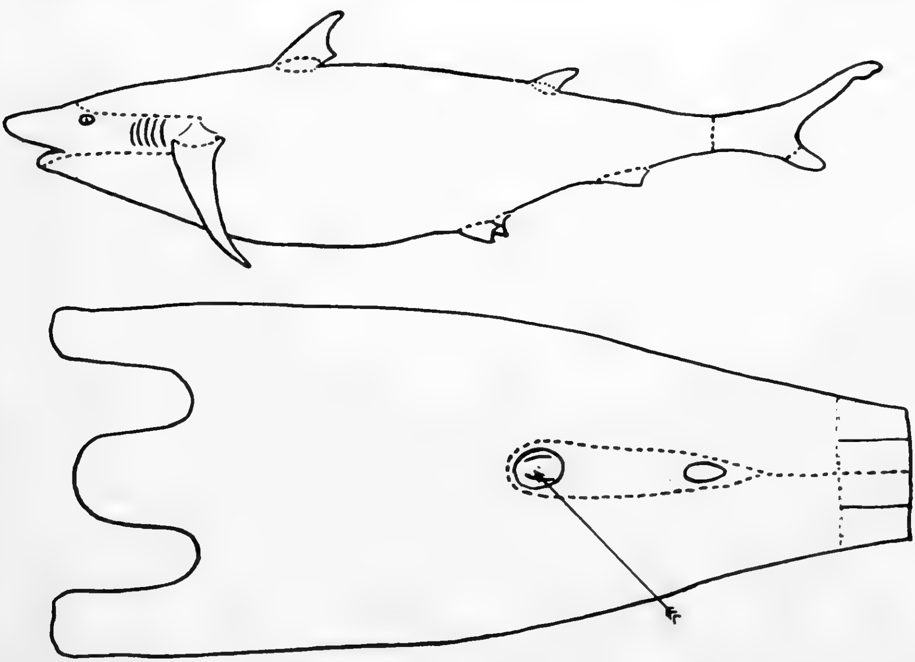
"Some of the men went crazy and jumped right into the sharks' jaws.

"How long the nightmare went on, Bill, I don't know. It ended as fast as it started. The sharks just disappeared. They didn't go away hungry, though. I'll vouch for that."

MOREHEAD CITY, NORTH CAROLINA

We're supplying sharks for a fascinating shark "disassembly line" at the Ocean Leather shark station here.

We're catching between 50 and 60 a day (on good days, and that's what most of them are). As soon as we pull into one of the station's wharves, the sharks are quickly unloaded and skinned right there on the platform. A skilled skinner can do the job in less than 15 minutes, providing his knife is razor-sharp and he knows his shark anatomy. The shark's dorsal fins are first hacked off. Then a long slit is made down the midline of the back. Next, the skinner peels away the hide by pulling it with one hand while, with the other hand, he wields



Shark-skinning is an art demanding skill—and a very sharp knife. The dotted lines on the figure of the shark and the hide show where trims are made. Skinning, according to Captain Young, begins with a cut down the center of the back, then up to the head and around the eyes and the gill slits. A second skinning operation begins along the top of the tail and is continued up the underside to the ventral fin, around it and back to the other side again. The result: the hide comes off in one piece, shaped as shown.
From *Shark! Shark!*

his knife to cut the hide away from the carcass. The hide is washed down with sea water, then put in a barrel of brine for 3 or 4 hours to prepare it for fleshing.

Fleshing is done by stretching the hide on a beaming board, a stout board about 3 feet wide and 5 feet long, which is curved to match the beaming knife, a curved, 16-inch blade with handles on both ends. Excess flesh is removed by carefully drawing the knife along the hide. It is now ready to be cured. Generous amounts of salt are spread on the flesh surface of the hide in the curing process. This is done in the salt house, at the end of the wharf. There, too, the hides are baled for shipment to the tannery.

While this is going on, the carcass of the shark is being readied for eventual sale. Though most species of shark provide tasty meat (I rank it among the best fish I've ever eaten), because of the prejudices that exist against shark, we had to find another use for the nutritious meat. The answer was fertilizer.

The carcasses were wheeled, on a narrow-gauge railway, from the skinning platform to the fertilizer sheds. Here, in several large frame buildings, was the machinery for reducing the carcasses to fertilizer. The carcass of each shark was run through a hopper, where it was ground up. Then the finely chopped pieces were fed into a hot-air dryer. The dried product was next pulverized and put into bags. The result was a fine fertilizer, so rich in vitamins and minerals that it had to be mixed with other, less potent fertilizers for best results.

The disassembly line had still other by-products. The shark's big, vitamin-filled liver was rendered by boiling it in a double-boiler contraption, then skimming off the oil. The fins were dried and shipped to Chinese merchants who sold them for shark fin soup. The teeth and dried jaws went to curio dealers.

Because of Prohibition, we had another unexpected by-product. I found out about this one night when one of the men at the station (most of us lived in bunkhouses right near the wharves) invited me to have a few drinks. I was surprised that he was serving the real stuff. Imported, too.

When I asked him where he had got it, he looked around very carefully and then told me the story. It seemed that a rum-runner had run aground on a sand spit offshore a few nights before. Afraid the Coast Guard would catch him if he was still hung up there at dawn, the rum-runner jettisoned his load of imported liquor. Thus lightened, the boat floated clear of bottom and the rum-runner sped off.

Somehow—my host never explained this—he heard about the bootlegger's jettisoned cargo. He went out with a grappling line and fished up several cases of liquor. He was a fisherman, not a bootlegger, though. He never sold a bottle. He just became a grand host and a connoisseur of fine spirits.

Bootleggers soon realized that our shark-fishing could be a fine cover-up for rum-running operations. I was approached by one of the members of the local gang, who made me an offer. His ingenious idea was for me to rendezvous with a liquor-carrying boat offshore after I had got my day's catch of sharks. I was to stuff bottles of liquor into the sharks and then go ashore. There, a member of the gang, who was to get a job working on the wharf, would smuggle the contraband into a "special shipment" of fertilizer. It sounded like a great idea. But I turned it down. I'd take my chance with real sharks, but not the human variety.

Shark-catching here is not as spectacular as it was in my *mano*-harpooning days. But it is much more effective. We set our nets in the afternoon to trap sharks, who do most of their foraging for food at night. Each day before sunset we embark on our three small boats and put out to the sharking grounds at Western Shoals or Cape Lookout. Each boat has ten nets, each of which is rigged with two anchors and four buoys. The anchors pull the net to the bottom, and the buoys mark the nets on the surface. A line strung with lead pulls the bottom of the net down, and a line strung with cork buoys holds up the top of the net.

The net hangs vertically in the water like a curtain. The nets are staggered so that a long line of them stretches for about half a mile out from shore. Thus, the sharks are stopped by the net "curtain" as they head for shallow water in search for food.

The nets are hung so that they will "fin" the shark. He swims into the net, whose diamond-shaped openings allow his head to get through, but hold him by his pectoral fins. Once trapped, the shark cannot back up. He is simply incapable of backing up. He hangs there and tries to get away by rolling. This maneuver only enmeshes him more. Frequently, his rolling wraps the net around his gill slits, and prevents him from breathing. He dies by suffocation.

Just before dawn, we set out again for the nets. Hand over hand, the crew hauls the boat along the length of each net, pulling up the cork line and passing it aft. When a shark's head breaks surface, it is hooked through the jaw. The shark is clubbed and, hopefully dead, is swung aboard.

Sometimes we set trawls. To a long line, secured at both ends by anchors and buoys, we fasten "gangens," or lengths of line about a fathom long strung with a length of chain and a steel, king-sized sharkhook baited with fresh-caught white fish. From 25 to 50 of these lines are set. The next morning, when we haul in the catch, often all we get are sharks' heads. The entire bodies, up to the gill slits, have been eaten by cannibalistic sharks. Sometimes, as we pulled in the trawls, the cannibals would still be attacking their helpless relatives.

Most of our luck, though, is good. The same cannot be said of the menhaden fishermen, for our good luck is their very bad luck. Cape Lookout is a great "pogie," or menhaden, fishing ground. The menhaden are caught by surrounding the huge schools with purse seines a thousand feet long. Once the seine is closed and the bottom pursed with a draw string, thousands of "pogies" are caught.

The sight of this mass of trapped prey is maddening to a shark. He bites a hole in the net, and the "pogies" pour out—right into the shark's mouth. Other sharks converge at the feast. Each one bites one or more big holes in the net to gorge himself on the fish, whose short-lived freedom ends where the shark's maw begins. The sharks stuff themselves on "pogies." I once caught a shark who had just left a "pogie" feast. He had in his bulging stomach 57 fish, each 5 to 8 inches long, and each swallowed head first, which showed that the shark had got them as they swam toward him, undoubtedly from a net he or another raider had ripped open.

PANAMA CITY, FLORIDA

Sharks are where you find them, but finding them is often much more difficult than catching them. One day, you are pulling them in with every haul of the net. The next day, they are gone. But one of the charms of shark-fishing is the interesting people you meet while you are trying to meet some sharks. While scouting the Gulf of Mexico for a likely spot for some profitable shark fishing, I met a couple of sharkers with some good yarns to tell.

Captain Charles Thompson told me about a whale shark that didn't get away. I'll pass along the story as he gave it to me.

"We were anchored just below Knight's Key, about half a mile from the old Florida East Coast dock. Looking over there one morning about 9 o'clock, I saw an unbelievably large shark within a few feet of the dock trestle. We immediately took to the launch and started after the fish.

"We got nearer and nearer until the boat was right over him and we could see his spotted back 3 or 4 feet below the surface. I drove a harpoon into him near the gills.

"We called to some nearby fishermen to come and help us, and with their assistance we did everything we could think of to make him fast: 40 or 50 times during the day we shot at him with a rifle. At a distance of about 2 feet from his back we let fly with a shotgun loaded with No. 2 shot, which just bounced, leaving a little circular mark in his skin.

"Unruffled by our little attentions, the fish circled several times in from the trestle to perhaps a mile inshore, coming back again and again, and about 1 o'clock in the afternoon, when the tide was running out, we thought he would get outside the bay.

"But the fish remained in the bay. I was surprised that he did not put up any fight and was so extremely sluggish. He seemed not to realize that anything in particular was happening to him. He kept circling around, moving his big tail in a slow, regular way, drawing the small boats after him with the greatest of ease. There were now several harpoons in him, and one line was fastened through his tail and another made fast to the dorsal fin.

"About half past five that night he made his last circle in from the trestle, and this time we headed him over toward a sandbank by poking his head with a boat hook. He finally stranded on the sandbank, where he was made fast with lines around his body stretched to oars stuck deep in the sand.

"A piece was then cut from the top of his head. With a knife on the end of a pole we tried to reach his brain and kill him. We were surprised to discover about three inches of gristle at this point in his head."

I later saw Captain Thompson's great shark on exhibit in Miami. It weighed 13½ tons and was 38 feet long and 18 feet in girth. A careful examination showed that it was a young Whale shark which had not yet reached maturity.

Another yarn came from Captain W. B. Caswell, Sr., an old-time Gulf fisherman who called Panama City his home port.

"I had built a campfire in the palmetto," he began, "and was boiling a pot of coffee about 2 o'clock one morning. It had been a cold, raw night, and my crew had made three long hauls over coral reefs. Just after midnight, a big shark, striking at the gilled mackerel in the bunt, had torn our seine half in two. So we were out of business temporarily until it got light enough to see to mend our net.

"While I was making the coffee, I heard the chug-chug of a motorboat coming in, and from the exhaust noise I knew whose boat it was. Sure enough, when the boat came abreast of our fire on the beach, I recognized it. My friend stopped the engine, and hailed: 'That you, Captain Caswell?'

" 'Yes,' I yelled back.

"Before I could shout that there was coffee ready, he must have smelled it, for his next inquiry was: 'How's coffee?'

" 'Sure,' I answered. 'Come ashore and join us.'

"The crew waded ashore, and even before they reached the fire I could tell there was something wrong. They just didn't have that air fishermen have when they've finished a good day's work.

" 'What's wrong, Captain?' I asked my friend. 'Sharks eat up your seine, too?'

" 'Seine, hell!' he said. 'Look at me!'

"He turned around. I saw that half his coat and the back of his pants had been completely torn away.

" 'What happened?' I asked.

" 'Well,' he answered, still angry about the incident, 'I was holding the lead line down in a swash below the Bell Shoals and we caught a seine full of sharks along with the mackerel, and one of them took a nip at me. Them slickers cost me six dollars and them dungarees cost one dollar and 90 cents—best duck brand—and that flannel underwear cost me three dollars a suit. And I had a big bandanna handkerchief in my hip pocket and he got that, too.'

"Even the coffee didn't cheer him up. He was still grumbling about that shark when he went back aboard his ship, getting more than his feet wet as he waded into the surf."

Captain Caswell, who retired after 42 years of fishing in the Gulf, developed his own method for keeping sharks from tearing his seines. But I wouldn't recommend it.

"A fisherman often cruises for four or five days through all kinds of weather, risking his life, health and the money invested in his rig," Captain Caswell said by way of introduction to describing his anti-shark warfare. "So, when he finds a 10,000-pound bunch of salable fish in his seine and a big shark tearing 10-foot holes in it, he is pretty apt to take the most effective and surest method at hand to get rid of the shark.

"My particular method was to shove off in the seine boat, get within reach of the shark and dive overboard for the dorsal fin. It's easy to grasp, being rough and not slippery. Usually, it's not difficult to get hold of this fin with the left hand, and to make myself secure I wrap my legs around the shark behind the fin. The shark makes a lunge and at the same time starts to roll over. I take my sheath knife and, reaching as far forward with it as I can. draw it strongly across the muscles of the back of his neck. One slash with a good sharp blade, 7 or 8 inches long, usually cuts the muscles and cords that direct the shark's movements. The head bends down, the wound opens and the loss of blood soon weakens the shark. I get out of the water while the shark aimlessly rushes about, rolling over and over and pounding the water with his tail. After a few minutes, he settles toward the bottom, and my catch is saved."

Captain Caswell later taught his son, Wallace, to ride sharks. But what the old Captain did to save his catch, Wallace did for a living. Billed as the "Tarzan of the Sea," Wallace would enter a tank at a seaside resort, and, while a crowd of paying viewers gaped, battle a shark. Wallace always won.

(During the New York World's Fair of 1939–40, Billy Rose wanted to stage a sensational show—Captain Caswell *versus* a shark. I was hired to design the tank, make arrangements for the delivery of sea water to it, and, of course, catch the sharks. It would have been a great show, but the New York Humane Society got wind of it, and the project was quietly dropped.)

Isle of Warimos, French Somaliland

When my employers at the Ocean Leather Company once asked me how far I would be willing to go to hunt sharks, I said, "To the ends of the earth." This is the end of the earth. Unbelievably hot, unbelievably desolate, this island is so barren not a blade of grass grows upon it, let alone a tree. It lies, low and sun-baked, about 8 miles south of Djibouti, the only place in French Somaliland that could be loosely termed a city. Djibouti has been called the hottest place on earth. Warimos is hotter.

Djibouti is on the Gulf of Aden, near the neck of water that connects the southern terminus of the Red Sea with the Gulf of Aden. Here, I was told, an experimental shark station could be set up. If it proved successful, another would be established on Madagascar.

On the way to Djibouti, I met Ras Tafari, a friendly, dignified little African. I invited him shark-fishing and he invited me to a lion hunt. Neither of us could accept the other's invitation. I was about to plunge into my job as a shark fisherman, and Ras Tafari was heading for his new job. He was on his way to Ethiopia, where he would be crowned Haile Selassie, Emperor of Ethiopia and Lion of Judah.

I often envied him his palace, in the months that followed. Imagine landing on the moon and trying to build something there. That is the way it was on Warimos. Lumber had to be brought in from Trieste. Water, scarce even in Djibouti, was non-existent on Warimos. Our drinking water was brought to the camp on the backs of donkeys from an oasis 10 miles in the desert. Other water came by boat. We had ice brought in, too—by a native runner, who carried it from Djibouti to the island, which was accessible by foot twice a day at low tide.

At night, hyenas prowled the island, looking for the shark carcasses which they could smell from shore. The terrifying howls of the hyenas woke us in the middle of the night, frightened the natives, and even sent the dogs whimpering under the beds.

A dry, unceasing southeast wind swept across the parched land, carrying sand and dust into everyone's eyes. The wind had been blowing for centuries, and it filled the floor of the sea around the island with fine mud. The water was always muddy; particles of sand and dirt were constantly being deposited on the water by the wind and drifting to the bottom. Mud clung to our nets and caked the hulls of our boats. But that mud was a good omen, for mud means sharks.

Our shark-hunters were a motley lot: tall, regal Abyssinians; wiry little Arabs; Dankali natives from northern French Somaliland; their long-time rivals, Somali from the south. Both the Somali and the Dankali carried knives. The natural rivalry between them would have been murderous if we hadn't disarmed them. We took advantage of the rivalry by urging them to compete against each other as shark-catchers.

My private shadow was a big, muscular, ugly Somali who wore tattered dungarees and a vest. He was handy with tools and quick witted. He attached himself to me and called himself Ali Young. He dogged my footsteps so closely, ashore or afloat, he was something of a nuisance.

But if he hadn't been an arm's length away from me one day . . .

We were in a small boat about 5 miles southeast of Warimos. It was a spot known for big sharks—*Kabir Lokhom,* the natives said. At daybreak, we started hauling in our first shark net. We pulled in a few Mantas, a couple of Hammerheads and some Tigers. Ali was ever at my side, as I helped to work the net or manhandled the writhing sharks and Mantas into the stowage compartment.

The nets were slippery with mud, and, as the nets were taken aboard, they coated the decks with slime. The sea was pretty rough. And the slippery decks didn't help us keep our feet under us. Suddenly, the sea heaved mightily, and I tumbled into a net which was already crowded with sharks. Just as I landed in the net, I heard one of the boys scream: "*Lokhom! Kabir lokhom!*—Shark! Big shark!"

I felt I was safe for a moment or two. I wasn't bleeding, so the sharks would probably not attack me immediately. Luckily, I hadn't landed on any of them, so I had not yet provoked them. And—except for the *kabir lokhom* who had just swum into the net—the sharks were near exhaustion from their hours of struggle in the net I now shared with them.

The big Tiger was a different matter. He was after prey, for he was still free and not yet entangled in the net. I felt I could hold him off momentarily by taking a chance at splashing and thrashing about. Then I realized that I could not move. A net is a treacherous thing, which I had learned to fear, for, if a foot or arm is caught in it, a fatal entanglement almost surely begins. It was like a variation on that old legend of the Tiger or the Lady. For me, it was the Tiger or the lethal embrace of the net.

Whenever I see the phrase "snatched from the jaws of death," I think of that moment in the net, for that is exactly what Ali Young did. He reached down and, holding onto the gunwale of the tossing boat with one hand, he grabbed me with the other. He tightened his big hand around my wrist and plucked me out of the sea.

That night, Ali was the hero of the camp. His own account of the adventure lost nothing in the telling. His listeners were properly awed by both the story and the large supply of tobacco I had rewarded him with.

One of the most spectacular catches off Warimos was made by a couple of natives in the smallest boat we had. They were hauling in a net when they felt something huge tugging it down. Inch by inch, they pulled the net up high enough to see a great Manta entwined, but still very much alive. Rigging a line through a block on the mast, they pulled away. But the mast gave way, cracked at the deckline and fell into the net, too. Still undaunted, the natives kept trying to pull in the net and, at the same time, make for shore, which was not far off. Then they discovered another monstrous Manta entangled in the net!

Towing the net, the two big Mantas and the mast, they somehow managed to make shore. We had a derrick on the wharf, but it was not big enough to lift the Mantas, so we beached them in the ebbing tide. When the water receded, we made lines fast around them and rounded up a few natives to pull them to the skinning platform. The Mantas wouldn't budge. We called a few more boys. Again, they could not pull them in. We finally needed 22 boys to lift and drag the carcass of each of the giant rays to the skinning platform. From one of the Mantas I removed an embryo weighing 50 pounds. It was folded up in the shape of a letter *S*, with one pectoral "wing" enwrapping the top of its body and the other enwrapping the bottom. I carried it to the sea and put it in the water. Its "wings" unfolded and it swam away, as gracefully as a bird.

The waters off French Somaliland were full of sharks, and their cousins. We caught not only sharks and Mantas, but Sting rays, Torpedoes and Sawfish. We dried and cured shark jaws and Sting ray tails, and sent them to the Commissioner of Fishes in Paris. He forwarded many of them to the Kensington Museum in London and the Museum of Natural History in New York. Years later, I learned from my friend Dr. Gudger at the Museum of Natural History that I had made several valuable contributions to ichthyology. Many times I would be sitting in his office, telling him some experience of mine, when he would say, "Just a minute, Captain Bill." He would ring for his stenographer, and, when she appeared with her pad and pencil, he'd say, "Now, Captain Bill, spill the beans." In many papers which Dr. Gudger wrote he generously credited me for supplying him with facts I had gathered in my shark travels.

Among my souvenirs of the shark-hunting days on Warimos was the 6-foot saw of an 18-foot Sawfish we caught one day. I had to restrain Ali when the Sawfish was brought aboard, brandishing her dangerous weapon. He was all for grabbing the fish as his own property, even before a few swipes of a hatchet lopped off the wicked-looking saw-toothed snout.

Back on shore, when the Sawfish was hoisted to the skinning platform, Ali danced around it, yelling, "*Les oeufs, les oeufs!*" His was the first of many greedy hands that reached into the shark's slitted stomach and pulled out *les oeufs*. The eggs were not truly eggs. The Sawfish is viviparous. But the embryos are connected in the womb to yolk-sacs which start off the size of ostrich eggs early in the embryo's development. As the embryo grows, the yolk-sac is used for food. Finally, at birth, the empty sac is cast off.

Ali and the rest of the epicureans who raided the Sawfish's larder were not aware of these anatomical facts. The yolk-sacs were true eggs to them. *Les oeufs*—there were about 10 good-sized ones—were roasted on hot rocks over a charcoal fire. When the cooks thought their "eggs" were done, they picked them up, smoking hot, opened their thin shells and ate the gooey mess with their fingers, which were carefully licked, one by one, when the feast was over.

Not long after the Sawfish egg cookout, our work ended at Warimos. We had amply shown that a successful shark station could be set up there to provide the natives with a badly needed industry. We were supposed to return to Paris, headquarters for the European branch of the leather company, make our report, and then head for Madagascar, where another shark station was to be established.

I said a sad goodbye to Ali. Then I started walking across the tide flat to our battered old Ford that rattled out to Warimos from Djibouti at low tide. The Ford had to make a fast turn-around in order to make the round-trip during a single low tide.

Ali, ever my shadow, ran after me. He knew there wasn't any time for ceremonies; the Ford had to start off right away. I tried to soothe him by telling him I'd be coming back to Madagascar, and, when I did, I would take him with me.

A big grin spread across faithful Ali's face. He knew practically no English, but he managed to say, "I wait for you."

How long Ali waited I'll never know. Our plans were changed in Paris. The company decided against starting a station at Madagascar. My next shark-hunting grounds would be Australia.

En Route to Australia

After a short Hawaiian vacation that included a few old-fashioned shark hunts, I set out for Australia on a ship that stopped at many South Pacific islands along the way. At every stop I made it my business to inquire into the local shark situation. A sharkman's holiday.

I spoke to missionaries who had spent much of their lives in the islands; through interpreters I interviewed native fishermen; I discussed shark, in pidgin English, with venerable chieftains whose knowledge of the ways of the shark was based on decades of practical experience.

I soon learned that there was no doubt in this part of the world about the shark's man-eating habits. Every island I visited had its own history of shark attacks. And, on nearly every island, there was visible evidence: one-legged or one-armed men and boys who explained their injuries with whatever their word was for *shark*.

The islanders respect the shark, but they do not panic at the sight or thought of him. They seem to have the same regard for the shark that the African has for the lion, and, like the African, an island fisherman is not afraid to hunt the shark when conditions are favorable.

In Samoa, natives catch sharks for food. They wrap the sharks in broad *ti* leaves and roast them in underground pits. Sharks are so abundant around some of the islands that for countless years the natives have had a regular trade with the Chinese for shark fins.

One popular method of fishing in the islands is with a great net which is taken out by about 10 men who form it into a semi-circle, with the open end pointing toward shore. As they slowly walk the net toward shore, corralling small fish in the process, sharks almost inevitably appear near the fishermen, who apparently are not bothered by this uninvited company.

But the natives will not share the water with the shark at night, the time when most species of shark prowl for food. The shark at night is looked upon as an aggressive predator who will attack any potential food. The sharks often follow boats and canoes at night, biting the oars, paddles and outriggers.

I was told of violent attacks by large sharks on boats. Oars have been ripped from natives' hands, and, many times, sharks have so savagely snapped at the outriggers that boats have been overturned, spilling the occupants to nearly certain death.

In the Ellice Islands, northwest of Samoa, about 40 natives, crossing in canoes at night between islands several miles apart, were caught in a sudden squall. One of the canoes was swamped. Instantly, the sea was seething with sharks that had been trailing the canoes. The sharks devoured the natives in the first canoe, and then began attacking the other canoes, which were foundering in the storm-churned sea.

The natives' two pitiless enemies—storm and shark—merged their malevolence. Canoe after canoe was capsized, native after native was torn to pieces. When the storm and the sharks disappeared with the coming dawn, only two natives were alive to carry the awful tale back to their home island.

Word of the massacre spread throughout Polynesia, and I heard the story again and again on many islands.

A similar story was told in the Fijis, where a large double sailing canoe had capsized well off shore. More than 20 natives clinging to the overturned canoe were attacked by sharks. Only a few escaped.

One of the tiny atoll islands I visited was the hunting ground, the natives insisted, of a single big shark that patrolled the entrance to the atoll. The natives would swim and dive without fear in the lagoon, but they would not venture into the entrance of the lagoon with its shark sentry. The shark, they said, would not enter the lagoon.

Solomon Islanders claimed that their sharks were fiercer and bolder than the sharks around other islands. There may have been basis for their claims, I was told, because the Solomon Islanders throw their dead into the sea, which is a sure way to attract sharks.

Shark teeth are not used for money in the South Pacific, despite what you may have heard to the contrary. But the teeth are often used as ornaments and talismans. I once met the widow of a New Zealand lawyer who had somehow aided the Maoris in New Zealand. Before he died, he presented his wife with a prehistoric shark tooth which had been given to him when he was initiated as a member of a secret Maori society. He told her to wear the tooth when she was among the Maori, for it would be honored as the sign of a friend.

The words *tooth* and *shark* are often synonymous in Polynesian dialects. *Mako* is the most frequently heard word for either *tooth* or *shark*. Other Polynesian words—*mao*, *mano*, *mago*—are local names for various kinds of sharks.

PINDIMAR, AUSTRALIA

While we were setting up Australia's first shark station here, I took a day off and went to Sydney, which was nearby, to try my hand at fishing for Australian sharks. Zane Grey's adventures as a game fisherman had received widespread publicity in Australia. Now here was another American who was going to not only catch sharks, but turn them into money. The Aussies were a bit skeptical, and, when I went out on my first hunt, it was a news event. Luckily, I received this notice in the Sydney *Daily Guardian:*

"Captain W. E. Young, well known in many parts of the world as a commercial shark hunter, took a holiday on Anzac Day, and went fishing in Sydney Harbor with two of his colleagues.

"Many and various were the lines which hung down from the boat's side, and many and various were the creatures that came squirming into the cockpit; but Captain Young was beyond such trivialities. His line was stout manila rope, his hook was a terrifying affair reminiscent of a shepherd's crook, and his bait was one large mullet. He watched the line and brooded, while the others trifled with the flathead and similar prosaic beasts, and made merry amongst themselves.

" 'I don't want a great big brute,' said Captain Bill, 'and I don't want a little runt. I want a nice one—about 400 pounds. And I'm going to get it.'

"And he did. His sudden bellow, 'Clear all lines!' meant swift and ordered action, and within a few seconds the boat was cleared for combat.

"Captain Young stood by the bitt round which his line was turned, and watched intently the convulsive movements in the water, to which all eyes were now directed. He took the line in his hands as soon as these movements changed in character, and, with the dexterity of long experience, proceeded to find out how safely the hook was embedded in the monster.

"In those hands Mr. Shark never had a chance. When he dived, he found himself swept up to the surface and above it; when he swerved he was pulled around in a circle; when he made a full-speed attempt to get away from the scene of his discomfiture he was stopped with a dreadful jerk as his tormentor took a sudden turn with the line around the bitt.

"Captain Young chuckled and spoke words of wisdom. 'Just about 400 pounds, I reckon.' The rope slackened and was as quickly hauled in. A tremendous splashing, and a first view of the monstrous fish. 'No, I guess he's a "she." '

"More splashing, and another brief glimpse. 'A Tiger, about 10 feet.'

"Five more minutes of watchful endeavor and cunning line-play; then, for an instant a sleek gray head and a baleful eye appeared. Crack!

"Young's automatic appeared from nowhere, planted a slug in exactly the right spot, and disappeared again. Twenty seconds later the victor gazed down cheerfully into the leering dead face, with its rows of ghastly teeth.

" 'This lady's a respectable married woman. Let's tow her home and count the family. About two dozen, I should say.' So Mrs. Tiger Shark went on her last voyage, ignominiously dragged up the harbor.

"There may be other men who can catch just the size shark they require, and even name its length and species by the feel of the line. But Captain Young raised himself above the heights of mere man when he finished his operation on the corpse. Three pairs of eyes asked him a mute question, and he grinned engagingly.

" 'Just twenty-four,' he said."

That highly successful demonstration in Sydney Harbor did wonders for our venture. Word spread that we were not a bunch of amateurs with a harebrained idea. And we received wonderful cooperation in setting up our station in Pindimar.

Buildings still stood from a refrigeration plant the government had built and later abandoned. Sharks abounded there, we were told. Pindimar oystermen, plagued by sharks, happily showed us where to find sharks—right in the middle of the oyster beds.

On our first day of operation we headed out into the bay, near the oyster beds, with mullet-baited hooks. I decided to use my prize hook, made to order for me in London by a fine hook-maker. Galvanized, of half-inch carbon steel, with a chisel-pointed barb that was razor-sharp, it was designed to catch the biggest, toughest sharks in the sea. The gleaming hook hung from a brass chain and a sturdy swivel designed to keep the shark from twisting off the hook.

All the way out I thought about the monster this gear would surely land. When we reached a likely looking spot, the weather turned nasty. I made the hook line fast and went below to the shelter of the cabin—a comfort our 50-foot boat boasted. There, protected from the weather, I could still keep an eye on my line.

I hadn't been down below long when the launch shivered from stem to stern! My line was taut, drawn stiff as a ramrod by a huge shark on the other end.

I rushed on deck to begin what I thought would be a classic battle. But when I grabbed the line it was slack. The shark had struck and managed to get off the hook. Cursing under my breath, I hauled in the line as quickly as I could. I was determined to bait it and get it back in the water immediately, for the monster might still be about. When I pulled in my hook, though, I discovered that it was broken in two. I examined it carefully. There were no defects in it. The explanation was simple, but incredible. A shark had struck my steel hook hard enough to break it as easily as I could have snapped a twig.

We decided to use nets, the like of which had never been seen in Australia before. They were about 1,000 feet long, 16 feet deep, with an 8-inch mesh. They were hung in the same "curtain" fashion that I had found to be so effective elsewhere. In my entire sharking career never had I been given an opportunity to test out the theory that sharks were attracted to white or light objects. I decided to try an experiment with the nets. We alternated blue, green and white sections in one net. Invariably, we found sharks in the white section—and none at all in the colored. The experiment left no doubts, in my mind at least, about the effect of color on a shark's senses.

We had been told that the waters were full of sharks of many kinds—Gray Nurse, Hammerhead, Carpet, Whaler, Tiger, Blue Pointer, Wobbegong, Shovel Nose, Port Jackson, Angel, Gummie. But we were not prepared for the bonanza we would strike.

Our specially built boats arrived at Pindimar from Sydney, trim 30-footers powered by 12-horsepower diesels. We set our nets for the first time, about 3 miles out from the station. The next morning, we began to under-run our nets.

Our first surprise came when we saw that the sealed cans which buoyed the top-line of the net had collapsed. That meant the net had been dragged to 20 fathoms by some enormous weight.

The weight was pure shark. The net was alive with them, and every one big.

As each shark appeared, his tail was securely lashed, the derrick arm was swung out, the windlass was turned, and up came a shark, tail-first, still enmeshed in the net. The shark could be cut out of the net, of course. But nets cost money, and, as long as you watch your fingers when you're near the entangled shark's jaws, untangling the net is not as dangerous as, say, working around a buzz saw.

We clouted the shark with an outsized baseball bat, and sometimes shot him, but we could never be sure he was dead.

Anyway, in that furious under-running on that first day's haul, we had hardly time to do anything more than swing 'em aboard. We hauled in 22 from that net, all of them big Dusky sharks, and we were lucky there weren't 23, for the boat gunwales were hardly 3 inches above the water when we headed home.

We never topped that first day's catch. It was a record for a single net. Apparently, a school of sharks had blundered into our net. But it was a great start, and good catches continued.

Of course, the usual cannibalism deprived us of many a good hide. The Tigers were particularly vicious. When we took in a net with Port Jacksons, Wobbegongs and Tigers, the Tigers would usually be the only whole captives.

Once, though, we saw evidence that a little 3-foot Port Jackson had outwitted a big, 12-foot Tiger. The Port Jackson shark is an inoffensive shark that feeds on shellfish and has pavement-stone-like plates instead of teeth. Put a Port Jackson and a Tiger in a net, and the life expectancy of the Port Jackson is about 30 seconds.

Never underestimate the shark, though. And that means any shark. For I know at least one Port Jackson who attacked a Tiger—and survived.

We found them both in the net. Reconstructing what had happened, we decided that the wily, 3-foot Port Jackson had been netted first. Next came the 12-foot Tiger. He darted for the Port Jackson, but the latter somehow evaded the Tiger's attack. The Tiger was now entangled himself, but he made another lunge for the Port Jackson. As he did, the little Port Jackson, though also enwrapped in the net, grabbed the Tiger as he flashed by. The Port Jackson bit the Tiger in the soft vulnerable flesh near the gill slits. The little shark's pavement-stone teeth clamped on the gills and hung on.

That's the way they were found when the net was hauled in the next morning. How long the Port Jackson had clung there, we didn't know. But clung he had. Even as the Tiger, still alive, was hauled up, the game little Port Jackson hung on. The Tiger was killed and tossed into the hold. The Port Jackson, exhausted, fell back into the net. No one had the heart to kill him. He was thrown back, and swam away, almost proudly, it seemed. The Tiger, incidentally, had two Port Jacksons in his stomach.

Porpoises were frequently found in our big Australian sharks' stomachs, which made these Aussie monsters somewhat unique, for never before had I seen sharks who made a regular diet of porpoises. Usually, a porpoise does the chasing. And, when a porpoise mother is giving birth, other porpoises will gather around her to protect her from sharks. If a shark comes close, the porpoises will actually charge him and butt him aside.

[The first porpoise (Bottle-nosed dolphin, *Tursiops truncatus*) ever born alive in captivity came into the world at Marineland in Florida in 1947. Several Sand-bar or Brown sharks were in the tank at the time, and biologists observing the birth saw protective porpoises butting sharks away from the mother.

[Porpoises often seem to have no fear of sharks. In the Gulf of Mexico, I know, porpoises will sometimes chase sharks out of a feeding area. In captivity, at least, porpoises have even been accused of ganging up and killing a shark, apparently by butting its relatively delicate gill slits and crowding it against the wall of the tank, preventing it from swimming—and thus breathing.]

While we were setting up the Pindimar station, several bathers were attacked by sharks at Sydney's beaches. A day after a fatal attack at Bondi, one of Sydney's most popular beaches, we sent a shark boat down to sweep the waters of any sharks that might be around. The man-eater who attacked the bather was shrugged off by some as a rare rogue whose presence at the beach was extraordinary. We didn't find the sharks rare; we caught 29 sharks in one day, right off Bondi. Most of them were man-eaters, and one of them, a 14-foot Tiger, was caught in the first line of breakers, a favorite rendezvous for surf enthusiasts.

When the station was running smoothly at Pindimar, my job was done. I could have stayed on, but I was seized by wanderlust again.

After a brief stay in Honolulu, where I got in some shark fishing for sport instead of profit, I received my next assignment: the Caribbean.

Tortola, British West Indies

Tortola means *Land of the Turtle Dove*, and, though the turtle doves have long since vanished, it is the kind of beautiful, peaceful island that would be a homeland for them. Tortola is about 12 miles long and 3 miles wide at its broadest point. Its only community is Roadtown, a neat, quiet little town which has the charm of a small English village.

There are sharks around Tortola, and there is *obeah* in the air. *Obeah* is a kind of sorcery that originated in Africa and is still believed in here.

On one of my first hunts here, I towed out a horse carcass. It didn't work the way it did in Honolulu. "Perhaps I need *obeah*," I mused, as I cut loose the carcass and sailed home empty-handed.

Just then, a school of porpoises appeared. I harpooned a large one, cut him up for bait and drew off his blood into a bucket. My companion in the boat was John Neville, one of the best shark-catchers on the island and a man who reeked of the scent of shark oil. He ate shark liver raw. He rubbed himself with shark oil. He even used soap he made from shark oil, lye and ashes.

John and I let out a trawl line with several hooks on it. Each hook was baited with porpoise, and the sea where we dropped the line was tinged with porpoise blood, which we dumped, still warm, from the bucket.

No sooner had the third hook hit the water, than down went the barrel that marked the end of the trawl line. A shark! As we started to haul him in, two more sharks hit two other hooks on the trawl line.

Three sharks were all we could accommodate in our small boat, so we headed for port. The next morning, we returned to the trawl line. Five more big sharks hung on the only remaining hooks. The rest of the hooks had been ripped off the line.

Never before had I seen sharks go so avidly for bait. I wondered, "Was it the porpoise blood—or the scent of John Neville?"

Another outstanding shark-hunter was a remarkable old man named John Smith. Gray-haired with a flowing white beard, he was 75 years old, didn't have a tooth in his head, sailed the smallest boat in our shark-catching fleet—and caught the biggest sharks.

John knew every rock and shoal within 50 miles of the island, and he rarely came in without a shark. One day, though, he moored his 18-foot boat at our wharf, and, walking straight and tall as he always did, strode up to me.

Captain Young caught this Hammerhead shark (*Sphyrna zygaena*) during his shark-catching days in the Virgin Islands. The Hammerhead was torn by another shark while it was fast in the net. From *Shark! Shark!*

"Boss," he said, "there's a big shark hooked out there, but I can't lift him into my boat. Will you come and help me?"

I was surprised to hear an appeal for help coming from him. But I hopped aboard our biggest boat, the 40-foot *Venus*, and we set out for the net, which was not far from shore. A large shark was thrashing about in the net. Not until we starting under-running the net, though, did I realize how large the shark was.

Alone in his 18-foot boat, John Smith had been struggling with a 990-pound Tiger shark 16 feet long!

On the leeward side of Tortola was a strait we called The Gut, which separated Tortola from Beef Island. While standing on a bluff overlooking The Gut one day, I was startled to see a school of big sharks swimming from the windward side of Tortola and into The Gut. Then came another school, and another. The Gut was filling with sharks which would normally be found only at sea.

I was excitedly planning the strategy for an epic shark hunt in The Gut when one of my native shark-catchers politely suggested that I should be planning for a hurricane instead. It was hurricane *obeah*, he explained, that had sent those sharks to the shelter of The Gut. And hurricane *obeah* had sent the smaller fishes away, for the fish pots put out the night before were nearly empty in the morning. It was another sign.

Call it instinct, *obeah*, intuition—Tortola's people knew a hurricane was coming, and they knew it would be a bad one that would strike their island hard. (I learned later that the Governor of the nearby Virgin Islands had been warned of the hurricane by natives long before the official forecast had reached him. Acting only on the natives' warning, the Governor sent out a hurricane alert that enabled the islands to batten down for the blow.)

No amount of money would have lured my shark-catchers to sea. They were drawing up their boats from the water, nailing fast the shutters of their homes, taking their barrels of precious rain water inside.

Our two big boats—the *Venus* and the *J. H. Smith*—had to be anchored as firmly as possible. We put down four anchors fore and aft on the *Venus*. The *Smith* had two big anchors well bedded in the coral. We put down two more. But my helpers advised me to string a heavy line from the *Smith* to shore, and make the line fast to a sturdy coconut tree. This was necessary, they told me, because, after blowing in from the sea, the hurricane would suddenly shift and blow outward from the shore in the direction of the *Smith*. No safety line was necessary for the *Venus*, they said, since the off-shore wind would not bother it.

We had made our preparations just in time. Our work done, I started for my cottage atop a hill. Halfway up, I was flattened by a mighty gust. I crawled the rest of the way on my hands and knees. I nailed down the windows and door of my cottage from the inside, and, alone, waited out the hurricane. Above the winds I could occasionally hear the bleating of goats which had sought shelter under my cottage. The cottage was built 4 feet above the ground to allow the buffeting winds to pass through, thus weakening their force. For 24 hours my little cottage shivered, but it was not even weakened. A straw-thatched native hut, built on the ground next door to me, was swept away early in the storm.

The day after the hurricane was calm and clear. I rushed down to the waterfront to inspect the damage. There was none. Both the *Smith* and the *Venus* still rode at anchor. An off-shore blast had hit the *Smith*, as my native weathermen had predicted, but the coconut tree anchor had held.

Weeks passed before the small fish returned to shore and began appearing again in the fish pots. And not until they reappeared did the hungry sharks return from their hurricane haven.

When shark-catching was back to normal on Tortola, I put John Neville, the man with the scent of shark, in charge of the station. I then set up a smaller station, as an auxiliary to Tortola, on the island of Anegada, about 40 miles away. I left this in the hands of native supervisors. Once more, I had finished a job and was anxious to get started on another one.

HAVANA

I had known for a long time that sharks were prevalent in Cuban waters, and I thought a shark industry might be feasible here. But I soon learned that, through a curious mixture of sharks and politics, the government had given a mysterious Cuban named Dominguez exclusive rights to shark hunting in Cuban waters. Dominguez' job was to exterminate the sharks, especially those around Havana, so that political enemies of the régime would not have such a convenient way to dispose of their victims. A kind of Murder, Inc., that specialized in liquidating politicians, was reportedly using the sharks, if not as assassins or *corpus delicti* removers, at least as a cover-up. It seemed that when a politician disappeared, the inevitable verdict was: sharks. But it was never made clear whether the victim's killers were two-legged sharks.

In years past, sharks had been used effectively, I was told, to snatch prisoners trying to escape from Morro Castle, the grim old fortress that guarded Havana harbor. Accompanied by the old keeper of the Havana harbor lighthouse, I went out to the ruins of the castle to see if I could find any basis for this tale.

After exploring a while, we came to a long, dark stairway that led up to a little room which had in the center of its floor a round hole open to the sea, about 200 feet below. Leading from the hole was a chute that ended in mid-air quite a way above the sea. When the castle was used as a prison many years ago, garbage was thrown down this chute, and naturally, hordes of sharks gathered there to gorge themselves on the refuse.

"Amigo," I asked the old keeper, "what is there to the tale that prisoners in Morro Castle were permitted to escape through the garbage chute?"

He paused a moment to light his pipe. Then, looking down the hole in the floor, he replied, "*Quién sabe?* Who knows whether there is truth in the story? There are many tales."

As far as I could see, the plunge into the sea from that height would be enough to kill a man. If he survived the fall, though, he would have little chance of surviving the sharks.

Several times a day, garbage scows would leave Havana to dump garbage about 4 or 5 miles off shore. Sharks would suddenly appear, and so would shark-catchers, who were poaching on Dominguez' private concession.

I went out on several of these shark hunts. I once asked my host how he was able to get away with catching sharks when Dominguez had exclusive rights.

"Ha!" he laughed. "He cannot be everywhere, and sharks are in all places, no?"

Sharks did seem to be in all places around Cuba, and so did the poachers. The poacher lay in wait in his small boat amid the freshly dumped refuse until a shark appeared near him. The harpoon flashed, the shark was pulled alongside the boat and then the fisherman slashed the shark across the back with a long, keen knife. If he was lucky, he severed the backbone and paralyzed the shark. Next, he sliced off the shark's fins.

That was all he took of the shark; the rest was left to the other sharks. The fisherman could get a dollar a string for fins from Chinese merchants, and didn't bother with anything else. (Dominguez, though, went into the shark business, processing both hides and oil.)

On one of the poacher hunts, I saw a startling example of the keenness of the shark's scent. Among the litter that had been dumped by the garbage scow was a burlap sack. As it floated by our boat, I saw a big Tiger shark appear in the spreading circle of refuse. He headed straight for the burlap sack, grabbed it between his jaws and shook it. The sack ripped open, and for an instant I saw its contents—a dead cat and four kittens. We rowed over to harpoon the shark, but he gulped down the cat and swam off, leaving the kittens for his companions. He had found, and gone straight to, the only bit of animal meat in the garbage-strewn area. Then, in a split-second decision before fleeing, he had selected the biggest morsel, the cat.

Cuba is the only place where I caught a shark with a piece of cloth for bait. The fisherman I accompanied to the dumping grounds had a scrap of white cloth tied onto a big shark hook. When he had this, he explained, he did not need bait. Somewhat skeptically, I hung it over the side. Sure enough, a large shark took the hook in a few minutes.

We pulled him in, but he turned out to be a *she*. She was close to giving birth, so I cut her open carefully, performing a cesarean section with the bottom of our little rowboat as my operating table. Two lively pups emerged, each about 15 inches long. One leaped out of my hands, fell into the sea and swam away. It was a perfect cesarean, which I believe would have been a credit to any obstetrician.

Home Port

In the years that followed my stay in Cuba, there were fewer entries in my Log. I was growing old, happily growing old, with no regrets. But no longer were my hand and eye as swift as the shark, and I knew that it was only a matter of time before I would make that one mistake that would be my last. Reluctantly, I decided to give up shark-hunting. I became a lecturer on sharks. It was a poor substitute for shark-hunting, but I knew, as the years passed and I neared 70, that it was the only way.

I had just about convinced myself that I would never again see a shark outside an aquarium when World War II began, and I was summoned back to the sharks.

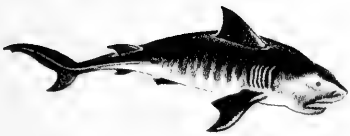
I had two missions. I aided the Navy in its research to develop a repellent that would keep sharks away from fliers downed at sea. And I led a search in the Gulf of Mexico for sharks. Sharks were vitally needed during the war for the vitamin A in their livers, and even an old man could help.

One beautiful day I was in the Gulf aboard the pickup boat that was carrying ice to the shrimp boat fleet. As we sailed along, I threw some chum over the stern, and dropped over a couple of hand lines. A shark took the moving bait. He came fast and he hooked clean. I was an old gaffer, and some of the younger men aboard tried to give me a hand. But I wanted to land this one alone. I pulled him aboard, trying not to look as if my arms were aching. I almost had to let go. But I kept on pulling, and I landed him.

Sixty years had passed since that day off La Jolla when I looked over the side of the boat and saw my first shark. Now, as this big, gray beauty struggled on the deck, I looked at him and I knew that I was looking at the last shark I would ever catch.

Chapter 4

Sharks on a Line



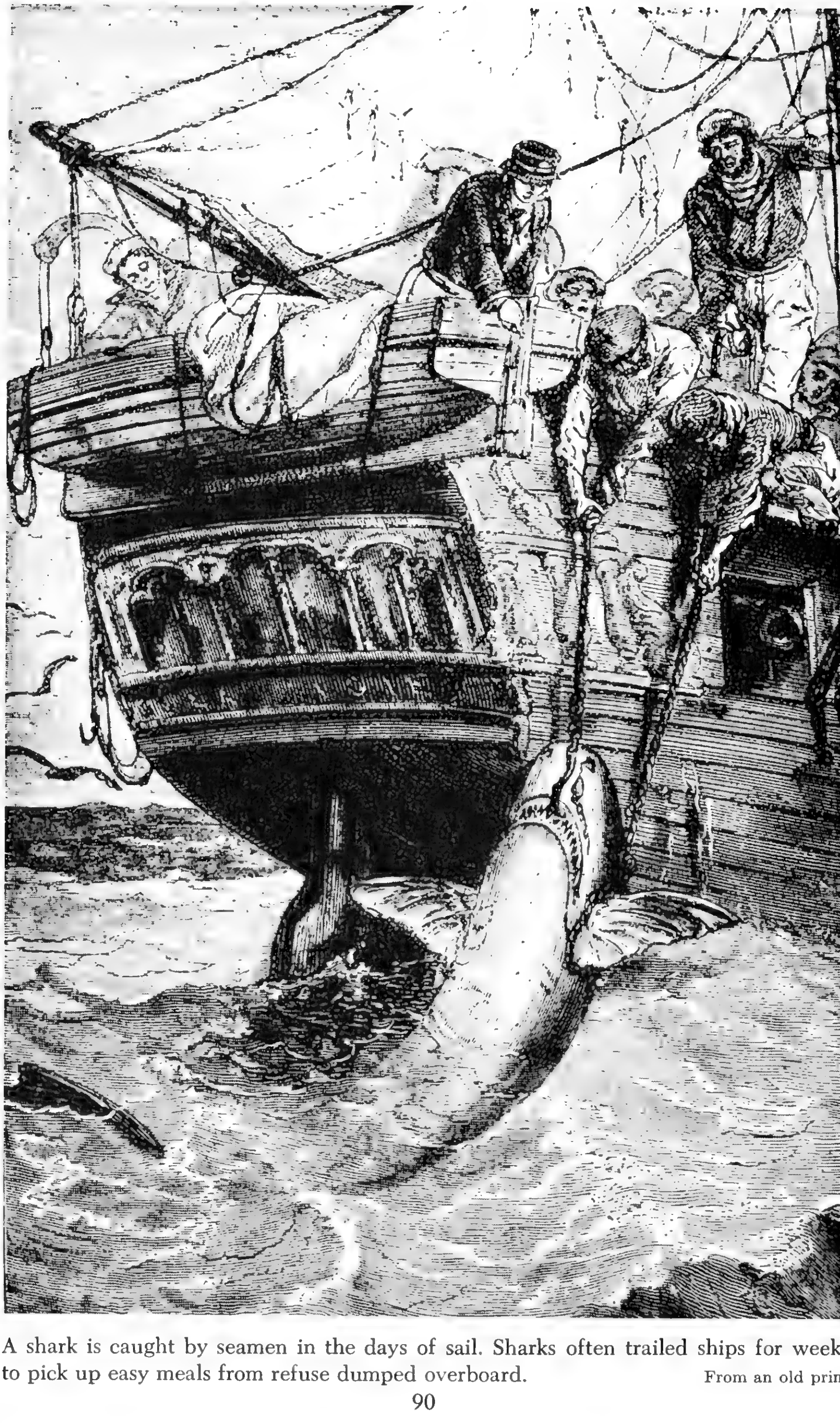
One distant, unchronicled day in some prehistoric sea, man and shark met—and, incredibly, man triumphed. Since that epic day, men have been seeking the shark; and, not merely for food, for there have always been drab and feckless fish enough for food. Men have hunted down the shark for the matchless sport and keen-edged danger.

We can today envision some of the early duels between shark and man in the Pacific. We have artifacts that have survived the participants; we hear the ageless tales that have been handed down from generation to generation of native fishermen in Japan, the East Indies, Polynesia, and Micronesia; and we can see the curious vestiges of ancient shark fishing still found today in the islands of the Pacific.

One of the oldest devices for catching sharks in Micronesia is the shark snare, which has been used for centuries. The snare is a coarse rope of plant fibers, made into a noose. The noose is dropped in the sea from a canoe. The fisherman attracts sharks to the area by swinging a rattle—usually hollowed-out coconut shells or large sea shells threaded onto a stick. Small fishes or bits of meat are swirled in the water to further attract the shark, once the rattles have brought it near. Slowly, with infinite patience, the fisherman lures the shark's head into the noose. Suddenly, the noose is drawn tight, snaring the shark just behind the gill slits. Then, as the shark struggles in the noose, it is clubbed to death. The Maoris of New Zealand are said to have favored the noose method because they treasured the center tooth of the "*mako*" (*Isurus* sp.)[1] as an ear ornament. The tooth might have been damaged if a hook were used.

Some snare fishermen found that their hands were the most dependable bait for sharks. While one occupant of a canoe trailed his hand along in the water, another man dropped a noose aft of the enticing hand. The shark swam into the noose in pursuit of the hand. Then, when the shark's body was well into the noose and the jaws near the hand, the noose was tightened and the man withdrew his hand. The hand had to be gently, slowly swished in the water. If the hand moved

[1] The name Mako is of Maori origin and applies in their language to this shark specifically. We have adopted it (in English) for the genus.



A shark is caught by seamen in the days of sail. Sharks often trailed ships for weeks to pick up easy meals from refuse dumped overboard. From an old print slowly, so did the shark. If an unwary "baitsman" jerked his hand or made a sudden movement, the shark would strike—and snatch off the hand.

Some snares have a kind of float, a propeller-shaped block of wood whose upcurving ends resemble the hull of a boat. This block is decorated with ornamental carvings or paintings whose patterns are derived from some dimly remembered rituals involving fishing magic. For the hunting of the shark has long been involved in magic and religion. The mixture of sharks and sorcery is complex, and neighboring islands sometimes show vastly different attitudes toward the shark. In the Tabar Islands of the Bismarck Archipelago off New Guinea, sharks are caught, but in the nearby Tanga Islands there is a long-standing taboo against the hunting of the shark, which is believed to be a dangerous wizard. There are reasonable grounds for this superstition, because snared sharks have frequently towed away their would-be captors' canoes and neither canoes nor canoeists were ever seen again.

A dangerous variation of the snare was developed by some unsung primitive Pacific island fishermen. They would dive from a canoe to caverns in the reefs, where sharks sometimes rested with their heads in crevices and their tails sticking out. The diver would loop a noose around the shark's tail and signal, by tugging on the rope, to his confederates in the canoe. The startled shark would be hauled to the surface, tail first, and clubbed to death. This technique is still used by some natives in Papua and New Guinea. They also believe in the use of shark rattles—as does, oddly enough, A. M. Rapson, the Chief of the Division of Fisheries there. One theory is that the rattle sounds, to a hungry shark at least, like the excited cries of sea birds feeding upon a shoal of small fish, and the shark rushes to share in the feast. Native divers on Thursday Island, Australia, are afraid to go after crawfish (Spiny lobsters) in deep water because of another phenomenon of sound. The natives say the crawfish make a snapping noise with their tails when anyone tries to catch them—and this sound lures sharks like an underwater dinner bell.

There is some evidence to suggest that crude hooks preceded the snare as an implement for catching sharks. Hooks made from human bones were common, and, in old Hawaii, a chief might will his bones to friends or personal servants so that they could fashion hooks from them. In some areas, the bones of great fishermen or brave chiefs were particularly prized for hook-making. The hooks were made by drilling a series of holes along a line following the desired curve. This weakened portion was knocked out and the remainder was smoothed down.

Other hooks were made of wood. A twig of a young ironwood tree was bent so that it curved back on itself. It was lashed in this position for a year or two, until it was more than half an inch thick. Then the

These primitive shark hooks from Tahiti and Hawaii were formed by lashing a young twig into a curved position, allowing it to grow the hook-curve permanently, then hacking the hook portion off the living tree. The point on the shark hook at the right is bone—possibly human bone, a favorite with ancient fishermen of the South Seas.

Courtesy, Almqvist & Wiksells Boktrycheri Ab from *Contribution to the History of Fishing in the Southern Seas* by Bengt Anell, 1955

portion of the twig bearing the natural curve was hacked off the tree and fashioned into a hook. Sometimes a point of sharpened bone was lashed to the end of the hook. The hooks were baited with small fish, or even a piece of white tree bark, lashed to a fiber-strand rope, and usually trolled from a canoe.

In New Zealand, among the Maori, shark fishing was once a religious ceremony supervised by a priest who stood atop a rock on shore and directed as many as a thousand men who set out to sea in big canoes on two specified days of the year. They hunted, on these appointed days, only one kind of shark—*kapeta*, apparently a species of dogfish. Other species of sharks could be caught any time.

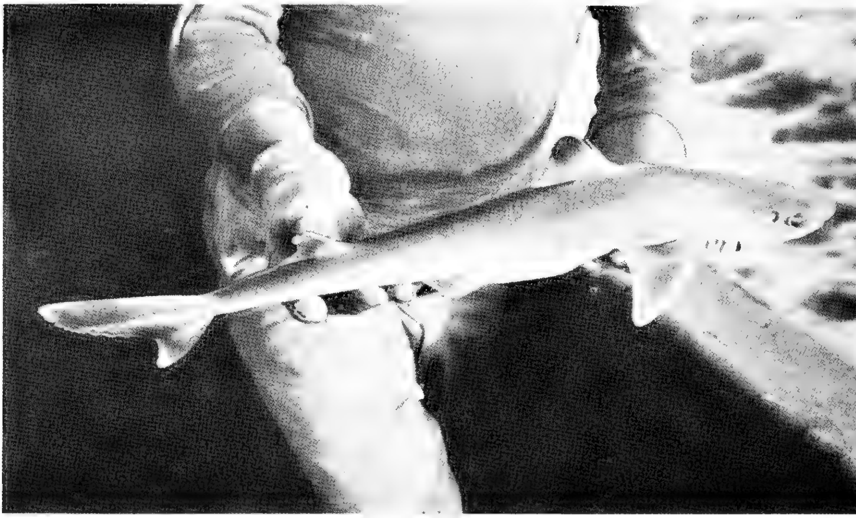
In 1961, in the apparently civilized precincts of Lauderdale-by-the-Sea, Florida, there was a taboo on shark fishing. The taboo was inspired not by black magic, but by the even more potent talisman of the tourist's dollar. Fishing for sharks, barracuda, or sting rays in the territorial waters of Lauderdale-by-the-Sea was forbidden in 1961 because, in the words of Mayor G. H. Colnot, "the sight of them being caught frightens tourists and makes them believe our waters are infested with dangerous fish." The fact is that Florida waters *are* full of sharks. In one 6-month period, a shark-fishing club in Palm Beach, Florida, caught 21 sharks, averaging 318 pounds, right off the pier, near the world-famous bathing beach.

For years a Florida shark-fishing enthusiast has been pulling in sharks every Sunday by casting for them from Boynton Beach. The surf-casting sharker is Herb Goodman, a 5 foot–6 inch, 135-pounder who habitually catches sharks three or four times his own weight. Goodman fishes exclusively for shark, using a unique method. He attaches balloons to three big, baited 10/0 hooks, which are strung on a 130-pound test line. The balloons act as floats, carrying the hooks 1,000 feet out to sea on the swift-flowing currents of Boynton Beach Inlet. The hooks are baited with about 6 pounds of bonito, kingfish, or dolphin. When a shark strikes, Goodman works it in on a 9-foot glass rod, and the fight the shark puts up usually draws a crowd. Once, deciding to give the crowd a thrill, he decided to ride a 10-foot Hammerhead he had hooked and reeled in close to the beach.

"I passed my rod and reel to someone else," Goodman recounted, "and climbed on the shark's back. A sudden swell tipped both me and the shark, and when he tried to right himself, he swished his tail and caught me across both my legs. My legs were covered with bandages for almost two weeks."

That was the last time Goodman tried to ride a shark.

Another unorthodox shark fisherman who hauled in sharks to the consternation of bathers was U.S. Marine Sergeant Richard C. Lawrence. His hunting grounds were the waters off Fort Weaver, Hawaii. Lawrence's fishing line consisted of an inner tube lashed to a piling on the Fort Weaver pier and attached to a 150-foot length of quarter-inch manila rope. Secured to the other end of the rope were 3 feet of ½-inch chain and a 4-inch shark hook. He threw the baited hook about 20 feet off the pier and just waited. Soon a shark grabbed the bait and tried to dislodge the hook by pulling on the line. The inner tube—and Sergeant



A fisherman holds a small Spiny dogfish (*Squalus cubensis*) caught in the Gulf of Mexico. Dogfish of similar species are found throughout the world, often in fantastic abundance. Tagging experiments have shown that some species travel at a rate of 3 to 8 miles a day. One tagged specimen migrated from St. John's, Newfoundland, to Massachusetts, a distance of at least 1,000 miles, in 132 days.

Courtesy, U.S. Fish and Wildlife Service

Lawrence—fought the shark. Lawrence has caught some 40 sharks, including a 1,950-pound, 17-foot Tiger, with his inner tube tackle.

Sharks are hauled out of the surf at Long Island, New York, often before bathers' frightened eyes. Using conventional surf rods and reels, spooled with 220 yards of 45-pound test line, a surfcaster can reel in 100- and 200-pound sharks, and occasionally 150-pound Sting rays, not far from one of America's biggest bathing spots, Jones Beach. Eel is a favorite bait of the Long Island surfcasters.

Sharks are both liked and disliked in the waters around Long Island. Sports fishing parties, seeking game fish, are often plagued by packs of Dogfish which flock around the boats, snapping at bait and driving off game fish. Bigger sharks also rob fishermen of hard-won fish. It is not unusual for a Mako to snap 40-pound stripers right off a man's hook. A knowledgable angler in shark-prowled waters will release the drag and let a fish run if a shark of any kind is seen after a game fish is hooked—and before the fisherman strikes it. A hooked fish can, sometimes at least, outrun a shark that is pursuing it, and eventually, the game fish can be struck and reeled in.

The game fisherman who ignores the shark as a game fish is passing up some of the best fighters—and most abundant big fish—in the sea. On the West Coast, sports clubs have been fishing sharks for years. One favorite spot is Monterey Bay, California, about 60 miles south of San Francisco. There, twice a year, shark derbies are held. Fishing begins at 7 A.M. and continues until 1 P.M. In those 6 hours, in a typical derby, fishermen will reel in about 150 sharks and rays whose total weight will be around 2,000 pounds.

Sharks often come big—so big that they cannot be weighed on ordinary scales. Their size has to be figured out mathematically, by the formula given on page 314. And sharks are fast. The Great Blue is said to be able to reach speeds up to 20 miles an hour. A shark of unknown species was once speared by an underwater spear-fisherman off Cape Cod. A pursuing boat eventually overtook both the exhausted spear-fisherman and his apparently tireless quarry. The boat clocked the shark—and its human caboose—at 14 knots.

One of the biggest sharks ever taken by a spear-fisherman was a 1,400-pound Basking shark caught in 1955. About 25 yards off Santa Monica, the spear-fisherman, Bob Lorenz, spotted the huge shark. Lorenz was armed with a gun that shot steel darts with cables attached.

"I got a good shot in, just ahead of the dorsal fin," Lorenz said. "The shark headed for the open sea, and sounded in about 10 feet of water. I followed the line down and hit him again, but it wasn't a good shot. His lashing tail stirred up the sand so that it was hard to see. The dart hit just forward of the tail."

Lorenz continued the battle in his boat, a 30-foot cruiser. The cables were made fast to the boat, and the fish towed it for 90 minutes until Lorenz and three other men managed to pull it in and lash it to the side of the boat. It measured 13 feet, 9 inches.

Neither the Basking shark nor the Whale shark is a game fish, but their sheer enormousness attracts fishermen interested in landing something larger than anyone else has ever landed. Native fishermen in the Persian Gulf say they catch the Whale shark by rowing alongside its lazily moving hulk and then boarding it. A fisherman walks down to the torpid shark's mouth, stuffs a big iron hook into it, and then reboards the boat, which tows the shark ashore.

Still, the Whale shark can give a ponderous battle, not between the sports fisherman and itself, but between itself and the fisherman's boat. One day, during the annual Bimini Marlin Tournament in the Bahamas off Miami, a 45-foot cruiser, the *Alberta*, was searching for marlin. The biggest tackle aboard was a light rod spooled with 9-thread line. But when the skipper, Captain Johnny Cass, spotted the hulk of a Whale shark, he decided to try for it.

Another boat had got a flying gaff into the 37-foot fish, but the gaff had hardly slowed it down. When the *Alberta* hove to, the skipper of the other boat told Cass he was welcome to try his hand at the shark.

Cass decided not to use the 9-thread line. He chose instead a 1¼-inch line, a length of chain, and a grapnel. When the *Alberta* was directly above the huge shark, the grapnel and chain were lowered under its jaw, then jerked upward, so that the grapnel hooked into its neck. The shark thrashed, snapping the line that reached from the gaff to the other boat. But the *Alberta*'s line held. Cass played the fish for about 3 hours—a 19-ton cruiser against a 10-ton shark. The shark was relatively lethargic, but each twitch of its great body shivered the *Alberta.*

Two men were sent out in a small boat to make fast two heavy lines around the shark's tail. They managed to do it, though once their small boat was nearly swamped by a casual flip of the tail. Now secured, the shark was towed to Bimini, a 3½-hour trip, during which the shark cumbersomely struggled against the fetter of the lines.

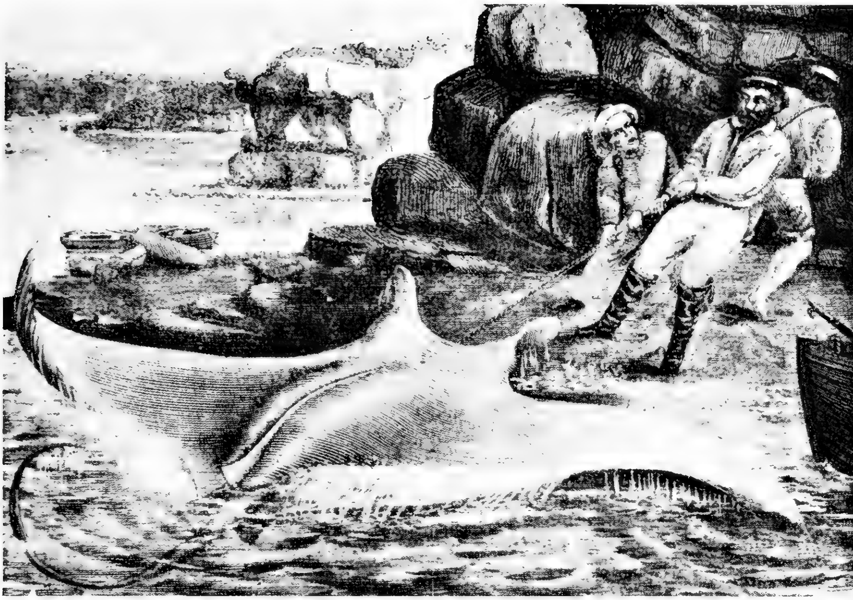
Cass made it to port, and with the shark he brought in an unusual record for a boat whose orthodox fishing tackle consisted of a 9-thread line and a light rod. Cass's record: the largest Whale shark ever caught without the aid of gunfire, harpoons, or a platoon of helpers.

Another skipper who tangled with a Whale shark of about the same 10-ton size was Captain J. B. Mathews of the *Captain Bae Strickland.* Off St. Petersburg, Florida, Mathews sighted a Whale shark. After snaring the shark by snagging a hook in its jaw, Mathews added a new twist. He had double-spliced 500 feet of ⅝-inch manila line into the anchor cable of his 65-foot boat. He attached the line to the steel leader on the hook in the shark's jaw. Then, using the anchor windlass as a gigantic reel, he tried to play the shark. The shark would not play, however. It headed off with the power of a locomotive, and towed the *Bae Strickland* for 18 miles, and then, with one burst of energy, it parted the line and kept going without looking back.

Hooking into a Whale shark is not a guarantee of a thrilling ride or several hours of a mighty tug-of-war. The Whale shark's inertia is often as massive as its bulk. For some reason, however, stories of exciting Whale shark encounters have a way of becoming more widely told than the dull ones.

Zane Grey, for instance, once hooked a Whale shark off the tip of the peninsula of Lower California. He snagged its tail with a gaff hook. Grey later vividly described how the Whale shark tried for 5 hours to fight off capture, towing Grey's boat for miles. Finally, it plunged into the depths, running off some 1,600 feet of line before it tore out the hook. During the chase, or rather, the tow, harpoons were hurled at the shark. Grey said they bounded off the shark's thick hide or bent under the pressure exerted by harpooners trying to thrust them into the shark.

Writing about effortless captures of Whale sharks and their "entirely inoffensive . . . sluggish" habits, E. W. Gudger, the outstanding au-



This old print portrays fishermen landing the first Devil ray caught off Sydney, Australia, in 1868. Dr. Whitley identifies it as *Daemomanta alfredi* Krefft, 1868. He reports that it grows to a width of at least 13 feet.

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

thority on the Whale shark, drily remarked, "Mr. Grey's fish seemingly was the most active of any of which we have accounts."

It must be said for Zane Grey, however, that he did go after real fighting sharks. And he probably did more to establish the shark as a game fish than any other angler. Like the 4-minute mile and the 7-foot high jump, the 1,000-pound shark stood for years as a seemingly unattainable goal for game fishermen. Gradually, as tackle and fishing techniques improved, the records went higher and higher: 800 pounds . . . 900 pounds. Then, on March 11, 1936, a 996½-pound Tiger shark was caught off Australia. The record stood but a month, for Zane Grey had arrived in Australia determined to land a 1,000-pound shark. He got one—a 1,036-pound Tiger shark.

Since then, the records have been tumbling regularly, especially in Australian waters. One Australian shark fisherman extraordinary, Alf Dean, has caught the four largest fish ever taken on rod and reel—each a Great White and each weighing more than a ton.

Dean, a genial, burly man who runs a small vineyard when he isn't shark fishing, caught his first shark in 1939. It weighed 868 pounds. In the years that followed, Dean's prowess as a shark fisherman increased, and so did the weight of his sharks. His fishing ground has been the

Great Australian Bight, that huge, crescent-shaped curve along the southern coast of the continent. Great schools of fish sweep through the Bight, and, savagely competing for food among them, are innumerable sharks, including some of the largest found in any sea on earth.

In 1951, Sir Willoughby Norrie, governor of South Australia, caught a 2,225-pound Great White shark, at that time the largest fish ever landed with rod and reel. Dean was determined to beat Norrie's record, and, in 1952, he did.

Dean's encounter with his first record shark began at 2 o'clock one morning when his hired boat was riding at anchor in the Bight after a futile, all-day search for sharks big enough for Dean's taste. A banging on the hull of the boat awakened him; he rolled out of his bunk with a flashlight, went on deck, and in the flashlight's beam caught the dorsal and tail fins of the biggest shark he had ever seen. The shark was violently nuzzling the boat, intoxicated by the scent of whale oil dripping from a tank in the stern. (Using whale oil, and an occasional bucketful of steer's blood, Dean lays down an alluring, provocative slick that sharks pick up miles away. They trail his boat, ravenous for the food promised by the savory scent of the wake.)

All night long the great shark banged noisily against the side of Dean's boat. The maddening scent of food so excited the shark that once it grappled the propeller and shook the boat, as if to awaken the occupants to get the meal it yearned for. Soon after dawn, Dean dropped his line off the stern, and the shark took it, racing off 250 yards. The shark writhed and rolled. Once it leaped almost fully out of the water. But, by fighting on the surface instead of sounding, the shark soon tired. It was all over in about 45 minutes. The shark, a Great White, weighed 2,333 pounds and was 16 feet long. The world's record belonged to Alf Dean! Less than a year later, he topped his own record by landing a 2,372-pound Great White.

On April 10th, 1955, Dean caught a 1,600-pound shark, lashed it to the side of the boat, and went off looking for something more worth while. Suddenly, a huge shark began to attack the captured 1,600-pounder. Oblivious to Dean, who clouted it with the handle of a gaff, it kept ripping big chunks out of the dead shark. Finally, the mate aboard the boat threw a set of baited hooks to it. The shark lunged for the line, but somehow managed to hook itself in the tail. Dean fought to land the shark, tail-hooked or not. It was impossible. He cut the line. Again, a set of hooks was cast out, and the shark grabbed for the bait, this time hooking itself in the mouth. Dean struggled for half an hour to set the hooks. They tore out, and the shark disappeared.

The boat had gone about a mile from the spot where the shark first struck. Dean decided to head back to the spot and anchor. As soon as the boat anchored, the same shark—the cut line still hooked in its tail—reappeared. Dean tried again, and this time, after a fight of an hour and a half, he landed the persistent shark. It weighed 2,536 pounds. Dean had once more broken his own record.

Dean broke his world record a fourth time, in 1959, when he landed a 2,664-pounder. But Dean's biggest fish, like the biggest fish of all fishermen, was the one that got away.

In Australia they call Alf Dean's biggest fish Barnacle Lil, for she is a female and she has broken the heart of many a shark fisherman. Dean met her one moonlit night in the Bight when she banged his boat and tore off a seal carcass, a *pièce de résistance* Dean often hangs over the stern of his boat to lure sharks that follow his piquant wake. He got a look at her as she lingered near the surface a few yards from the boat, munching on the seal. He looked her over avidly and estimated her measurements: more than 20 feet long and at least 4,000 pounds.

He lowered a new seal lure over the side. Near it he dropped his line, baited with his favorite shark bait, seal liver, skewered on two great hooks. Barnacle Lil charged for the hooks, the lure, the liver—everything, including part of the boat's transom. Through the spray churned up by her explosive lunge, Dean could see that she had the hooks in her mouth. He put his reel in gear and set the hooks. Time after time, she fought the hooks by rocketing to the surface, lifting her huge, graceful white body nearly out of the sea. Then she settled down, pitting her 4,000 pounds of controlled fury against Dean's straining arms and ever-taut line. For two solid hours she fought. Then, slowly, foot by foot, turn by turn, he began reeling her in.

He got her to the side of the boat. A crewman reached his gloved hands down to the wire leader attached to the end of the line. (Under game fishing rules, in order to claim a record, the fisherman cannot be aided until he brings his fish to gaff. At that time, another person can grasp the leader, but not the line. During a fight, no part of the fishing tackle may be touched by anyone except the fisherman.) But Barnacle Lil was not through. She suddenly found new strength and whirled seaward again, tearing the leader out of the boatman's hands. "Twenty men could not have held it," Dean later reported.

Dean's hands were turning to mush. Blisters erupted and broke on his palms. His fingers, chafed raw by the constantly bobbing rod, were stiff with pain. His legs were knotted with cramps. The aching muscles in his back and arms seemed ready to burst. And the fight went on. One hour . . . Two hours . . . Three times Dean brought the shark to the boat. Three times the glistening leader cleared the water, and three times Barnacle Lil dashed out to sea with new strength!

As the fight went into its fifth hour, Dean was seized by a new torment, stomach cramps. Still in the bolted-down tractor seat he used for his fishing chair and still fighting the shark, he relieved the cramps somewhat by urinating in a can, a feat he never could figure out how he performed.

After five and a half hours, Dean knew he could hold out no longer. But some tremor in the line, some mysterious signal he felt almost intuitively, told him that Barnacle Lil was tiring. Once more, with aching hands, he began to reel in. He got her to the boat, and the boatman began pulling up the leader. About 10 feet of the 30-foot leader were in the boat when Barnacle Lil made her last, wild try for freedom. She dove, straight down. The leader, snagged on the boat's pipe railing, followed the shark down and, in a flash, tore out 7 feet of railing, then snapped. The indomitable Barnacle Lil was free.

Several big-game fishermen had sighted and pursued her before Dean had his frustrating affair with her; others have since given chase, but she has not yet been vanquished.

There are many stories of sharks spoiling world's record catches of other game fish by gnawing on the carcass as the proud fisherman sails home with his prize attached to his boat. By the time the fish is strung up to be officially weighed, it has lost several pounds. Often this loss to ravening sharks has been enough to make a chewed-up also-ran out of a record-breaking fish. The most poignant story of a shark's theft of a record is told by Dolly Dyer, of Australia, undisputed champion woman shark fisherman. Mrs. Dyer and her husband Robert, between them, currently hold 16 world shark-catching records, attested by the International Game Fish Association.

Mrs. Dyer landed a promising-looking Tiger shark a few years ago. To her expert eye, it looked to be at least 1,400 pounds. And it was there, right alongside the boat. Sharks did come to gnaw on it, but she successfully warded them off by personally clouting them on the snout with a gaff handle. She lost no precious poundage to them. A pinnacle record—the largest Tiger then ever taken by rod and reel by man or woman—seemed to be hers as her boat reached the dock. But, shortly before the dying Tiger was to be weighed to establish the record, it played a dirty trick on her. It gave birth to 40 pups. The loss of her progeny transformed the mother Tiger into an ordinary, non-record-breaking shark.

Australia is not the only place on earth where record-making sharks are caught. Seventeen current shark records were achieved in the waters off Montauk, Long Island. Blue, Porbeagle, and Mako sharks abound there, and many of them are potential record-breakers.

Long Island's shark fishermen say that the best times for catching the monsters are the days—and nights—around the full of the moon.

After finding a place where bait-fish, such as whiting or porgies, are abundant, and the water 50 to 150 feet deep, they chum. Whalemeat is the favorite chum of Frank Mundus, Montauk's most famous and successful shark-fishing charter-boat captain. He also recommends using small, live fish for bait. On calm days, his advice is to fish close to the surface, using cork floats. When the sea is choppy, he suggests fishing about halfway down.

Mundus tries to make shark fishing as sporting as possible by urging his patrons to fight their sharks standing up, in a belt harness, rather than in a fighting chair. He also prefers that they use nothing heavier than 45-pound test line. For real sport, his customers sometimes use 30- or 20-pound test line. The Mundus-preferred tackle is a heavy-duty star drag reel and a glass rod. Aboard Mundus' "monster-fishing" boat, *Cricket II*, fishermen have also been known to use crossbows and arrows on sharks.

"Of all the game fish in the sea, none—when fighting the hook and line—can outjump the Mako shark," one of Mundus' passengers ecstatically reported, telling how a Mako (*Isurus oxyrinchus*) ran out 100 yards of line from Mundus' boat, then made four successive vertical leaps 10 to 15 feet out of the water. It is fight such as this that has given the Mako a reputation as one of the gamest fish in the sea.

"The Mako shark, which can jump as high as any fish, run faster than most, and pull as hard as any, seems to me to be a true fighter," Ernest Hemingway wrote of this aggressive shark. "He will deliberately leap at a man in a dory who has hooked him on a handline . . . I have seen a Mako, after being clubbed and tied up, come out of the effect of his clubbing and wait quietly until someone would come within range of his jaws."

The Mako shark of the western Atlantic is a very close relative of the Blue Pointer (*Isurus glaucus*) of the Indian and the Pacific Oceans, which is also sometimes called a Mako. The Blue Pointer, in turn, is a name given by some South African fishermen to the shark elsewhere known as the Great White, called in Australia the White Death or White Pointer. The mix-up in nomenclature stems from confusion over the word *mako*, which originally was a Maori word for a certain kind of shark. Out of all this confusion, one thing is certain: the Blue Pointer of South Africa, by any name, is a fighter. And the pursuit of it has produced some of the most exciting battles in the annals of shark fishing.

The scene of these battles is the South Pier of Durban, which stretches out from the beach for about 700 yards. The pier, made of great concrete blocks, is about 40 feet wide. More blocks have been dumped, helter-skelter, along both sides of the pier and around its tip. They are covered with seaweed and barnacles and provide a precarious perch for fishermen. When he hooks a shark, a fisherman must simultaneously fight the shark and fight to keep from falling into the sea. Then, to beach the shark, he must stumble along the blocks, working his way back the length of the pier to shore. A misstep can send him plunging into a maelstrom of swift currents and voracious sharks, lured to Durban harbor by the scent of whale carcasses towed into port by whaling ships.

Brian Bernstein, a veteran fisherman at the age of 15, may serve as an example. At the age of 7, Brian caught his first fish, a 15-pound salmon. At the age of eleven, he caught his first shark, a 20-pound Hammerhead pup. By the time he was 14, he had caught several little Hammerheads, some Small Black-Tipped sharks (called Gray sharks in Durban) and a few Milksharks (*Scoliodon walbeehmi*), which never grow to more than 4 feet. One of his Gray sharks was a 444-pounder, a respectable size, especially considering that Brian weighed 140 pounds himself.

The Blue Pointer of Durban harbor is a match for any fisherman. It is a ferocious fighter and, though its Durban alias masks its man-killing notoriety, it is indeed the dread *Carcharodon carcharias*—the Man-eater, the White Death, the Killer. Brian's first Blue Pointer was a 430-pounder, which, by the standards of the South Pier shark *aficionados*, is a small one. It had not given Brian a great fight—again, by South Pier standards. But, in a patronizing sort of way, he was welcomed, at 15, into the informal fraternity of Blue Pointer hunters.

A few days after he caught his first Blue Pointer, Brian was out on the seaward corner of the South Pier again. At 9:30 a.m., a shark took his bait and streaked 500 yards seaward. Only 200 yards of line, strained to the breaking point, remained on the lad's burning reel. He succeeded in preventing the shark from ripping out the rest of the line. But the battle was far from over. It took six hours of fighting to land that 764-pound shark (another Blue Pointer), and, before the duel ended, Brian had used every trick known on the South Pier. He had run up and down the pier, struggling to keep the shark from running out to sea. He had "winched"—that is, he squatted down, crooked his right leg around the butt of his rod, and rested the rod on his left leg. Then, with both hands, he arduously turned the reel. At one point in the battle, the boy had even shouldered his rod like a rifle, turned his back to the water, and dragged against the shark, as a plowhorse strains against the plow. This is *real* shark fishing.

No shark hooked off the South Pier is an easy catch. Every battle is exciting and unpredictable, for inevitably the angler must clamber over rocks and struggle along the pier to land his shark. Under the code of the pier, no one may aid him—unless, which is unthinkable, he asks for help—until the wire leader is near enough to grasp. It is also considered cricket to muster help for getting a rope around the shark and hauling it up to the pier. These post-battle tasks are not always easy.

One day, Peter Botha was out at the end of the pier when another fisherman caught an 800-pounder, which was technically landed, except for the fact that it was lodged in some rocks a few feet off the pier. Botha jumped out on the rocks, one hand holding onto the wire leader, the other grasping a gaff. He leaped atop a small rock and, just as he lunged to gaff the shark, a wave smashed over his perch and hurled him into the sea, directly in front of the jaws of the thrashing shark. Luckily, Botha had not lost his handhold on the leader. Hand over hand, he pulled himself along the leader and got back on the rocks.

A year after this incident, Botha found out what can happen to a person who strays near the jaws of a killer shark. He caught a 600-pounder and cut it open. In its belly he found the head, right arm, and part of the backbone of a man.

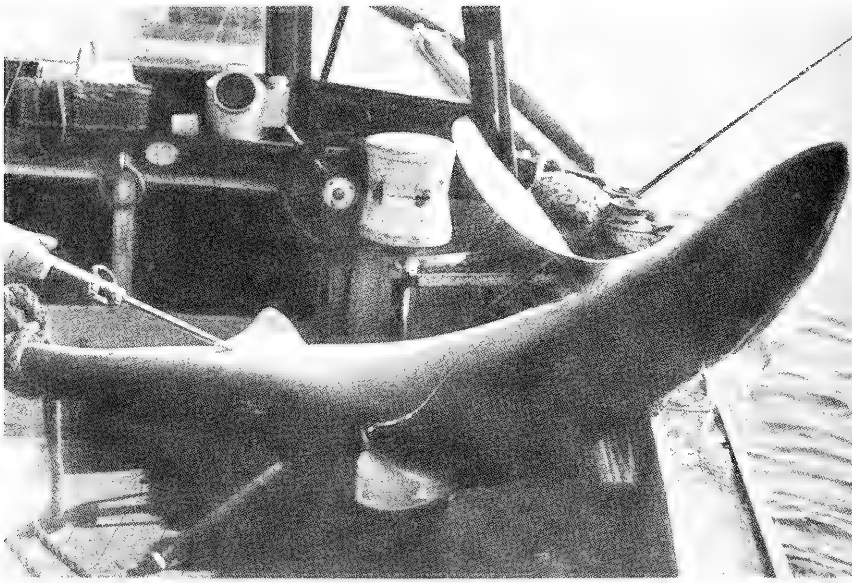
Colonel Hugh D. Wise, who long and avidly fished for several species of sharks along the Atlantic coast of the United States, says some sharks were fast, some struck savagely and then ran, and some were just plain mulish. All, however, exerted formidable pulls on the line. Curious about the force of these pulls, Wise set up a novel experiment to determine how hard a shark pulls. From his boat, he hooked some sharks on a thick rope that was threaded through a spring scale held by two men in the boat. Wise found that a 230-pound Sand shark 8½ feet long could exert a 110-pound pull—about .48 of a pound of pull for each pound of its weight. When the shark tired, the pulls dropped drastically to feeble surges averaging a mere 18 pounds. Wise reported that sharks use their maximum strength sparingly, and rest frequently from their exertions.

"It is interesting to consider this in comparison with the wild and almost continuous fury of the swordfish," Wise noted,[2] "but also let it be remembered that it is this intermittent resting which adds to the difficulty of conquering the shark."

The Sawfish and six species of shark—Blue, Mako, Great White, Porbeagle, Thresher, and Tiger—are recognized as game fish by the International Game Fish Association, which sternly authenticates world game-fish records. Anglers are beginning to recognize sharks too. Fishing clubs devoted exclusively to shark-catching have been attracting anglers from Florida to New Zealand.

Members of the Shark Angling Club of Great Britain, who fish the sharky waters off Looe in Cornwall, have been reeling in more than

[2] Hugh D. Wise, *Tigers of the Sea* (New York: Derrydale Press, 1937).



A Great Blue shark (*Prionace glauca*) is hauled aboard the boat *Paula* off Looe, Cornwall, England. Thousands of sharks—mostly Great Blues—are caught off Looe each year by members of the Shark Angling Club of Great Britain.

Courtesy, *The Field Magazine*

5,000 sharks—mostly Makos and Great Blues—a year. One Looe sharker in a single day landed 44 Great Blues, whose total weight topped a ton. A champion Looe fisherwoman, Mrs. Hetty Eathorne (weight 108 pounds) has caught a record Great Blue (1,671 pounds). She never wears a harness. "I fish only for sport," she says, "and this way it gives the shark a better chance."

A shark fisherman never knows what he is going to haul in when he hooks a shark. Dr. C. T. Newnham, regional medical officer for the Western Region of the British Transport Commission, for instance, was presented with a maternity case when he landed a shark off Looe.

"It was noticed on landing that she was 'fat-bellied' [a term used by local fishermen] and also that there was a healing gaff wound towards the tail," Dr. Newnham reports in his account of what he calls a case, not a catch. "Apart from these two observations, there was nothing particularly unusual about the captive. As is customary, the shark was killed by hitting it several times on the head with a truncheon carried for this purpose, and then, when movements ceased, the hook and trace were cut out and the body put under the floorboards of the well of the deck. In an attempt to rid itself of the hook, the shark had obviously tried to vomit, as, when caught, the everted stomach was protruding from the jaws. (This is not an uncommon thing to happen.)"

Dogs confront a shark which is being brought aboard H.M.S. *Challenger,* the converted British man-of-war which logged 68,350 miles in an epic oceanographic voyage that began in 1872 and lasted three and a half years. From an old print

When the boat started heading home for Looe, the seemingly dead shark was removed from under the floorboards to be washed down. The man who washed the shark noticed that something was emerging from her, and the call went out for Dr. Newnham.

"Within a very short space of time," the doctor noted in his clinical report on the case, "the tail of the first baby shark presented itself. This was rapidly followed by a further four babies and two spherical bright yellow objects which were enclosed in loose folds of membrane and which were taken to be placentae. . . .

"Each of the first five baby sharks born was alive and made swimming movements in the fluid which was escaping from the mother and which had changed in appearance and become far less viscous and clear. Palpation of the abdomen suggested that there were more to come and, by exerting slight pressure, a further six or seven babies were born. It was noticed with interest that each one arrived tail first. During the course of a few minutes the remainder of the babies—there were 22 in all—were born, and at no time was any movement of the mother noted, nor was there any contraction of the abdominal muscles or waves of uterine contraction, such as seen in a human."

As the ship entered port, two yellow pennants flew from her mast, the customary sign that two sharks had been caught. And fluttering beneath the pennants was a string of tiny flags made of rags and brown paper. By the time the ship reached Looe, all the sharks were dead.

Dr. Newnham concludes the report on his case with this note: "On arrival in Looe harbour the usual ceremony of weighing and photographing was gone through and the mother was found to weigh 100 pounds exactly and the 22 babies, six and three-quarter pounds. Whilst the mother was suspended by a hook in the lower jaw during the weighing, another baby shark fell out. But this was dead on arrival. It was subsequently learned that a post-mortem examination had revealed two further dead babies, but the author was not present at this examination because the interests of science were forgotten in the celebration of this interesting adventure."

An angler who returns from a shark fishing trip may not always bring back a fish story as good as Dr. Newnham's. The chances are good, though, that even the shore-hugging fisherman who seeks sharks will not have much trouble finding them. There are plenty of sharks near shore, and a fisherman needs only a small boat, an outboard motor, and savvy to get them. (One such American spot is the Delaware Bay: 300-pound Sand sharks have been reeled in there by fishermen in 14-foot boats.)

Along the entire coastline of the continental United States, and in the waters of Hawaii and Alaska, there are sharks waiting to be caught by fishermen with strong arms, strong backs—and great expectations of the unexpected.

SHARK CATCH RECORDS

Sharks of truly monstrous weight, length, and girth have been harpooned, trapped in nets, shot or gaffed to death while snared, caught on long-lines, and hauled in by anglers aided by one or more companions. But the sharks listed here have been caught on lines by anglers and sport fishermen.

What follows is the roll of the premier amateur shark fishermen—and fisherwomen—of the world, anglers who have reeled in, without aid, on regulation tackle, and according to the strict protocol of game fishing, sharks of record size.

The records are kept and authenticated by the International Game Fish Association (IGFA), the arbiter of official, world-record catches of all game fishes. The IGFA recognizes the Sawfish (*Pristis pectinatus*) and seven species of sharks as game fishes. Of the 49 types of game fishes listed in the 1961 All-Tackle Records of the IGFA, the only bony fish which comes close to the record sharks in size is the Black Marlin. (The record Black Marlin weighed 1,560 pounds and was 14 feet, 6 inches long. The record shark, a Great White, weighed 2,664 pounds and was 16 feet 10 inches long.)

The shark species recognized by the IGFA, and the common and scientific names under which they are listed in IGFA records are: Blue shark (*Prionace glauca*), Mako shark (*Isurus oxyrhynchus* or *Isurus glaucus*), Man-Eater or White shark (*Carcharodon carcharias*), Porbeagle shark (*Lamna nasus*), Thresher shark (*Alopias vulpinus*), and Tiger shark (*Galeocerdo cuvieri*).

The 1961 shark records as listed by the IGFA follow. They include the All-Tackle Records for both men and women, the All-Tackle Records for women, and records based on line size, the system the IGFA uses in classifying catches according to the tackle used. The women's records in all line-test classes are also listed.

Note: All the following records are based by the IGFA on line tests. All records where the name of the angler is followed by (*) were arbitrarily assigned to their classes on a 3-pound wet test to a thread. No further claims will be accepted by the IGFA unless accompanied by a sample for testing of the actual line used in the catch: 10 yards up to and including the 30-pound class; 30 yards in the 50-pound class and over. Records in the 180-pound class are kept, but not listed, except in All-Tackle Records.

All-Tackle Records

(Both Men and Women)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*	*Line (lb.)*
Blue	410 lb.	11 ft., 6 in.	52 in.	Rockport, Mass.	9/1/60	Richard C. Webster	80
Mako	1,000 lb.	12 ft.		Mayor Island, New Zealand	3/14/43	B. D. H. Ross *	130
Man-Eater	2,664 lb.	16 ft., 10 in.	9 ft., 6 in.	Ceduna, S. Australia	4/21/59	Alfred Dean	130
Porbeagle	366 lb., 8 oz.	8 ft., 4 in.	46 in.	Montauk, N. Y.	6/5/60	D. P. Walker	50
Sawfish	890 lb., 8 oz.	16 ft., 1 in.	92 in.	Fort Amador, Canal Zone	5/26/60	Jack Wagner	80
Thresher	922 lb.			Bay of Islands, New Zealand	3/21/37	W. W. Dowding *	130
Tiger	1,422 lb.	13 ft., 7 in.	95 in.	Cape Moreton, Australia	7/20/58	J. H. Robinson	130

* See p. 107 for explanation.

All-Tackle Records

(Women)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*	*Line (lb.)*
Blue	298 lb.	11 ft., 6 in.	40 in.	Montauk, N. Y.	10/5/59	Valerie Wuestefeld	50
Mako	858 lb.	11 ft., 7 in.	64 in.	Cavalli Island, New Zealand	4/14/51	Mrs. Rita Beaver	130
Man-Eater	1,052 lb.	13 ft., 10 in.	72½ in.	Cape Moreton, Australia	6/27/54	Mrs. Robert Dyer	130
Porbeagle	271 lb.	8 ft., 2 in.	49 in.	Looe, England	8/18/57	Mrs. Hetty Eathorne	130
Thresher	729 lb.	8 ft., 5 in.	61 in.	Mayor Island, New Zealand	6/3/59	Mrs. V. Brown	130
Tiger	1,314 lb.	13 ft., 9 in.	89 in.	Cape Moreton, Australia	7/27/53	Mrs. Robert Dyer	130

12-Pound Line Test Records †
(*Both Men and Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue.	169 lb.	8 ft., 11 in.	36½ in.	Montauk, N. Y.	6/24/59	James F. Baldwin
Mako.	261 lb., 11 oz.	7 ft., 4 in.	44½ in.	Montauk, N. Y.	10/1/53	C. R. Meyer
Man-Eater.	66 lb.	5 ft., 10 in.	28 in.	Acapulco, Mexico	10/26/51	Dr. Phil Corboy
Porbeagle.	66 lb.	4 ft., 10 in.	30 in.	Montauk, N. Y.	6/8/58	M. H. Merrill
Sawfish.	40 lb.	6 ft., 1 in.	33 in.	Islamorada, Fla.	5/6/59	Ernest R. Braun, Jr.
Thresher.	92 lb., 8 oz.	4 ft., 9 in.	31 in.	Long Beach, Calif.	12/12/59	D. F. Marsh

† Up to and including 12 pounds.

12-Pound Line Test Record †
(*Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Mako.	52 lb., 5 oz.	4 ft., 6½ in.	27¼ in.	Montauk, N. Y.	9/11/53	Anne Bowditch

† Only woman's record in 12-Pound Line Test Class.

20-Pound Line Test Records †

(Both Men and Women)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	218 lb., 2 oz.	9 ft., 9 in.	42 in.	Montauk, N. Y.	7/22/55	M. B. Mittleman
Mako	242 lb., 12 oz.	8 ft., 1 in.	44 in.	Montauk, N. Y.	7/12/58	M. B. Mittleman
Man-Eater	1,068 lb.	12 ft., 6 in.	77 in.	Cape Moreton, Australia	6/18/57	Robert Dyer
Porbeagle	180 lb.	8 ft., 7½ in.	37 in.	Block Island, R. I.	8/9/60	Frank K. Smith
Thresher	81 lb., 8 oz.	6 ft., 7 in.	30 in.	Santa Cruz, Calif.	8/2/58	E. G. Volpe
Tiger	341 lb.	10 ft.	55½ in.	Cape Moreton, Australia	7/6/57	Robert Dyer

† Over 12 pounds, up to and including 20 pounds.

20-Pound Line Test Records

(Women)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	204 lb.	9 ft., 9 in.	34 in.	Montauk, N. Y.	8/11/59	Jacqueline Mittleman
Mako	150 lb., 8 oz.	7 ft., 1 in.	37 in.	Montauk, N. Y.	6/29/56	Mrs. M. B. Mittleman
Man-Eater	369 lb.	9 ft., 3 in.	57 in.	Cape Moreton, Australia	7/6/57	Mrs. Robert Dyer

30-POUND LINE TEST RECORDS †
(*Both Men and Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	284 lb., 8 oz.	10 ft., 8 in.	42 in.	Montauk, N. Y.	8/11/59	Jacqueline Mittleman
Mako	322 lb.	9 ft., 1 in.	42 in.	Elberon, N. J.	8/25/52	W. J. Mahan
Man-Eater	1,053 lb.	12 ft., 8 in.	68 in.	Cape Moreton, Australia	6/13/57	Robert Dyer
Thresher	145 lb.	10 ft.	40 in.	Simonstown, S. Africa	4/6/53	R. C. Wack
Tiger	362 lb.	11 ft., 2 in.	52½ in.	Cape Moreton, Australia	7/6/57	Robert Dyer

† Over 20 pounds, up to and including 30 pounds.

30-POUND LINE TEST RECORDS
(*Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	284 lb., 8 oz.	10 ft., 8 in.	42 in.	Montauk, N. Y.	8/11/59	Jacqueline Mittleman
Mako	191 lb.	7 ft., 3 in.	40 in.	Montauk, N. Y.	8/31/58	Mrs. Lee Reichenberg
Man-Eater	803 lb.	12 ft., 5 in.	70 in.	Cape Moreton, Australia	7/5/57	Mrs. Robert Dyer

50-Pound Line Test Records †
(*Both Men and Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue......	334 lb.	10 ft., 9 in.	43 in.	Montauk, N. Y.	8/27/58	Julius Duciewicz
Mako.....	683 lb., 12 oz.	11 ft., 9 in.	4 ft., 9 in.	Montauk, N. Y.	8/10/56	R. P. Alex
Man-Eater.	1,876 lb.	15 ft., 6 in.	101½ in.	Cape Moreton, Australia	8/6/55	Robert Dyer
Porbeagle..	366 lb., 8 oz.	8 ft., 4 in.	46 in.	Montauk, N. Y.	6/5/60	D. P. Walker
Sawfish....	721 lb.	15 ft., 5 in.	71 in.	Fort Amador, Canal Zone	2/6/60	Jack D. Wagner
Thresher ..	338 lb.	12 ft., 8 in.		Port Stephens, Australia	3/2/57	G. Partridge
Tiger......	1,018 lb.	13 ft., 3 in.	68 in.	Cape Moreton, Australia	6/12/57	Robert Dyer

† Over 30 pounds, up to and including 50 pounds.

50-Pound Line Test Records
(*Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue.........	298 lb.	11 ft., 6 in.	40 in.	Montauk, N. Y.	10/5/59	Valerie Wuestefeld
Mako.......	478 lb.	11 ft.	46 in.	Broughton Island, Australia	5/17/57	Mrs. Ron Duncan
Man-Eater...	801 lb.	11 ft., 3 in.	75 in.	Cape Moreton, Australia	6/11/57	Mrs. Robert Dyer
Thresher.....	248 lb.	12 ft., 1 in.	40 in.	Broughton Island, Australia	8/16/56	Mrs. Ron Duncan
Tiger........	458 lb.	10 ft., 7 in.	57 in.	Cape Moreton, Australia	7/3/57	Mrs. Robert Dyer

80-Pound Line Test Records †
(*Both Men and Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	410 lb.	11 ft., 6 in.	52 in.	Rockport, Mass.	9/1/60	Richard C. Webster
Mako	745 lb.	9 ft., 5 in.	6 ft., 2¼ in.	Shinnecock Inlet, N. Y.	10/8/46	H. Hinrichs *
Man-Eater	2,071 lb.	15 ft., 9 in.	98 in.	Cape Donnington, Australia	1/9/52	J. Veitch
Porbeagle	260 lb.	11 ft., 4 in.	68¾ in.	Durban, S. Africa	2/5/49	J. L. Daniel
Sawfish	890 lb., 8 oz.	16 ft., 1 in.	92 in.	Fort Amador, Canal Zone	5/26/60	Jack D. Wagner
Thresher	413 lb.	15 ft.	49½ in.	Bay of Islands, New Zealand	6/28/60	Mrs. E. R. Simmons
Tiger	1,305 lb.	13 ft., 7½ in.	86½ in.	Coogee Wide, Sydney, Australia	5/17/59	Samuel Jamieson

* See p. 107 for explanation. † Over 50 pounds, up to and including 80 pounds.

80-Pound Line Test Records
(*Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue	144 lb., 8 oz.	8 ft., 3 in.	38 in.	Looe, England	7/30/59	Patricia McKim
Mako (**Tie**)	553 lb., 8 oz.	9 ft., 10 in.	68 in.	Cat Cay, Bahamas	3/30/53	Mrs. H. Stringer, Jr.
	554 lb.	10 ft., 1½ in.	65 in.	Montauk, N. Y.	9/1/53	Mrs. R. MacGrotty
Man-Eater	912 lb.	11 ft., 11 in.	71½ in.	Cape Moreton, Australia	8/29/54	Mrs. Robert Dyer
Thresher	413 lb.	15 ft.	49½ in.	Bay of Islands, New Zealand	6/28/60	Mrs. E. R. Simons
Tiger	871 lb.	12 ft., 6 in.	70 in.	Sydney, Australia	3/2/53	Mrs. Robert Dyer

130-Pound Line Test Records †
(*Both Men and Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue..........	258 lb.	10 ft., 1 in.	39½ in.	Block Island, R. I.	8/8/59	Theodore Belling
Mako.........	1,000 lb.	12 ft.		Mayor Island, New Zealand	3/14/43	B. D. H. Ross *
Man-Eater.....	2,664 lb.	16 ft., 10 in.	9 ft., 6 in.	Ceduna, S. Australia	4/21/59	Alfred Dean
Porbeagle......	271 lb.	8 ft., 2 in.	49 in.	Looe, England	8/18/57	Mrs. Hetty Eathorne
Sawfish........	736 lb.	14 ft., 7 in.		Galveston, Tex.	9/4/38	G. Pangarakis
Thresher.......	922 lb.			Bay of Islands, New Zealand	3/21/37	W. W. Dowding *
Tiger..........	1,422 lb.	13 ft., 7 in.	95 in.	Cape Moreton, Australia	7/20/58	J. H. Robinson

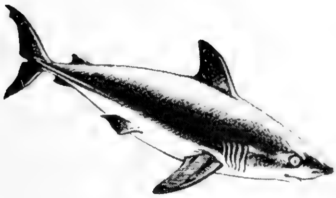
* See p. 107 for explanation. † Over 80 pounds, up to an including 130 pounds.

130-Pound Line Test Records
(*Women*)

Shark	*Weight*	*Length*	*Girth*	*Place*	*Date*	*Angler*
Blue..........	134 lb.	7 ft., 8½ in.	44 in.	Looe, England	10/10/56	Mrs. Daphne Case
Mako.........	858 lb.	11 ft., 7 in.	64 in.	Cavalli Island, New Zealand	4/14/51	Mrs. Rita Beaver
Man-Eater.....	1,052 lb.	13 ft., 10 in.	72½ in.	Cape Moreton, Australia	6/27/54	Mrs. Robert Dyer
Porbeagle......	271 lb.	8 ft., 2 in.	49 in.	Looe, England	8/18/57	Mrs. Hetty Eathorne
Thresher.......	729 lb.	8 ft., 5 in.	61 in.	Mayor Island, New Zealand	6/3/59	Mrs. V. Brown
Tiger..........	1,314 lb.	13 ft., 9 in.	89 in.	Cape Moreton, Australia	7/27/53	Mrs. Robert Dyer

Chapter 5

Anti-Shark Warfare



Christmas was 12 days away. The sound of carols was wafted among the shoppers along the streets of town. Choirs were rehearsing for their Christmas Eve concerts. And children were playing, not in snow, but in the surf. For this was Christmas time in Hawaii, and the temperature hovered at around 80 degrees.

It was Saturday, December 13, 1958, and 15-year-old Billy Weaver and five pals were in the surf off Lanikai, a long, wide stretch of beach east of Honolulu.

"All of us surfed for a while," one of the boys, Terry Oakland, aged 14, said later. "Billy was on an air mat. We had just caught a wave, all except Billy, and rode a short distance. We were about 50 yards from Billy when we saw him slide off his mat into the water."

Terry said he was within reach of Billy before he realized that his pal was not playing a prank. Billy was being pulled under by a shark. As Terry neared him, he heard Billy scream: "Help!"

Billy bobbed to the surface. "There was blood all in the water and his leg was cut off," Terry said.

The boys tried to keep Billy afloat and get him ashore. But he slipped from their grasp and, as he sank beneath the water again, they saw a shark move in toward him.

The boys rushed ashore and summoned help. Soon, boats were swarming around the waters of Lanikai searching for Billy's body—and a shark. The searchers found both. A shark nearly 20 feet long appeared among the boats. And, wedged in a hole in the reef off the beach, about 7 feet beneath the surface, was Billy's body, the right leg gone up to the knee.

The next day, Sunday, Lanikai beach gleamed under a bright sun. The sea was smooth. But there were no water-skiers on it. There was a gentle breeze. But no one was sailing. The water was clear. But no one was skin-diving or surfing. "We'll wait about three weeks," a teen-ager on the nearly deserted beach said. "Then, if nothing has happened, we'll start surfing again."

There was no panic, for Hawaiians have learned to live with sharks. Though sharks were no novelty in Hawaii, a shark attack was. Since

Young Lang Hedemann looks into the gaping mouth of an 11-foot, 2-inch Tiger shark (*Galeocerdo cuvieri*) caught in an Hawaiian shark hunt by his father (behind Lang) and three others. The shark weighs 700 pounds. It was caught in the same Hawaiian shark-hunting campaign inspired by the fatal attack on Billy Weaver. The shark shown was caught less than 1,000 yards from the spot where Billy Weaver was killed.

Courtesy, Honolulu *Star-Bulletin*

1886, there had been 16 known shark attacks in Hawaiian waters, and only 5 had been fatal. But, even before Billy Weaver was killed, there had been a growing apprehension about sharks in Hawaii. For six months prior to the boy's death, a research vessel had been hunting sharks around Oahu. The vessel had been scheduled to hunt off the Lanikai area early in December. The trip had been canceled because of heavy weather. And now it was too late. Billy Weaver was dead.

Within two days after Billy was killed, community leaders and government officials met to plan an attack on the sharks that menaced the island of Oahu. The plan called for the extermination of the sharks. A research vessel was sent to Lanikai two days after Billy was killed. Three Tiger sharks—one 12 feet long and weighing 800 pounds—were caught, along with two Sand sharks. That was only the beginning. A Billy Weaver Shark Control Fund was started to finance the catching and destruction of sharks menacing the inshore waters. Solicitors went from house to house on Oahu to raise funds. As an added inducement to the shark hunt, a merchant offered a $20 bounty for any shark caught in Oahu's inshore waters, and a jewelry company said it would pay 25 cents for each shark tooth a hunter brought in.

Under the chairmanship of Kenneth M. Young (a nephew of one of the authors, Captain Young), $27,476 was raised. The money was used for the chartering of a boat, the *Holokahana*, which was to make circuits of Oahu, killing as many sharks as possible, until the money ran out. Each shark was to be examined by a marine biologist. The shark-killing was not inspired by vengeance. Not only would the shark-catching produce new information about sharks, it was also hoped that the pressure of constant fishing would cut down the population of sharks around Oahu.

Holokahana means "hard worker" in Hawaiian, and the boat lived up to its name. On its shakedown cruise, it caught 63 sharks in 48 hours. The sharks were caught with specially designed shark lines—a main line of half-inch manila rope about a half-mile long, from which were suspended 24 hooks. The line was anchored at each end and buoyed by floats to prevent the hooks from fouling on the bottom. Three such lines were laid parallel with the shore, left overnight, and then hauled up.

The skipper of the *Holokahana* was Fred Inouye, vice president of Hawaii Marineland and a veteran sharker who had 5,000 kills to his credit when he took the shark-hunting *Holokahana* on its four circuits of Oahu. During the year-long campaign, 697 sharks and 641 unborn pups were captured and destroyed. One Tiger (*Galeocerdo cuvieri*) was carrying 57 pups when she was caught. At least nine species were taken—including a Six Gilled shark (*Hexanchus* sp.), a species which had never before been recorded in Hawaiian waters. Also caught was a Bramble shark (*Echinorhinus* sp.), the second ever caught in those waters. The first had been reported 30 years before.

The hard work of the *Holokahana* showed that constant fishing provides some defense against sharks. On each trip around Oahu, the *Holokahana* found fewer sharks. But it is expensive—it cost about $2,200 a month in Oahu, and that is only one of Hawaii's eight major islands.

A war of annihilation cannot go on forever, and if it stops, the sharks start appearing again. The Soupfin shark (*Galeorhinus zyopterus*) was practically exterminated off California during the vitamin A "gray gold rush" of the 1940's. After a couple of years of relatively light fishing, due to the slackening demand for shark-liver oil, the Soupfin again became plentiful.

"It must be remembered above all," warns Dr. Perry W. Gilbert, chairman of the Shark Research Panel, "that sharks are unpredictable. Moreover, we know relatively little about the behavior patterns of sharks, about the environmental conditions which compel a shark to attack, and about the conduct of a swimmer which may provoke a shark to attack."

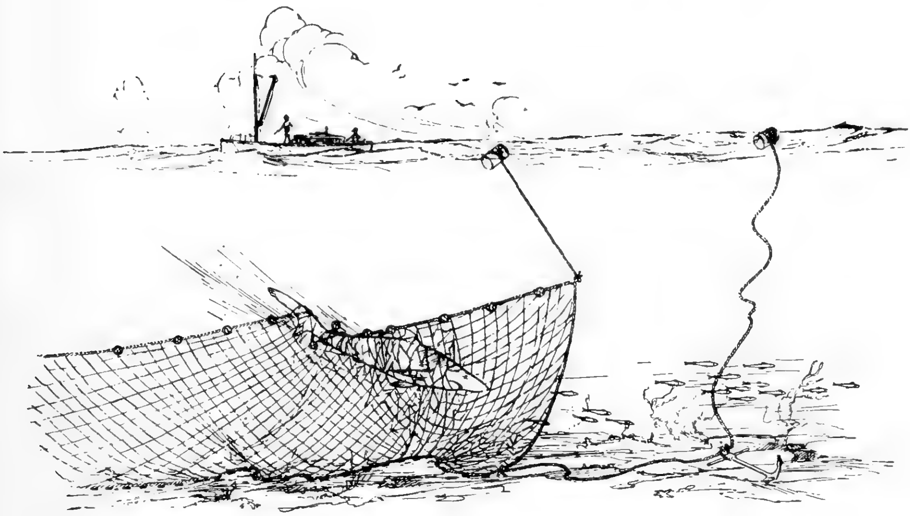
With this warning in mind, let us take a look at some weapons, new and old, in man's age-long war against dangerous sharks. Several methods of making beaches—and individual bathers—safe from sharks have been tried. All have been found to be far less than perfect, but some still offer some hope of shark defense. Many seem to work, but their apparent efficacy may be mere luck.

In 1934, after a series of fatal attacks around Sydney, Australia, a Shark Menace Committee was appointed to investigate ways to rid the beaches of sharks. The committee eventually recommended that nets be strung to catch sharks cruising along the beaches every night and then be removed the following morning. The scheme was called "meshing" by the committee. It was called "a stupid, futile waste of money" by one of its many critics. Because of the criticism, and because government funds to finance meshing were slow in coming, this effort to protect the bathing beaches did not begin until 1937.

Since then, however, there has not been a recorded shark attack at a meshed Sydney beach.

For several years, counts were kept on the number of sharks enmeshed in the nets. From December 1, 1939 to December 1, 1940, a total of 751 were caught. The following year, 705 were caught. No meshing was done during World War II, but even by 1948 the annual number of sharks caught was down to 260. Since then, the number of sharks caught each year has continued to decrease. The general assumption is that the shark population is decreasing also. There was a time when a dozen or more sharks would be caught overnight in a single net. Today, the nets are often empty for days at a stretch. Yet, barely a mile off the beaches, sports fishermen still regularly catch sharks 12 to 15 feet long.

The meshes used around Sydney today are great nylon mesh nets 500 feet long and 20 feet deep. The area is not actually enclosed; the meshes are anchored outside the breakers athwart the probable paths of sharks. The bottoms of the nets are weighted to keep them on the sea floor. Glass floats strung along the top of the nets keep them vertical.



This diagrammatic view shows how the shark meshing net system is used to protect the swimming area at Port Stephens, New South Wales, Australia. Once a shark's head is through the net, it is trapped because its gill slits are snared and a shark is physically unable to back up.
Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

Heavy anchors at each end hold them in position. The fishermen who have the government contract to keep Sydney's beaches shark-free are not permitted to set baits to attract them. Nor are they paid by the number of sharks caught. They get a flat annual fee, and government inspectors regularly accompany them in meshing trips to make sure that they are fulfilling their contract. Sharks are often drowned in the nets, their gills unable to function. Those that are still alive when the mesh is cleared are killed, and their carcasses towed to sea and dumped. (Though Australians do eat sharks, they abstain from eating dangerous species.)

North of Sydney, and along the rivers, estuaries, and harbors of the eastern coast of Australia, sharks still attack swimmers. In an average year, at least one swimmer is killed in Australian waters unprotected by meshing.

Meshing cannot be effective under all conditions. Heavy seas wash the nets away. If the nets are not properly located along shark pathways, they are ineffective. Meshes sometimes keep sharks *within* a bathing area, a chilling fact which has been proved by finding sharks that had been snared in the nets as they attempted to travel away from meshed beaches.

In 1952, after 35 shark attacks in 10 years, authorities in Durban, South Africa, decided to try meshing. In previous years, going back to 1907, they had tried practically everything else, from shark watchtowers on the beaches to a permanent enclosure, which was repeatedly smashed by waves and in almost constant disrepair.

The Durban nets are set about 800 yards off the beach, parallel with it. Since the nets were installed, no bather has been attacked in Durban. Careful records have been kept on the number of sharks netted each year. In 1952, a total of 602 sharks were caught. A year later, the number had dropped to 158. Since 1952, the average number has been about 170.

Dr. David H. Davies, director of the Council of the South African Association for Marine Biological Research, took a hard look at the Durban meshing. As a marine biologist and a specialist in sharks, he was baffled by the apparent effectiveness of the meshing as a shark barrier.

"There is no really satisfactory explanation for the success," Dr. Davies reported. "Although the nets extend for a considerable distance parallel to the bathing beaches, they do not form a continuous wall, and at all times sharks are able to penetrate the area between the beach and the nets by swimming between separate nets or round the ends. Sharks have been found to have been gilled on either side of the nets when traveling both toward and away from the beaches.

"The only reasonable explanation for the success of the set-net system seems to be related to the already established fact that it is possible to reduce a shark population by systematic netting. This has been shown in commercial shark fisheries in various parts of the world . . ."

Echoing Gilbert's words, Davies cautioned that "no completely reliable system has yet been devised for the protection of humans against shark attacks." But, marine scientists have known for years that *electricity* often has weird effects on fish. In an experiment in Australia more than 20 years ago, an 11-foot shark was seemingly paralyzed by an electrical barrier. When the current was turned on, the shark would not move; when the current was turned off, it swam away.

More elaborate electrical experiments have been conducted on bony fishes. When current is passed between two electrodes, *with fish between them,* it has been observed that the fish *turn* to follow the current toward the positive pole. The current does not attract them. Methods of using electricity for commercial fishing have not been practical so far in salt water because of the large amount of current required. Better success has been had in fresh water, especially in Russia.

Davies and Dr. J. P. Lochner of the National Physical Research Laboratory in Pretoria, South Africa, recently tried an "electric fence" on sharks. It seemed to work, they reported. Although they stressed that their experiments were only preliminary, they found that an electrical current passing between two electrodes acted as a barrier to sharks. They also found that an electrical charge strong enough to turn back a shark was not so strong that it would give a swimmer much discomfort.

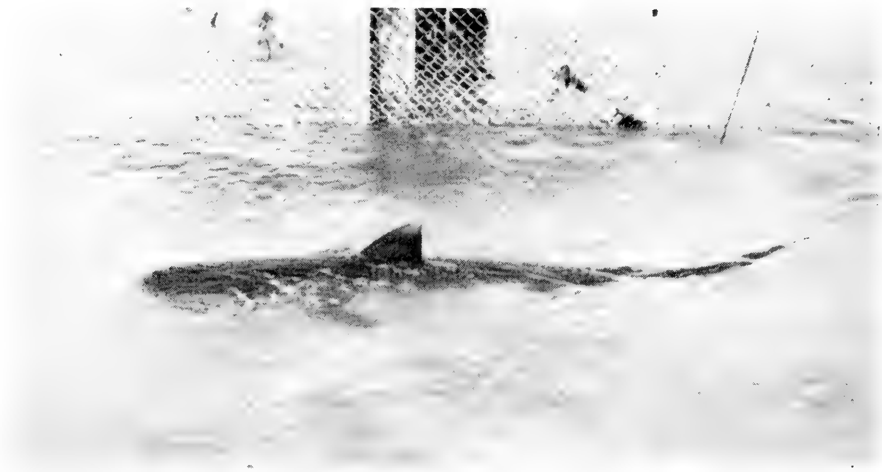
In November, 1961, John Hicks, a skin-diver turned inventor, demonstrated a "shark-shocker" in the shark channel of the Miami Seaquarium. Witnesses reported that 40 to 50 sharks in the channel rapidly swam away from a dangled chunk of fish when Hicks switched on his electronic gadget in the water. Hicks said he and his twin brother, Robert, had spent 6 years developing the shocker, one version of which is contained in an 11-ounce package. He said he hoped to sell the device to the National Aeronautics and Space Administration for use by astronauts. Representatives of the space agency witnessed the demonstration, which ended when a big shark of unidentified species nearly capsized Hicks' one-man life-raft with its tail as it rushed away from the raft. Hicks said he had planned to leap into the channel in a rubber suit to demonstrate the device, but Seaquarium officials refused to give him permission, which is a pity, because it looked quite effective.

It was August, 1960, when John Brodeur was attacked by a shark in waist-deep water off a resort hotel beach at Sea Girt, New Jersey. One of Brodeur's legs was so badly mauled that it had to be amputated. A week after the attack, with shark-panic still gripping New Jersey and most of the eastern seaboard, the proprietor of the resort hotel announced that he was going to keep sharks away from his beach with a "bubble fence." The fence consisted of a perforated pipe laid on the ocean floor between two jetties that jutted out 250 feet from the hotel beach, where the attack on Brodeur had occurred. Compressed air was pumped through the pipe, causing a curtain of bubbles to rise from the holes. The inventor of the bubble fence was said to have boasted that "sharks are so terrified by the 'shark fence' they will not even cross it to get a juicy steak."

The fence was said to have been tested against "60 large sharks" which "refused to crash past the barrier to reach food on the other side." Resort owners saw the bubble fence as the long-awaited answer to how to keep sharks from coming to ocean beaches, and how to keep bathers from staying away.

Some people were unconvinced by the "tests" of the bubble fence. One of these skeptics was the Shark Research Panel's chairman, Dr. Gilbert. He noted that reports of the tests did not mention the species of sharks that were reputedly repelled, their length, the distance of the bubble curtain from the wall of the aquarium where the test was conducted, or the time of day or night when the tests were held.

Gilbert decided to test the bubble fence himself in the special shark pens at the Lerner Marine Laboratory on Bimini Island in the Bahamas. Two pens were built with funds provided by the Office of Naval Research. Each is about 40 by 8 feet. They are next to a dock at the laboratory. At high tide, the water in them is 7 feet deep.



The dorsal fin of a Tiger shark (*Galeocerdo cuvieri*) parts the "bubble curtain" as the shark passes through the bubbles, in tests showing the ineffectiveness of the "curtain" as a shark barrier. The tests were conducted by Dr. Perry W. Gilbert, chairman of the Shark Research Panel. Courtesy, Dr. Perry W. Gilbert

Two types of bubble fence tests were conducted in the pens. In one, a bubble curtain was extended halfway across one pen. In the other, a *V*-shaped curtain was arranged, with an 8-foot gap of quiet water at the apex of the *V* so that both pens formed an 80-foot "fish trap." If the *V*-shaped bubble curtain were effective, the sharks would be funneled by it from one end of the pen, through the quiet-water gap, to the other end of the pen.

In all the tests, Gilbert used Tiger sharks, ranging in length from 5½ to 13 feet and weighing from 95 to 900 pounds. During the first 4-minute period of the first test, two Tigers seemed to be turned away by the bubble curtain that extended halfway across the pen. Ten Tigers passed through the bubbles "seemingly undisturbed," according to Gilbert. In a second 4-minute test, one Tiger appeared to be turned away and six passed through the bubbles.

In a 15-minute test using the *V*-shaped barrier which would theoretically funnel the sharks toward one end of the pen, the sharks "promiscuously swam back and forth through the bubble curtain."

To confirm his findings, Gilbert tried a 26-hour test of the *V*-shaped bubble curtain. Sharks passed through it in both directions, with the number apparently increasing as they became accustomed to the curtain's presence. During one 10-minute period in which a careful count was taken of the number of times sharks passed through the bubbles, the "fence" was breached 77 times.

"It would appear from these data," Gilbert reported, "that the bubble curtain is ineffective as a barrier to Tiger sharks . . . It is highly probable . . . that some of the sharks which seemingly were repelled . . . normally would have turned in this area of the pen anyway."

Other methods for repelling sharks have been tried but with equal lack of success. Let us take a look at some, starting with the most impressive.

A great crowd gathered along the waterfront of Margate, South Africa, one day in 1958, for a spectacular show was going on about 1,000 yards from shore. The frigate *Vrystaat* of the South African Navy was depth-bombing sharks. Geysers of water shot into the sky as the *Vrystaat* set off 25 depth charges. Seven sharks were counted dead. And, though a score of about 3½ depth charges per shark does not sound impressive, a newspaper reported, "There is every reason to believe that the operation will be a great success."

Actually, there is every reason to believe that the unusual naval warfare against the shark attracted far more sharks than were killed. An underwater explosion will kill bony fish over a wide area. Their swim bladders burst from the concussion. Sharks have no swim bladders, and they are impervious to any explosion except a virtually direct hit.

The bony fish stunned or killed by an explosion immediately lure sharks to the area. An eyewitness to such a phenomenon reports that sharks converged to feast on the wounded and dead fish within 20 seconds after an explosion. The British Shallow Water Diving Unit at Nassau in the Bahamas reported: "We threw TNT blocks into the water, and within five minutes of the explosion the area was full of sharks feeding on the dead fish. They averaged about 6 feet, the biggest being 8 feet. It was a remarkable sight."

Survivors of the torpedoing of the U.S. Destroyer-Escort *Frederick C. Davis* on April 25th, 1945, during World War II, told of sharks appearing and attacking survivors after two depth charges on the sunken ship had gone off underwater. The muffled explosions, not strong enough to cause much injury among the men in the water, indirectly killed many of them because the explosions brought more sharks to the scene—and the scene was the center of the Atlantic Ocean.

The chemical shark repellent was born as a wartime weapon to be used not only against sharks, but also against fear of reputedly shark-infested waters. Anxious mothers wrote their Congressmen about the sharks, and even the President received similar worried letters. Servicemen who should have been worrying about survival in combat were being unnerved by dread of an enemy more horrifying than a man with a gun.

Fear of death by bullet or bomb did not seriously weaken morale, but fear of death in the jaws of a shark could not be driven off by brave words. "Reports of shark attacks on members of our combat forces have created a wartime sea-survival problem that can no longer be neglected," an Army Air Corps bulletin warned. "The possibility of attack is a growing hazard to morale."

Dr. Harold J. Coolidge, on leave from Harvard to work in Washington on high-level public information problems arising from the war, also believed that worry over shark attacks was having a bad effect on morale both at home and overseas. Coolidge took the problem directly to the White House level and suggested that a scientific investigation be made into the feasibility of a chemical shark repellent. President Roosevelt himself reportedly ordered that the top-priority project be started immediately.

There were grumbles from some military leaders who apparently felt that the diverting of any manpower or money into the shark-repellent project was a waste of resources vitally needed for activities more directly concerned with the fighting of the war. Navy officials argued that, since shark attacks were rare, it was a psychological mistake to overemphasize the menace, and make sailors and others even more aware of it. But proponents of the shark repellent won out with the argument that the lessening of anxiety was an important factor in survival, and, if a man in the water knew he had some kind of protection against sharks, he could devote more of his strength and wit to keeping himself alive.

The job of finding a way to deter shark attacks was handed to W. Douglas Burden, president of the Marine Studios in Florida. Because the war had forced the closing of the Marine Studios, Burden conducted his first experiments at the Woods Hole Oceanographic Institution in Woods Hole, Massachusetts. Three Smooth Dogfish (*Mustelus canis*), each about 3 feet long, were placed in laboratory tanks. They were killed with poisoned food. But this did not have much significance. What was needed was something that would drive sharks away from food. The successors to the first three Dogfish were subjected to supersonics, stink bombs, chemical irritants, and a variety of ink clouds. Nothing worked.

Seventy-eight different substances—including several poison gases—were tried out before the scientists experimented with one that was literally right under their noses. It was nothing more than "essence of dead shark." As one of the authors and other shark fishermen long before had discovered, if they left sharks hanging on their hooks long enough for the bodies to decompose, live sharks avoided their odorous brethren. The Woods Hole sharks also turned tail when the scientists confronted them with an offering of very dead shark meat.

But a 3-foot Dogfish in a laboratory tank is not a 20-foot Great White shark charging a man in the open sea. So the experiments were shifted to Florida, where the researchers hoped to test their potential repellent against real man-eaters.

They couldn't find any sharks!

The scientists, aided by local fishermen, scoured the Florida coast from St. Augustine to Jacksonville. No sharks. Navy and Coast Guard submarine-chasers were assigned to hunt sharks in Cuban waters. No sharks. Ernest Hemingway offered his services, and gave the frustrated shark hunters some locations where he had caught sharks. There were no sharks to be found, at least in the numbers the repellent project needed.

The problem became a matter of international diplomacy. On December 1, 1942, Secretary of State Cordell Hull cabled the American Embassy at Quito, Ecuador. After briefly describing the shark project, Hull ordered:

". . . You are requested to secure permission from the Ecuadorian government for the . . . necessary investigation of the territorial waters of Ecuador . . . You are also authorized to transmit reports from the investigators via diplomatic pouch. Please take up this matter on an urgent basis and report by telegraph."

Even with the aid of the United States Department of State and the government of Ecuador, the shark hunters could not find sharks. Near the island of La Plata, 25 miles off the coast of Ecuador, sharks had disrupted a dolphin-hunting expedition two years earlier by massacring all the dolphins the hunters caught. This would seem to make La Plata a good place to find sharks. But the frustrated shark hunters got only an occasional one there. They moved on, from one place to another, and the sharks still eluded them.

They finally found a spot, near the mouth of the Guayaquil River, and there, for 16 days, the scientists tried out their "dead shark" repellent. Actually, the repellent was the chemical equivalent of what seemed to be the ingredient in decomposed shark that was so repulsive to live sharks. This chemical—copper acetate—produced startling results. Sharks struck again and again at baited lines unprotected by the repellent. But they avoided the adjacent baited line, identical with the others except for the repellent, which was suspended in a bag directly above the bait.

Convinced that the repellent worked on individual sharks, the experimenters next tried it on a pack of sharks in a feeding frenzy. Samples of the repellent were dispatched to St. Augustine, Florida. The shrimp fishermen who work off the St. Augustine coast throw away as "trash" small fish that have been scooped up with the shrimp, and the cleanings from the shrimp. As the shovelfuls of trash are dumped into the sea, schools of sharks gather behind the boat and excitedly feast upon the fishermen's largess.

In a classified report on the use of the repellent against shark packs, one of the researchers said: "Sharks were attracted to the back of the shrimp boat with trash fish. The sharks appeared as a slashing, splashing shoal. We prepared a tub of fresh fish and another tub of fish mixed with repellent powder . . . I shoveled over the plain fish for 30 seconds while the sharks, with much splashing, ate them. Then I started on the repellent fish and shoveled for 30 seconds, after which I shoveled plain fish for 30 seconds, repeating the procedure three times.

"On the first trial the sharks were quite ferocious in feeding on the plain fish right at the stern of the boat. They cut fish for only about five minutes after the repellent mixture was thrown over. A few came back when the plain fish were put out immediately following the repellent. On a second trial 30 minutes later, a ferocious school fed for the 30 seconds that plain fish were supplied, but left as soon as the repellent struck the water. There were no attacks on fish while the repellent was in the water. On the third trial we could not get the sharks nearer than 20 yards to the stern of the boat."

The repellent appeared to be an astounding success. The government ordered a crash program for manufacturing it in cakes to be attached to lifejackets. Copper acetate was mixed with a nigrosine-type dye, which released a blue-black cloud. Compressed into a cake that was packed into an envelope, the repellent was eventually attached to the lifejackets issued to servicemen. They were instructed to open the envelope and swish the cake around them when threatened by sharks. The repellent would diffuse in the sea and surround the swimmer with a cloud of dye and copper acetate.

The shark repellent was classified a military secret, and its production was not disclosed to civilians who wondered what the awful smell was around the Borden Company's Shark Industries Division plant in Salerno, Florida. Borden, which had been catching sharks to extract vitamin A from their livers, boiled down shark meat in great vats to extract the essence of the repellent. (The Borden dead-shark repellent manufacturing was soon supplemented by mass production of the chemical repellent.)

The repellent, dubbed "Shark Chaser," was issued as part of all Mae West (lifejacket) and life-raft equipment. How effective it was will probably never be known. Thousands of men were set adrift in seas all over the world during the war, and undoubtedly the repellent provided them with at least an important psychological weapon against sharks. "Beyond question, the greatest value of the Shark Chaser was the mental relief and sense of security it afforded the men who had it on hand," observed Dr. Llano, the Air Force research specialist who made the previously mentioned exhaustive study of wartime survival at sea.

After the war, the product was marketed commercially, without great success, by the Shark Chaser Chemical Company of San Pedro, California. Two of the authors made extensive efforts to gather information about the repellent's effectiveness, both for protecting swimmers and for protecting fishermen's nets against sharks. Their efforts were notable for their failure to gather any credible evidence whatsoever as to the efficacy of the product.

The Presto Dyechem Company of Yonkers, New York, now manufactures Shark Chaser for the armed services. In 1961, this company, which said it manufactures the product under exclusive license, announced that the repellent had been released for civilian use. (The announcement failed to note the previous public sale of the repellent by the California firm, or the fact that it had long been sold by dealers in surplus property who had acquired repellent packets from government stocks.) The company, in 1961, began advertising Shark Chaser in packets for skin-divers, and Shark Chaser in liquid or packet form to protect commercial fishermen's nets from sharks.

Shark Chaser was also sold to protect beaches. In the summer of 1961, Maurice J. Fleischman, city manager of Long Beach, Long Island, announced that the beaches of his town were going to be "sharkproofed." The sharkproofing would be done in this way: when a shark was sighted, or when the Coast Guard notified lifeguards, in some way, that sharks were in the vicinity, the lifeguards would tow 720-foot lines, to which canisters of repellent were attached, into the surf, and anchor them beyond the bathing area. They would, as quickly as they could, string the lines along 2,400 feet of the town's beaches. The repellent would diffuse in the water, and the swimmers would be protected from sharks; or at least that was the hope. "Visitors to Long Beach this summer may be assured they will be protected from the perils of shark attack," the city manager stated. He did not speculate on the possibility that the repellent line might actually fence sharks *within* the bathing area.

Soon after Long Beach announced its sharkproofing plan, Howard B. Reiffel, the president of Presto Dyechem, appeared in New Jersey to explain the workings of the repellent to 13 New Jersey sea resort officials, some of whom, only a year before, had been pondering the erection of bubble fences along their beaches. Reiffel estimated that a dozen canisters of Shark Chaser strung from a line parallel to shore could protect about 200 feet of beach for about 9 hours.

The product being sold commercially as Shark Chaser is identical with the repellent issued to U.S. servicemen who fly over, or who may have to abandon ship in, shark-menaced waters. Packets of it are also attached to the lifejackets of astronauts.

How good is Shark Chaser? Like any question associated with sharks, this one has a variety of answers.

Developed in a wartime crash program during which there was little time for extensive testing (as it was, the repellent was not issued until late in the war), Shark Chaser was not tried on enough sharks under enough conditions to satisfy careful scientists.

When several sharks are in a feeding frenzy, for instance, nothing seems strong enough to repulse them.

Burden, one of the developers of the repellent, said: "Let us assume that a lot of blood has gotten in the water prior to the introduction of the repellent material. Let us assume further that voracious sharks are present in large numbers. Under such circumstances sharks have frequently been seen biting at oars and boats, with such savage determination that they completely ignored heavy blows. This would seem to indicate that at some point in the characteristic shark-feeding program, the olfactory sense no longer plays a dominant role and is superseded by a mob-impulse in which visual and auditory senses both have probably played a part. This mob-impulse might be likened to the stampede behavior in animals. Under these conditions it is very doubtful if any chemical repellent would inhibit their feeding behavior thoroughly."

Burden believed, however, that "the sense of smell initiates the subsequent feeding pattern, so that if this behavior can be arrested at the outset through a repellent, the more violent aspects of it could not come into being."

This may have been the case in a test of the repellent conducted by the Fish and Wildlife Service in 1945. In a fishing ground off Massachusetts, shark repellent was spread around the nets of a Gloucester mackerel seiner, the *Angie and Florence*. The Fish and Wildlife Service reported: "In spite of the abundance of sharks, the *Angie and Florence* received no damage to its nets, and caught about 58,000 pounds of mackerel. Other boats fishing in the same area, but without protection against sharks, averaged only 5,000 to 25,000 pounds of fish, and suffered severe damage to their nets."

That was in 1945. Only in recent years have marine biologists begun to probe very deeply into why and how a shark responds to food, including human prey. It has been learned, for instance, that the shark may vary its feeding pattern from a slow, determined assault on the food to an attack consisting of rapid, seemingly wanton bites. But little is known about what triggers these different modes of feeding—or attacking.

The Shark Chaser repellent consists of about 20 per cent copper acetate, believed to be repugnant to sharks, and about 80 per cent nigrosine dye, which diffuses in the water as a blue-black cloud similar to the inky fluid ejected by squids when they become alarmed.

Since the time the repellent was developed, the formula has remained the same. Many marine scientists have suspected that the formula could be improved, their suspicions being based on reports of the repellent's dubious effectiveness. For example, the repellent was tried by champion Australian sharker Bob Dyer on packs of sharks in waters bloodied by whales killed by professional whalers. Some of the sharks were repelled; some actually ate the packets of repellent in their frenzy!

In correspondence with the authors, the British Admiralty reported that repellent tests the British conducted were inconclusive. The *British Medical Journal* said that the efficacy of repellents "is rather doubtful." The Royal Air Force said that repellents are not in general use for RAF fliers. Tests of repellents at the Point Cloates whaling station in Western Australia "proved ineffective." Ward, Brooke and Company, Ltd., the British chemical firm which manufactures the same repellent under a government formula, wrote: "The common opinion is that whilst it bolsters morale its effectiveness is in some doubt." Stewart Springer of the Shark Research Panel, who worked on the original research that developed the repellent during the war, today doubts whether *repellent* is even the correct word. "It probably should be called a *feeding inhibitor*," Springer says.

In its 1958 diving manual for frogmen and helmet divers, the U.S. Navy warned that "shark repellents are useless" when sharks "are hunting in packs and food or blood is present."

The British Shallow Water Diving Unit at Nassau tested shark repellent under conditions that would be more pertinent to skin-divers. The British reported: "The use by us of shark repellent [copper acetate] did not prove anything. It does not seem reasonable to suppose that a shark in the fury of an attack would pause or retreat from its headlong rush for food because it did not care for the smell of the repellent. Again, if the repellent were effective it would be only so down tide."

Dr. Albert Tester, a University of Hawaii zoologist, summed up the reports on shark repellents by saying: "I do not think at the present time that we have a sure-fire repellent of any kind. There are sharks and sharks. One repellent may work with the Tiger shark, but not with the Gray sharks we have here in Hawaii. Another may work with the Gray and not on the Tiger."

Concerned about the skepticism that had been developing over shark repellents, in 1958 the American Institute of Biological Sciences, Tulane University, and the Office of Naval Research called a conference on shark repellents. Shark experts from the United States, Australia, Japan, and South Africa attended. The consensus of the conference, as reported by Lester R. Aronson, a specialist in animal behavior and a member of the staff of the American Museum of Natural History, was: "Reports indicate that under certain conditions it [Shark Chaser] may not be effective, and many of those who are required to depend upon this preparation for their personal safety do not have the necessary confidence in it."

Shark experts at the conference even suggested that, since strong stimuli generally repel and weak ones attract, a dilute solution of a repellent might actually have a reverse action and act as an *attractant.* This was one of the many puzzling aspects of sharks and repellents which led the experts to realize that research into a new kind of repellent was not enough. The shark itself had to be studied, and attacks on men had to be examined for clues to shark behavior. Thus, out of the quest for a more effective repellent, the Shark Research Panel evolved.

Perry Gilbert, the SRP chairman, decided to test Shark Chaser. "Although 'Shark Chaser' performed admirably in various tests," he said, "subsequent accounts of its effectiveness as a shark repellent by airmen and skin-divers have been conflicting, and a re-evaluation and more rigorous testing of this repellent is now needed."

Gilbert, Michael Lerner, and Dr. Evelyn Shaw made the tests at the Lerner Marine Laboratory. The tests, on Lemon and Dusky sharks, "suggest that copper acetate may not be as repugnant to the sense of smell of a dangerous shark as was originally believed," Gilbert reported.

In the tests, a lure (usually fresh beef blood in a porous container), suspended from a line on a long bamboo pole, was presented to sharks in the experimental pens for 10 minutes. The sharks "readily" approached a lure "through a cloud of copper acetate." But, when Shark Chaser was used, "the sharks repeatedly avoided the lure."

"This suggests," Gilbert said, "that possibly the 'Shark Chaser' dye is more repellent to sharks than is the copper acetate . . . The value of copper acetate as a shark repellent is open to serious question."

Researchers are now trying to find a better shark repellent. They are experimenting with many substances, such as the poison emitted by the sea-cucumber. Until a better shark repellent is developed, the best that can be said of the combination of copper acetate and nigrosine-type dye is it *sometimes* seems to repel *certain* sharks under *some* conditions.

Whether strung along a beach or on a skin-diver's weight belt, its effectiveness may be conditioned not merely by its ingredients, but also by the mood and hunger and type of shark that approaches.

Captain Cousteau, the man who so rightly said that one can never tell what a shark is going to do, once had an opportunity to try just about every piece of advice that has ever been given on what to do when approached by a shark. He and a companion, Frederick Dumas, were skin-diving off the Cape Verde Islands when they were confronted by three sharks, one of which seemed determined to attack them.

Cousteau and Dumas flailed their arms, released bubbles from the air tanks, yelled underwater, and released shark repellent. The shark came ever closer. Finally, Cousteau banged the shark on the snout with his camera. The shark swam past, and began circling again. The other two sharks approached. The three sharks continued to menace the divers until their boat approached and apparently frightened the sharks away.

From then on, Cousteau and Dumas carried "shark billies," clubs 4 feet long, studded with nails at one end. They planned to use them because, as Cousteau says in his book, *The Silent World:* "After seeing sharks swim on unshaken with harpoons through their heads, deep spear gashes on their bodies, and even after sharp explosions near their brains, we place no reliance in knives as defensive arms."

At the time he wrote, Cousteau had never used the billy, so he had no way of knowing its effectiveness. "It may," he wrote, "prove to be merely another theoretical defense against the creature which has eluded man's understanding."

All defenses against the shark are theoretical. But some defenses that have been suggested by self-proclaimed experts are not merely theoretical; they are virtual incitements to suicide.

Item, from a skin-diver magazine: "You can actually swim up to a Nurse shark and kick it without eliciting harm to your person. Try it some time."

Item, by the author of a book on skin-diving: "If a shark comes too close, put your head under water and yell as loud as you can, 'Go away, you bum! Get lost!' He can't hear you, but he can feel the vibrations. If he still comes on, hit him on the nose . . ."

Item, from a skin-diver magazine: ". . . If hand-to-shark combat becomes necessary (a most remote possibility), avoid those snapping jaws by stiff-arming the brute's long nose. Use your knife in the gill slits or slash him across the back of the neck . . . If you are caught without a knife, jam your fingers into his nostrils or gill slits, if possible, hang on to the pectoral or side fin as long as you can hold your breath."

If the survival of swimmers confronted by sharks depended on gross misinformation such as this, there would be few survivors. The man who provokes a shark—any shark—does so at peril of his life and/or limbs. Men have provoked, ridden on, stabbed, and hit sharks—and lived. So, too, have men lived after hurling themselves from tall buildings, throwing themselves under the wheels of trucks, and shooting themselves in the head.

Hitting or stabbing a shark is suicidal unless it is the last, desperate act of a man fighting to live at the moment that comes when he is facing death. Captain Jonathan Brown, commander of an Air Force C-124 Globemaster which crashed in the Pacific in 1958, was one such man.

He and two other members of the crew of nine survived the crash. The three men fashioned a raft out of a piece of wood and buoyed it up with mail sacks. They clung to this during the night. At dawn, the sharks appeared. For a while, shark repellent seemed to keep them away.

U.S. NAVY "SHARK DANGER" RATINGS
(From *General Principles of Diving*: Marine Life—Sharks.)

Name	*Danger* *	*Maximum Size*	*Appearance* †	*Behavior*	*Where Found*
White shark.......	4+	30 ft.	Slaty brown to black on back	Savage, aggressive	Oceanic; tropical, subtropical, warm temperate belts, especially in Australian waters
Mako shark........	4+	30 ft.	Slender form; deep blue-gray on back	Savage	Oceanic, tropical, and warm temperate belts
Porbeagle shark....	2+	12 ft.	Dark bluish gray on back	Sluggish except when pursuing prey	Continental waters of northern Atlantic. Allied forms in north Pacific, Australia, and New Zealand
Tiger shark........	2+	30 ft.	Short snout, sharply pointed tail	Can be vigorous and powerful	Tropical and subtropical belts of all oceans, inshore and off-shore
Lemon shark.......	2+	11 ft.	Yellowish brown on back; broadly rounded snout	Found in salt water creeks, bays, and sounds	Inshore western Atlantic, northern Brazil to North Carolina, tropical West Africa
Lake Nicaragua shark	2+	10 ft.	Dark gray on back	Found in shallow water	Fresh water species of Lake Nicaragua

Dusky shark.......	1+	14 ft.	Bluish or leaden gray on back	Found in shallow water	Tropical and warm temperate waters on both sides of Atlantic
White-Tipped shark	3+	13 ft.	Light gray to slaty blue on back	Indifferent, fearless	Tropical and subtropical Atlantic and Mediterranean. Deep offshore waters
Sand shark........	2+	10 ft.	Bright gray-brown on back	Stays close to bottom	Indo-Pacific Mediterranean, tropical West Africa, South Africa, Gulf of Maine to Florida, Brazil, Argentina
Gray Nurse shark...	3+	10 ft.	Pale gray on back	Swift and savage	Australia
Ganges River shark	4+	7 ft.	Gray on back	Ferocious, attacks bathers	Indian Ocean to Japan; ascends fresh water rivers
Hammerhead shark	4+	15 ft.	Ashy-gray on back; flat, wide head	Powerful swimmer	Warm temperate zone of all oceans including Mediterranean Sea, out at sea or close inshore

* 1+ means minimum danger, 4+ means maximum danger.
† All sharks listed are of some shade of white on the under side.

Then they came closer. "We'd do a lot of yelling and the sharks would back off and look the situation over," Brown said later. "We don't know how many there were. I don't know how big they were. They seemed to be attracted to anything of light color. We were wearing black socks and our flight suits, which was a help."

One of the sharks seemed to single Brown out. It charged him. "The shark had me by the shoulder and was shaking me," Brown said. "We yelled, thrashed and kicked about in the water trying to get rid of it.

"*Finally, I beat on its head with my fist and it let go.*"

Brown's *last* act of defense worked. The shark swam off, though it remained nearby in the water, along with others, until, after 12 hours amid the circling sharks, the three survivors were rescued.

The desperate yet purposeful defense Captain Brown and his companions put up shows the only kind of thinking that gives a man a chance in the water against an attacking shark. *No* defense guarantees survival, for the odds are against a man who is facing an onrushing shark.

Shadows beneath the surface are what we most often see when we are privileged to see a shark or a skate or a ray. When you see a shark's dorsal fin cutting a wave above the surface, beware! That shark is hunting and he may be looking at you for a meal. Unless it is the fin of a Basker sunning himself and lazily straining plankton, it is probably one of several species of sharks that are known or suspected to be aggressive hunters. It may be wary in its approach or it may be direct in its attack. Do not be lulled into security if you see no fin. Many shark attacks have been made by a foraging shark that was not seen until the moment of its attack—and often not until after it attacked.

The authors subscribe to the beliefs of some of the leading explorers of the underwater world who have made long observations of the behavior of sharks in their own habitat, that all must be considered as *individuals.* This does not preclude the observation that there are species that are peaceful in their way of life and species that are more aggressive. But, it *does* imply that individuals of *any* species should be treated with respect and caution.

In its instructions to its frogmen and divers, the U.S. Navy gives a "danger rating" on 12 large sharks. The ratings range from "minimum danger" to "maximum danger." As long as you remember that *any* shark can be dangerous, especially when provoked, the Navy guide is not a bad index to the relative known ferocity of the larger sharks. But the index should not leave the implication that sharks not on it are harmless.[1]

With the admonition, then, that the Navy is describing only *how* dangerous *some* sharks *can* be, we reproduce the guide on pages 132 and 133.

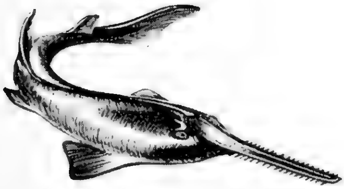
[1] The sharks mentioned in the Navy guide are described in Chapters 11 and 12.

Part 3

Man and Shark

Chapter 6

Shark Devils —and Gods



As the Greeks wrote their myths in the constellations, Orion, the mighty hunter, wheeled across the winter sky in eternal, futile pursuit of Taurus, the great bull, and Leo, the couchant lion. But long before the Greeks looked skyward and evolved their myths, primitive men discerned in the flickering patterns of the stars cosmic enactments of their fearsome struggles with their own devil-god—the shark.

The stars the Greeks saw as Orion's Belt were to the Warrau Indians of South America the missing leg of Nohi-Abassi, a man who had got rid of his mother-in-law by inducing a murderous shark to devour her. As legions of men were to learn in the ages to come, Nohi-Abassi learned that it does not pay to provoke a shark—or a mother-in-law. His leg was cut off by his sister-in-law, apparently playing the role of a shark, and Nohi-Abassi died. His leg wound up in one part of the heavens; the rest of him in another.

To some primitive men, the shark was a vengeful god; to others, the shark was a cunning devil. In many primitive religions, the worship of the shark grew so complex that the shark had several roles: sharks became men, men became sharks. On many a Pacific island, the awesome deity could not be satiated by the occasional man, woman, or child he snatched from the sea in his inscrutable forays. The shark-gods then demanded the ultimate homage: human sacrifice. The chief or the high priest of some islands went among the people at this fateful time. An acolyte accompanied him, carrying a noose similar to a shark snare. At a signal from his leader, the acolyte hurled the noose at a crowd. The person—whether man, woman, or child—around whom the noose fell was immediately seized and strangled. The body was ritualistically cut into pieces and flung into the sea for the ravenous shark-gods.

In the Solomon Islands, deified sharks lived in sacred caverns built for them near shore. In front of these caverns were erected great stone altars upon which were placed the bodies of chosen victims. After mystical ceremonies, the bodies were then given to the sharks. Some sharks in the

Gilbert Islanders brandish swords studded with sharks' teeth. Pacific islanders fashioned several types of weapons using shark teeth. Islanders in the photo are wearing helmets of porcupine fish skin and coir armor.

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

Solomons were regarded as incarnations of dead ancestors. These were good sharks, which would help their relatives. Alien sharks, who ventured into the islands on evil missions, were thought to be malevolent. But fishermen could supposedly drive these evil sharks away by brandishing before them small wooden statues representing the native sharks.

Vietnamese fishermen still refer to the Whale shark as *Ca Ong*, or "Sir Fish." Small altars imploring *Ca Ong's* protection can be seen on sand dunes along the central and southern Vietnamese coast.

Woven into the rich tapestry of Hawaiian legends are many tales of sharks—tales still told by venerable *kanakas*, repeating the words heard from the lips of their fathers' fathers, who lived when myths shrouded the islands, as the mists still shroud the Hawaiian dawn.

I will tell you, the storyteller will begin, *of Kamo-hoa-lii, the king of all the sharks . . .*

Kamo-hoa-lii, so the old, old tale goes, fell in love with a maiden, Kalei, whom he saw swimming in the sea. *Kamo-hoa-lii* transformed himself into a man, married Kalei, and fathered a child. *Kamo-hoa-lii* then returned to the sea as a shark. The child, Nanaue, looked like any other child—except that on his back he bore the mark of his shark-father, the mouth of a shark. Although *Kamo-hoa-lii* had warned that the child must never be fed the flesh of an animal, the taboo was broken, and Nanaue thus learned the magic of making himself into a shark. As a shark, he devoured many islanders. Finally, he was caught and his body—in the form of a great shark—was taken to a hill in Kain-alu.

"And even today," the old storytellers say, "the hill they took Nanaue to is called Puumano, the Shark Hill . . . The people took bamboos from the sacred grove of Kain-alu and made sharp knives from the bamboo splits, and they cut pieces from the body of the shark-man. But the gods were angry, and they took the sharpness from the bamboos in the sacred grove, and to this day the bamboos of Kain-alu are not strong and they cannot cut."

When the Navy made a major sea base at Pearl Harbor, the dredging operations destroyed the remnants of an ancient shark pen. There, unknown ages before, Hawaiian kings had hurled living men to the royal sharks, and gladiatorial contests had been staged between starved sharks and native gladiators.

In his invaluable study of South Sea islanders, missionary William Ellis told of shark worship he had witnessed in the Society Islands in the early nineteenth century. He said that the natives deified the Great Blue shark (*Prionace glauca*), though they killed and ate other species. "Rather than destroy the Great Blue sharks," the missionary said, "they would endeavor to propitiate their favor by prayers and offerings. Temples were erected in which priests officiated, and offerings were presented to the deified sharks, while fishermen and others, who were much at sea, sought their favor."

Just as half a world away, in other times, Roman gladiators entered an arena to battle to the death with lions for imperial entertainment, so did Hawaiian warriors enter the shark pen in duels with sharks. The warrior's only weapon was a shark-tooth dagger, a short length of wood shaped like a stout broomstick, gripped in his hand. Protruding from the stick was a shark's tooth, which stuck out between two fingers of the man's fist. Unlike the matador who can make a misstep and live to face a charging bull again, the shark-warrior had but a single life-or-death chance. He had to let the onrushing shark charge him. Then, at the last instant, the warrior dived beneath the shark and tried to rip the shark's belly with his crude weapon. It is said in Hawaiian legends that the warriors sometimes killed the shark. If they did, they must have used much *akua*, or magic. Perhaps it was stipulated by royal edict that if a warrior drew blood he was allowed to leave the pen, providing that he was able to escape the shark. But it seems impossible that the duels between man and shark ended any other way than in victory for the shark, which, after all, had a maw of teeth to use against the one tooth gripped in its antagonist's fist.

The shark pen was a circle of lava stones, enclosing about a 4-acre area at the edge of a bay in the harbor. The circle of rocks had an opening on its seaward side so that water could flow into it. Fish—and human bait—were thrown into the pen to lure sharks through the passage. When a contest was to take place, the passage was closed so that neither opponent could escape. Close to the shark pen, on the bottom of the harbor itself, lived the Queen Shark, regally guarded by two stalwart sharks from each of the Hawaiian Islands. The Queen condescended to allow the shark jousts near her royal lair. But she had to be propitiated with offerings which were undoubtedly human, for it was an economic fact of life in old Hawaii that people were cheaper than pigs.

As mentioned previously, some of the stones that formed the shark pen were still in place when the dredgers began tearing up the harbor bottom in the early 1900's for the construction of Pearl Harbor Naval Base. As part of the harbor project, a big drydock was built at a cost of more than $4,000,000. The foundation suddenly collapsed under the pressure of an underwater eruption, and the drydock was destroyed. Navy inspectors and construction men scurried around trying to find the cause, but the natives knew what had happened. "Queen Shark is *huhu*—angry—and humps her back," they said.

Belief in shark myths has persisted for years, even in modern Hawaii. Less than a century ago, many Hawaiian women wore tattoos on their ankles in remembrance of an ancient chieftainess who had been bitten on the ankle by a shark but had escaped. Apparently, the tattoos were considered good luck against shark bites.

In 1956, the Bishop Museum in Honolulu, repository of a matchless collection of Hawaiian artifacts, acquired an ancient relic known as *Kapaaheo*, the "Shark Stone." It took a bit of shark *akua* to get it, though. The sorcerer was Heloke Mookini, a 71-year-old *kamaaina* (an old-time islander is called a *kamaaina;* a newcomer is a *malihini*).

Long ago, according to Heloke, maidens of the Big Island—the Island of Hawaii—would go swimming in a cove that sheltered them from the sea. Many times, however, a swimmer would disappear and never be seen again. Coincidentally, a mysterious stranger was always in the vicinity when a disappearance occurred. Fishermen near the cove were suspicious of the stranger, but they could not prove that he had anything to do with the girls' disappearance.

One day, armed with their spears, they went swimming with the girls. A shark attacked the group, but the fishermen stabbed it several times with their spears, and the shark fled. A short while later, the mysterious stranger was found on the shore, dying of spear wounds. And when he died, his body turned into *Kapaaheo*, a large stone shaped like a shark.

When the Bishop Museum decided to ship *Kapaaheo* from Hawaii Island to Honolulu, Heloke Mookini had a dream in which his mother visited him and told him of *Kapaaheo*, and asked him to help with its removal to Honolulu.

"So I went to the stone," Heloke recounted, "and saw three bulldozers that were damaged from trying to lift the stone on a sled. I hit the Shark Stone with a rock, and the sound was like a dull thud. I knew the stone was unhappy. So I told it that to go to the Bishop Museum and be with all its old friends of Hawaii would be the best thing."

Heloke said he tapped the stone again, and "the sound was now like a clear, ringing sound which meant that the stone was happy."

Kapaaheo was no longer stubborn, for, according to the *Honolulu Star-Bulletin*, "The next day a single bulldozer pushed the stone onto a sled without any difficulty."

Mythological sharks were not always malevolent. They often guided lost fishermen to land, and even saved swimmers from other ill-mannered sharks. *Nei de Tuahine*, a goddess in the form of a sting ray, was a one-woman Coast Guard in Tahiti, according to the old tales. Her specialty was saving people lost at sea. She'd load them on her broad back and go skimming off to land with them.

In the Cook Islands, the tale is told of Hina, a nasty young lady who wanted to journey to the sacred island of Motu-tapu. Hina did not have a canoe, but that didn't stop her. She rode a relay of fishes, leaving each one permanently scarred by her rough-riding habits. She lashed one fish so hard that welts covered its body, and so it became a striped fish. Another she beat, producing black-and-blue spots, and that is the way its coloration remained. A third she battered so thoroughly it wound up forever blackened. She stepped on the obliging sole so hard that it has been flat ever since.

By the time she boarded a shark, she was hungry. She cracked a coconut on the shark's head, raising a bump which has been on sharks' foreheads ever since and is known as "the bump of Hina." Incidentally, the shark proved itself far less docile than the other poor fish Hina abused. When she cracked that coconut, the shark dived, leaving Hina in the middle of the ocean, and it is a matter of some doubt whether she ever did make it to Motu-tapu.

Rays were similarly looked upon as benevolent among the Norse men. An ancient account of the ray's kindness—and the Dogfish's malevolence—written by Olaus Magnus says: "There is a fish of the kind of Sea-Dogfish . . . that will set upon a man swimming in the Salt-Waters, so greedily, in Troops, unawares, that he will sink a man to the bottome, not only by his biting, but also by his weight; and he will eat his more tender parts, as his nostrils, fingers . . ."

When this happens, however, the account goes on, the ray rushes to the rescue, and, "with some violence drives away these fish that set upon the drown'd man, and doth what he can to urge him to swim out."

Out of the mists of legends in the Torres Strait, between the northernmost tip of Australia and the coast of Papua, comes the tale of the wondrous deliverance of Mutuk, a man who was swallowed by a shark. The details of Mutuk's sojourn in a shark's belly are not as well known as Jonah's stay in what is generally thought to be a whale. But the two stories are basically similar.

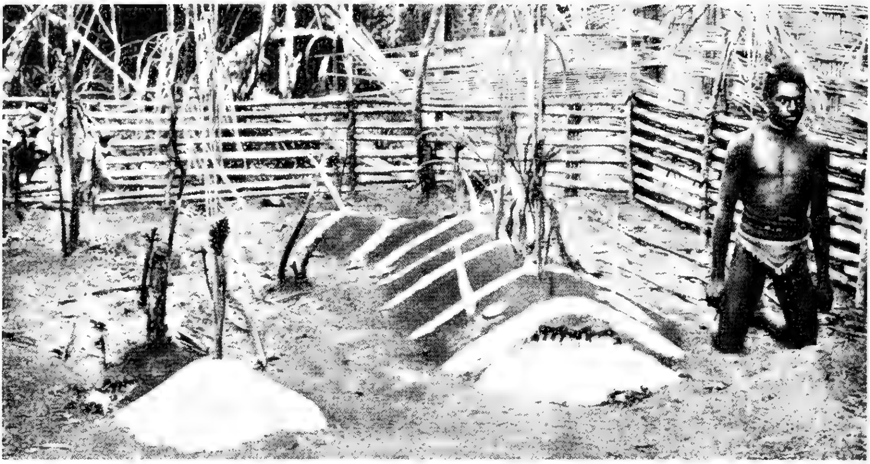
Countless religious paintings to the contrary, there is support for the claim that Jonah was swallowed by a shark, not a whale. The Bible says that Jonah was swallowed up by "a great fish," and, though the biological distinction probably was not known to Biblical scribes, the whale is a mammal, not a fish. Bishop Erik Pontoppidan of Norway, a prolific writer on denizens of the sea, in 1765 wrote a long and learned paper which proved, to his satisfaction at least, that Jonah had been gulped down by a Basking shark. Anatomically, this would be difficult for a Basking shark, whose diet is restricted to plankton and whose gullet would have trouble passing a prophet. For this reason, supporters of the Jonah-was-swallowed-by-a-shark theory favor the Great White shark (*Carcharodon carcharias*), which certainly is a man-eater. The regurgitation of a man—alive—would be far more miraculous on the part of a Great White than a whale. The notion that Jonah was swallowed by a whale may have been inspired by the fact that Joppa, whence Jonah was going when the sailors tossed him overboard, was an ancient whaling port.

The western Pacific is not the only ocean whose sharks have been worshiped or made the heroes and villains of mythology. Many American Indian tribes were awed by sharks. Laurence M. Klauber, an outstanding herpetologist and an authority on the rattlesnake, was surprised to discover that some tribes of Indians, though not very familiar with the sea, called rattlesnakes "the little sharks of the woods." The Tlingit Indians of southern Alaska divided their tribes into *tus*, or "shark," lodges. The chief of one of the tribes was called *Ha yeak*, an Indian term for the hollow left in shallow water by a swiftly swimming shark. To the Tlingit Indians, the skate was known as "the canoe of the land otter." Shark crests marked the carved emblems of tribal clans, and the sticks the Indians used in playing a gambling game, vaguely similar to dice, were named after several animals, including the *tus*.

In South and Central America, images of sharks appear on ancient Indian pottery, and figurines depicting swimmers being devoured by sharks have been unearthed. Archaeologists have found sting ray barbs that were probably used as sacrificial knives on Indian altars where human victims were offered to the gods. Along the Honduran coast, even today Indian children play an old, old game in which the child who is "it" dives into the water and tags other children by pinching or biting them. The game is called "playing at shark."

The *Kojiki*, the oldest Japanese history book, has a tale of shark to tell. Once, long ago, the story goes, a white hare on the Island of Oki called to a shark near shore. "Isn't it interesting to compare the number of your fellow creatures and that of mine?" the hare asked. "If you would let your fellow creatures lie in a row from this island to the Cape of Keta, I should step over them, counting their number." The shark agreed, and the hare began hopping, shark by shark, toward what is now the main island of Japan. Just as the hare reached the cape, it taunted the sharks by shouting: "You foolish sharks, you have been deceived. I only wished to come to the mainland." The shark which lay nearest the hare caught it and angrily skinned it alive.

The naked hare was lying on the cape, weeping with pain, when the god Yasokami came along. Yasokami told the hare to bathe in the sea and lie down on the hill in the wind. The hare took the god's advice, but the salt and the wind only intensified the pain. As it lay there, weeping even more, another god, Okuninushi, passed by. Okuninushi, Yasokami's brother, was carrying Yasokami's baggage. The brothers were on their way to visit the goddess Yakami in Inaba; they were both in love with her. Okuninushi kindly told the hare to bathe in river water and lie down on a bed of cattails. The hare recovered, and, in gratitude,



The "Festival of the Shark" used to be held annually in some parts of the New Hebrides. The ceremony lasted for a week. The body of a shark was placed in a sort of native altar and was buried. A native artist, with white pigment, painted the figure of a shark upon the grave, which for a time was constantly guarded.

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940. From *Pacific Island Monthly*

prophesied that Okuninushi, not his brother, would win the hand of the goddess. And, as the hare had foretold, the goddess Yakami did marry Okuninushi.

One of Japan's mythological deities is a god of storm, known as the Shark Man. In fact, the shark is so terrifying in Japanese legends that when the Chinese sought a talisman to be painted on war planes raiding the Japanese, they chose the evilly leering face of the Tiger shark. The American pilots who flew these shark-invoking planes were known throughout the world as the "Flying Tigers," but actually they should have been called the "Flying Sharks."

Wars are not new to shark-gods. On some Pacific islands, such as the Marshalls, tribes fought religious wars over sharks centuries ago. These battles were caused by members of one tribe defying the shark or sting ray taboos of another. What usually happened was that a member of a tribe which did not worship a certain kind of shark or sting ray would catch one of the sacred creatures. When word of the sacrilege reached the tribe that did worship that specific shark or sting ray, a delegation would be sent to the tribe whose member had committed the sacrilege. If that tribe refused to heed the worshipers' pleas to desist from the desecration, a holy war would begin.

The coming of Christianity lessened shark worship among the Pacific islanders, but the white man's religion did not completely stamp out devotion to the shark. On Samoa, for instance, the Great White shark was looked upon as an emissary of Moso, the god of the land. To protect his coconut or breadfruit trees, a Samoan would fashion from coconut fiber an image of the shark, and suspend the idol in the tree. Similar images were placed in gardens to protect them. If a thief stole from a shark-guarded tree or garden, he risked being devoured by a Great White the next time he went fishing. The story is told on Samoa about a native, newly converted to Christianity, who showed his contempt of this superstition by mockingly thrusting an arm into the mouth of one of the shark idols. Shortly thereafter, so the story goes on, the native went on a fishing trip and was seized by a shark which bit off both of his arms.

India has its snake charmers, and the Pacific has its shark charmers. According to newspaper reports, a Catholic priest, the Reverend A. J. Laplante, witnessed shark charming in the Fiji Islands during the decade he spent as a missionary there between 1928 and 1938. Father Laplante said the islanders subdued sharks by kissing them.

"It's some occult power they have which I can't define," the priest reported after returning from the islands in 1938. "But once the native kisses it, that shark never moves again."

Twice a year, when the natives made a drive for food for tribal feasts, or when they wanted to make their swimming areas safe from sharks, shark-kissing ceremonies would be held. Father Laplante said,

> The night before the drive, the man who wants the shark fishing done goes to the house of the chief, who is also the sorcerer or medicine man. There they enact a ceremony which survives from their oldest superstitions and beliefs.
>
> This ceremony always includes the presentation of *kava*—a mildly narcotic beverage made from juice extracted from finely ground root—and the sacrifice of an animal. The *kava* is drunk and some of it is sprinkled on the important main post of the house, where the spirit lives, and the animal is strangled, cooked and eaten.
>
> The next day, the natives drive the sharks into a large net, the shark-kissers wade out, seize the man-eaters, kiss them on their up-turned bellies and fling them on the bank. I don't know how they do it, but, among the natives, it is taken for granted that once a shark is kissed—upside down—that is the end of it.

Shark-kissing suddenly cropped up as an occult collegiate ritual in 1960 in Fort Lauderdale, Florida, when cavorting college boys on Easter vacation there procured a 4-foot shark named Freddy and forced coeds to kiss it. Fort Lauderdale police, long inured to college pranks, arrested one of the shark's owners, but Freddy, apparently dead, was thrown into the sea and was never seen again.

Pearl divers off the coast of Ceylon in the Indian Ocean have long relied upon shark charmers to protect them from sharks. Sir J. Emerson Tennent, who studied the customs of Ceylon pearl divers, reported in 1861 that the "mystic ceremony of the shark charmer" was "an indispensable preliminary" to every pearl hunt. Sir Tennent noted, His power is believed to be hereditary; nor is it supposed that the value of his incantations is at all dependent upon the religious faith professed by the operator, for the present head of the family happens to be a Roman Catholic. At the time of our visit, this mysterious functionary was ill and unable to attend. But he sent an accredited substitute, who assured me that, although he himself was ignorant of the grand and mystic secret, the mere fact of his presence, as a representative of the higher authority, would be recognized and respected by the sharks.

Shark superstitions and shark tales followed in the wake of the sailing ships that touched the exotic isles and strange lands where the shark was a god or an instrument of the gods. And civilized men themselves often used this deity for their own ends. When the British maintained prison colonies on Tasmania, in the early nineteenth century, fierce dogs and armed guards patrolled the prison encampments. But hardy prisoners were managing to escape from one of the settlements, located at the end of a narrow peninsula. The captives slipped into the sea, swam past the patrolled area, then waded ashore and crept through the undergrowth to eventual freedom. The governor of the colony ordered that garbage be dumped every day in the waters along the peninsula. Lured by the daily promise of free meals, sharks began congregating in the waters of the escape route. After a few screams in the night, and after the prisoners learned about their hungry new watchers, the escape attempts stopped. Sharks were a similar menace to prisoners attempting to escape on frail floats from Devil's Island in the tropical Atlantic off French Guiana.

Even today, on Ile Royale, a prison island next to Devil's Island, one can see the moldering coffin in which the bodies of prisoners condemned for killing fellow convicts or guards were placed after they were guillotined. Only one coffin was needed, for the executed men were not buried in the earth. The coffin was loaded aboard a boat which guards rowed a short way off land. The body was there consigned, not to the sea, but to the sharks that swarmed in the blood-stained waters.

How many dead or dying slaves were thrown to the sharks will never be known. Whispered tales of these evil deeds inspired this anonymous poem in *The Book of Fishes*, published in London in 1835:

> . . . here dwells the direful Shark, lured by the scent
> Of reeking crowds, of rank disease and death.
> Behold! he rushing cuts the briny flood,
> Swift as the gale can bear the ship along;
> And from the partners of that cruel trade
> Which spoils unhappy Guinea of her sons,
> Demands his share of prey . . .

"A master of a Guinea ship informed me," the British naturalist Thomas Pennant wrote in 1776, "that a rage of suicide prevailed among his new bought slaves, from a notion the unhappy creatures had, that after death they should be restored again to their families, friends, and country. To convince them at least that they should not reanimate their bodies he ordered one of the corpses to be tied by the heels to a rope, and lowered into the sea, and, though it was drawn up again as fast as the united force of the crew could be exerted, yet in that short space the sharks had devoured every part but the feet, which were secured at the end of the cord."

In *Sharks Are Caught at Night*,[1] François Poli recounts a story still told around the shores of Lake Nicaragua about the greedy Dutchman who fished for the sharks which consumed the bodies of Indians hurled into the lake. After elaborate funeral ceremonies, the corpses, bedecked in jewels and gold ornaments, were consigned to the sharks, apparently to appease them, for their man-eating habits were—and are—notorious. The Dutchman, the natives told Poli, fished for the sharks, ripped them open, and stole the sacred sacrificial jewelry and gold. He had harvested a fortune, so the story goes, by the time the Indians discovered his desecrations and killed him. His body was not thrown to the sharks, of course; he wasn't good enough for that. "So then," Poli quotes his tale-teller as saying, "they set fire to the house. And cut the Dutchman's throat."

In the days of sail, many ports of call were reputed to be the homes of sinister sharks whose evil deeds were luridly recounted to wide-eyed apprentices by old salts, who familiarly referred to the sharks by name. Two of the most infamous were Port Royal Jack, who guarded the entrance to the harbor of Kingston, Jamaica, and Shanghai Bill, who prowled the waters of Bridgetown Harbor, Barbados, West Indies. Shanghai Bill gobbled down many a sailor in his time, but it was a shaggy dog that did him in. Bill, it seems, seized in his great jaws one day a big brown sheep dog that had fallen into Bridgetown Harbor. The dog's hair got caught in Bill's teeth, and he finally choked to death. This may be the world's first shaggy dog story.

Then there were the two sharks that became an island. What their names were isn't known, but they were certainly the laziest sharks that ever inhabited the sea, or a seafarer's tale, the seafarer being Captain B. J. Whip, once an officer on a cable ship in the Red Sea. According to his tale, the two sharks, then only a few feet long, discovered a fine dining area in the middle of the Red Sea. The fish were so easy to get that all they had to do was stay there, motionless, and let the fish swim into their

[1] François Poli, *Sharks Are Caught at Night* (Chicago: Henry Regnery, 1959).

mouths. Gradually, they became anchored by the seaweed that attached itself to them and, like two great hulks, they remained moored at their eatery, ever growing and ever becoming encrusted with barnacles. When last reported on by the captain, which was back in 1916 during the shark scare, when he told his whopper to the *New York Times*, they were each about 50 feet long, and hardly looked like sharks at all, so barnacle-covered were they. Some day, perhaps, they will have grown so large that they'll become a menace to navigation and will have to be sunk. Or maybe some enterprising fishermen will colonize them and make a fortune fishing those very fishy waters.

Many sharks that followed sailing ships were neither jokes nor tall tales. A steady diet of galley garbage flowed in the ships' wakes, and any shark that picked up the scent of such an easy meal would follow a ship for weeks. Sharks even bit off the brass rotators of the "patent logs" ships trailed behind them to register their speed.

One of the earliest English-language references to shark attacks occurs in a 1580 *Fugger News-Letter*, which gives this eye-witness account of how a seaman virtually fell into the jaws of a shark, somewhere between Portugal and India:

> When a man fell from our ship into the sea during a strong wind, so that we could not wait for him or come to his rescue in any other fashion, we threw out to him on a rope a wooden block, especially prepared for that purpose, and this he finally managed to grasp and thought he could save himself thereby. But when our crew drew this block with the man toward the ship and had him within half the carrying distance of a musket shot, there appeared from below the surface of the sea a large monster called Tiburon; it rushed on the man and tore him to pieces before our very eyes. That surely was a grievous death.

Ships' logs recount many similar tragedies, but there were some close races which the mariners won. The captain of the *Ayrshire* fell overboard during a cruise in 1850. His valiant Newfoundland dog leaped into the sea to save him. A shark headed for them, but, according to the log, both the captain and the dog were saved. The captain was unscathed. The dog's tail was bitten off.

Many a sailor who died aboard ship and whose body was buried at sea found his tomb in the belly of a shark. The superstition grew that sharks somehow *knew* when a man was about to die, and the appearance of sharks in the wake of a ship came to be considered an omen of death. When an epidemic of yellow fever or cholera broke out aboard a ship, the superstitious believed that sharks would stay with the accursed ship until the epidemic had claimed its last victim. One skipper who sailed out of San Francisco many years ago added to the legend. He often carried an unusual cargo—the bodies of Chinese who died in the United States, and, according to ancient custom, had to be buried in China.

A painting which one critic says "stands alone in its age," *Brook Watson and the Shark* by John Singleton Copley, was painted in 1778. Watson, who later became Lord Mayor of London, lost a leg in the attack, which occurred in Havana Harbor. It is said that when, as Lord Mayor, he was asked about his leg, he delighted in mystifying his friends by simply saying, "It was bit off!" Copley's painting was commissioned by Watson himself. He also commemorated the accident in his family crest, which shows a shark being repelled as it seizes its prey. Courtesy, Museum of Fine Arts, Boston

The skipper swore that on voyages when he carried corpses his ship was followed by a pack of sharks, which were able to detect the corpses even though they lay in lead-lined coffins deep in the hold. The shark pack, he insisted, never appeared when he carried a less funereal cargo.

The seaman's dread of sharks, oddly enough, has not spawned a superstition against naming ships *Shark*. Six United States Navy ships, in fact, have been called *Shark*. The first, a 198-ton schooner of 12 guns, was launched in 1821 and had for her first commanding officer a young lieutenant named Matthew Calbraith Perry. Three decades later, as Commodore Perry, he would lead the first American mission to Japan. During his rather undistinguished career aboard the *Shark*, Perry took formal possession for the United States of what was to become one of the country's best-known shark-fishing spots: Key West, Forida.

The other five vessels named *Shark* by the Navy were all submarines.

The first two, pioneer underwater craft, were retired without having achieved much of a record. The next two *Sharks* vanished on patrol during World War II. The sixth *Shark*, an atomic-powered submarine, was launched in 1960.

Sharks appear in several British coats-of-arms.[2]

Sir Brook Watson, Alderman of London, lost a leg from the bite of a shark in the harbor of Havana. The incident was magnificently portrayed by the painter John Singleton Copley in his famed "Watson and the Shark." But that wasn't enough for Watson. Created baronet in 1803, he assumed for a crest a demi-triton, grasping a trident and repelling a shark in the act of seizing its prey. The crest of the family of Molton has a shark's head regardant, swallowing a Negro. A similar crest was granted to the Garmston family. A shark issuant regardant, swallowing a man, is the crest of the family of Yeates of Ireland. Argent, three dogfish in pale sable, are the arms of the family of Gesse. Dogfish also appear in the arms of the family of Malvish. A demi- (or half) dogfish sable is the crest of the family of Meer of Dorsetshire.

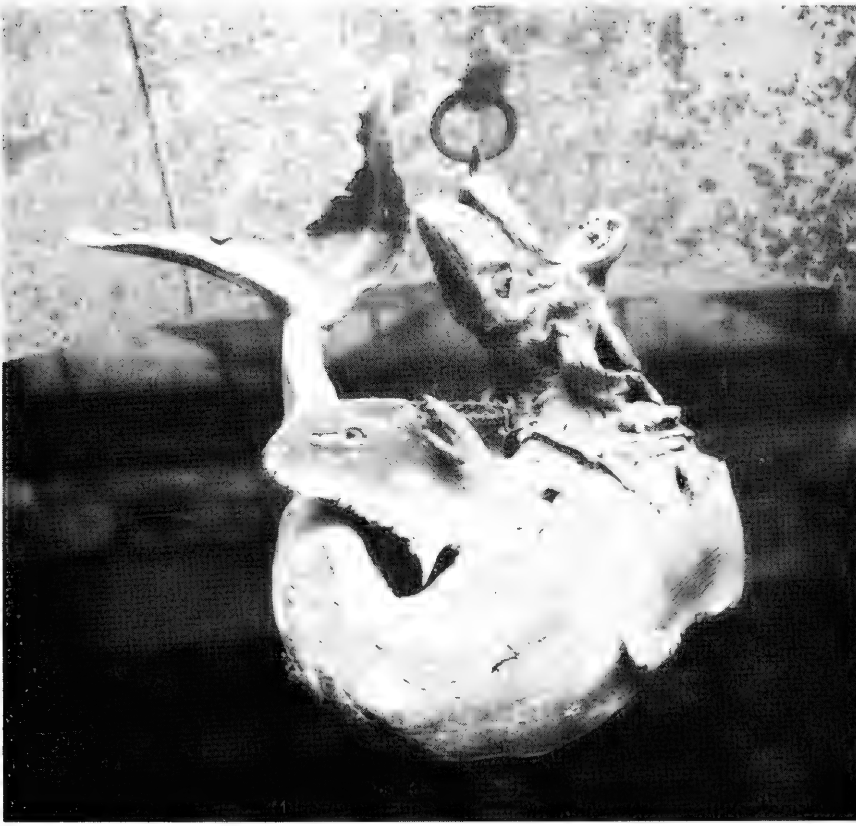
A shark posing as a mermaid guards the little town of Bregenz, Austria, on the shore of Lake Constance. How it got there, no one knows. The mermaid hangs in an archway. Legend says she has been hanging there since the thirteenth century when Bregenz was suffering from almost constant sieges by German armies and an almost continual series of plagues.

One day a fisherman drew in his net at Lake Constance and found a mermaid. He was going to throw her back when a voice from the lake cried out: "Take my daughter and hang her in the Arch of Martinster. She is begat of a land woman and is of no use here."

Fearing to disobey the Spirit of the Lake, the fisherman followed the eerie command. The next morning, the mermaid was found dead. In her struggles, she had twisted into a grotesque shape. Her death, according to the legend, resulted in a century of peace and prosperity for Bregenz.

The mermaid, still frozen in her death throes, hangs in the archway today. She is a shark. Dr. Denys W. Tucker, formerly of the British Museum (Natural History), in correspondence with one of the authors, tentatively identified the mermaid, from a photograph, as a mummified Porbeagle shark. Did it come from Lake Constance? That possibility is as unlikely as the mermaid legend. But to this day no one knows how a shark, and a mummified one at that, came to be hung from an arch in an Austrian town so far from the sea.

[2] Sharks and rays also are found on postage stamps of French Somaliland, Ifni, Eritrea, Tristan da Cunha, Gibraltar, Spanish Guinea, and Kenya.



Hanging in an archway in the Austrian town of Bregenz is this "Mermaid of Bregenz," whose appearance after being hauled from nearby Lake Constance saved Bregenz from a plethora of perils, according to a thirteenth-century legend. The "mermaid" is actually a shark, but how it turned up in a lakeside town is a 700-year-old mystery. The original mummified shark has been replaced by a stone replica, so that the town's guardian will remain in perpetuity. Courtesy, R. B. C. Twidale

Apparently there is nowhere that a shark—or a tale of a shark—cannot find its way.

For centuries, sailors' imaginations, fired by superstition, terror, and a yen for a good yarn, have spun tale after tale about sharks. Some of these tales die hard, so it should be made a matter of record that sharks do not nurse their young, produce ambergris, or beat whales to death with their tails. Nor, sad to relate, is there any basis for Mark Twain's great story that, by catching in Australia a shark that had swallowed a newspaper in London 10 days before, Cecil Rhodes fortuitously obtained advance information about the wool market and thus began to amass his vast fortune.

But stranger than all the tall tales inspired by sharks, more incredible than any sharky yarn told by a fibber of the foc'sle, are the true stories that have starred sharks. Crimes have been revealed and mysteries raised from the deep by the shark's habit of gulping down whatever passes before its mouth.

Shark-delivered mail of a grim sort was reported by Italian fishermen in 1952. They said they had found a bottle in a shark they had caught, and in the bottle was a letter a French fisherman, dying alone on a life-raft, had written as a farewell to his wife and children.

Sharks have three times ferreted out crimes which undoubtedly would never have been detected without their aid. Each of these true stories is well documented, and each is based, not on rumor or legend, but on the chronicles of courts and the footnotes of history.

Truth from the Jaws of a Shark: On July 3, 1799, the *Nancy*, a brig of 125 tons, slipped out of Baltimore and into the Chesapeake, bound south for forbidden waters. The *Nancy*, an American ship, was barred from where she was going, the British West Indies. But her owners had hit upon a scheme to disguise her true identity.

She sailed first to Curaçao, a Dutch colony in the West Indies, where she obtained fraudulent ownership papers indicating that she was owned by a Dutchman. With these papers, she sailed on. But, on August 28th, she was overtaken by a British cutter, *H.M.S. Sparrow*. The cutter's captain, Lieutenant Hugh Wylie, was unimpressed by the Dutch papers. He put a prize crew aboard the *Nancy* and ordered it taken to Port Royal, Jamaica, where the case could be settled in the Court of Vice-Admiralty.

Meanwhile, the crew of another British vessel, the *Ferret*, caught a shark, in whose jaws were found the papers of an American ship—the *Nancy*. By chance, the captain of the *Ferret* invited Lieutenant Wylie aboard for breakfast around the time the shark was captured. Wylie examined the shark-produced papers and immediately perceived the fraudulence of the Dutch "ownership" papers he had sealed with his own hand when he sent the *Nancy* to Port Royal.

The "Shark Papers," as they came to be called, were introduced into court in time to prove the true ownership of the *Nancy*, and, on November 25th, 1799, she and her cargo were condemned as a prize.

When the case ended, the shark's jaws, which measured 22 inches at their widest point, were set up on shore in Kingston as a warning to perjurers that the truth can be found, even if it is sunk in the sea. And with the jaws was a sign that said: "Lieutenant Fitton recommends these jaws for a collar for neutrals to swear through." The "Shark Papers" are still on exhibit in the Institute of Jamaica in Kingston.

The Witness Was a Shark: In November, 1915, the U.S. Government brought to trial, in the U.S. District Court for the Southern District of New York, four executives of the Hamburg-American Steamship Company. They were charged with violation of U.S. customs laws. But, in effect, they were being tried to put on record Germany's use of neutral American ports by falsely registered freighters that were used to carry supplies to German U-boats and raiders.

In his opening statement, Assistant U.S. Attorney Robert B. Wood told how a Norwegian ship, the *Gladstone*, had been given a provisional registry as the Costa Rican ship *Marina Quesada* and, on December 16, 1914, had sailed from Newport News, Virginia. Ostensibly, she was headed for Valparaiso, Chile. Actually her mission was to rendezvous with German raiders.

Early in January, 1915, Wood said, the ship's Costa Rican flag was hauled down and a Norwegian flag was run up. The name *Marina Quesada* was painted out, and *Gladstone* was once more painted on her bows and counter. And, as the *Gladstone*, after some minor adventures and misadventures, she anchored in the harbor of Pernambuco (now Recife), Brazil.

"And there," Wood recounted, "the customs authorities demanded the ship's papers, and the Captain, after giving several excuses, put the papers in a leather pouch and got in a small boat and dropped the papers overboard.

"Now, gentlemen, I do not vouch for this story, but one of the witnesses says that the crew of a Brazilian warship lying alongside the *Marina Quesada* killed a shark, and in the belly of the shark they found the ship's papers. At all events, we have not been able to get hold of the papers."

The witness was John Olson, chief engineer of the ship. He told, on the stand, the story of the ship's masquerade and its arrival in Brazil. He said that the captain of the ship had dropped the papers as he entered a small boat that was to carry him to shore. Later, Olson testified, the captain told the first mate about the incident and said: "Did you see the trick I done?"

"Did you see any of the ship's papers again? Olson was asked on the stand.

A. I seen the handbag; yes, sir.

Q. Whereabouts?

A. In a news office in Pernambuco.

Q. Did you ever see any of the papers?

A. No, sir.

Q. Did you leave the ship there?

A. Yes, sir.

At this point in Olson's testimony, according to the *New York Times* account of the trial, Olson seemed about to say more. But, "to his evident great disappointment," the *Times* reported, "Olson was not allowed to tell of the ship's papers being found on the inside of a shark."

Thus, the mystery of the shark of Recife was never cleared up, at least publicly. There is no record of it, so far as the authors' researches could determine, in newspaper files in Recife today. And there is no record, other than the scant remarks in Wood's opening statement, in the transcript of the trial. But, even with the shark as only a phantom witness, the story of the *Gladstone-Marina Quesada* was put into the record, along with many details of the German government's flagrant violations of U.S. neutrality—and the four Hamburg-American executives were found guilty.

The Shark Arm Mystery: A Sydney, Australia, fisherman named Albert Hobson hauled up his fishing line, and lifted the curtain on the weirdest murder drama Australia had even known. Hobson had set his bait about a mile off Coogee—a popular Sydney bathing beach—on April 17th, 1935. Now it was the following morning and, when he pulled in his line, he saw that he had caught not one, but two sharks.

A small shark apparently had taken the bait during the night. Then, not too long before Hobson arrived in his boat, a 14-foot Tiger shark had nearly devoured the smaller one, whose remains were still on the hook. The Tiger, still dangerously alive, had entangled itself in Hobson's line. Hobson and his brother Charles managed to get the big shark ashore. With the help of spectators who had watched the capture from the beach, the two brothers dragged the shark across a stretch of sand to the Coogee Aquarium. By the time it was placed in the aquarium pool, the shark looked more dead than alive. For 24 hours it lay in the pool, apparently lifeless. Oxygen was pumped into the pool. This seemed to help. By April 20th, two days after its capture, it was eating all the fish thrown to it.

Even in Sydney, where sharks have never been uncommon, the Tiger in Coogee Aquarium was a mild sensation, and the exhibit was crowded every day. Like a terrestrial tiger in a cage, the shark "stalked" from one end of the pool to the other in an unceasing search for escape from its prison. Then, on April 24th, the shark stopped eating. It began to languish; it hardly moved.

On April 25th, while 14 persons stood at the pool watching the listless shark, it suddenly came to life. It lashed the water with its tail. It charged into the side of the pool. It rushed to the shallow end of the pool and whirled about in eccentric circles. A brown, foul-smelling scum enveloped it. One of the spectators was standing about 10 feet from the shark when this happened. He saw the dark cloud erupt around the shark. And he saw, emerging out of the cloud and slowly rising to the surface, the remains of a rat . . . the body of a sea bird that eerily floated to the surface on dead wings . . . and, disembodied, seemingly beckoning to the gasping spectators—a human arm, with a rope tied around its wrist.

The arm was taken to the city morgue, where Dr. Arthur Palmer, the government medical officer, examined it. The arm—the left arm of a muscular man—was intact and remarkably well preserved. On its forearm was a tattoo of two boxers confronting each other, one in blue trunks, the other in red. A 6-inch rope was tightly knotted about its wrist. The knot was a seaman's knot, a clove hitch.

Dr. Palmer called in Dr. V. M. Coppleson, a Sydney surgeon, for consultation. Coppleson, who had been making a detailed study of shark-bite wounds, saw immediately that the arm had not been ripped from the man's body by a shark. It had been cleanly severed at the shoulder by a knife, wielded by a skillful butcher. No surgeon had done it, for the usual procedures in surgical amputation had not been followed.

A medical student could have severed the arm from a cadaver and, either the arm had somehow been dropped in the sea, or a prankster with a grisly sense of humor had thrown it into the aquarium pool. Both possibilities were quickly ruled out. Spectators at the pool recounted their story of seeing the shark regurgitate the arm; inquiries at medical schools established that no cadavers or portions of cadavers were missing.

The shark was killed. A few fish bones and part of a small shark were found, but there were no other human remains, not even a shred of clothing. So the arm was the only clue to the man's identity.

A Sydney police fingerprint expert was given the assigment of identifying the arm. It was a ghoulish task. The shriveled fingertips could yield no prints. The skin was peeled off the hand, treated chemically to remove its wrinkles, and fashioned into a kind of glove, from which prints could be made.

The prints matched those of James Smith, a former amateur boxer who ran a billiard parlor in Rozelle, a Sydney suburb. Smith's prints were on file in Sydney because he had been arrested three years earlier for illegal betting, a not particularly unusual offense in Australia. Smith was known to be a friend of several criminals, but he himself was not considered to be a criminal by the Sydney police. Smith's brother, Edward, identified the arm by the tattoo.

William Prior, superintendent of the Criminal Investigation Branch of the New South Wales police force, knew he was looking for a murderer, but he could not even prove that a murder had been committed. A shark had disgorged the arm of a man named Smith. Smith had disappeared. The arm, carefully preserved as the Crown's only evidence of a crime, was not enough to warrant an inquest. The coroner could not assume that Smith was dead until other parts of his body were found. In a quiet way (he was called "William the Silent" by reporters), Prior enlisted the aid of Gilbert Percy Whitley, shark expert of the Australian Museum in Sydney, and probably the first ichthyologist ever called into a murder investigation. Whitley was asked to gather all possible scientific data on the food and physiology of digestion of sharks, particularly the Tiger. Prior knew that, if the case ever came to court, the Crown prosecutor would have to tell an incredible tale. Only the scientific evidence Whitley was gathering could make the tale credible to a jury.

While the ichthyological phase of the murder investigation was pressed by Whitley, detectives went about the more familiar job of looking for a killer. The detectives soon unearthed a series of interesting facts: (1) Smith, a pool-hall operator, had been involved in some seemingly shady business deals with one Reginald William Holmes—a wealthy Sydney boat-builder. When questioned by the police, Holmes admitted knowing Smith and giving him money for business purposes. That was all. (2) Smith had last been seen in the company of Patrick Brady. The two men had stayed in a cottage in the fishing town of Cronulla. The landlord reported that after they left the cottage, a trunk, a mattress, some rope and sash cords were missing. (These articles were never seen again.) He also stated that he had found a can of evil-smelling liquid in the cottage, which he thought was blood.

An alarm went out for Patrick Brady. After questioning him, the police charged him with the murder of James Smith. Four days later the police received a startling phone call: Reginald Holmes was racing his boat around Sydney Harbor with a bullet in his head. When they caught up with Holmes he was babbling incoherently—"Jimmy Smith is dead. I'm nearly dead, and there is only one other left." But Holmes did not die—then. An x-ray picture showed that a .32-caliber bullet had flattened itself against the unusually thick frontal bone of his skull. He was released from the hospital several days later. That same night he was found murdered in his car.

Now the police had two murders to deal with. The Crown's case was shaky in each instance. It was almost impossible to make the charge against Brady stick: there was no body; there was no known date of death; there were no clues as to how Smith was murdered. Fingerprints found in Holmes's car belonged to a business associate who admitted using the car many times. Each man was tried and acquitted.

To get a clearer idea of what happened to Smith and Holmes we must return to the "avenging arm" disgorged by the shark. What the arm told was interpreted in this way:

Smith had been killed. His body had been disposed of, somehow . . . all but the arm. Either it had eluded the oblivion to which the rest of Smith's body had been consigned (his body was never found), or it had been used as gruesome proof of the deed to the man who had wanted Smith killed. Then, a rope knotted about its wrist and a weight tied to the other end of the rope, it had been hurled, probably from a boat, into the sea.

The arm floated near the sea bottom at the end of its tether, grotesquely beckoning a relatively small shark which smelled the fresh blood. The shark circled warily, then seized the arm as it would have seized a fish—with one, swift lunge. If the arm had been floating on the surface, the shark would probably have snapped at it, tearing it and obliterating the fingerprints and the tell-tale tattoo which disclosed the arm's identity. But, tethered as it was, the arm was scooped intact into the shark, whose jaws clamped down on and parted the rope that held the arm.

Soon after finding the arm, the shark discovered Albert Hobson's bait, lunged for it, and was hooked. The shark's struggles were detected by a 14-foot Tiger shark, which immediately sensed easy prey. Again, the wary approach; again, the swift thrust; again, huge jaws scooped instead of seizing. This time, however, the shark meets resistance as it attempts to bolt down its meal intact. The Tiger's prey is held by the big hook. The Tiger's jaws rip and tear near the hook. (Perhaps the Tiger itself is temporarily snared by the same hook—as often happens.) It begins thrashing, entangling itself in the slackened line. And it is held fast. Fortunately, before the Tiger's own struggles draw other sharks to the scene, Hobson arrives, captures it, and brings it ashore.

Why didn't the first shark's potent digestive secretions disintegrate the arm? Why was the arm so remarkably well preserved? The theories are many. Perhaps the sudden death of the first small shark suspended its digestive process and, when it in turn was devoured, its own body may have acted as a protective casing, shielding the arm from effacement by the Tiger shark's digestive system. Smith was murdered, apparently, some time around the middle of April. (He arrived in Cronulla on April 7th and was last seen by the landlord "a few days" later.) The shark was caught on April 18th. The arm was disgorged on April 25th.

Australian physicians and police have authenticated several cases of preservation of human remains in sharks for even longer periods than this.

Thus did investigators recount the bizarre odyssey of Smith's avenging arm. But the arm that had revealed a murder was never to lead justice to the murderer. Instead, the arm led justice down a labyrinth. . . .

There are some who say that the shark disclosed the murder of

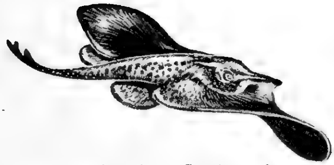
James Smith in vain, for no man was ever convicted of the slaying, and no court of law ever learned the true story of how and why James Smith was killed.

But those who have studied the incredible case have raised the question of whether Reginald Holmes was behind the murder. And, when the arm fatefully appeared, mutely demanding justice, was it like a wraith clutching at Holmes? He tried to still the torment in his soul by killing himself. But it was not to be that easy. Murder had conjured up the arm, and, when Holmes left his home on the night of his death, murder—a propitiating murder—may have been what he sought. Perhaps he kept a tryst with murder.

No matter who actually killed the haunted Holmes, the arm from the shark brought about his death just as surely as if its accusing hand had pulled a trigger.

Chapter 7

Shark-Eating Men



Sharks as food?

Yes! Salted, smoked, kippered, flaked, or shredded, the flesh of many species of shark is delicious. Fresh shark meat often has an offensive odor, because of the large quantities of urea in it. This can be removed by soaking the meat in brine. Shark has a tendency to spoil more quickly than many other fish. With proper preparation, however, spoiling can be prevented.

Skates and rays also yield good food, and are considered a delicacy in some countries. The Barndoor skate (*Raja laevis*) is sold as food along the U.S. Atlantic coast. A close European relative, the Common skate (*Raja batis*), is an important European food fish. The California skate (*Raja inornata*) is eaten on the Pacific Coast.

In 1961, an English translation of *Larousse Gastronomique*—the epic book of French cuisine—was published in the United States (by Crown Publishers, Inc.). This encyclopedic book, which lists 8,500 recipes—including some for bear claws and lapwing eggs—all but dismisses shark. But it devotes considerable space to such skate dishes as jellied skate, skate liver fritters, and *foie de raie*.

Compared to other fishes, shark is not a very popular food in the United States. In 1959, for instance, 6,202,000 pounds of shark, worth about $162,000, were landed at public fish markets in the United States and sold as such. This may sound impressive, until compared with, say, cod. In the same year, 59,809,000 pounds of cod worth $3,976,000 were landed in the United States. And cod accounted for barely 1 per cent of the more than 5 *billion* pounds of fish landed in the United States in that year.

On the other hand, seven sharks, including the dreaded Great White, and three rays, including a sting ray (*Dasyatis sabina*), are regularly caught and eaten in Texas, according to the Texas Fish and Game Commission.

Statistics tell only part of the story. Some of the shark eaten in this country does not appear on the dinner plate as shark. When a commercial fish marketer is offered, say, some Mackerel shark, he may be seized by a temptation to bestow disguised shark upon his customers. He need only chop off the shark's head, tail, and fins, then cut it into steaks. These

A skate is visible in front of the lobster in this eighteenth-century painting, *The Fish Merchant,* sometimes ascribed to Hogarth, but probably painted by Joseph van Aken.
Courtesy, The Clerk to the Worshipful Company of Fishmongers, London

steaks can be sold as swordfish steaks, and few people will know the difference.

Similarly, some fish marketers wield a device like a cookie-cutter on the pliable, fleshy wings of skates. The disk that is punched out looks, to an untrained eye, very much like a scallop. A true *aficionado* of scallops would detect the counterfeit, although it tastes good. (It must be labeled "Deep Sea Scallop," or by some other name, to be offered *legally*.)

In some U.S. fish markets, dogfish are sold as "grayfish" and skates are sold as "rajafish." Mako sharks and possibly other species may be legally marketed as "swordfish" in some areas, but the extent of these laws is not clear.

One day in the summer of 1944, a patron in a Long Beach, California, restaurant, looked coldly at some fish being sold as white sea bass, California halibut, barracuda, and salmon. The salmon looked particularly suspicious, but all of the fish, the patron knew, was actually Soupfin shark

(*Galeorhinus zyopterus*), sliced into fillets. The customer happened to be William Ellis Ripley of the California State Bureau of Marine Fisheries.

"Upon questioning," Ripley later reported, "the owner of the establishment admitted that the fillets sold for salmon had been treated with food coloring to simulate the color of salmon tissue. Elsewhere throughout the state, shark has been misrepresented as various other species . . . Even in a fishery port such as Santa Barbara, entrepreneurs have been known to pass off Bonito, Thresher and Soupfin shark as halibut, rockfish, cod, etc."

Ripley emphasized in his report on the misnamed sharks that "there is no sound nutritional, esthetic, or scientific basis for the reluctance attached to the consumption of sharks." But he pointed out that connoisseurs of other kinds of fishes, while not able to tell that they are eating shark, may feel that the halibut, say, is not quite up to par. "A few such experiences and the halibut customer is lost to the trade," Ripley said. "Therefore, if for no other reason than to maintain their integrity before the fish consuming public, the industry should attempt to restrain these perfidies."

For many years, Italian and Chinese immigrants and their descendants have for all practical purposes been keeping the U.S. shark market alive. Of the 70,000 to 80,000 pounds of dogfish (generally *Squalus acanthias*) sold each year in New York City's sprawling Fulton Fish Market—largest wholesale fish market on the Atlantic Coast—almost all are sold to customers of Italian extraction. On both the Atlantic and the Pacific coasts, customers of Chinese extraction support a shark market with their demands for fins for their cherished sharkfin soup.

In recent years, according to U.S. Bureau of Commercial Fisheries statistics, the annual receipts of dogfish and rajafish have been increasing at the Fulton Fish Market, and no one knows why. In 1950, dogfish landings totaled 54,800 pounds; in 1960, the dogfish catch amounted to 88,600 pounds. During the same period, rajafish receipts rose from 71,500 to 120,600 pounds, while fish sold as just plain shark [1] dropped from 69,800 pounds in 1950 to 23,500 in 1960.

Why did shark sales drop while dogfish and rajafish sales increased? One possible answer is given by T. J. Risoli, supervisory market news reporter of the Bureau of Commercial Fisheries: "We do not know the specific reasons for the sharp drop in shark receipts here, but we believe it is probably due to the unfavorable light the shark has been seen in as a result of injuries to swimmers."

That, of course, is the major reason people do not eat shark in the

[1] The Bureau of Commercial Fisheries does not include species designation in its report.

United States. Sheep, cows, pigs—and dogfish and skates—do not attack living people (though both dogfish and pigs will eat corpses). So no one feels queasy about eating them. As a matter of fact, the sharks which can and do occasionally attack bathers are not especially good as food. The notorious Great White shark, for instance, is *rumored* to be poisonous; and so are others.

Reports of poisonous sharks are recorded as far back as 1758 in France, and to the earliest times in some Pacific islands. But the basis for many of these reports is difficult to find. On Saipan, because of a taboo on all black fish and most red fish, the Black-Tipped Sand shark (*Carcharhinus melanopterus*) is not eaten; yet, on Guam, where no such taboo exists, it is eaten. The Six-Gill shark (*Hexanchus griseum*) is sold as food in California, but is eaten in Germany not so much as food but as a strong purgative! Mantas (*Mobula*) are eaten in tropical American ports, but some Pacific islanders believe that he who eats the Manta sups with the Devil—and they won't touch it.

We may look patronizingly upon such quaint superstitions, but the fact is that an equally irrational prejudice is keeping shark off American tables. Attempts to make Americans shark-eaters have usually gone aground on the shoals of such prejudice, or have been scuttled by bad timing. The U.S. Bureau of Fisheries, for instance, was readying an elaborate sharks-are-good-for-you campaign in 1916. Then came the New Jersey shark attacks. After the panic touched off by four killings and one non-fatal attack in rapid succession, apparently no one wanted to contemplate a shark on his dinner table.

After America's entry into World War I, another campaign was launched. At the request of the War Food Administration and the still willing Bureau of Fisheries, the well-known fish cannery, Gorton's of Gloucester, was asked to try canning dogfish. According to F. M. Bundy, president of the firm, "The product looked good and apparently was satisfactory until, a short while after the canning, the fish developed a strong ammonia odor when the cans were opened. This resulted in more being returned than were shipped. Naturally, we have steered away from it since."

Teddy Roosevelt thought that sharks tasted bully, and said so publicly, to try to get people to eat shark meat during World War I. Roosevelt called for an endorsement from one of his friends, Russell J. Coles, long-time watcher and catcher of sharks in the Carolinas. Coles boasted that he had sampled no less than 18 varieties of shark and ray. At Roosevelt's behest, Coles replied to the inevitable question—What does shark taste like?—with the following enthusiastic answer:

"Nurse shark, fairly good for food, although tougher than most species; Smooth Dogfish, one of the most delicious fish that exists; Cub shark, of strong odor, but, when specially prepared, suitable for food; Hammerhead shark, a crowning dish for dinner; Bonnet-Nosed shark, ranks well up as food; Sandbar shark, most desirable for food; Barndoor skate, excellent for food; Clear-Nose skate or Brier ray, good eating, similar to shrimp; Small Electric ray, flavor delicious; Large Sting ray, good for food; Sand skate or Butterfly ray, good; Spotted Sting ray, excellent, flavor similar to bluefish; Cow-Nosed ray, flavor similar to scallops; Eagle ray, excellent, with the flavor of scallops; Small Devilfish, delicious."

But the combined efforts of Cole's eulogy of cooked shark, Roosevelt's fervent defense of it—and even sheer patriotism—did not get Americans to eat shark.

It seems to take something as colossal as a world war to get Americans even to *think* about eating shark. In World War II, once again the Bureau of Fisheries called upon the meat-rationed public to build up their protein intake by eating all kinds of fish, including shark. One of the authors, Captain Young, was delegated to catch a batch of sharks to start the nation's second wartime sharks-are-good-for-you campaign. Captain Young recalls,

> I had an order to send a thousand pounds of fresh shark to a New York corporation for distribution to their customers. I went shark fishing on the Gulf of Mexico, off Biloxi, Mississippi, and caught Duskies, Black Tip and Sharp-Nose by hand line from shrimp boats. The shrimp men throw millions of pounds of what they call "trash fish" into the water when they sift through their catches for shrimp. The sharks were abundant.
>
> When I caught the sharks, I used a trick I knew to make their flesh whiter. I cut their tails off as soon as they were hauled aboard. The blood drains out of their bodies through two big arteries that lead to the tail. As soon as we got ashore, I shipped the sharks to New York by express, on dry ice. They arrived in perfect shape, and, I found out later, most of the customers liked what they tasted.
>
> But, knowing that there was a prejudice against the word "shark," the company decided to sell the fish under the name of "Grayfish." But the government ordered the company to sell the shark as *shark*, and that was the end of that.

The camouflaging of shark with another name is a ruse that has been used—and is still being used—in many parts of the world. The British have been eating shark and skate for centuries, at times under disguised names. An anonymous Elizabethan poet, chronicling the fish "that's eatable to us," rhapsodizes the herring, cod, mackerel, sole, and whiting; then, in a wretched rhyme, says:

> *The haddock, turbet, herb, fish nourishing and strong;*
> *The thornback and the scate, provocative among.*

That last line, which mentions the Thornback skate (*Raja clavata*) and presumably the Common skate (*Raja batis*), may not be very poetic, but it is candid. And it establishes that Elizabethans called a skate a "scate." Shakespeare also referred to sharks, though not in ways that complimented them as food. The recipe for witches' stew in *Macbeth* calls for

Scale of dragon, tooth of wolf,
Witches' mummy, maw and gulf
Of the ravin'd salt-sea shark.

And *dogfish* found its way into *Henry VI*, Part One, though only as an ingredient of a complex pun. When Talbot is speaking angrily about the slaying of Salisbury before Orleans, he vows revenge:

Frenchmen, I'll be a Salisbury to you:
Pucelle or puzzel, dolphin or dogfish,
Your Hearts I'll stamp out with my horse's heels
And make a quagmire of your mingled brains.

Dogfish was used commonly in Shakespeare's time as an opprobrious epithet. *Dolphin* was a pun on the Dauphin of France.

Elizabethans ate a variety of selachian dishes, and, when the exporting of fishes to the Continent drove domestic prices up, British fish eaters became angry men. In 1578, a group of them drew up a stirring petition which began:

> Whereas divers kinds of sea fishes, as congers, hakes, pilchards, skates, rays, thornebags [Thornback skates], papillions [Butterfly rays], and dogs [dogfish] being necessary victuals for the people of this realm . . . now of late altered from their kinds by curing without salt or otherwise converting them into gross oils, for the contention of foreign realms and to the great increase of dearth and lack and penury of this realm . . .

Some of the methods of preparing skates and dogfish in the British Isles in the old days would paralyze a modern palate. In the Shetland Islands of Scotland, skate was buried in the ground to cure it, and it was said to have an unusual flavor after its resurrection. In the Highlands, "sour skate" was produced by simply hanging skates up to dry for a few days in the open air. Dogfish was also skinned, to prevent identification, then cut open, dried outdoors, and sold as a special kind of salmon!

Perhaps because of sour skates and phony salmon, the eating of sharks and skates eventually became unpopular in Britain. The modern emergence of shark as a British food fish came around 1904, during an industrial depression.

Fried fish retailers, looking for a cheap fish they could sell to the poor and still make a profit, discovered that they could buy dogfish for as

A Fishmonger's Shop, painted by Alex Fraser in 1812, shows two skates in the foreground, proving then—as now—that skates were on the British menu.

Courtesy, Lord Leverhulme

little as two shillings for 140 pounds. The fried fish sellers dubbed the dogfish "Rock Salmon," and, with a side order of fried potato chips, sold portions of it for one and a half pence, which is about as cheap as a meal could be.

Dogfish—the Rock Salmon pseudonym did not fool people very long—failed to catch on, especially when better times came to the poor and a man could afford more than a penny and a half for a square meal.

By the eve of World War I, dogfish had become victims of prosperity. Cursed as trash, they were thrown away by the fishermen unlucky enough to land them.

But, just as grass is always greener in the yard next door, so, apparently, are sharks more tasty from foreign waters. For, around 1922, the English began importing dogfish from Norway, even though British waters abounded with them. The Norwegian dogfish, well packed and in prime condition, again found a ready market among the fish 'n' chips merchants. The merchants claimed that the dogfish were fine for frying because they absorbed less oil. Put a mess of dogfish in a deep-fat fryer, the merchants said, and the dogfish would use up less fat than a comparable weight of bony fish.

Today, more than 17,000,000 pounds of dogfish and 24,000,000 pounds of skates and rays are landed in Great Britain each year, much of the catch finding its way into London's Billingsgate Market, the acre of fish and fishmongers which has been noisily supplying Englishmen with their fish for centuries.

A single boat in a single day may land as much as a ton of salable dogfish. In official publications and in fishery reports, the catches are frankly described as dogfish, skate, and ray. The old habit of disguising the selachians with fanciful names still persists, however. Good old "rock salmon" is still used, along with "nursehound,"[2] "flake" and "huss." No longer fashionable, probably because it was just a bit too much, is "Folkestone beef."

Calling upon Britishers to face the dogfish name problem squarely, a Member of Parliament recently went on record with a plea for standardizing shark nomenclature. He lamented the habit of calling all species of sharks by the same name, dogfish. Spur dogfish, he orated, is "sweet and nutritious"; Sandy dogfish is "quite good to eat." But some kinds of dogfish, he thundered, "smell like a polecat."

The honorable MP's confusion is shared by many an Englishman, for no less than six species of vaguely named sharks are eaten in Great Britain, and some of them, at times, do smell like polecats. The pungency of one has led to its being nicknamed "Sweet William," after a British flower that has a pleasant scent. The British common and scientific names of the dogfish regularly marketed as food in England are: the Pinked dogfish (*Squalus acanthias*), Lesser Spotted dogfish (*Scyllium canicula*), and Greater Spotted dogfish (*Scyllium catulus*).

Today, in the more than 17,000 fish 'n' chips shops that flourish in Britain, dogfish and skates are among the most popular fish. But sharply distinguished geographical zones have somehow sprung up to

[2] This is a "popular" name for all dogfish in the British Isles.

separate one area's "fish" in fish 'n' chips from another area's "fish." Cod seems to cut across all geographical lines. Hake is used in the shops of Lancashire and South Wales; haddock is preferred in Leeds and in the industrial areas of Yorkshire; small haddock appears in Scottish shops. In London and the south of England, skate and dogfish still reign supreme, however. In Ireland, the fleshy "wings" of skates and rays are the mainstays of fish 'n' chips shops.

For many years, Italy imported Porbeagle sharks from Scandinavia. When Benito Mussolini rose to power, however, he forbade the importing of alien sharks, apparently because he did not want Italians disparaged as shark-eaters. Despite Il Duce's edict, Norwegian and Danish sharks were smuggled into Italy. Nowadays, although some 60 species of sharks, skates, and rays can be found in Italian waters, the Italians are once more importing Scandinavian sharks. Most of the Norwegian and Danish catch of Porbeagle shark (*Lamna nasus*)—over 1,000,000 pounds a year—is iced and shipped to Italy.

Norway, which has solved the problem of preserving fresh shark, has a long list of customers for its millions of pounds of sharks, skates, and rays. Norwegian exports of selachians for January to June, 1961, included more than 4,000,000 pounds of dogfish to Great Britain and Northern Ireland and about 2,000,000 pounds more to Sweden, Belgium, Holland, Luxembourg, France, Italy, and West Germany. Another 5,000,000 pounds of frozen dogfish were sold to most of these countries, along with East Germany, Czechoslovakia, and Austria. Norway also exported some 500,000 pounds of skates and rays during that six-month period.

Norway has perfected a process for preserving dogfish and keeping them in nearly perfect condition for long periods of time. The sharks are cleaned and the belly walls are cut away. They are then packed in boxes in an alginate jelly and placed in refrigerators at a temperature of $-15\,^{\circ}$C. for 24 to 36 hours. The fish are frozen solid, but the jelly is not. The jelly forms a protective coating in which the fish may be preserved indefinitely. The fish can thus be removed singly from the packing boxes as they are sold. This is the first process that has enabled packers to preserve shark in a fresh state.

In Norway, the eggs of the dogfish (*Squalus acanthias*) and of skates are used in puddings as a substitute for hen's eggs. As a matter of fact, the eggs of this dogfish contain more yolk than do hen's eggs.

More than 2,500,000 pounds of shark were landed in Germany in 1959. Porbeagle sharks are sold in the markets at prices more than twice as high as those for plaice (a flounder) and nearly four times higher than cod. Other species of shark are among the cheapest fish, selling for about the equivalent of a penny a pound, or slightly above the going price for herring. Some sharks are marketed under the trade name "Sea Eel."

Norway ships iced belly-walls of dogfish to Germany, where they are prepared by smoking. During the smoking, they curl up. These are a delicacy called *Schillerlocken*, after the long, flowing curls affected by the poet Schiller. Usually sold packaged, they are a popular food in thousands of homes.

In Denmark and Sweden, the tender meat of the Thornback or Thorny Maid skate (*Raja clavata*) is savored as a substitute for lobster. About 500,000 pounds of Thornbacks are caught each year in Denmark alone. The Common skate (*Raja batis*), which also ranks with lobster as a seafood on Danish and Swedish tables, is hauled in at the rate of 220,000 pounds a year by Danish fishermen.

Such statistics are feeble, however, when the world-wide catch of sharks, skates, and rays is compared to the catch of fishes that are not saddled with prejudice. A United Nations survey of food fish in 1956 showed that selachians accounted for a bare 1 per cent of the world's total marine and fresh-water harvest. Herring, sardines, and anchovies, by comparison, accounted for 24 per cent.

These UN statistics are not wholly reliable, however. Some countries, perhaps because of a piscatorial form of nationalism, do not report any landings of sharks, skates, and rays. One of the authors has seen all these unmentioned selachians on sale in markets of countries whose fisheries reports to the UN are sharkless.

In nations where common sense has won out over prejudice, sharks have become a dietary staple, and an extremely nutritious one, too. Analyses of the flesh of a lowly dogfish (*Squalus acanthias*) have shown that it contains more protein and more energy value per pound than eggs, milk, oysters, mackerel, lobster, or salmon. Yet, in the United States and Canada, this same dogfish is labeled a predator and marked for execution, not for use as food. Since 1956, the Canadian government has been posting a bounty on dogfish in an attempt to eradicate them as a pest. In 1958, President Eisenhower signed a bill authorizing the U.S. Department of the Interior to spend up to $95,000 a year to find new ways to exterminate dogfish *or to find some use for them.* The fact that some countries have found a use—as food—has been almost totally overlooked in the United States. Driven by an obsession to exterminate sharks instead of utilizing them, American fishermen annually destroy tons of dogfish.

At a time when a burgeoning population is exhausting traditional food supplies, such wanton destruction of a cheap, abundant, nutritious maritime resource is absurd. The world's 2,900,000,000 population has almost doubled in the past 70 years and is expected to redouble every

42 years from now on, if the current explosion continues at its present phenomenal rate. Population experts believe that only by more efficient exploitation of the riches of the sea can the new mouths be fed.

A study of the catch per unit of effort for long-line-caught sharks made during cruises by Pacific Oceanic Fisheries research vessels during 1956 showed that six species are captured commonly and are abundant over wide areas.

The White-Tip and the Brown are equatorial; the Mackerel shark less abundant but wide-ranging; the Great Blue very abundant in colder waters; the Bonito shark, scarce; and the Thresher, not uncommon but subject to unknown factors causing it to appear only in certain longitudinal belts and nowhere else. All of which indicates that (a) the sharks are there and (b) we know almost nothing about their habits.

In the 90 billion acres of ocean that girdle our crowded planet, an incredibly bountiful crop is often unharvested. That crop is fish, a food rich in protein and containing—unlike some forms of protein on land—all the amino-acids essential to the human diet. Yet, while an estimated two out of every three persons on earth are not getting even a minimum protein diet, one of nature's finest and most readily obtained sources of protein is virtually ignored. Some one billion tons of fish—about 30 times the current world catch—could be landed each year, and not from depleted fishing grounds such as the North Sea. But the technology of fishing remains for the most part on the level of primitive hunting, not on the level of modern farming. But we are awakening, at last, to the fact that more fish must be harvested to feed a famished world. In its Freedom-from-Hunger Campaign, the Food and Agriculture Organization of the United Nations is seeking ways to catch and use more fish. And among them is the shark.

Fortunately, in some countries where the population explosion is particularly critical, sharks are being caught and used for food. Centuries ago, Arab fishermen introduced shark fishing to natives along the East African coast. Not until a few years ago, however, was shark fishing carried on as a large-scale commercial venture. To meet the demand for a low-priced protein food among Africans in Kenya, the Fish Division of the Kenya Game Department began teaching native fishermen modern fishing techniques. Hand-made nets of the lowest grade of cotton, quick to tear and rot, were replaced by tough, rot-resistant nylon nets. Modern marketing procedures were introduced.

Now a native fishing boat proudly pulls into a port such as Malindi with perhaps 30 or 40 sharks and a couple of Mantas. Some of the flesh is cut into small chunks that are sold for a dime each. And each Friday in Malindi, after midday prayers, the fish auction beings. In a babel of a dozen African and Arabic tongues, dealers bid excitedly for salted

A big Hammerhead shark is weighed in Malindi, Kenya, before being cut up for salting and selling. Sharks are sold in a fish auction in Malindi, where tons of sharks are marketed annually. Virtually every bit of the shark is used in some way. The liver oil, for instance, is used in the tanning of leather and also as a wood preservative for native dhows. Courtesy, *Veld & Vlei* Magazine

shark meat. So great is the demand for the food that local waters cannot supply enough, and shark meat is imported.

Meat is not the only shark product Kenyans are using. They have learned to use other products from the shark's ample "larder." Oil, used for leather tanning and wood preservation, is extracted from the sharks' livers; fins are exported for sharkfin soup fanciers; from the gelatinous fibers in the fins comes an ingredient for luxury soap; the skin is shipped off to European tanneries to be made into leather; the teeth are sold for novelties; and fertilizer is made out of virtually all that is left.

Sharks have made a boom town out of the little South African fishing village of Gansbaai, 115 miles east of Cape Town, on the tip of the great continent. For generations, the fishermen of Gansbaai have been ignoring the sharks off their shore, and Gansbaai remained a sleepy little village. Then, in 1950, a shark industry was begun. Now, on some days, more than 2,000 sharks are delivered to the Gansbaai Fishery Cooperative. The sharks are mostly the familiar Soupfins also found in California waters, and, as once they were in California, the Soupfins (called *Vaalhaai* in Gansbaai) are tapped for their "gray gold."

The cooperative sells the livers to a pharmaceutical manufacturing company which operates a small oil-extraction plant in the village. About 2,800 pounds of oil are processed each day during the shark-catching season, which runs from April to September. Shark meat, for which many African natives have developed a taste, is shipped to the Congo, Ghana, and Mauritius. Dried fins are exported directly to China. Some fishermen make as much as $56 a day catching sharks—and they are caught the hard way, on hand-lines! With the shark came prosperity. Fishermen's tiny cottages gave way to larger, more comfortable homes. Big power boats replaced the traditional cockleshell skiffs. Electricity and telephones appeared for the first time in most Gansbaai homes. All because of the shark.

The Pacific Ocean teems with sharks. American fishermen using long-lines to catch Pacific tuna have cursed the thousands of sharks that were caught on hooks intended for tuna. In Australia long-lines are used to *catch* sharks.

Out of Melbourne harbor and into Bass Strait, which separates the mainland of Australia from Tasmania, sails a 50-foot boat, especially

A huge Sawfish, taken off Malindi, Kenya, is part of the catch which African fishermen hauled in during a regular shark-fishing voyage. The Sawfish broke through the nets, which are usually strong enough to hold the sharks which make up most of the Malindi catches. The nets are of nylon, which are said to be three times more effective than nets made of cotton. One advantage of nylon, besides its strength, is its tendency to blend with the color of the sea. Cotton nets cannot be used in bright moonlight because they show up and the sharks bypass them. Courtesy, *Veld & Vlei* Magazine designed to catch shark. When the boat reaches the sharking grounds, a winch unwinds the long-line, which has 300 to 500 hooks strung from it. Buoys mark the ends of the lines. This one boat may sow as many as 2,000 hooks for the shark harvest. When the hooks are pulled in by the winch, a three-man crew works with assembly-line speed. As each 4- or 5-foot shark is hauled over the stern, it is swiftly gaffed, unhooked, and beheaded by one man. Another man is working the winch. A third is cleaning the beheaded sharks as they are tossed to him. This is not a pleasant job, for fresh sharks develop an ammonia-like odor and, on a warm day, the odor is so overwhelming that the crewmen often suffer headaches, stiffness of the jaws, and nausea.

But the suffering pays off. A catch of 160 sharks is not unusual. Each averages about 22 pounds, dressed. That adds up to 3,520 pounds of fish, and in Melbourne, where more shark is sold than any other variety of fish, the catch would be worth more than $300.

Shark was once discreetly called "flake" in Australia, but in recent years it has been sold openly as shark, in both Australia and New Zealand, and the demand has been great enough to produce large-scale commercial shark fishing. So unrestrained did the shark fishing become, in fact, that the Commonwealth Fisheries Office began a campaign to protect certain sharks from extinction—and this in a country where bathers have been trying for years to protect themselves from the shark! Sharks classified as "man-eaters" are not sold in Australian markets, but this is the only commercial notice paid to those sharks that reverse Australians' shark-eating habits.

The Fisheries Office tried to educate shark fishermen in the ways of conservation by circulating a film whose title, *These Sharks Need Protection*, must have struck Australian bathers as rather ironic. Finally, strict conservation laws had to be passed, despite the opposition of some fishermen. The two principal protected sharks used for food in Australia are the Schnapper, School, or Sharpie shark (*Galeorhinus australis*), which grows to about 5 feet, and the Gummy shark (*Mustelus antarcticus*), which usually grows to about 3 feet. The Gummy gets its name from its "toothless" appearance. Actually, it has pavement-like teeth. Because of its tendency to stink after it has been out of the water a while, it is called by a name imported from England: "Sweet William."

Government-sponsored studies of the School shark have shown that a strict conservation program is necessary if Australians are going to enjoy eating shark for many years to come. Although females usually carry about 28 young, it takes 12 years for the smallest female School shark to give birth to her first brood. And the smallest male does not mature until it is at least 10 years old. For some reason, only about half of the adult females carry young each year. All these facts add up to an unusual situation in the usually fecund sea, for they indicate that there is never a population explosion among School sharks.

For generations, Australians hated all sharks, and certainly any prejudice against the shark there had a better basis than in most other countries. But when species of sharks were found that provided tasty, nutritious, and abundant food, Australians began eating shark. Australian mothers even discovered a dividend—shark meat is boneless, and can be fed to small children without risk. Australia's acceptance of sharks, *as* shark, on the dinner table is rare among so-called civilized countries, however.

Prejudice against the shark has been traced back to the Bible: "These may ye eat of all that are in the waters: Whatsoever hath fins and scales in the waters, in the seas, and in the rivers, them may ye eat. . . . Whatsoever hath no fins nor scales in the waters, that is a detestable thing unto you" (Leviticus 11:9–12). In the opinion of Isaac Ginsburg, zoologist of the U.S. Fish and Wildlife Service, to whom this Biblical admonition was submitted for a modern interpretation on ichthyological grounds, sharks are not under the ban. Ginsburg points out that sharks and, presumably skates and rays, have both fins and scales, though the scales, in the form of denticles, are technically placoid scales, and differ markedly from the usual scales found on fish. Ginsburg extends his opinion to cover shark liver oil. But, whether for religious reasons or not, Israel consumes but little shark.

The followers of Mohammed are split on the shark issue. In the Persian and Oman Gulfs, the eating of fish without scales—both sharks and catfish are included—is forbidden by the dietary laws followed by the Shiah Mohammedans who predominate in Iran. The Sunni Muslims of the Arabian Peninsula, who consider themselves orthodox and the Shiahs heretics, do eat the sharks they catch in the Persian Gulf. In the Philippines, researchers of the Fish and Wildlife Service were surprised to learn that Christian Filipinos rarely eat shark, but Muslim Filipinos eat shark with gusto.

Status-building may inspire abstinence from shark. Until recent years, shark was the usual ingredient of fish cakes made and sold in Hawaii. Perhaps it was merely coincidental, but, as Hawaii edged toward statehood, the territory's selachian dietary habits started falling in line with those of the mainland United States. Marlin and swordfish gradually took the place of shark in fish cakes. The average Honolulu shark landings fell off from an average of 21,000 pounds a year to 200 pounds in 1954 and *twelve* pounds in 1955. The shift in diet has touched off a marine chain reaction. Sharks have begun building up in ever-increasing numbers. Federal fisheries experts predict that more and more food fish will be devoured by Hawaiian sharks. This, the experts say, will result in poor fishing for both commercial and sports fishermen around Hawaii. It probably could increase the danger of attacks on Hawaiian bathers. And all this may be due to Hawaiians not putting shark meat in their fish cakes!

In Latin America, the eating of sharks is a custom that varies from nation to nation, and often from village to village. In Peru, for instance, sharks are eaten by people of all classes, as is the *Guitarra*, or Guitarfish, (*Rhinobatos*). But the skate—considered an epicurean dish in some countries—is looked upon as a dish fit only for the very poor. In Mexico, shark is one of the principal food fishes, and the annual catch is measured in millions of pounds. In Venezuela, both Sawfish (*Pristis pectinatus*) and shark are eaten. The sharks of several unspecified species are called simply *cazon*. A 1948 U.S. survey of the Brazilian fishing industry showed that 16 selachian genera, from *Alopias* (Thresher sharks) and *Ginglymostoma* (Nurse sharks) to *Sphyrna* (Hammerhead sharks) and *Trygon* (Sting rays) were included among commercial fishes.

No statistics are available on shark consumption in Communist China, but it is known that the importing of shark fins has been forbidden. Shark fin soup, an epicurean dish of Old China, is looked upon by the Peiping Communist régime as decadent and bourgeois—a luxury that has no place in a People's Republic.

In Old China, shark fin soup was part of the delicate filigree of protocol and manners that entwined an ancient culture. The ingredients of shark fin soup included, most of all, time and contemplative labor. Only a fine chef would dare attempt to make shark fin soup, and only the finest chef would risk his reputation on the almost sacred task of creating the supreme repast, The Shark Fin Dish.

Chinese hosts in Old China were often judged by their chef's ability to make shark fin soup and The Shark Fin Dish. And the host needed a finely tuned sense of tact as well as a sensitive palate. To provide a banquet with shark fin soup for an honored guest and to fail to serve shark fin soup to a guest of equal social rank—this was the grossest gaucherie. The serving of shark fin soup could be used to show favor, and the withholding of it could show contempt. The Shark Fin Dish was reserved for the especial guest, a man who would have few or no social rivals.

Twenty or more dishes—thousand-year egg, bear's claw, frog, turtle, snail—might have been served at a banquet. The cost of them all hardly equaled the cost of The Shark Fin Dish.

People in Korea, China, and Japan have been eating shark since earliest recorded times. In 1956, according to a United Nations survey, South Korea landed nearly 15,000 tons of sharks and rays. About the same amount was landed by Taiwan's fishermen. In Hsinchu, on the west coast of Taiwan, shark fishermen have developed a kind of perpetual-motion system. They catch sharks, use the flesh for food, and then feed the shark offal to cultivated eels, which, in turn, are used as bait to catch more sharks.

Probably nowhere on earth are sharks consumed as avidly as in Japan, whose annual landings of sharks, skates, and rays are measured in the thousands of tons. The lower grade sharks are made into fish cakes, called *kamaboko*. About 420,000 tons of *kamaboko* are produced in Japan each year. Shark is also sold both fresh and canned. Smoked shark, marinated in soya sauce, is one of the canned products of the large Japanese shark fisheries industry.[3] This product, sold as smoked shark-meat, is exported, in relatively small quantities, to the United States as a gastronomic oddity.

The United Nations Educational, Scientific and Cultural Organization —UNESCO—has described the virtually untapped fishing resources of the Indian Ocean as one of the most vital food-harvesting areas on earth. Some 726,000,000 people live in the tropical and subtropical regions around the Indian Ocean, and the very survival of millions of them, a UNESCO report says, depends on the fish in the Indian Ocean. These fish, says UNESCO, appear to be the only readily available food for combating the "prevalence of diseases attributed to protein starvation" that are common in India, Ceylon, Indonesia, Malaya, and parts of the east coast of Africa.

And among the many abundant fish found in the Indian Ocean are sharks. Surveys in the Seychelles Islands, which lie in the western portion of the Indian Ocean, have shown an astounding abundance of sharks, many of which seem to be species peculiar to those isolated islands. Fishing explorations aimed at developing a viable fishery industry in the Seychelles have had shark-catching experiences reminiscent of the tuna long-lining explorations in the Pacific. One expedition, for example, boated 15,287 pounds of various fish—and 24,326 pounds of shark. "It is possible to fish exclusively for sharks, but it is rarely possible to fish for bony fishes without catching sharks as well," a survey report notes.

Sharks, skates, and rays are eaten by most nations whose shores are washed by the great Indian Ocean. Indians, for instance, eat shark. On the west coast of India, sharks and rays are a favorite food of all classes. In the eastern coastal districts of Madras, only the very poor eat sharks and rays. Under a government-sponsored program, shark-liver oil is distributed to hospitals and sold at low prices to the public to increase the vitamin A in their diet.

[3] For more about Japanese and Chinese shark-eating customs and recipes, see the Appendix.

In the Chagos Archipelago in the middle of the Indian Ocean, the eating of shark, oddly enough, has led to an increase in the consumption of pork. After sharks have been butchered for meat, their carcasses are fed to pigs, which would otherwise find little to eat on the islands. The pigs grow fat on the protein-rich diet, and produce enough progeny to keep pork in the islanders' diet.

UN-sponsored research has also found another use for meal made from shark meat: flour. Actually, fish flour is so nutritious compared to wheat flour that its developers feel "flour" is an inferior word to describe it. Flour produced from fish meal (virtually any kind of fish can be used) contains 85 per cent animal protein as compared with 15 per cent protein found in fresh meat and fish. This is one of the highest concentrated protein substances yet developed by man.

United Nations researchers say that the development of fish flour may mark a major victory in the battle to supply the mass of the world's people with adequate amounts of animal protein. Fish flour now can be produced at little more than the cost of flour made from wheat or maize. Further research will drive the cost down even further. Fish flour can be used any way wheat flour is used, from making bread to making spaghetti.

In *World Sea Fisheries*,[4] a comprehensive world survey of the fishing industry, Selachians are recognized as important food fish from Europe to Japan. It will no doubt come as something of a surprise to most people to learn that thousands of tons of sharks, skates, and rays are caught annually by the fishermen of many countries. *World Sea Fisheries* gives these approximate 1951 tonnage catches of sharks and rays in leading shark-eating countries:

Japan, 85,000 tons; Norway, 66,000; United Kingdom, 35,700; Spain, 11,600; Belgium, 4,700; United States, 3,400; Denmark, 2,900; Eire, 2,400; West Germany, 1,500; Iceland, 300; Canada, 200. These figures, probably derived largely from the *Yearbook of Fishery Statistics*,[5] are incomplete. As indicated earlier, some countries do not keep any reliable figures and others, for one reason or another, do not report their commercial catches in standard classifications.

But, as the accompanying table shows, the landings of sharks and dogfish from commercial fishing are sometimes accurately reported. This table shows the 1961 Selachian landings in Denmark, *in toto*.

The eating of shark has been going on since men first started catching oceanic fish. Some of the earliest Americans, shore-dwelling Indians in southeastern Florida, ate shark. Ancient Greeks and Romans not only

[4] Robert Morgan, *World Sea Fisheries* (London: Methuen & Co., Ltd., 1956).

[5] Food and Agriculture Organization of the United Nations, *Yearbook of Fishery Statistics* (Rome, Italy, annual).

Danish Landings, Value, and Exports of Sharks and Dogfish, 1961 *

Item	*Herring Shark or Porbeagle* [1]			*Piked Dogfish* [2]		
	Quantity	Value		Quantity	Value	
	Metric Tons	1,000 Kroner	U.S. $ 1,000	Metric Tons	1,000 Kroner	U.S. $ 1,000
Landings	425	1,443	209	191	165	24
Exports:						
Fresh—to:						
Italy	378	1,401	203	—	—	—
West Germany	15	48	7	—	—	—
Other [3]	7	25	4	—	—	—
Total fresh	400	1,474	214	—	[4]	—
Frozen—to:						
Italy	82	338	49	—	[4]	—

[1] *Lamna cornubica.*

[2] *Acanthias vulgaris.*

[3] Individual countries not available in 1961, but in 1960 Belgium–Luxembourg, Switzerland, and Sweden imported almost 4 tons from Denmark.

[4] Quantities of piked dogfish exported were so small they were lumped in an "Other" category and unavailable as to amount or value.

* Herring sharks are taken in the North Sea and Skagerrak mostly by vessels fishing with long lines. Dogfish are taken incidentally in trawls and Danish seines. There is a fishery for Mackerel sharks in the Northwest Atlantic off the New England and Canadian coasts by a Faroese company utilizing three vessels. The sharks are frozen on board and sold in Italy under a current contract amounting to about $580,000. (Report of April 5, 1962, from the Regional Fisheries Attaché, United States Embassy, Copenhagen.)

From *Commercial Fisheries Review*, U.S. Fish & Wildlife Service, Vol. 24, No. 6, June 1962.

ate them, but also brought them into their arts and writings. Authors frequently discuss the eating of shark in the midst of learned essays. Epicharmus remarks that skate goes well with cheese. Lynceus of Rhodes twits the proud Athenians by writing that none of their fishes can compare in taste with the Rhodian fish supreme, the Thresher shark. The Roman satirist Petronius makes a comment on how men determine their values, noting:

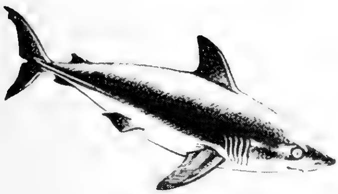
What must be sought, and dearly bought,
Scari and Swans, we prize;
While skate and goose, in vulgar use,
Men utterly despise.

Soon after Plato's *Republic* became famous in Greece, the satirical playwright Aristophanes wrote a play, *The Ecclesiazusae*, in which he lampooned Plato's idea of an ideal republic founded on the principles of communal living, and he used the shark in his satire.

In *The Ecclesiazusae*, Aristophanes has written of a communal state ruled by a council of women. Since there is no private property, the citizens eat in public halls at public expense. It is difficult to serve everyone what he wants, but the women valiantly try by offering a single meal that has everything on the Greek menu. The meal is described in what is probably the world's longest word, a word that runs to 77 syllables in Greek, and when translated into Latin contains 179 letters. And right in the middle of it, along with the leek, the oyster, the wine sauce, and the pullet's wings, are the skate and the shark!

Chapter 8

Shark Treasures



The sharks are there—uncountable millions of them—for any maritime country whose people will eat shark and whose fishermen will catch them. But the hunting of sharks is a frustrating, hazardous, and usually not too profitable enterprise. And the capture of a shark can be an exploit—the duel of a solitary man in a rowboat against a thrashing, maddened shark often bigger than he or his boat.

Sometimes shark-hunting methods are downright incredible. Around the Seychelles in the Indian Ocean, a crude shark fishery has been built up. A six-week expedition in Seychelles waters has brought in 170 tons of sharks.

Aboard some of the boats, the fishermen depend on "shark callers"—sea-going, self-proclaimed sorcerers. A shark caller drums his feet in a wild tattoo on the deckboards of the pirogue, then slaps the surface of the water with one hand and the hull with the other. Finally, he lets out a loud, spine-tingling wail. Fishermen swear that the antics of the shark caller do bring in sharks.

Perhaps the fishermen of the Seychelles have found, at last, a socially useful purpose for rock 'n' roll troubadours. But they haven't found a way to make shark-catching commercially profitable. Only time, patience, and some kind of government subsidy could do that. William Travis, an entrepreneur of shark fishing in the Seychelles, gave it up after two years. The logistics of commercial fishing called for more money than he had. Like many shark hunters, he managed to salvage an interesting book (*Shark for Sale*)[1] out of the debris of his failure. He earned little else from sharks, however.

If all the many by-products of the shark are tapped; if markets are developed for all of these by-products; if modern methods of catching, preserving, and utilizing these products are employed—then, and only then, can a shark industry be made profitable. On paper, at least, these profits are possible. A U.S. Fish and Wildlife study showed that $15 to $20 could be earned on a good-sized shark, if it were utilized as thoroughly as the meat industry utilizes pigs or cattle. The study esti-

[1] William Travis, *Shark for Sale* (London: George Allen & Unwin, Ltd., 1961).

mated that a 400-pound Tiger shark would produce 112 pounds of edible meat, 20 pounds of dried meal, 8½ gallons of liver oil, 3 pounds of salable fins, $1.50 worth of teeth suitable for sale to curio dealers, and a hide worth at least $3.

The trick is to catch enough sharks and then prepare them for market. Set your net or your line and you get only whatever species happen by. Shark meat spoils quickly. Livers begin turning bad as soon as the shark is dead. Hides can go sour if skinning is delayed as little as 6 hours. And after a full day's shark fishing—or, in the lairs of nocturnal sharks, a full night's fishing—the fishermen are too tired to put in another day's work immediately after they land. So they hire a work crew, thus driving up expenses.

Though sharks may be abundant in a given area, they are known to become will-o'-the-wisps and vanish inexplicably from the places where, theoretically, they should be prevalent.

Take the Basking shark (*Cetorhinus maximus*) for a bankrupting example. This huge, potentially valuable, and relatively easy-to-catch monster can afflict fishermen with acute economic anemia. Basking sharks run to at least 30, and perhaps 40 or more, feet in length; they weigh up to several tons. They are too colossal to be weighed accurately. They have immense livers, heavy with oil, and it is this oil that men have sought for centuries.

For many years, the oil of the Basking shark played a part, with the oil of the whale, in lighting many of the lamps of the Western world. Most Basking sharks caught were stumbled upon by whalers, who were equipped to handle gigantic carcasses and would take on a Basker if it happened by. Not until modern times did single-minded men go after Basking sharks with any hope of making a living from them.

One of these men was Gavin Maxwell, a British Army officer who set up a shark fishery on Soay Island in the Gulf of the Hebrides in 1947. Maxwell planned to get from the Basking shark liver oil, liver residue, fish meal, king-sized fins for shark fin soup, fertilizer, and chemical products from the great shark's enormous load of plankton. He caught a good number of Baskers and even sent some samples of the flesh to Billingsgate. But, as Maxwell later reported, the flesh merely appalled the dealers, for they found it "twitching in a disgusting way when the cases were opened in London." The twitching chunks of Basking shark were somehow symbolic of Maxwell's venture. He found the sharks hard to kill, hard to find a use for, and generally eerie, in an enormous sort of way. The venture failed.

Another seeker after Basking sharks in Scottish waters was Anthony Watkins, a London clerk who put down his pen one day and took up a harpoon. Watkins usually harpooned Baskers from an open dinghy.

He and a companion would row up to a Basking shark—often so close that the dinghy was actually directly over the shark's huge back. Then Watkins would plunge a harpoon into the shark, leap nimbly out of the way of the whistling line attached to the harpoon, and let the shark tow the dinghy until it tired enough to be hauled up and lashed alongside a bigger boat that accompanied the dinghy. Once a shark towed Watkins' dinghy for 24 hours. The shark, harpooned in Kilbrannan Sound near the Firth of Clyde, Scotland, set a course due west when it left the Sound, and all that stood between Watkins' 8-foot dinghy and the United States of America was the open sea. When a rescue boat finally found Watkins, after the shark had towed him 100 miles, he had to cast off his indefatigable shark, which swam away with a 9-foot steel harpoon sticking out of its back and was never seen again. Watkins said he did eventually make some money on his Basking shark venture. He quit the business shortly before the price of shark oil plummeted.

P. Fitzgerald O'Connor, a British writer turned sharker, also had a short-lived fling at catching Basking sharks. He said he broke even. Basking sharks produced for these three men an unusual by-product: books. O'Connor, Watkins, and Maxwell each wrote a book[2] about his adventures, and each man's experiences and observations added much to the previously scanty scientific knowledge of the Basking shark.

Today, on the small island of Achill off the western coast of County Mayo, Ireland, a group of hardy fishermen are pitting the luck of the Irish against the Basking shark. The great sharks—the Irish call them *muldoans*—appear out of nowhere around St. Patrick's Day, but not until the end of April, when the winter weather dies in Achill's Bay of Keem, can the fishermen go after the *muldoans.*

Great nets are stretched across one side of the bay, and shark after shark blunders into them. Then men set out in small boats called *currachs* to battle the sharks, stabbing them with hand harpoons, and wrestling them out of the nets. As many as 30 sharks a day—most of them 25 to 35 feet long—are captured in the bay during the season, which ends in July or August. From 60 to 70 gallons of oil are produced from the average shark, but the value of oil fluctuates wildly, and the market price is rarely stable. Low in vitamin content, the oil is used primarily for industrial purposes, such as in some tanning processes. The liver of the slaughtered sharks is usually all that is used; their carcasses are dumped at sea. Attempts have been made to induce Irish farmers to use pulverized shark meat in cattle feeds, but the farmers will have no *muldoans*, ground up or not, upsetting the dietary traditions of their

[2] Maxwell's was *Harpoon at a Venture* (London: Rubert Hart-Davis, 1952); O'Connor's was *Shark-O!* (London: Secker & Warburg, 1953), and Watkins' was *The Sea My Hunting Ground* (New York: St. Martin's Press, 1958).

fine Irish cattle. The sharks' tremendous hides have defied efforts to make them into leather. Even the sharks' teeth, minute and very unterrifying, are commercially worthless.

American attempts to cash in on the goliath Basking shark have often shown a spectacular flair. In 1924, two men began harpooning Baskers for sport in Monterey Bay, California. Eventually they discovered that the big sharks could be turned into money. Meal made from the carcasses was used in livestock feed and dog biscuits, and a spiritual descendant of the old frontier snake-oil salesmen bottled and sold "Sun Shark Liver Oil" as "Nature's Own Tonic." The industry all but died out around 1938.

After World War II, a new generation of California sharkers attacked the Basking sharks with a combined air-sea-land operation, using war surplus equipment. A shark-spotting aircraft patrolled the California coast around Monterey. When the pilot saw a school of sharks living up to their name by basking on the surface, he began circling the sharks and radioed a crew standing by in an amphibious "Duck" vehicle parked on the beach. The Duck raced along the beach until it came opposite to the circling plane. Then it plunged into the surf and headed for the sharks, which were usually a quarter to a half mile offshore.

As the Duck neared the school, a shark was selected and the seagoing truck bore down on it. The harpooner, in a "pulpit" rigged to a bowsprit, leaned down over the shark and plunged his 65-pound weapon into it. Attached to the harpoon were several hundred feet of ¾-inch manila rope. The heavy rope smoked as it ran out, pulled by tons of writhing energy plunging toward the bottom. Usually, 500 feet of rope ran out before the shark seemed to be tiring. A sealed oil drum was often tied to the line at about the 250-foot mark. This drum was intended to act as a drag on the fish, but frequently it was towed so deep below the surface that the pressure caused it to collapse.

If and when the shark was finally subdued and pulled to the surface, it was shot with a 30/30 rifle. Only a shot through an eye or between the eyes could possibly kill a Basking shark, so it sometimes took hours to administer the coup de grâce. After the shark was killed, it was tied to a buoy, and the Duck returned to shore to await another radio message from the plane. Meanwhile, another man of the group phoned processing plants until he found a customer. When a shark was sold, the Duck would return to the buoy, untie the shark and tow it to shore, where a winch hauled it up a ramp and into a truck.

One hundred sharks were killed in one year at one beach by the shark commandos, and one champion harpooner killed 7 in a single day—with the same harpoon. The sharkers got 7 to 9 cents a pound for the sharks' livers, which weighed from 700 to 2,000 pounds. Nothing was paid for the carcasses, though the processing plants sometimes converted them into meal for chicken feed. One of the plants that handled the huge fish was designed for a fish somewhat smaller. It was a sardine plant!

The price for livers eventually dropped to a point where the amphibious sharkers were getting less than $35 for a 5-ton fish that took an airplane, a Duck, and a crew of men to land. And finally, if not inevitably, the great Basking shark adventure collapsed. By 1953, Basking shark fishing in California was described by the State Department of Fish and Game as sporadic.

Sharks are often enemies of man, but the brigand can yield bounty, too. For the shark is a valuable fish. Locked in the livers of some sharks are oils often more potent in vitamins than cod liver oil, and a chemical found in the liver is leading medical researchers down promising new avenues in the search for ways to destroy two enemies of man far deadlier than the shark—cancer and heart disease. The denticle-armored skin is stronger than cowhide.

Though the shark is a cornucopia of the sea, many attempts to bring this treasure to shore have ended in failure. When the stakes have been high enough, men have sought the shark, and the shark has made some of them rich. But, even when man's avarice is pitted against the shark, the odds of survival are on the shark.

In 1938, sharks accidentally caught by U.S. fishermen were considered worthless predators of useful fish, whose destruction of nets cost fishermen much more than they could ever make by selling the sharks' carcasses. The top price was $10 a ton. Most carcasses were ground up and used for fertilizer.

Then the war in Europe began. German troops overran Norway, and abruptly a major source of a vital commodity was cut off from Great Britain and the United States—cod liver oil. Millions of pounds of cod liver oil had been exported for many years from Norway to the United States and England. Vitamin A was extracted from the oil and added not only to human diets but also to the diets of livestock and poultry. In both countries, a search began for new sources of the vitamin.

In San Francisco, Tano Guaragnella, a wholesale fish broker, heard about the hunt for a substitute source of vitamin A. On a hunch, Guaragnella took some fresh shark liver to a chemist for analysis. The liver, from a dogfish (*Squalus acanthias*), produced an astonishing assay. There was ten times more vitamin A in the dogfish's liver than was usually found in the liver of the cod (*Gadus morua*).

Guaragnella went back to the docks and, as casually as he could, dropped the word to fishermen that he would pay $25 a ton for dogfish. The fishermen thought he was crazy, but they started landing the "worthless" dogfish, of which there had never been a shortage on their fishing grounds.

Soon after he made his discovery about the dogfish liver's vitamin potency, Guaragnella happened to see some fishermen dressing a Soupfin shark (*Galeorhinus zyopterus*), whose colloquial name derived from the Chinese gourmet's preference for its fins in shark fin soup. Guaragnella noticed that the Soupfin's liver was immense. Again, he had a hunch.

This time the chemist's report was fantastic. The liver of the Soupfin was ten times more potent in vitamin A than the liver of the dogfish, which meant that the Soupfin liver oil was 100 times richer in vitamin A than cod liver oil itself!

Guaragnella announced that he would buy all the Soupfin sharks the fishermen could bring in, and that he would pay $40 a ton for them. Word of his startling offer flashed through the waterfront of San Francisco and up the West Coast as far as Alaska. Soon, too, other wholesalers learned the secret of their competitor's sudden desire for shark livers. And the bidding for shark livers began.

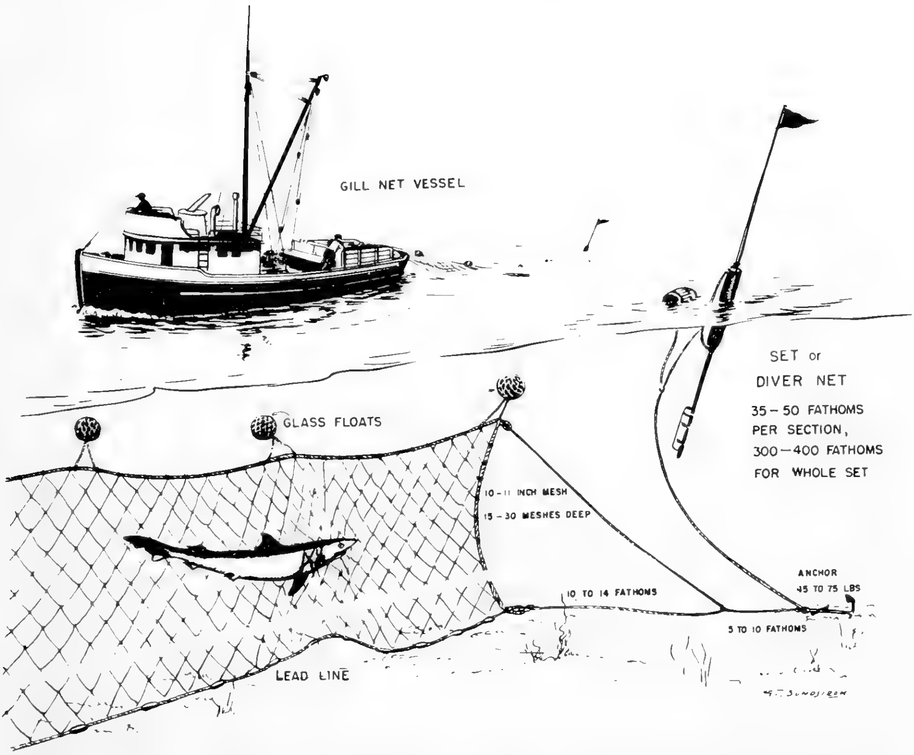
Another California "Gold Rush" was on! The new *El Dorado* was called "gray gold," and the fishermen who set out to mine the California seas were as wild with "gold" fever as their prospecting predecessors had been. Prices, set by daily bidding in fishermen's exchanges, shot up from Guaragnella's original $40 a ton to $60 . . . $80 . . . $100. From Alaska to Mexico fishermen deserted their usual commercial fishing banks to seek a bonanza of Soupfins. The price kept rocketing. By September, 1941, it was hitting $1,200 a ton!

The attack on Pearl Harbor was only three months away, but the Japanese suspended their growing belligerency toward the United States long enough to profit from the shark-oil boom. Tons of frozen shark liver were shipped out of Japan to meet the insatiable demands of the United States.

And the bidding kept on. By the time the United States had entered the war, the price had hit $1,500 a ton. The average Soupfin was worth $25. Some of the larger ones were worth $200 each for their livers alone.

Never before had fishermen earned so much money so quickly. A San Francisco fishing boat went off on a four-day Soupfin hunt and came back to the wharf with $17,500 worth of shark. One fisherman made $40,000 in five months. The professionals weren't the only ones making money. Students at the University of Washington skipped classes to fish for shark in Puget Sound. Farm boys who had never been to sea were recruited by shark fishermen and earned as much as $800 for a week's work.

Most of the sharks were caught in gill nets, which are either suspended from the surface, like great curtains a half mile or more in length, or dropped to the bottom, where floats along their top and weights along their bottom keep them vertical. The sharks, pursuing smaller fish, such as sardines, swam into the diamond-shaped openings of the net's



A shark gill net as used in shark fishing on the U.S. Pacific Coast. Once the shark's gill slits are snagged in the net, it cannot get away. When shark fishing was at its zenith during the Soupfin shark bonanza, gill net vessels fished the entire coast from Washington to southern California. Courtesy, U.S. Fish and Wildlife Service

weave and were trapped when their gills or fins became snared by the net. Unable to back up, the sharks hung there. In their death struggles, the sharks often ruined the nets. Or hagfish (*Myxine*), a relative of the lamprey, provided with a rare opportunity to turn from prey to predator, attacked the enmeshed sharks. Like the fishermen, the hagfish were after the sharks' soft parts, and many a net was hauled up with liverless sharks. So many sharks were being taken and so great was the price, however, that the cost of damaged nets or damaged sharks could be absorbed by the West Coast fishermen, when as many as 200 sharks were pulled in with one haul of a net.

While the frenzied, every-man-for-himself shark rush was going on along the West Coast of the United States and Canada, a more systematic assault on the shark was being organized in Florida by an organization known as Shark Industries, Inc. It had been found that other types of sharks also had livers rich in vitamin A. In 1944, this company was taken over by one of the best-known brand names in the country, a firm whose trademark was a happy, personable cow named Elsie—the Borden Company, largest processor of dairy products in America. Probably because they did not want to get their customers' image of gentle Elsie confused with the fierce visage of Jack Shark, officials of the Borden Company did not ballyhoo their connection with sharks. It will undoubtedly come as a surprise to many a milk-drinker to learn that sharks as well as cows provided him with his vitamin-enriched milk.

The Borden Company is reputed to have invested at least a million dollars in the enterprise. Its shark fleet grew to 40 vessels, many of them equipped with refrigerated holds and capable of staying at sea for periods as long as six months. Instead of nets, the Borden ships usually relied on long-line fishing. Steel cables stretching out almost two miles were unwound from the bigger ships. Strung from the cables were large baited hooks about 40 feet apart. The cables, marked with buoys, were set out one day and hauled in the following day—and so were the sharks. As a power winch slowly brought in the cable, a man stood at the bow of the boat with a big wooden mallet. If a shark were still alive when gaffed, it was clouted on the snout and stunned, and a boom swung it into the hold. It could then thrash in the hold until it expired.

It was arduous but profitable work. Off Salerno, Florida, where Borden's shark-catching eventually was concentrated, as many as 341 sharks were caught in a single day by four boats. The weights of individual sharks ranged as high as 1,500 pounds. In one month, 1,972 sharks were brought in. One boat brought in a single catch of 182 sharks.

Borden also joined in the West Coast shark boom. But from the relentless overfishing of sharks there soon resulted a dramatic decline in Soupfins. In 1944, almost 53,000,000 pounds of shark were caught. That was the peak. Soupfins became more and more scarce. The price of their livers held up, though, finally reaching a giddy summit of $14.25 *a pound.*

At a small fish-marketing and processing firm in Provincetown, Massachusetts, the production of oil from livers had been a minor sideline. Suddenly, the company was turning out more than $2,000,000 worth of shark oil a year. Borden opened its own plant for the extraction of shark-produced vitamin A, which was added to dairy products. By 1946, three cents of every dollar Borden earned came from non-food products and, for most of this, Borden's stockholders could thank the maligned shark, not Elsie.

During the war, shark liver oil supplied approximately 75 per cent of the vitamin A produced in the U.S. Though shipyards were restricted to turning out war vessels, the rule was lifted to permit the building of boats to go after sharks. And, as more and more sharks were caught under the inspiration of war and profit-making, more and more was learned, not only about vitamin A but also about the shark family itself.

Vitamin A came close to being labeled a panacea. It was found to stimulate growth, increase resistance to infection, aid in combatting fever and colds, and prevent excessive dryness of the skin. Not every shark's liver was packed with vitamin A. The potency, measured in U.S. Pharmacopoeia units, varied from 35 units to 43,000,000 units. The variance ranged from shark to shark and from species to species.

West Coast fishermen, for the most part, threw away all but the liver, though canny Chinese traders usually managed to get the fins, which they sold at premium prices. Under Borden's aegis, however, a profit was made on virtually every ounce of the shark. The fins were cut off and sold to shark fin buyers for as much as $6 a set. On this sideline alone, Borden sometimes made $3,000 to $5,000 a month. The teeth of some sharks were sold to costume jewelers. The entire jaws of big sharks were sometimes dried, preserved, and sold to would-be game fishermen. These jaws, as a Borden spokesman diplomatically put it, "found their way into trophy rooms on plaques with brass plates which could be inscribed at will."

Some of the sharks' hides were tanned into leather. Prime shark meat was cut into steaks, frozen, and shipped to countries, primarily in South America, where there was, and is, no prejudice against eating shark. Less palatable meat went to Borden's Special Products Division, where it was used in poultry and livestock feed preparations. What was left of the shark was ground up for commercial fertilizer.

The abundance of sharks in the Caribbean, and the profits that could be made from the shark's many products, soon came to the attention of the U.S. Department of State, which, as World War II neared its end, was concerned about the post-war economic problems of underdeveloped countries. The Anglo-American Caribbean Commission published and distributed to Caribbean fishermen a handbook on shark fishing. The booklet told fishermen how to identify and catch sharks, how to skin and process shark hides, and how to make a profit on shark liver, meat, fins, and even teeth. "Good-sized, sound sharks' teeth and sharks' jaws and backbones, either cleaned or made into novelty items," the booklet said, "have always been in demand by tourists."

Cojimar, Cuba, the setting of Hemingway's classic, *The Old Man and The Sea*, was one of many places on the Gulf of Mexico where small "shark factories" sprang up. Most of the money came from liver oil, which was distilled in the factories by a simple method. Livers, chopped into fist-sized chunks, were rendered down in big vats. The oil was skimmed off, cooled, canned, and shipped to U.S. dealers for about $4.75 a gallon, depending on its vitamin potency. The process required little skill and paid big dividends.

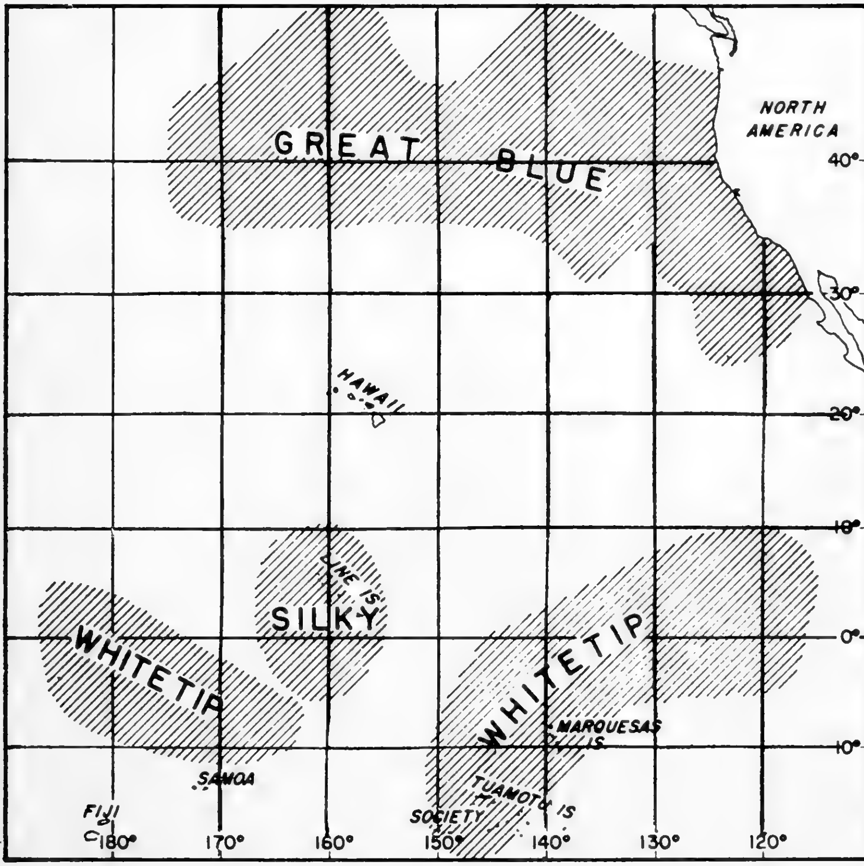
From Ketchikan to Monterey on the West Coast of America, in the little towns of the Caribbean, in fishing ports where the shark had been a feared and hated enemy for generations, suddenly it was a boon. The shark was giving men profits instead of stealing them.

But the intensive research into vitamin A was to have an ironic twist. Thanks to the abundance of vitamin A provided by the shark, scientists came to know the vitamin so well that they discovered how to make it. Vitamin A was synthesized.

By 1950, the shark boom was over. It took some time for production of the man-made vitamin A to supplant the natural vitamin obtained from shark liver oil but, one by one, the shark fisheries folded up. In California, where nearly 53,000,000 pounds of shark had been landed in a single year, shark catches shrank to a little more than 1,000,000 pounds and finally dropped to the insignificant pre-boom level. In Washington State, where as much as $3,000,000 worth of sharks had been caught in a single boom year, dogfish livers began selling at 10 cents a pound, and the total value of shark livers plummeted in 1953 to $3,000. Borden's Elsie no longer had competition from any shark. In 1950, Borden went out of the shark business. Cojimar managed to hold out until 1958, when the little shark-oil factory shut down, and, once more, the shark became a nuisance or an enemy.

A 1956 survey of California waters showed that the Soupfin, whose ranks had been thinned by the shark-oil boom, was again abundant. By careful fishing of all the shark species, the survey showed, from one to two *billion* pounds of shark could be caught a year within the range of California's fishing fleets. All that was needed was a market . . . But a market was no longer there.

The menhaden is a prolific fish used almost entirely for processing into feed rather than for human consumption. It is a valuable commercial fish in the United States and is sought by fleets of boats. But it is also sought by sharks, and, as the great schools of menhaden sweep up and down the East Coast or through the Gulf of Mexico, they are inevitably accompanied by sharks, which take a heavy toll. In a letter to one of the authors, Harvey W. Smith of the J. Howard Smith Company, a major menhaden fishery, reported that his boats sometimes net as many as *70 to 800 sharks a day* in the Gulf of Mexico. These *4- to 6-foot* sharks do damage which, Smith said, "is beyond one's imagination." He added that the company spent $20,000 to repair or replace shark-ravaged nets in a single five-month season.



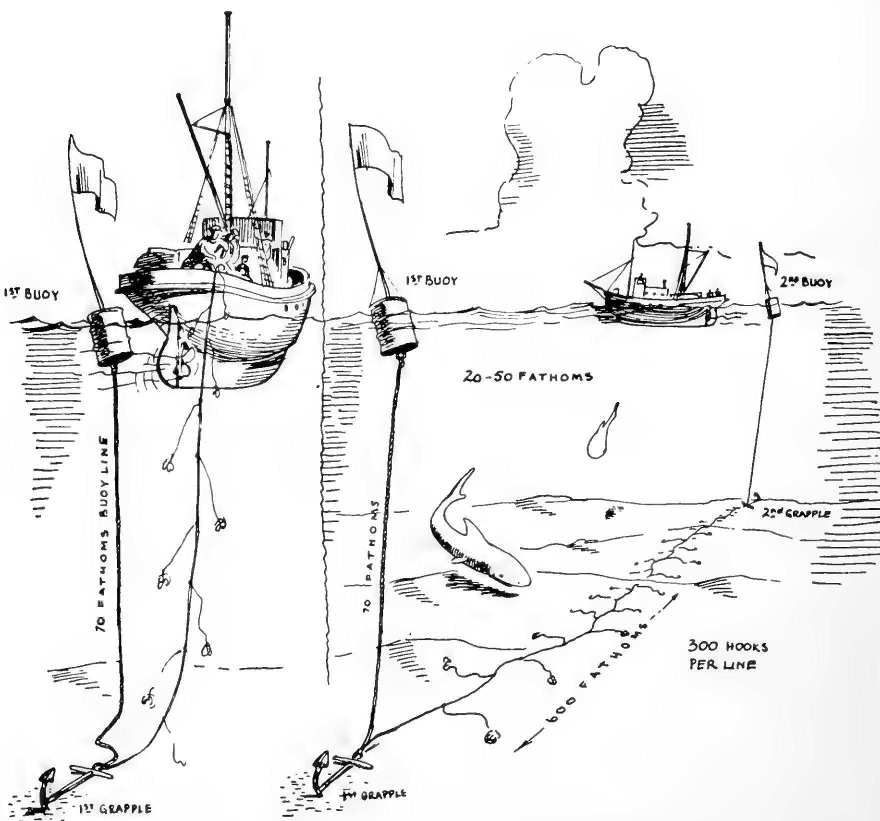
Tuna-fishing explorations by the U.S. Fish and Wildlife Service revealed the presence of great numbers of sharks in the central Pacific. The map shows some regions where various species predominated. Courtesy, U.S. Fish and Wildlife Service

In the Pacific, tuna fishermen often haul in more sharks than tuna. And the tuna that are pulled in frequently are mutilated by hungry sharks. In 1950, the Pacific Oceanic Fishery Investigations research vessel *John R. Manning* trolled for tuna around the Line Islands. Tuna were found—and so were sharks. "They would follow the boat in schools of one hundred or more," during trolling, the researchers later reported, "frequently striking the lures even at 8 knots." The Blue shark (*Prionace glauca*) was the commonest catch.

Fishing surveys have shown sharks to be as prevalent as most of the commercial fish being sought—and sometimes more so. Commenting on the incalculable abundance of sharks in the Pacific, Donald W. Strasburg, fishery research biologist for the U.S. Fish and Wildlife Service's

Pacific Oceanic Fishery Investigations, said: "We are . . . faced with the problem of controlling shark numbers to protect our sport and commercial fisheries, or, better yet, *of devising some means of utilizing this potentially valuable resource to the benefit of us all.*" [*Italics ours.*]

Strasburg's statement is buttressed by many reports of shark abundance. One stretch of long-line hauled in by a tuna fisheries research vessel had on it 21 tuna and 73 sharks. Another long-line had strung upon it 169 tuna—66 of which had been gouged by sharks—and 222 sharks. An exploratory fishing expedition along the North Pacific coast, about 800 miles off Oregon and Washington, reported the capture of 25 tuna—and 225 sharks. Similar reports have been made by exploratory fishing expeditions in the Gulf of Mexico and the Atlantic. One Gulf



The sketch shows the Australian method of commercial shark fishing, which interested South Africans enough for a story about it to be published in the South African magazine *Veld & Vlei*. A line, with baited hooks, is payed out (*left*). The buoys it is attached to are anchored and left overnight. On the following day, the line is hauled up, usually with plenty of sharks on it. Courtesy, *Veld & Vlei* Magazine expedition for tuna found one-third of its catch "badly mutilated" by sharks; another fixed the shark damage at 19 per cent. Reporting on a 1953 Gulf of Maine long-line exploration for tuna, J. J. Murray of the U.S. Bureau of Commercial Fisheries said: "Shark catches totaled 493 individuals (13 times the tuna catch) with an estimated round weight of 90,000 pounds."

Yet, most of these sharks are being wasted. Almost invariably, they are thrown away as trash, when the fact is that they are not. For the most part, as we have seen, they are tasty, nutritious food, eaten in many parts of the world and in some areas of the United States. They are also the source of a wide variety of useful and amazing products.

Since ancient times, the shark has been a source of magical potions. The Greeks of Aristotle's day believed that the ashes of a shark's tooth rubbed on a child's gums relieved teething pains; that shark brains boiled in oil and applied to an aching tooth eased the pain; that the flesh of the flat-bodied Monk or Angelfish prevented swelling of the breast; that the liver of the skate was a remedy for earache; that the brain of the Torpedo ray could be used as a depilatory; that the liver of the Sting ray cured scrofula, relieved itching, and cleared up skin diseases.

Fishermen have insisted for years that shark oil is practically a panacea, equally good externally as a balm for rheumatism, an ointment for burns, or an antiseptic for cuts—and internally as a cough medicine, a laxative, and an all-around tonic. Sir Samuel Garth, a physician, in 1699 mocked British apothecaries for using such outlandish pharmaceuticals as dried crocodiles and sharks' heads, but the use of selachian remedies persists to this day. A recent advertisement for "the most expensive facial preparation in the world" boasted that one of the beauty cream's priceless ingredients was shark oil, "so vital to skin health."

Among some primitive peoples, the shark's claspers are regarded as exceptionally effective aphrodisiacs, and one of the charms of shark fin soup, according to some Chinese, is its aphrodisiac quality.[3]

The uses of other shark products are often more practical than fanciful. Some Eskimos in Greenland make knives from the teeth of the Greenland shark (*Somniosus microcephalus*) and cut their children's hair with the shark-knives, for iron is considered taboo for hair-cutting. The Eskimos also cut long strips from the hide of the Greenland shark, join the strips together, and use the tough shark hide as rope. Some American Indian braves lucky enough to encamp near fossil grounds used fossilized shark teeth—still sharp after millions of years—as razors.

In the Sandwich Islands, now our fiftieth state of Hawaii, when the

[3] Maidens of ancient Rome who read their Pliny carefully would know how to counteract shark fin soup's amorous effects; all they had to do was eat the liver of a Torpedo ray, which Pliny said was an *antaphrodisiac*.

men of a village went on a fishing trip, the women were left undefended, and warriors from neighboring villages often swooped in. The women needed a weapon with which to defend themselves at close quarters. They invented a Hawaiian version of the knight's mailed gauntlet—a glove whose back was studded with rows of shark teeth. The shark-tooth gauntlet transformed a lady-like slap into a blow that could scar a man for life.

In his monumental study of Pacific folkways, *Polynesian Researches*, missionary William Ellis told in 1830 of the strange use shark teeth were put to in funeral services among the natives of the Georgian and Society Islands—the best known of which is Tahiti. The Reverend Ellis observed many of these practices at first hand during his stay in the islands in the early 1800s. He wrote:

> Almost every native custom connected with the death of relations or friends was singular, and none perhaps more so than the *otohaa*, which, though not confined to instances of death, was then most violent. It consisted in the most frantic expressions of grief, under which individuals acted as if bereft of reason. It commenced when the sick person appeared to be dying; the wailing then was often most distressing, but as soon as the spirit had departed, the individuals became quite ungovernable.
>
> They not only wailed in the loudest and most affecting tone, but tore their hair, rent their garments, and cut themselves with shark's teeth or knives in a most shocking manner. The instrument usually employed was a small cane, about four inches long, with five or six shark's teeth fixed in, on opposite sides. With one of these instruments every female provided herself after marriage, and on occasions of death it was unsparingly used.
>
> With some this was not sufficient; they prepared a short instrument, something like a plumber's mallet, about five or six inches long, rounded at one end for a handle, and armed with two or three rows of shark's teeth fixed in the wood, at the other. With this, on the death of a relative or a friend, they cut themselves unmercifully, striking the head, temples, cheek, and breast, till the blood flowed profusely from the wounds.

Otohaa, the missionary reported, was also performed as "an expression of joy, as well as grief." To celebrate a homecoming or a narrow escape from some danger or calamity, he wrote, "loud wailing was uttered, and the instrument armed with shark's teeth applied, in proportion to the joy experienced."

A shark-tooth club, called the *paeho*, was also used in combat. It was "more frequently drawn across the body, where it acted like a saw," the missionary wrote.

"Another weapon of the same kind resembled a short sword," he further reported, "but instead of one blade it had three, four, or five. It was usually made of a forked *aito* branch; the central and exterior branches, after having been pointed and polished, were armed along the outside with a thick line of sharks' teeth, very firmly fixed in the wood." Still another selachian weapon was the *aero fai*, a Sting ray stinger, "which being serrated on the edges, and barbed towards the point, is very destructive in a dexterous hand."

In the Ellice Islands of the Pacific, natives have found a more constructive use for shark teeth. A tooth is lashed to a stick and used as a scalpel in crude surgery.

The Maoris of New Zealand call the Seven-Gilled shark (*Notorynchus cepedianus*) that lives in their waters a *tuatini*. From its teeth they once made a saw-like instrument, the *mira tuatina*, which reputedly had one special use: cutting human flesh. The Maoris associated sharks with blood, war, and death. They mixed shark oil with red ocher and painted it on their war canoes and the funeral monuments erected in memory of their greatest chiefs. They also used shark oil as a cosmetic, a hair dressing, and for the anointing of bodies in their elaborate funeral ceremonies.

Some Pacific islanders once used shark skins as drumheads; the skins were strong, did not stretch, and thus gave an unvarying tone. In Sumatra, the skin of the Cowtail ray (*Dasysatis sephen*) is used for making drums and tambourines.

In Bermuda, natives have used shark oil to make a crude but, according to them, dependable barometer. They extracted oil from a shark's brain and liver and put it in a sealed bottle. When a storm approached, they claimed, the oil became cloudy.

Eric Sloane, the historian of weather lore, tells in his *Almanac and Weather Forecaster* of an advertisement he found in an old Connecticut newspaper. The advertisement offered an "absolute weather predicter for one dollar . . . A magic liquid that clouds up when it is about to rain." Sloane wonders if the magic liquid could have been shark oil. For several months, one of the authors kept a sealed bottle of shark oil in a window in his study. He cannot vouch for the oil's dependability as a weather "predicter," but it *did* cloud in cold weather and clear in warm. And, at the approach of a rainstorm, when temperatures usually drop, it also sometimes clouded. The cloudiness was caused by the solidifying of the oil. An hour in the refrigerator turned the oil into a semi-solid with the consistency of butter. Other authorities have validated this statement, such as Dr. H. B. Moore of the University of Miami.

When Australia was first settled in 1788, it was the oil of the shark that fended off the hostile darkness from most of the colonists' homes. David Collins, writing on Australia in 1794, said: "Nothing was lost; even the shark was found to be a certain supply; the oil which was procured from its liver was sold at one shilling the quart; and but very few houses in the colony were fortunate enough to enjoy the pleasant light of the candle."

In more modern times, shark oil has been used in the tempering of high-grade steel, the manufacture of margarine, in pharmaceuticals, the currying of leather, the making of soap and cosmetics, as an oil in paints, as a lubricant of purest quality, and to clean the delicate works of watches.

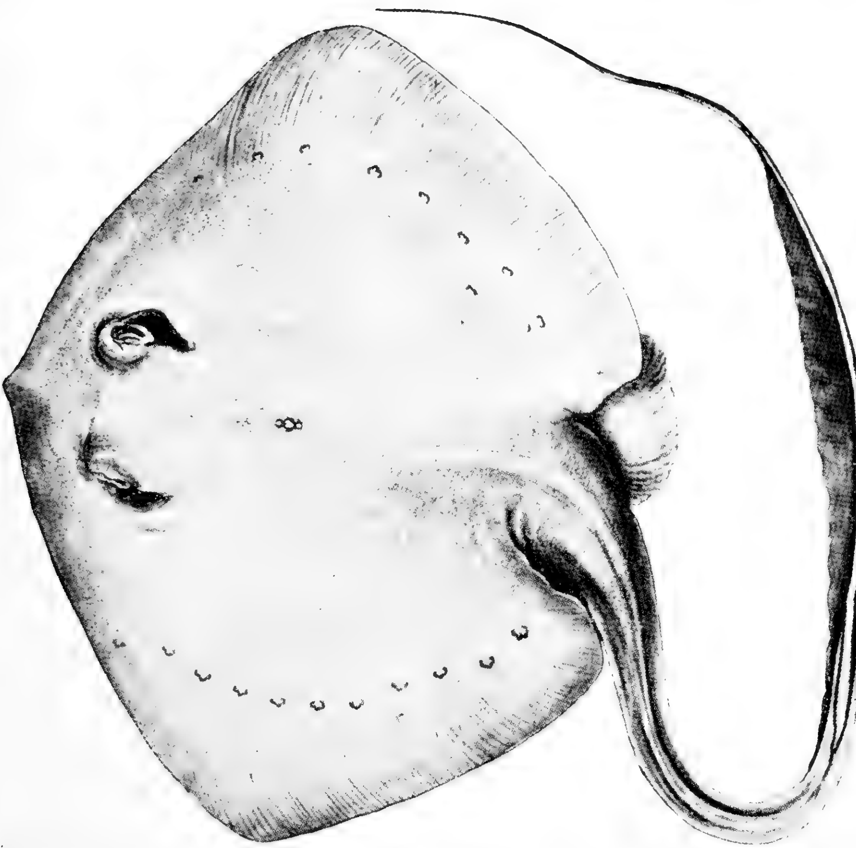
But it is the adamantine hide of the shark that man has best learned to utilize in a variety of intriguing and serviceable ways. Sharkskin began its long career in the Occident at the hands of ancient Greek artisans who discovered that the hide could be used to smooth hard wood to a high polish. In the age of sail, mariners caught sharks, skinned them and dried the skins to use for holystoning the wooden decks. Pieces of sharkskin were wrapped around oars to cut down wear on the wood in the oarlock. Eventually, sharkskin came to be called *shagreen*, a word apparently derived from the Persian *saghari* and Turkish *sagri,* words which, oddly enough, have nothing to do with sharks.

Saghari or *sagri* is the tough skin of the rump of a horse, which was made granular by imbedding hard seeds into the softened skin, then drying it. The seeds fell out, leaving permanent indentations in the skin. Sharkskin, with its pattern of denticles, resembled *saghari* or *sagri,* though in sharkskin the denticles were permanent fixtures.

The Persian *saghari*, with its rough, granular surface, was found to be ideal for sword hilts, for it gave swordsmen a good purchase on their weapons. The Japanese are believed to have been the first to use sharkskin and ray skin for this same purpose. The favorite sword hilt of the Japanese came from what they call the Pearl ray, the same ray (*Dasyatis sephen*) that provides the Sumatrans with their tambourines.

The Pearl ray produced a beautiful sword hilt, for the Japanese used the skin from the center of the ray's upper side, which bears three large, distinctive denticles that give the appearance of a row of inlaid pearls. The sword hilt had a grimmer utilitarian purpose, too—even when blood-smeared, the rough-textured skin provided a dependable grip.

Some other Japanese uses of shark products include *Shark-amino,* an "elixir of life" made from shark cartilage; a gelatinous glue made from cartilage or skin too "stale" to be tanned as leather; shark-liver oil; and, from the shark's pancreas, the drugs insulin and pancreatin, an extract used as a digestive aid. Although shark leather was made during World War II in Japan, its quality was not good, and hardly any shark tanning is being done commercially today. However, Professor Wataru Shimizu of Kyoto University says that the skin of the *Aizame* (*Centrophorus atromarginatus*), a member of the family *Squalidae,* is still used on sword hilts "to prevent them from becoming slippery."



The skin of the Cowtail ray (*Dasyatis sephen*) is used for making drums and tambourines in Sumatra, and for making sword hilts in Japan, where it is called the Pearl ray because of the pearl-like dermal denticles in the middle of its back. When used for decorative purposes, the denticles are highly polished and left in the hide.

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

In the seventeenth century, when shagreen-covered objects, such as jewel cases, were brought out of the Orient by travelers, word of the beautiful, durable leather spread all over Europe, and shagreen artisans began an art which has been almost forgotten today. By the eighteenth century, the art had become so developed that a guild of *segrnywerkers* (shagreen workers) sprang up in Holland, and in France a skilled pair of shagreen artists won lingual immortality. This rare honor—for France guards her language with a fierce pride—was bestowed upon Jean-Claude Galluchat and his son Denis-Claude. Their exquisite shagreen was called *galuchat*, a term still used in France for polished shark and ray skin.

Ink stands, portrait frames, cases for silverware, spectacles, and watches were made of *galuchat*. Fine editions of books were bound with shagreen, and instruments, such as microscopes and telescopes, were covered with it. In the nineteenth century and in the early years of this century when pince-nez were popular, shagreen was used to hold them in place on the nose—often with disfiguring results.

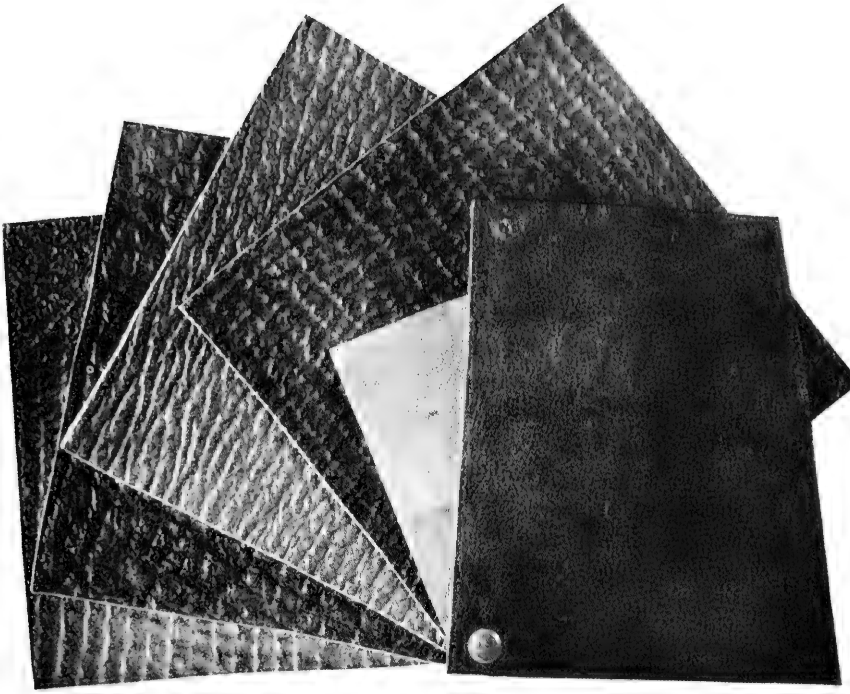
Possibly because they simply cannot believe that a shark or ray could yield such an exquisite leather, or because they are not aware of what they are handling, antique dealers today often describe shagreen-covered objects as being covered with snake, lizard, or seal skin.

Shagreen—shark or ray skin with the denticles still in it—is a leather of lasting beauty. The denticles are usually polished down by hand to remove the sharp points or, in the case of some species and the uses to which they are put, the denticles are ground down on carborundum wheels. But shagreen is still not an all-purpose, practical leather. It has limited use, mostly as a decorative covering. One use was a "pickpocket-proof" wallet, one side of which was covered with shagreen. The denticles prevented its removal by acting as so many tiny thorns that snagged against the pocket. It could be removed only by slipping the hand between the wallet and the pocket.

The removal of the denticles without injuring the natural grain of the sharkskin remained a problem for many years. The denticle roots beneath the surface are firmly imbedded in the epidermis of the skin. The use of potent chemicals either failed to dissolve the roots, or, if too strong a solution was used, the grain of the skin was destroyed in the process. Imperfect removal of the denticles produced a leather so weak or so hard and brittle that it was virtually unmarketable. A way had to be found to gently "lift" the denticles out of the epidermis, leaving a leather with the beautiful markings of the natural grain; flexible, yet still tough and strong.

Shortly after World War I, the Ocean Leather Corporation engaged an American industrial chemist, Theodore H. Kohler, and assigned to him the seemingly impossible task of removing the denticles by a satisfactory commercial process. Kohler, working with a consulting leather chemist, Dr. Allen Rogers of Pratt Institute, spent many long hours on this assignment, making many tests and experiments—and failing. Finally, after a few years and endless expenditures, they developed a chemical process that could be used on a commercial scale to remove them and, at the same time, meet all of the requirements for excellent leather. This process was promptly patented in the name of Kohler.

This was the breakthrough. Leather from the sea—sharkskin leather—could now be marketed for use in practically all articles for which there is no substitute for leather. It could be—and was—promoted as a rival of the long-established exotic leathers. Thereafter, the Ocean Leather Corporation launched a new industry that is still unique.



Samples of shark leather show how it can be dyed in various colors. Black, brown, tan and natural (smallest sample) are shown here. Courtesy, Ocean Leather Co.

Jealously guarding the denticle-removal process through the years, Ocean Leather has remained virtually unchallenged by competitors. It is the only shark-leather tannery in the United States that has consistently produced excellent quality shark leather, and, except for a few foreign firms not considered serious rivals, it is the only large-scale sharkskin tannery in the world. Attempts have been made by other tanneries to produce a durable leather from the hides of sharks. The results have always been disappointing, although some success has been reported in Europe, Mexico, and Japan.

For decades now, hundreds of thousands of shark hides have been arriving at the tannery in Newark, New Jersey, and shark leather has been emerging, to be transformed into luxury articles—men's shoes, belts, wallets, watch straps, and other fine leather goods. It is an ideal leather for cowboy boots, ski boots, shoes, and practically anything else that can be made from leather. Many years ago sharkskin leather was found to be ideal for the highly vulnerable tips of children's shoes. The laces will inevitably break; the counters will collapse; the soles and heels will wear out with appalling speed. But the shark tips will not even scuff. A small boy's destructive energy, tameless as it may be, is simply no match for the impregnable hide of the shark!

A cross-weave of strong fibers runs through the thick epidermis of sharkskin, forming a sinewy network that resists great strain, yet remains pliable. Tests have shown that shark leather has a tensile strength of about 7,000 pounds per square inch. Cowhide's tensile strength is about 5,000 pounds per square inch.

Sharks are hauled in principally from the waters off the coasts of Florida, the Gulf of Mexico, the Caribbean, and the west coast of Mexico. The supply is subject to sudden curtailment by hurricanes and revolution (pre-Castro Cuba was a key shark hide source). The whims of both sharks and fishermen also continually affect the irregular flow of hides to the tannery. But, somehow, hides usually come in every month of the year, and every hide represents the personal triumph of a man over a shark.

Individual fishermen hauling in handlines still supply Ocean Leather with many of the nearly 50,000 shark hides it receives each year. But most of the sharks are being caught nowadays by special shark-fishing boats operating out of Florida and other well-established shark-fishing stations. The sharks are caught on mile-long lines strung every 25 feet with 2½-inch hooks. About 300 hooks dangle on 7-foot leaders from each line. The lines are set in from 20 to 200 fathoms.

The hides arrive at Ocean Leather's odoriferous tannery in neatly folded piles in burlap wraps and bundles about as beautiful as bundles of old grocery bags. After a complicated tanning process that takes about 4 weeks and involves seemingly endless baths and batterings in great vats and tumbling drums, the hides become a luxury leather whose beauty and durability have engendered a demand that has never been matched by the supply. And it is this simple economic fact that explains why all-sharkskin shoes cost about $40 a pair. Texas oil millionaires once commandeered most sharkskin shoes. Lately, however, with the spread of the affluent society beyond the boundaries of Texas, that fief has lost its near-monopoly on shark leather.

Shark-hide tanneries have existed in many parts of the world for centuries—possibly the first recorded instances are from China and Japan. In recent times, there have been tanneries in Norway, Germany, France, Italy, India, Australia, Cuba, Mexico, and elsewhere. So far as is known, however, none of them enjoyed any great success.

Tiger, Dusky, Brown, Sand, Blacktip, Mackerel, and Nurse sharks are the most desirable species for leather. Each species has its own peculiarities. The Nurse, for instance, yields a hide that produces a very desirable leather, but its fins are no good for shark fin soup and its liver oil is low in vitamin A potency. The Hammerhead's hide and fins are not very desirable, but Hammerhead liver oil is usually rich in vitamin A.

Ocean Leather Corporation experts have tried to tan samples of the colossal hide of the Basking shark and the huge hide of the Giant Devil ray, but their attempts have so far been unsuccessful.

The insatiable demand for sharkskin has inspired few fishermen to give up their regular fishing and concentrate on sharks alone, for sharking is usually a very undependable way to make a living. Though there is a practically unlimited supply of sharks in the sea, catching them, skinning them, and preparing them for shipment is work that is always hard and frequently frustrating.

An expert at one of the world's rarest professions—shark-skinning—can separate a shark from its hide in about 15 minutes. It's a job that tires the strongest man and dulls the sharpest knife. (One advantage of the shark's sandpaper-like hide, though, is that the knife can be honed on it!)

After a shark has been flayed, the hide is fleshed and then cured in salt for four or five days. The hides must be protected from the sun and the rain, for, at this stage, they are relatively perishable and can be spoiled by dampness or burned by the sun. After the curing, the hides are packed in bundles or barrels and sent to the tannery.

Fishermen are paid on the basis of the hide's size and condition and the species of shark. In skinning the shark, the tail, part of the head, and the area around the gill slits are lopped off, so the over-all length of the shark's body is not what the fisherman is paid for. His payment is based on the length of the hide. The basic price for a first-grade hide runs from $1 for a hide 35 to 39 inches long to $9 for a first-grade hide 110 inches or more long. There is a premium on Tiger shark hides. The Tiger commands a price of from $2 for the smallest size to as much as $14 for the large sizes.

For a hide to be first grade, it must have no sour spots (caused by rotting of the hide); no butcher cuts (caused by slips of the skinner's knife); no harpoon holes—and no fighting scars, so called because they are believed to be the result of encounters with other pugnacious sharks. (Some shark experts believe, however, that since the scars are so frequently found on adult females, they result from encounters with over-amorous males.) Second- and third-grade hides are relatively lower in price.

Enterprising fishermen can also make money on such odd but marketable shark products as canes and "petrified pups." The canes are made by stringing shark vertebrae along metal rods; they sell for as much as $20. A "petrified pup" is made by preserving fully formed shark embryos in formaldehyde. The mummified result is a shark model, suitable for display on a mantelpiece. (A similar embalming process has been used—so help us—to make earrings out of shark eyeballs!)

The denticles are not removed from the hide of certain small sharks.

Instead, the diamond-shaped ones are polished to a dazzling gloss. Though difficult to stitch because of its armor, this hide—called *boroso*—has been made into such fashion accessories as evening slippers. It may be the world's most expensive leather since it sells for $1 a *square inch*.

The denticles are also left in an industrial type of sharkskin, whose abrasive qualities are put to such unusual tasks as the fluffing of nap in the felt used to make men's hats. In Italy it is used for polishing marble. Another type of industrial sharkskin is used in looms, where a flexible yet indestructible material is needed for the straps that control the darting shuttle.

Modern science has resurrected the shark as the bearer of a strange chemical which the ancients once believed was a potent potion. The drug is called squalene (the name comes from the Latin word for shark, *squalus*), an organic chemical that is today still only an oddity in the medical researcher's laboratory.

Several years ago, a chemical company bought a large supply of squalene distilled from the liver oil of the Basking shark. The firm made the purchase mostly out of scientific curiosity since the shark-originated chemical intrigued some researchers, who began tinkering with it.

One of the tinkerers was Dr. John H. Heller, director of the New England Institute for Medical Research and one of the nation's outstanding research scientists in organic chemistry. Convinced that squalene would be a valuable research tool in the study of heart disease, Heller wanted to use "marked" squalene as a tracer in observing chemical activity in animals. The tracer Heller used was radioactivity. He proposed injecting radioactive material directly into live sharks to obtain his squalene tracer, since squalene was elusive and was produced in relatively minute amounts in every other known creature except the shark.

With the help of Dr. Eugenie Clark, the marine biologist, Heller caught and injected sharks, often getting into the water with them. Though the sharks were snared, with hooks and lines, there was always danger. The hazardous experiments proved to be a failure. But some researchers are still tinkering with squalene, in the hope that radioactive-tagged squalene may some day be used as a research tool in the study of both heart disease and cancer.

Squalene from shark liver oil once was profitably put to work—but by crooks, not scientists. They put out an alleged vegetable oil for cooking and on the label they stated, "20 per cent olive oil." But experts who sniffed and sampled this oil said it was obviously not a blend of olive oil and another vegetable oil, as claimed. Further, these experts—legitimate olive oil merchants—strongly suspected that the olive oil racketeers were back in business again. It was not too long after the end of World War II when olive oil from Europe was still scarce.

Samples of the suspected olive oil blend were turned over to a Food and Drug Administration laboratory. The FDA, long the nemesis of the olive oil racketeers, had developed an irrefutable test to prove the percentage of olive oil in a blend. The test had been devised by Dr. Jacob Fitelson, chief food chemist of the FDA's New York laboratories. Fitelson's test was based on his knowledge of squalene, that odd organic chemical found in shark liver oil. Squalene is also found in animal and vegetable oils—especially olive oil. Fitelson determined that there was more squalene in olive oil than in any other oil with which it was blended.[4] So, by testing for the squalene present, the actual olive oil content could be discovered. The test had exposed several frauds and had been upheld in court, where convictions had been obtained.

Yet, when the olive oil blends that did not taste or smell of olive oil were now brought into the FDA labs, the scientists were startled to find that the blends were passing the test. "Exactly as labeled, a blend of 20 per cent olive oil," said a chemist's report. The report added privately: "That's what the analysis shows, but we can't believe it."

FDA chemists, swamped by complaints from legitimate dealers, were baffled. Then Fitelson, while talking to a former colleague at a scientific convention, picked up a clue. The ex-FDA chemist told Fitelson that the chemical and drug firm he worked for was extracting vitamins from shark liver oil. A by-product—squalene—had been considered worthless. Suddenly, however, a demand had started for squalene. That was it! Fitelson surmised that the racketeers, taking advantage of the squalene test, were simply mixing the squalene with cheap vegetable oils. By adding the precise amount of shark-originated squalene into the blend, the oil would test out as if it contained 20 per cent olive oil. The fact that the squalene came from a shark and not an olive made no difference; it appeared to be the same under the Fitelson test.

Fitelson realized that the only way he could prove his theory was to mark the squalene in some way before it found its way into the blend, and then seek the marked squalene again in labeled products on the market. The marker Fitelson needed was a chemical that was harmless, stable, and soluble in squalene, and not obviously detectable to anyone who looked at, smelled or tasted the oil. Also, it had to be able to show up in dilutions of one part to ten million parts of oil. The chemical used was anthranilic acid, a white crystalline powder used industrially as a starting point for the manufacture of dyes. The squalene supplier allowed the FDA to put this marker in his product. Then the FDA just waited.

Shortly after the next large purchase of the marked squalene, hun-

[4] The average squalene content of olive oil was about 330 mg./100 Gm. of oil, while the average squalene content of other edible vegetable oils varied from 11 for soya bean oil to 28 for peanut oil.

dreds of samples of blended oil under different brand names were picked up throughout the Middle Atlantic states. They were all tested, and many sample showed the marked squalene. The FDA spread out farther . . . from the dealers to the packers . . . to the shadowy leaders of the racket . . . to an olive oil dealer who refused to talk because, he told an agent, "If I talk, I'll get splattered all over the street."

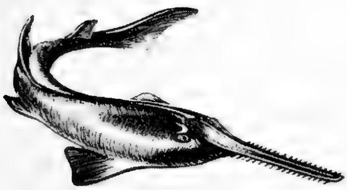
It was a big and vicious racket. Using powerful persuasive techniques, the racketeers terrorized many packers and dealers. G. S. Goldhammer, director of the FDA's Division of Regulatory Management, Bureau of Enforcement, estimates that the racketeers had perpetrated a nearly $1,000,000 fraud before the racket was smashed. And a top-level racketeer had been caught in the shark-baited trap. He was Joseph Profaci, reputedly "untouchable" crime boss. He rarely appeared in public, let alone in a courtroom. But the FDA brought him in. He pleaded guilty and was fined $8,000. When Profaci died of cancer in 1962, U.S. Attorney General Robert F. Kennedy assessed the FDA's catch. Profaci, the Attorney General said, had been "the most powerful" figure in the U.S. underworld.

Part 4

Shark and Company

Chapter 9

Whence the Shadows?



Eons before man or his works appeared on earth, the shark was the monarch of the primordial seas. Our greatest mountains—the Andes, the Alps, the Rockies, the Himalayas—thrust upward from the earth some 60 million years ago. Man, as *Homo sapiens*, is believed to have appeared barely a million years ago. While the evolutionary forces of life spawned countless forms that lived briefly in the crucible of the awakening earth and then expired forever, sharks have lived on. As prehistoric era after era passed—as amphibians, reptiles, birds, and mammals came forth—the shark remained. The pterodactyls, flying reptiles which coursed the skies during countless millennia, disappeared. The dinosaurs—*Brontosaurus*, *Allosaurus*, *Triceratops*, and a thousand more—stalked the earth in ponderous supremacy and vanished into extinction. But, the shark lived on.

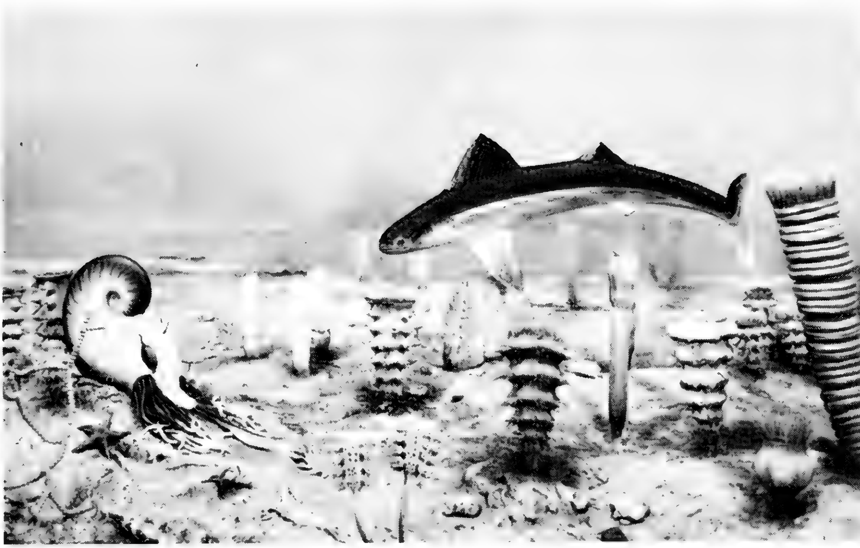
In the vast spectrum of life, each creature finds its place, from the humble protozoan to the reigning vertebrate. The spectrum begins with a faint glimmer out of the void—a small packet of protein. Almost imperceptibly, the spark of life flickers next in the ultrafiltrable virus, the bacterium, the protozoan, then the multiple-celled sponges, jellyfishes and corals. Then, more strongly, in the starfish and the worm. Now, its glow brightening, it passes through the snail, the clam, and the squid. Next the light bathes the spider, the scorpion, the lobster, and the insect. Finally, in a burst of brilliance, the spectrum ends with the vertebrates —fish, amphibians, reptiles, birds, and mammals. And there, among all these species of the modern animal kingdom, are two creatures. One, man, newly arrived; the other, the shark, which has passed through some 500 million years of existence, but still persists, and in some cases with but very little change.

In the Devonian Period, which spanned the time between 320 and 265 million years ago, millipedes, mites, spiders, and wingless insects appeared on an earth turning green with the first land plants. In the times that preceded the Devonian Period, fish dwelt only in inland waters. Some barely resembled modern fish, for they were jawless and heavily armored. Others had jaws, and among these jawed fish appeared a new breed. These had developed "lungs" and paired fins strong enough to perform a function that changed forever the course of life. For, in times of drought, when tidal rivers or estuaries dried up, some of these fish were able to crawl, and so move to new and undried ponds, or else bury themselves in the mud—and breathe air. From them came the primitive amphibians with their tenuous grasp on the land.

The Age of Fishes apparently dawned in the sea, but it is at the beginning of the Devonian Period that the first records of shark-like creatures appear. These ancestors of the shark were already highly developed, and *their* progenitors had doubtless been spawned in the previous Silurian Period, for some Silurian rocks contain faint evidence of shark-like fishes. Since fossils provide the only tangible clues to prehistoric life, the shark's origin is a matter of some speculation. But fossils themselves are but perplexing pieces of a gigantic puzzle that seems destined to remain forever unsolved in its entirety. Sir Arthur Smith Woodward, an outstanding authority on fossils, wrote in 1898 of the difficulties in gleaning knowledge from fossils. There have been great paleontological discoveries since he made his observations, but what he said is still true:

> We may, in fact, without exaggeration declare that every item of knowledge we possess concerning extinct plants and animals depends upon a chapter of accidents. First, the organism must find its way into water where sediment is being deposited and there escape all the dangers of being eaten: or it must be accidentally entombed in blown sand or a volcanic accumulation on land. . . . Lastly, man must accidentally excavate at the precise spot where entombment took place, and someone must be at hand capable of appreciating the fossil, and preserving it for study when discovered.

The oldest fossil records of sharks were found in what are known to paleontologists as the American Middle Devonian beds—limestone deposits in Ohio, rich in marine fossils. The beds gave up a few specimens of the type of tooth known as *Cladodus.* These primitive teeth, amazingly similar to the teeth found in some species of modern sharks, are outstanding for their dagger-like points. Another American fossil-hunting ground, the Cleveland Shales, has given posterity one of the most valuable records of a prehistoric shark. These late Devonian fossils show, in delicate traceries, not only the bodily outline of a shark, *Cladoselache*, but also the imprints of its muscles—and even its kidneys. From these dim outlines, more than 265 million years old, paleontologists have been able to reconstruct a shark from 1½ to 4 feet long. The *Cladoselache* and another primitive shark with similar characteristics, the *Ctenacanthus*, are believed to be close to the source of the shark's earliest ancestors.



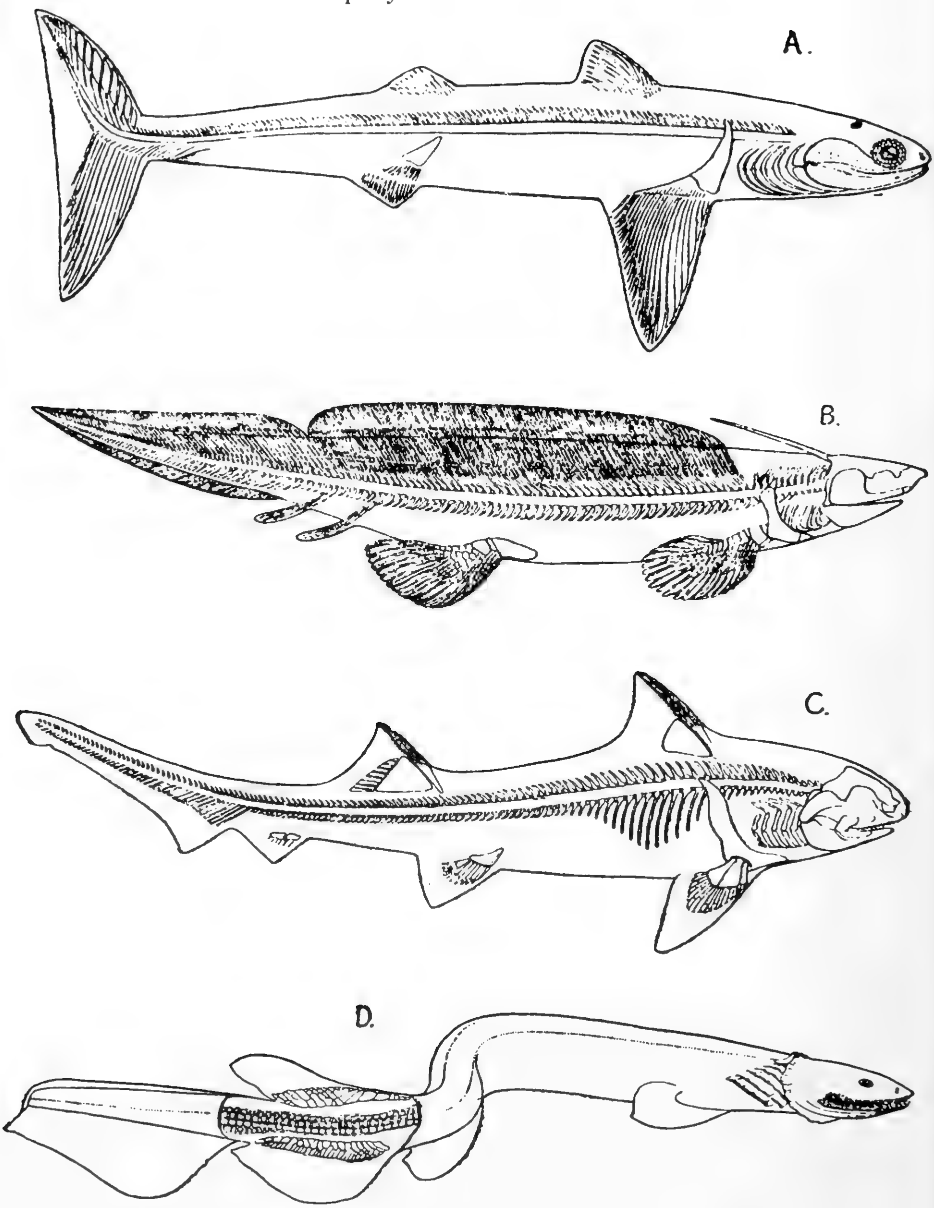
In this restoration of life in a Devonian Period shallow sea, a prehistoric shark (*Cladoselache*) swims toward a large coiled cephalopod crawling about amid several types of primitive sponges growing on the sea floor. The form of the modern shark can easily be seen in this ancestor of eons ago. (This Devonian sea model was prepared by George Marchand, under the direction of Irving G. Reimann.)

Courtesy, Rochester Museum of Arts and Sciences

From more indistinct clues than the *Cladoselache* skeleton scientists have reconstructed prehistoric sharks of astounding size. In Devonian deposits and in strata of the next geologic period (the Carboniferous of 210 to 265 million years ago), fossil spines called ichthyodorulites have been unearthed. These are dart-like quills found in the dorsal fins of various fishes. These quills are similar to the strong, sharp quills found in some present-day sharks, such as the Spiny dogfish (*Squalus acanthias*), one of the most prolific species of shark in today's seas. The modern Spiny dogfish is a small shark; it is no longer than 4 feet, and its spines, or fin-quills, are usually only 1 or 2 inches long. Some fossil spines, however, are *3 feet* long, and may even have carried venom.

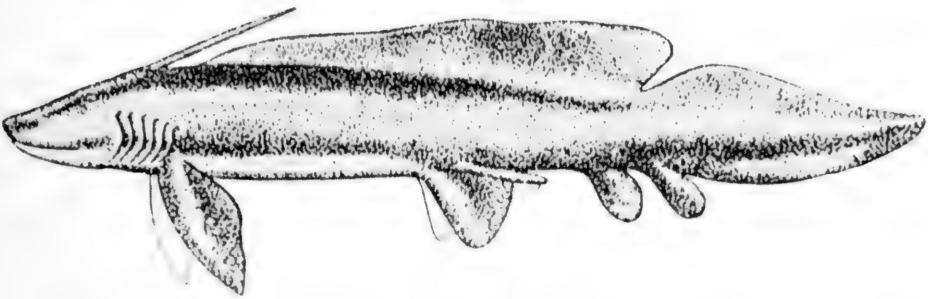
Shark skeletons, for the most part, have vanished from the geologic record because their skeletons contain no true bone. Shark skeletons were—and are—cartilaginous, and usually the relatively soft cartilage is obliterated due to its being soluble. The fascinating ichthyodorulites, made of tougher dentine, often survive, however, as the only remains of some gigantic shark-like creatures.

The *Cladoselache* disappeared during the Permian Period, from 185 to 210 million years ago, leaving the continuance of the evolutionary drama to the Hybodonts, from which can be drawn almost direct lines to the



Successive types of prehistoric Elasmobranch fishes are shown in this series. (A) *Cladoselache,* of the Devonian Period, with fins supported by simple parallel rods of cartilage and the paired fins serving merely as balancers. (B) *Pleuracanthus,* typical of the Permo-Carboniferous, with paired fins used as paddles. (C) *Hybodus,* of the Jurassic, with paired fins for swimming, a persistent notochord and simple vertebral arches. (D) *Chlamydoselache,* which exemplifies the Cretaceous and Tertiary types, but which is still in existence today as the Frilled shark.

Courtesy, American Museum of Natural History



Fossil remains of this Selachian ancestor, *Pleuracanthus*, have been found in the Carboniferous and Permian Period rocks of North America, Australia, and Europe. It ranged in size from 18 inches to 6 feet or more. Note its claspers, which show that it was more shark-like than teleostean. Its teeth are shark-like, but the fossils do not indicate the presence of dermal denticles. After Hussakof

modern shark. The typical Hybodont had the basic appearance of a modern shark and a remarkable arrangement of teeth—sharp ones in the front for seizing prey, and flat ones in the back of the jaw for crushing the shells of mollusks. Thus, they could alternate between two kinds of diet—fast-swimming fish and sedentary bottom-dwellers. This ability to vary feeding habits in the event of a shortage of one kind of food undoubtedly aided the Hybodonts' survival. For, by the Triassic Period (155 to 185 million years ago), the Hybodonts apparently were the only cartilaginous fish in the sea.

At this pivotal era in the dynasty of the shark, the hardy little Hybodonts were relatively rare. They struggled in the primitive seas against the hard-skeletoned ancestors of the bony fishes of today. Their principal enemies—or at least competitors—were probably carnivorous, fish-shaped reptiles, some almost 30 feet long, which roamed the open seas using sharp teeth on the same prey the Hybodonts sought. These marine reptiles were abundant, but the shark line did not die out.

The Hybodonts eventually gave way to new shark forms, but at least one of their descendants still thrives today, little changed from Triassic times. This is the Port Jackson shark (*Heterodontus portusjacksoni*), which still retains the dual-denture system of the Hybodonts. With its blunt, bull-like head and sway-backed body, this usually small Australian shark somehow looks as if it belonged to the past.

The Hybodonts of the Triassic Period were the harbingers of the modern sharks, which evolved in the next geologic period, the Jurassic. The spectacular flying pterosaurs and the great dinosaurs were spawned in the Jurassic, but they were forms ultimately abandoned by nature because they failed to adjust to changing conditions. The shark, a tried and tested form, had apparently already reached a stage of nearly perfect adaptation. During the Jurassic, the sharks began to flourish, forming many families, including variants we now call the skates and rays. And, by the close of the Miocene Period (26 to 12 million years ago), sharks were among the most abundant creatures in the sea. Every now extant family of shark was there, from the ancestor of the common dogfish to the colossal forebears of the modern Great White shark.

Relics of these ancient sharks still exist. They lie in the ooze of seabeds and they are buried in the bottoms of ancient seas where, today, man grows crops and builds his cities. Hundreds of shark teeth have been found on the plains of central Kansas; in Wyoming, Idaho, New Mexico; in New Jersey, South Carolina, New York, and Maryland. In Alabama cotton fields, shark teeth have been unearthed amid the fossilized bones of the *Zeuglodon*, a prehistoric whale which grew to 70 feet and may have been a prey of sharks.

In the soil of a farm in Parke County, Indiana, is a tableau, formed of fossils, that tells a tale of the primeval epoch when Indiana was awash with sea. The story, pieced together by paleontologists of the Chicago Natural History Museum, began when an uncommonly high tide apparently carried several large sharks across a sand bar and into a shallow saline basin. When the water receded, the sharks were trapped. They were too large to get over the bar. Smaller fish could enter and leave the basin at will, and these became the sharks' prey.

But the sharks were not all of the same species. At least one was large and voracious, with rapacious teeth and a jaw 16½ inches long. So long as fish were plentiful, the big shark apparently was content to let its smaller brethren, with their crushing, pavement-like teeth, munch on crustaceans and mollusks. The day came, however, when the big shark hunted down the smaller ones. It ate them, sometimes so gluttonously that it merely bit off a mouthful and let the rest of its victim sink to the bottom, uneaten.

The whole story is there to see in a fossil lode rich in detached skulls and tail fins. Ordinarily, scavengers or bacteria would soon have consumed these tidbits, and the evidence that tells the tale of the trapped sharks would have been erased from the fossil record. But, luckily for paleontologists, there were no scavengers. Mud, perhaps hurled by some convulsion of the earth, shrouded anything that fell to the bottom, protecting it for millions of years from bacterial destruction.

Another drama that lay unseen for millions of years was unveiled in 1853 when a geologist with the Pacific Railroad Survey found several shark teeth on a parched California hill more than a hundred miles from the sea. Since that day, thousands of shark teeth have been found in that hill and the cluster of hills around it. The area, about 7 miles northeast of Bakersfield, California, is called Sharktooth Hill.

Some 20 million years ago, a sea—the Temblor, paleontologists call it—covered the area. Around what is now Sharktooth Hill the sea was no more than 200 feet deep, and the thousands of fossils found there today show that it teemed with marine life. There were whales, porpoises, dolphins, sea cows, seals, and sea lions. Aloft and on the surface, where they were frequently snatched by predators, were seabirds not unlike today's gannets, petrels, albatrosses, and geese. And prowling about this rich hunting ground were giant sting rays weighing several hundred pounds, and 25 or more species of sharks—including one monstrous species as long as 120 feet or more.

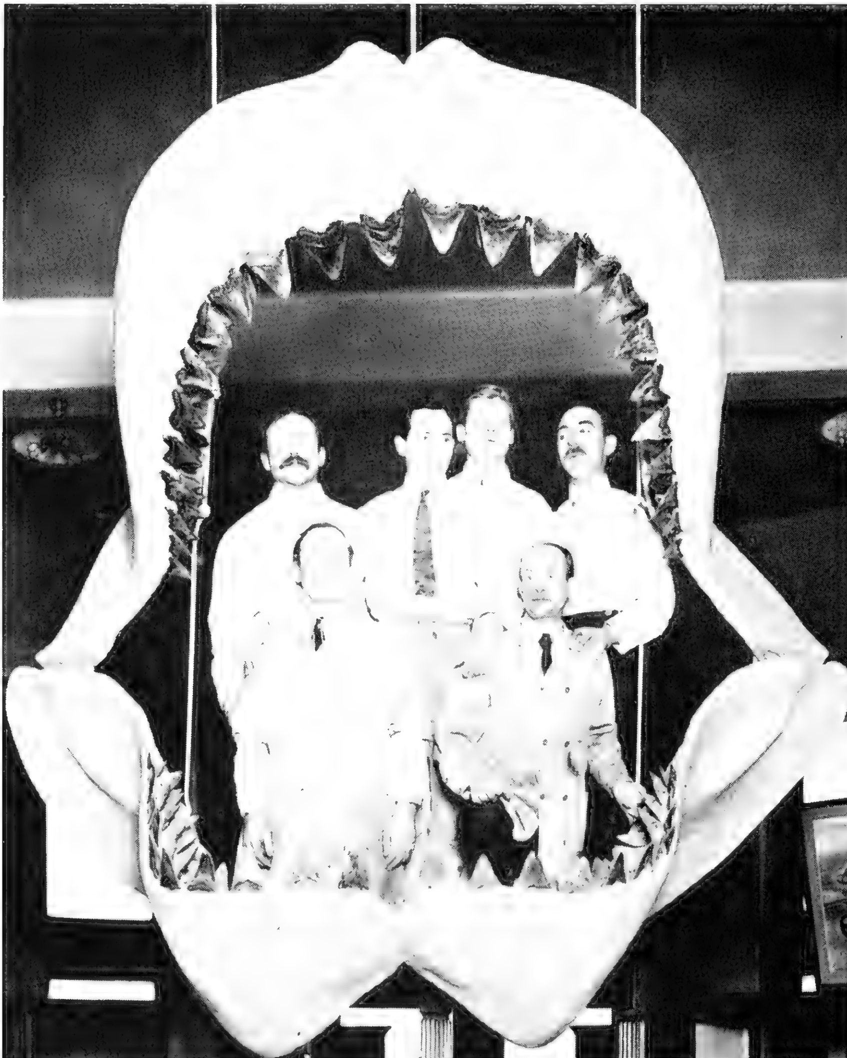
The length of this fantastic shark has been determined by its enormous teeth. Some of the teeth found at Sharktooth Hill weigh 12 ounces and are nearly 6 inches long; 3-inch and 4-inch teeth are common. They are triangularly shaped, similar in shape to those found in today's Great White sharks, which can exceed 30 feet but whose teeth are about an inch and a half long at that size.

Large, triangular fossil shark teeth like those from Sharktooth Hill have been found in many geologic sites and in several present-day coastal areas, such as Staten Island, New York; Venice, Florida; the Calvert Cliffs on the western shore of Chesapeake Bay, and also in the West Indies and New Zealand.

The teeth belonged to an ancestor of the Great White, the *Carcharodon*, which abounded in Miocene seas. When fossil shark teeth were first found and reported by naturalists in the seventeenth century, they were classified as fossil birds' tongues or vipers' teeth. It was inconceivable that they could have come from a shark, so non-existent beasts were conjured up to fit the fossils.

Even today, the immensity of the *Carcharodon* strains the imagination. The American Museum of Natural History has built a model of the jaws of this monstrous shark, basing the size on actual teeth that have been found. The jaws, large enough for a man to stand in with arms outspread, would fit a shark at least 80 feet long. And this was a medium-sized member of the species! Its teeth were not up to the prodigious size of the biggest found at Sharktooth Hill, whose *Carcharodon* was a giant among giants.

The *Carcharodon* is the largest fish of which man has yet found evidence and, though it is apparently extinct, it seems not to be very extinct. Early in this century, 4-inch *Carcharodon* teeth were dredged from the bed of the Pacific Ocean. They seemed to be "fresh," rather than fossilized. The fact that they were dredged up indicated that they had been deposited recently. Older teeth would probably have been covered by so much silt that the dredging gear of those days could not have snagged them.



The gigantic jaws of the prehistoric shark (*Carcharodon*), reconstructed from its fossil teeth, easily accommodate 6 men. The model, in the American Museum of Natural History, would fit a shark about 80 feet long. Courtesy, American Museum of Natural History

Supposedly extinct sharks do still emerge from time to time. At the end of the nineteenth century, an unknown shark was caught off the coast of Japan. It was about 4 feet long, had a long snout shaped like a paper-knife, and a snaggle-toothed jaw. The shark was a complete mystery—except for its teeth, which were sharp, with thorn-like cusps. Distinctive teeth like these had been found in fossil beds in Europe, North and South America, Asia, Africa, and New Zealand. The shark that bore these teeth had been assumed to be extinct for about 100 million years. Yet, there it was.

It was given the name of its fossil ancestor: *Scapanorhynchus*. But the shark's appearance—its strange teeth and forbidding mien—suggested the childhood horror of the goblin, and Goblin shark became its common name. By the way, the Goblin shark lived up to its name not long ago. A break occurred in a telegraph cable lying on the bottom of the Indian Ocean at 750 fathoms. When the cable was hauled to the surface, workmen discovered it had been damaged by a fish that left a distinctive tooth imbedded in it. The work of a Goblin!

Other sharks that are living fossils swim today's seas. These sharks, virtually unchanged from the Jurassic Period to the Atomic Age, include members of the *Hexanchidae* family, whose most distinguishing characteristics are their 6 or 7 gill slits. (All other "modern" sharks have 5, save for *Pliotrema*, one of the Sawsharks.)

Whether still alive in a modern ocean or locked forever with the other fossils in a forgotten prehistoric sea, the shark is a creature of marvelous consistency, a triumph of adaptation to the harsh demands of life on this planet Earth. Millennia upon millennia ago, the shark mastered its environment. Millions upon millions of years before the first precursor of man appeared, the shark began a dynasty that has remained unbroken.

The Modern Shark

Shark is a word whose very letters are rooted in fear—the fear of a jaw filled with biting, slashing teeth. The fish we know today as the shark was first known in English as the *tiburon*, the Spanish word for shark. In 1569, back from a freebooting expedition against the Spanish, sailors of Sir John Hawkins' fleet put a *tiburon* on exhibit in London. But Spain and Spanish words were not popular in England then, and perhaps for this reason the great fish was given a new name—shark.

The word may derive from several sources, for its origin is as hazy as the origin of the ancient shark family itself. All the possible roots point toward attributes of the shark—*Schurke*, the German word for villain; the Anglo-Saxon word *sceran*, which means "to shear or cut." *Shark* appears to have been applied to human varlets as early as to murderous fish; a petty thief or swindler was called a "shark" as far back as Elizabethan times. And today we have loan, pool, card, and business sharks. *Shark* is a fine word. Its very sound is sharp. Perhaps no other cry can command such immediate attention. It has that harsh and piercing note of emergency appropriate to so many of the species.

This fossilized shark tooth (*Carcharodon*) is nearly 6 inches tall. It was unearthed by Mrs. E. L. Anderson at Sharktooth Hill, near Bakersfield, California. Except for its colossal size, it is similar to teeth found today in the Great White shark (*Carcharodon carcharias*).

Courtesy, Mrs. E. L. Anderson

In classifying the many forms of animal life with which he shares the earth, man has sought names of permanence and international meaning, and has turned to the changeless words of Latin and Greek. He has sought, too, some kind of order in his classification, so he founded two major kingdoms—that of plants and that of animals.[1] The animal kingdom is divided into great Phyla, or tribes, and, to those who first explore it, this kingdom is a jungle full of familiar creatures with unfamiliar names. The dog becomes *Canis familiaris;* the crow becomes *Corvus brachyrhynchus;* the bullfrog becomes *Rana catesbiana.* Each species of shark gets a similar double name—the Great White becomes *Carcharodon carcharias;* the Common Hammerhead, *Sphyrna zygaena.*

The first italicized name connotes the genus—a group of species having some fundamental characters in common. The second italicized name is that of the species itself. An animal's scientific name often is based on some obvious physical feature. *Carcharodon* comes from two Greek words meaning "rough" and "teeth." *Sphyrna* is derived from the Greek word for "hammer," and *zygaena,* an ancient word for the Hammerhead, is Greek for "yoke."

The common names of sharks are handy to use but, when a species of shark is introduced or when the common name might cause confusion, the shark's formal scientific name is used.

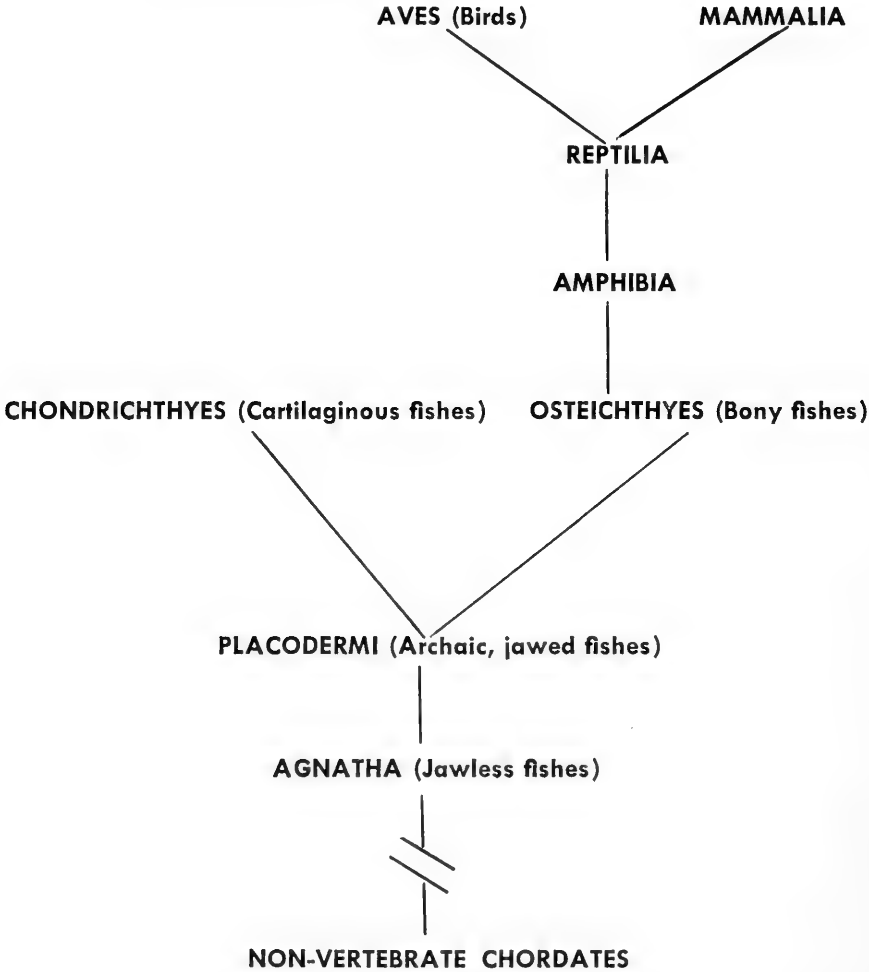
Man and shark share the same phylum—the *Chordata*—which encompasses all vertebrates: fishes, amphibians, reptiles, birds, and mammals. Below this level, we all go our own way, including the classifiers who, in attempting to chart man's way through the animal kingdom, have often got lost themselves! Sometimes the sharks are put in a Sub-Class called the *Euselachii* or *Plagiostomi;* sometimes they are called the *Elasmobranchii* and upgraded to a Class. It still depends on which book you use.

Here is a guide to finding the shark in the animal kingdom:

Phylum: *Chordata*
  Class: *Chondrichthyes* (having cartilage instead of bone)
    Sub-Class: *Elasmobranchii*
      Orders: *Selachii*
        Batoidei

And here is how the sharks—as *Chondrichthyes*—fit into the "family tree" of the vertebrates:

[1] Currently, three are recognized—animal, plant, and bacterio-virus. There is even the suggestion that animals may be but mobile "plants" derived from algae (seaweeds).



From the Orders, one proceeds downward to the Sub-orders, the Families, the Genera, and finally to the Species. The Tiger shark, for instance, belongs to the sub-order *Galeoida*, the family *Carcharhinidae*, the genus *Galeocerdo*, and ultimately gets the specific name *Galeocerdo cuvieri*.

Chondrichthyes include not only sharks and their own close relatives, but also the curious Chimaeroids, sometimes called Ghost sharks. These cousins of the sharks are believed to have evolved from a shark-like ancestor. Their scientific name derives from the Greek mythological monster *Chimaera*, which breathed fire, had the head of a goat, the body of a lion, and the tail of a dragon. The Chimaeroids are not so fearsome as all that, but those that are found today do look more like mythical than real fish. One genus (*Callorhinchus*), for example, has a trunk-like proboscis or snout, and is variously known as the Elephant shark or the Southern Beauty, depending on one's sense of humor.

Elasmobranchii takes in both the *Selachii*, or sharks, and the *Batoidei*, or skates and rays, which are very close relatives of the sharks. The entire family, including all the species of sharks, skates, rays, and oddities in between, are sometimes called the *Selachians*, and if we accept Selachian as a kind of informal family name, we have one word that covers all of these types.

There are about 40,000 known species of fish in the waters of the world. They can be roughly divided into three types: the Cyclostomes, eel-like creatures such as lampreys and hagfish, which have no jaws, no bones, and are so primitive that experts do not all agree on whether or not they are true fish; the Teleosts, which have bony skeletons; and the Selachians.

The overwhelming majority of fishes are Teleosts. However, there are at least 250 species of sharks, and some authorities put the estimate as high as 350. New species are being reported by every important oceanographic investigation. There are 300 to 340 species of skates and rays, and undoubtedly many more remain to be discovered and classified. Numerous as Selachian species may be, their diversity does not compare with that of the Teleosts. Because Teleosts are so numerically superior to the Selachians and, because the Teleosts have bony skeletons like man's, they are sometimes called "higher fish" or "true fish." Some ichthyologists, in fact, prefer not to class the sharks as true fish at all. But the typical shark is usually rated by all other zoologists as a fish.

No matter its classification, it is well adapted to the sea. In the fish-eat-fish world beneath the waves, few fish regularly feed upon the shark —except the shark. There are sea creatures that may challenge the shark —Killer whales and an occasional swordfish. Like man, however, the shark is normally prey only to its own kind.

The basic difference between Teleosts and Selachians is skeletal. Sharks have no bones, only cartilage; the Teleosts have true bones. But there are several other basic differences, the technical details of which are beyond the scope of this book. However, these may be summed up as shown in the accompanying table (page 218).

The digestive system of Selachians is very primitive in structure; the flesh contains urea which gives it a distinctive odor and causes more rapid decomposition than in most Teleosts. The pectoral fins in many species are capable of little or no swimming movement; the breathing organs include not only gill slits but also spiracles on the sides or top of the head. The bodies of most sharks are shaped much like those of some

Basic Differences Between Teleosts and Selachians

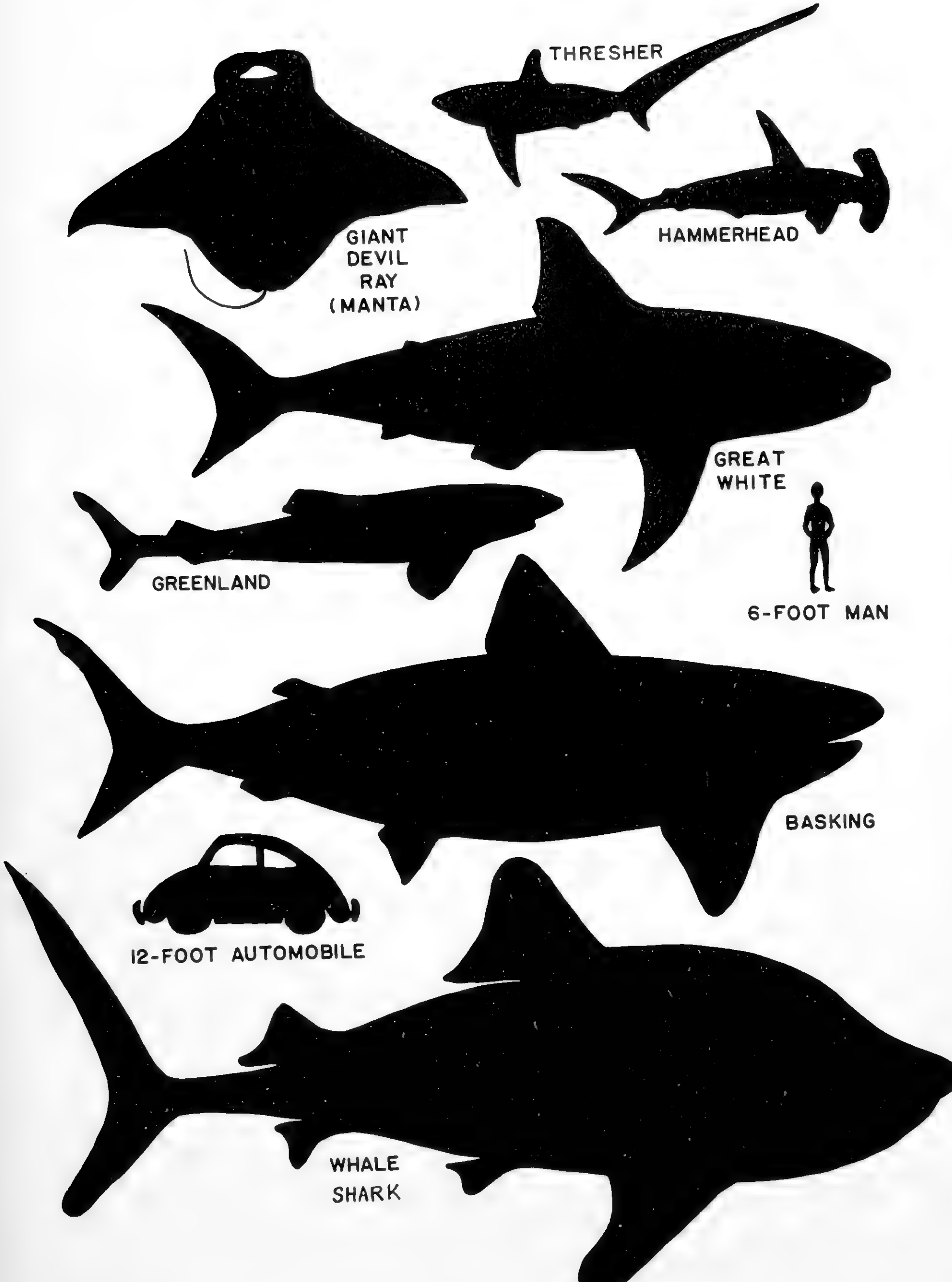
	Teleosts (*All Bony Fish*)	*Selachians* (*Sharks, Skates, and Rays*)
Scales.	Usually large, rounded; bonelike in origin	Usually have denticles; actually tiny *teeth*
Gills.	Typically, one on each side of head, covered by operculum	Typically, 5 to 7 gill slits on each side of head, with no covering
Air bladder. . . .	Usually present	Never present
Reproduction. .	Usually by spawning; young usually hatched from eggs	Always by copulation; young of most species born alive
Anatomy.	Skulls have sutures; teeth in jaw sockets; mouth typically at end of head; tail usually symmetrical, with backbone ending where tail begins	No sutures in skull; teeth not firmly attached to jaw; mouth typically under head; tail usually asymmetrical with vertebrae extending into upper lobe of tail

true fishes, or Teleosts; but others assume more bizarre forms, such as the Hammerhead. But this is only the beginning of the Selachians' diversification. For, included under the dull-sounding phrase "skates and rays" is a strange parade of what amounts to flattened sharks. These, together with the marginal forms that link them to the rest of the shark family, are as fascinating as sharks themselves.

Sharks come in many sizes. Ishmael, awed by the immensity of Moby Dick, rightfully called the whale "the mightiest animated mass that has survived the Flood." But the whale is a mammal, and the largest fish in the sea is a species of shark, the Whale shark (*Rhincodon typus*). The Whale shark's confirmed measurements are 45 feet in length and more than 13 tons in weight. Creditable reports have put its length at 60 feet and more. [Blue whales (*Balaenoptera musculus*) commonly grow to 90 feet, and have been known to reach 110 feet in length.] There are small sharks, too: some mature at less than 18 inches. One species, *Squaliolus laticaudus*, found at abyssal depths in the Pacific, retains a complete shark form but at full size is believed to be less than 3 inches long.

Between the Whale shark and the tiny *Squaliolus* are sharks whose fame rests not on their size but rather on their versatility, feats, and reputation. Rightly or otherwise, this reputation is often bad, and the consensus of most seafarers, fishermen, and landsmen is that the best shark is a dead one.

The notion that the shark deserves a hideous death seems to be uni-



A 6-foot man is shown to scale with 6 of the largest sharks and the largest known ray, all drawn to reliably reported sizes. At *left, top,* is a Giant Devil ray (breadth of 20 feet); at *right, top,* is a Thresher shark (20 feet, including tail) and, below it, a Hammerhead (15 feet). Four large sharks, from *top* to *bottom,* are a Great White (36 feet), Greenland (24 feet), Basking (40 feet), and Whale shark (45 feet).

Courtesy, Scottie Allen

versal among sailors. Since the age of sail, seamen have usually caught sharks only to curse them and butcher them, though when shipwrecked they have been happy enough to eat them for survival on many occasions. More often they have hacked the shark into pieces, or chopped off its tail and hurled it back into the sea to be devoured by other sharks. In Panama, the natives have devised a fiendish death for captured sharks: crucifixion. They nail the shark's pectoral fins and tail to a board and then launch the board, sending the shark out to death under a glaring sun or into the jaws of other sharks attracted by the victim's bleeding and writhing.

Native divers in the Red Sea share man's common terror of the shark, though they show it in another way. They give friendly names to the sharks as a means of placating the evil spirits lurking within them.

Doctors J. T. Nichols and R. C. Murphy, the shark experts mentioned in Chapter 1, witnessed one attempt to kill an almost indestructible shark. They reported: "We have seen one hooked, shot full of lead from a repeating rifle, then harpooned, hauled on deck, and disemboweled, yet it continued alive and alert for a long while, thrashing its tail and opening and shutting its weird, expressionless eyes by moving the whitish lower lids."

And a "dead" shark is often very lively. One fisherman, for instance, had a hand bitten off by a disemboweled shark. A naval officer contemptuously kicked a seemingly dead shark lying on deck; the shark's retaliation was immediate and massive—it tore off most of the calf of the officer's leg. The shark's hold on life is incredible. There is a reliable record of a shark that was cut open, gutted, and thrown back into the sea by a fisherman who then baited his hook with the shark's intestines—and caught the same shark again!

The shark dies hard. Gavin Maxwell, writing in *Harpoon at a Venture* of an attempt to kill a gigantic harpooned Basking shark (*Cetorhinus maximus*), reports:

> He was . . . a huge bull of unusually black coloring, and . . . he was still moving, shuddering and undulating down his entire length, though he had been beached for two days . . . At point-blank range I shot the shark between the eyes four times, so that the brain must have been completely obliterated. There was no visible effect; the movement of the body neither accelerated nor slowed. Then, to make certain that the fish was dead, we cut off the entire forepart of the head with axes, but this, too, produced no change. Four days later, when we dragged the carcass off the beach, the body, now headless and disemboweled, was still twitching and jerking over its whole length.

Yet in some ways, the shark is delicate. A relatively slight injury to its gills, for instance, will usually cause a shark to bleed to death. If a shark is hoisted out of the sea by the tail, it has little chance of survival:

the head-down suspension seems to have some effect on its nervous system. Some experts believe that the shark's primitive nervous system may be damaged by fright alone, a reaction animal behaviorists think they have detected in some mammals.

A sports fisherman tells of catching a shark, removing its liver for chum, and then tossing the shark back into the sea as so much offal. The shark swam away, showing no apparent ill effects. A Dogfish (*Mustelus canis*) captured in Buzzards Bay, Massachusetts, had a large hole through the wall of its body. The wound had been plugged by a lobe of the liver which had simply grown into the hole!

Stories are many of sharks' struggles against death and their apparent insensitivity to what in other creatures would be intense pain. But a headless, disemboweled shark writhing on a beach is not really struggling against death. Rather, its biologically simple body is throbbing with reflex actions. It is death that is doing the struggling, for snuffing out such a vibrant, basic form of life takes a long time.

All evidence points to the belief that pain, as we know it, does not exist for Selachians—or fishes in general—or at least they have a very high pain-threshold. In man, the sensation of pain originates in certain nerve receptors that transmit impulses to the higher evolved nerve centers of the brain. Presumably, the lower a creature on the evolutionary scale—and Selachians are well down it—the less developed is its sense of pain.

The shark's tenacity of life begins at the moment of birth, when it emerges from its mother or its egg-case as a miniature replica of its elders: voraciously hungry, ceaselessly moving. Day-old pups, as shark young are called, have been seen going for baited hooks. Two of the authors have seen captured sharks give birth to pups that skittered across the deck of a boat, wriggled through the scuppers or leaped over the gunwale and plunged into the sea—to begin a swim that would end only when they died. For, though sharks can rest on the bottom, they lack the swim bladders that give buoyancy to the Teleosts.

This lack of a swim bladder (or, as it is sometimes called, air bladder) makes it impossible for the shark to maintain an equilibrium of depth. Its body is more dense than the water it displaces and will sink to the bottom unless sustained by constant motion. The shark, then, is constantly striving to keep itself from sinking. Only by a continual undulation of its muscular tail and, to some extent, its fins, can the shark overcome the gravity that inexorably pulls it downward. Unlike the typical Teleost fishes which lie bloated in death on the surface of the sea, when the shark can swim no more its body settles to the oblivion of the deep.

However, at least one species, the Sand Tiger shark (*Carcharias* *taurus*), is said to have developed a kind of substitute for a swim bladder by swallowing air and keeping an "air pocket" in its stomach. Thus, its stomach is believed to act as a hydrostatic organ similar to the Teleost's swim bladder.

In its lifelong swim, the shark does not sleep, at least as we humans know sleep. Sharks that spend their lives inshore seem to rest—or perhaps sleep—by swimming into shallow caverns, apparently alighting on rocky ledges, or seemingly resting on the bottom. Divers frequently are able to approach these "sleeping" sharks with ease. Sharks that spend their lives in the open ocean do not appear to rest, for, if they ceased moving, they would sink, often to abyssal depths. Of course, some sharks live in the great deeps permanently. The "sleep" of any shark, at any depth, however, is possibly only a physiological pause in its activity.

The shark is a creature marvelously adapted to its environment. It achieved this harmony with the sea eons ago, and, from what we know of evolution, the shark's basic structure has remained virtually unchanged mainly because its prehistoric adaptation was so perfect, although much specialization has occurred among different species.

A tough skin plated with row upon row of teeth; three great muscles flexing nearly the length of each side of its body; a strong, gristly, resilient skeleton—these form the dwelling place of what might be said to be the essence of the shark. In addition, there is a tiny brain and a nervous system perfectly attuned to the animal's activity in its environment.

The silhouette of a typical shark is unmistakable. Unlike the mouth of the typical Teleost, the mouth of most sharks is curved and lies on the under side of its head. Its tail, or caudal, fin is almost always asymmetrical, with the upper lobe usually the far longer one. Its fins are flipper-like and differ from the Teleost's fins, which are held rigid by a network of rays or spines. Sharks cannot move their side fins freely to swim, as Teleost fishes can. A shark's fin arrangement is also distinctive. The pectoral fins are generally larger than those of the Teleost. The ventral, or pelvic, fins have, in the male, appendages called "claspers," which are intromittent or sexual organs. Aft of the ventral fins, between the vent and the tail, is the anal fin. The caudal itself sweeps upward, forming the two lobes, the upper of which may have a notch, whose purpose is not known. And jutting from the back of most sharks is the familiar dorsal fin that, when seen, is the warning banner of a shark's presence.

The skeleton of the shark is formed of cartilage, but in some species so much calcium is deposited in the cartilage that it is almost as rigid as bone. Never, however, is true bone developed. This lack of bone does not mean a lack of skeleton; the familiar structural framework of the fish is there, at least at first glance. But, demonstrating in still another way its tendency to remain basically simple, the shark has a skeleton that differs considerably from that of the bony fish. Without going into anatomical detail, it may be said that the Teleost's skull is a far more complex bony structure than the Selachian's cartilaginous skull.

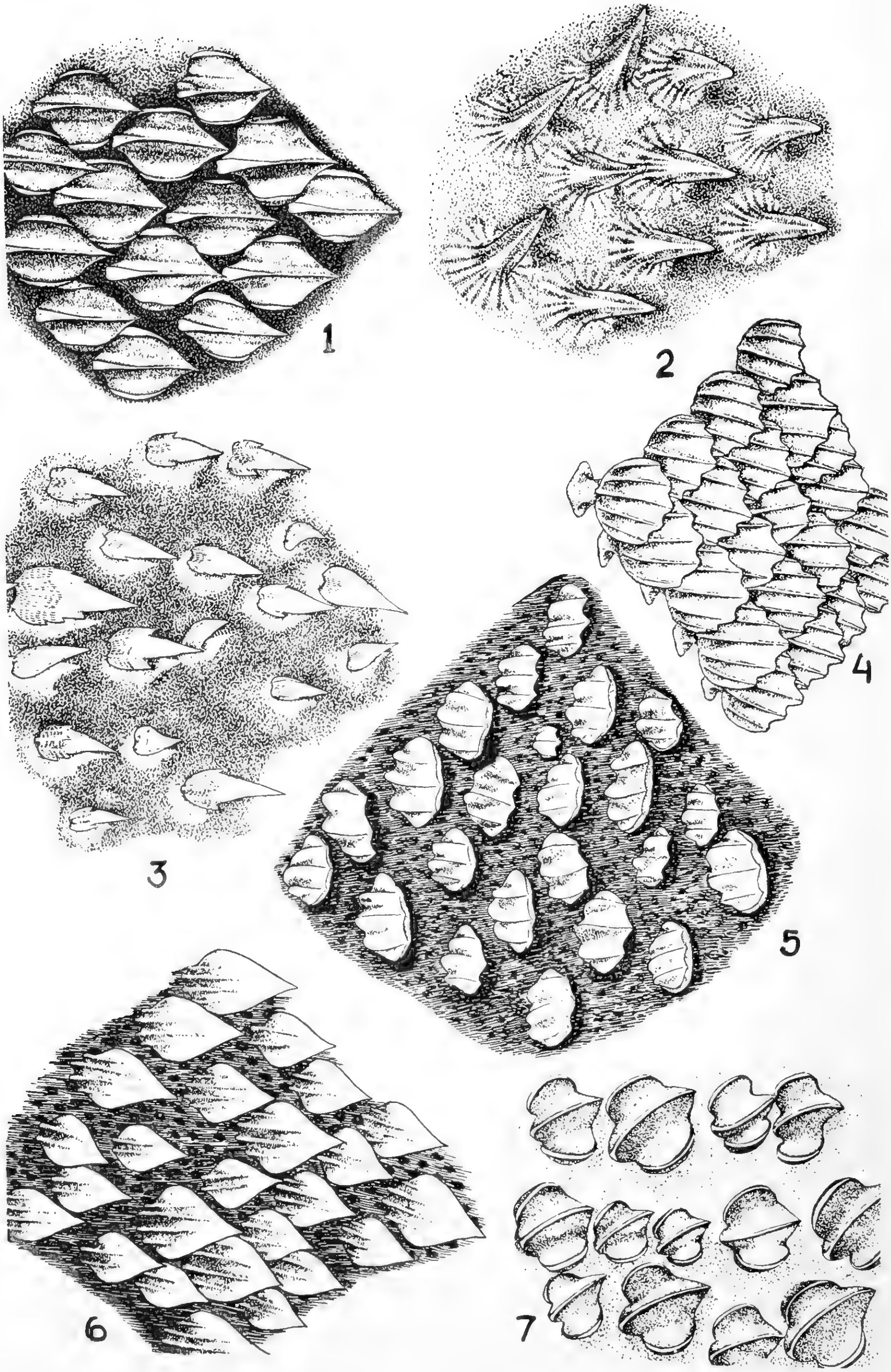
The skin of fish, like the skin of man and other vertebrates, consists of an epidermis, an outer layer of cells, which is continually wearing away and being replaced, and the dermis, an inner layer of more complex cells which include the pigment cells that determine color. Generally, the skin of fish is covered with scales, and most fish scales are of two types: cycloid scales, found in such fish as carp and herring, and ctenoid scales, which have minute spine-like projections at their exposed edges (a black bass has ctenoid scales). Sharks have a third type of scales—placoid. And these scales are really dermal *teeth*, set in the shark's hide.

Of all the many oddities of the shark, this is one of the most difficult to grasp, perhaps because it is so uncomplicated. These scales, called dermal denticles, are truly teeth. Each denticle in the shark's hide has the two attributes of a tooth: its surface is covered by dentine, and it has a central pulp canal containing a nerve and blood vessels. In some species, these denticles are visible to the naked eye; in other species, they are microscopic. But, no matter the size, they are teeth. The denticles give the tough hides of most sharks a sandpaper-like roughness that can scratch or even tear a swimmer's flesh. This abrasive hide, called *shagreen*, can smooth down the hardest woods and, in fact, was once used for that purpose by cabinetmakers, as has been mentioned.

Denticles are anchored in the skin of the shark much as collar buttons are held in a shirt. The sub-surface base of the denticle is larger than the opening through which the visible portion projects. The denticles project backward, which is very obvious if the skin is stroked from the tail toward the head. In some species, such as the Nurse shark (*Ginglymostoma cirratum*), the denticles are so large and so closely spaced that it is difficult to drive a harpoon into the hide. Other species produce scattered patches of denticles. The variety of denticle forms is nearly as great as the variety of shark species. Denticles are blunt, scalloped, spade-shaped, thorn-like, geometric, and even heart-shaped.

By a growth process called hypertrophy, certain denticles develop independently of others and become comparatively gigantic structures with no apparent relationship to the smaller and microscopic denticles. The possession of denticles is one of the many characteristics shared by sharks, skates, rays, and the links between them.

These other members of the Selachian family are usually so segregated from the sharks themselves in most writings about sharks that it is



The varied denticles shown in these samples are from 7 species of sharks: (1) Tiger shark (*Galeocerdo cuvieri*); (2) Basking shark (*Cetorhinus maximus*); (3) Cat shark (*Scyliorhinus boa*); (4) Thresher shark (*Alopias vulpinus*); (5) Brown shark (*Carcharhinus milberti*); (6) Smooth dogfish (*Mustelus canis*); (7) Sand, or Sand Tiger, shark (*Carcharas taurus*). Note: in these and other species, the denticle pattern may vary throughout the shark's body, so that these denticles are not necessarily a positive means of identification.

U.S. Bureau of Fisheries

easy to assume that the family connection is tenuous. This is not true. The Selachians are all intimately related to one another.

How does the hypertrophy, the increased size and changed shape of certain denticles, show this kinship? Shagreen denticles, which are seized by a hypertrophic urge for nonconformity, modify in various ways. One such modification is the fin spine, a thorn-like quill, which emerges in such species of shark as the Spiny or Piked dogfish (*Squalus acanthias*) and the Port Jackson shark (*Heterodontus portus-jacksoni*). The fin spine projects in front of the dorsal fin (and is similar to the ichthyodorulites, the prehistoric fin spines mentioned before). Another modification is the saw tooth which is found in the Sawfishes (*Pristoidea*). The Sawfish has a long, flat, narrow rostrum, or snout, which resembles a saw because along both edges are large, sharp teeth. A third denticle modification is the stinger of the Sting rays (*Dasyatidae* and other families), the defensive weapon which has earned the Sting ray well-deserved respect among both men and other fish. The spine of the Dogfish, the saw tooth of the Sawfish, and the sting of the ray—all are versions of the same "tooth," the denticle, the persistent sign of the Selachian.

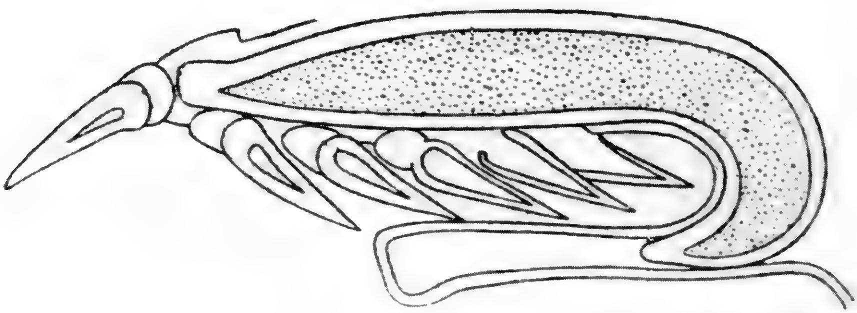
In the embryonic Dogfish, for example, there is virtually no distinction between the denticles near the mouth and those elsewhere on the body. As the embryo develops, however, the denticles around the jaws become bigger and complete their growth as distinctive teeth. The teeth of all fishes, the higher vertebrates—and man himself—have as their origin modifications of the dermal layer of the skin. Nowhere is this fact better demonstrated than in a shark's transmutation of the denticle into the tooth.

The teeth of sharks, skates, and rays are lined up in several orderly rows, as many as a thousand or more. The variety which characterizes so many other aspects of different Selachians is present in the teeth, too. They vary from the stiletto-shaped teeth of the Sand shark (*Carcharias taurus*) to the blunt teeth arranged like pavement stones in the mouths of most skates and rays. Other sharks have the more familiar triangular-shaped teeth, and these in turn vary, some having finely serrated edges and others flanking the triangle with cusps. In some rays, there is even a variation by sex in the teeth, the female having flat teeth and the male sharp ones.

Some sharks may call into action as many as five rows of teeth which, in fearsome phalanxes, obey muscular orders that erect or depress whatever teeth are needed on any predaceous occasion. And behind these teeth on active duty are row upon row of reserves lying in deep grooves inside the jaw.

When a tooth is worn or lost, another moves up to replace it. The teeth are on a kind of somatic escalator, with the developing teeth reposing in the jaw until they are needed.

The ability of these escalators to continually bring forward identical teeth has been curiously demonstrated in the examination of abnormal teeth found in some captured sharks. In one shark, for instance, an oddly split tooth was found to be duplicated by all the teeth on its escalator track. Each one of them, including the reserve teeth covered by gum tissue, was split down the middle, exactly as the first-row tooth was. Further investigation showed that a Sting ray's stinger had become im-



As teeth are lost or worn out, new ones rise up, escalator-like, from the shark's jaws, as this cross-section drawing shows. The dotted lines represent the cartilage. "Budding" teeth are protected by a membrane. After Ridewood

bedded in the shark's jaw, evidently while the shark digested the Sting ray. The stinger apparently had pierced a tooth bud deep in the jaw, dividing the bud into approximately equal halves. As each succeeding tooth (or, more correctly, half-tooth) moved forward, it carried this deformity with it.

In some of the larger sharks, such as the Tiger shark (*Galeocerdo cuvieri*), the flashing teeth are backed by a huge, powerful jaw. The skull of a horse was found in one Tiger not quite 11 feet long. The Tiger was able to swallow, whole, the horse's skull because of the peculiar construction of the Tiger's jaws and the muscles that power it. The upper and lower jaws have joints at each corner of the mouth. The joint is manipulated by strong, elastic muscles that enable the shark to distend its mouth. Each jaw, upper and lower, is hinged in the center, so that the lower jaw can gape into a deep V and the upper jaw can erect into a Λ. With this mechanism, the jaws of a large shark could easily pass over the length of a man without touching him, even if he were somewhat portly, and had, say, a 40-inch waistline. If those jaws should close, the shark biting and shaking its head, the man could be bitten in half. It has happened. . . .

When viewed from above, the brain case of the typical shark looks like a distorted hourglass whose upper half is larger than its lower. The upper half of the hourglass contains the biggest parts of the shark's brain—the olfactory lobes and the centers of the sense of smell. Because of the enormous size of these lobes, the shark's brain has been dubbed a "brain of smell."

Curiously enough, the cerebral hemispheres of man—the seat of his highest mental faculties—seem to have evolved from primitive olfactory lobes, originally the major channels through which man's evolutionary forebears gathered information. (This is an extremely significant fact.)

Thanks to the "brain of smell," the ability of the shark to detect the scent of food is amazing. Dr. Gilbert Percy Whitley of Australia, who has made a life-long study of sharks, tells of sharks following bathers who had merely scratched their legs while wading in the shallows. The sharks had detected these minute traces of blood. "I also found," Whitley reports, "that they would come very quickly to a spot in which sea-birds' eggs had been broken in the water, so that they must have a keen sense of smell."

Experiments have shown that a certain species of male moth can detect the scent of a female moth at a distance of 2 miles. Studies indicate that the ability of sharks and other fish to detect smells is often similarly keen, although almost nothing is known of scent diffusion in water. But, as zoologist A. D. Hasler has remarked, "We are concerned here with a sense of such refined acuity that it defies comparable attainment by the most sensitive instruments of modern chemical analysis."

All animals, man and Selachians included, ultimately use a liquid medium to employ their sense of smell. In terrestrial animals, the odor of a smellable substance travels through the air to a mucous film in the nostril. There, captured in a liquid, the smell is registered and relayed by the olfactory nerves to the brain, which interprets what it is. In the Selachians, the odor of the smellable substance travels through the water to the olfactory pits, or nostrils, on the underside of the shark's snout. Almost invariably, the pits are not used for breathing, the result being that they have only one purpose: the detection of smells. The pits are lined with a sensitive membrane that is usually folded into a series of ridges coated with scent-sensitive tissue. As the shark or ray swims, a current of water constantly passes over this olfactory tissue. Since the swimming is more or less uninterrupted, so is the flow of smell-messages that are being transmitted to its scent-oriented brain.

If a shark's nostrils are plugged and no water is allowed to flow over the olfactory membrane, the shark usually will swim over food without detecting it merely by sight. When its nostrils are unplugged, the shark can zero in on food even though it has been hidden.

Sharks have been seen zigzagging through the water in an apparently aimless pattern. They were probably homing in on a scent, veering to the right if the right nostril detected a stronger scent, and vice versa. Dr. George Parker of Harvard once demonstrated this by plugging first one, then the other nostril of a shark in a tank. When the left nostril was plugged, the shark swam clockwise, seemingly relying on the messages transmitted by its right nostril; it swam counter-clockwise when the right nostril was plugged.

The Selachian looks out on its watery world through eyes that, to man at least, may appear sinister.[2] Some sharks stare balefully; others "wink" weirdly, with a nictitating membrane that moves up instead of down, as eyelids do. Some bottom-dwelling species, such as rays, have a fold of skin that acts as an awning to protect the eye from light coming from above.

The eye of the shark varies from the enormous eye of some deep-sea species to the comparatively tiny eye of the huge Whale shark. Many nocturnal sharks have rudimentary eyes, and Electric rays of at least one genus (*Typhlonarke*) are blind. Some South African sharks (*Haploblepharus edwardsi* and *Holohalaelurus regani*), caught mostly at night, are called *Skaamoong*, or "Shy Eye," because, when one is taken from the water, it folds its tail over its head, as if to shield eyes sensitive to light.

Behind the retina of the eyes of at least some sharks are light-reflecting tissues similar to those that make a cat's eye glow ghostlike in the beam of a headlight on a dark country road. These natural mirrors intensify the feeble underwater light. If the shark is in water made dazzling by bright sun, a kind of curtain of non-reflecting cells drops over the mirror-like tissue. The iris muscle of the eye will continue to expand or contract in shadow or light—even when it is removed from the head. These experiments have indicated that the muscle responds directly to light falling on it and does not act through a nervous impulse from the brain. Such a primitive arrangement is another example of the Selachian's ability to have evolved to a simple level and then stayed there.

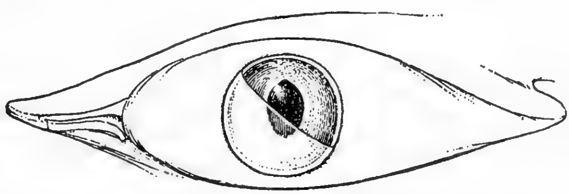
For many years, the theory has persisted that sharks do not have sharp eyesight. Some 50 years ago, Dr. Parker reported that Smooth dogfish (*Mustelus canis*) in experimental tanks rarely responded to an object that was held more than a foot away from their eyes. Primarily

[2] The authors have found occasional references to eye colors of various species of sharks in the literature—but, strangely, there is so little reported on the subject that it has been eliminated as a topic in the present work. The few occasional references do indicate that they range in appearance from the dull baleful eyes of the Tiger shark to browns and blues in other species which might tax the resources of *The Word Finder* to describe.

from laboratory experiments such as this, the belief grew that while sharks could see nearby objects they had limited distance vision.

But tests conducted within recent years by Dr. Perry W. Gilbert, chairman of the newly formed Shark Research Panel, have indicated that sharks depend considerably on their eyes in hunting prey. Gilbert reported that a temporarily blinded shark blundered into a wall and knocked itself out.

Working not with dogfish but with such big sharks as Tiger sharks (*Galeocerdo cuvieri*) and Lemon sharks (*Negaprion brevirostris*), Gilbert anesthetized these fish, put opaque plastic caps over their eyes,



The nictitating membrane, found in certain sharks, is a kind of eyelid which moves upward from the bottom of the eye. The eye shown is that of a Hammerhead (*Sphyrna diplana*). The membrane, found also in birds and reptiles, acts as a windshield wiper which keeps the eye clean.

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

and turned them loose in 80- by 40-foot outdoor pens. The pens, at the Lerner Marine Laboratory in Bimini, in the Bahamas, provide an environment more natural than that of an indoor laboratory tank. And, in this environment, Gilbert reports that a blinded shark is often helpless.

Gilbert believes that the shark's eyes become very important as it nears the food that its olfactory senses have detected. He reports that recent tests have indicated that sharks depend more and more on vision as they near their prey. At about 100 feet from the prey, Gilbert says, the sense of vision seems to take over. The distance depends on how clear the water is.

The tests from which this theory stems were conducted by temporarily blocking vision or smell, and observing the results. When Gilbert and his associates obliterated both senses simultaneously, by putting shields over the eyes and plugging the nostrils, the sharks swam about helplessly, usually injured themselves by crashing into the pen barriers, and died in 3 to 5 days.

Though there seems to be some evidence that sharks can—and do—distinguish between light and dark objects, they are generally thought to be unable to discern colors because the retinas of the eyes of most species do not seem to have color-perceiving cones. Recent experiments conducted by Dr. Eugenie Clark indicated, however, that at least one shark was violently repelled by the color yellow. The experiments were performed at the Cape Haze Marine Laboratory at Sarasota, Florida. Dr. Clark was working with 8-foot Lemon sharks (*Negaprion brevirostris*) enclosed in a pen next to a dock, trying to train them to push a "target" for food. One shark, trained to a white target, hungrily dashed toward it, as usual, one day. But Dr. Clark had substituted a yellow target to test the shark's color perception. A few feet from the target, Dr. Clark reported, the shark whirled, did a back flip out of the water and then began going crazily around in circles. Transformed into what appeared to be a very neurotic shark, it refused to eat, and soon died.

Did the mere sight of yellow do all this? Neither Dr. Clark nor anyone else knows. Certainly yellow isn't that repulsive to other sharks, for, during World War II, many yellow life-rafts were nudged and sometimes attacked by sharks.

Aristotle, a pioneer fish-watcher, said that fish could hear, "for they are observed to run away from any loud noises like the rowing of a galley." There have been times when marine biologists were not as positive as Aristotle that fish could hear, but in relatively recent times discoveries have been made which clearly demonstrate that fish can hear, and can discriminate pitch. Little, however, is known about the hearing of sharks in particular. There seems to be little doubt that Selachians can hear, or at least pick up vibrations accompanied by what humans sense as sound. Selachians respond to vibrations, such as the pulsations of a steamer's screws in the open sea, or the ringing of an underwater bell in a laboratory experimental tank. And they do appear to have ears—inside their heads.

The question of how sharks can detect prey at considerable distances has long fascinated both fishermen and marine biologists. Neither vision nor the sense of smell can explain some of the amazing prey-detection performances sharks have put on before observers' eyes. Although there is no doubt that the shark's super-sensitive olfactory system can detect minute quantities of blood whose odor is carried toward them by currents, the sense of smell alone cannot explain how sharks can track prey whose scent or blood is being carried *away* from the shark by currents. Nor can vision alone be the sense sharks use to find prey that is behind obstructions, such as rocks. (Skin-divers have reported many such incidents.)

Somehow, sound or vibration detection would seem to be the answer to these mysteries. Dr. Warren Wisby of the Institute of Marine Science at the University of Miami has been seeking the answer in a long-range study of the shark's sensory system. Wisby's subjects are Nurse sharks (*Ginglymostoma cirratum*), and his observations are carried on not in a tank—but in a drainpipe.

The drainpipe, 16 feet long and 3 feet in diameter, was chosen so that distracting sounds and sights could be blocked out. One end of the pipe is buried in a box of water-soaked sand, which absorbs sound. The pipe rests horizontally on springs that further absorb sounds from the outside. When the shark is strapped on a kind of sled and suspended in the water-filled pipe, it is thus isolated from any stimuli except those which Wisby introduces.

The shark is next conditioned to associate a sound with an electrical shock. When it detects a sound in its drainpipe prison, the shark's heart skips a beat—as it does when it gets an electrical shock. The telltale heart-skip, which proves that the shark hears a given sound, is registered by a "lie detector." This is simply an electrode implanted near the shark's heart and connected to recording devices in the laboratory. From these recordings of shark reactions, Dr. Wisby believes, scientists may eventually be able to determine what types of sound attract—and repel—sharks.

The sense of hearing alone does not fully explain the shark's detection of and reaction to low-frequency water vibrations—caused, for instance, by the struggles of a hooked fish. Certain fish, such as Croakers, make clearly audible sounds. But the struggles of a fish on a hook are not audible; they are vibrations undetectable by what we normally call hearing.

Skin-divers, whose observations are adding vast lore to marine science, report that schools of fish do not always take flight when sharks appear. Why are these fish apparently unconcerned about the presence of predatory sharks? One explanation, as yet unproved, is that they can somehow detect, possibly through varying vibration patterns, the difference between a "hunting" and a "non-hunting" shark.

Such low-frequency vibrations, however, are apparently picked up by a mysterious sense, peculiar to fish and well represented in sharks. The organ that copes with this sense is apparently the *lateral line*, a network of nerve tunnels which run the length of the shark's body and fan out on its head and jaw. Reaching up vertically from the tunnels are shafts that end as large pores of the skin. The lateral line might be compared to a subway line, the shafts corresponding to the passages that lead from the subway to the stations on the surface.

The importance to the shark of the lateral line has been dramatized by experiments in which sharks, rendered deaf and blind, still responded to wave motions, such as those produced when a stone is thrown into the water. When the nerves linking the lateral line to the brain were severed, the shark showed no response to movements in the water. This also indicates that the lateral line has something to do with balance.

Although the functions of the lateral line are not fully understood, experiments such as Wisby's may prove the theory that the lateral line is a sense of "distant touch," a kind of signal receiver which can translate distant vibrations into meaningful messages to the brain. Subtle movements in the water far from a shark send out feeble vibrations that travel through the sea at about 5,000 feet a second. It may be that the lateral line picks up such vibrations, and, through some process, the shark "reads" the vibrations as, say, waves lapping a shore—or the swimming pattern of a potential meal.

In addition to the lateral line, most sharks, skates, and rays possess another curious sense system, which appears as a number of pores—sometimes several hundred of them—scattered about the head. Each of these pores forms one end of a tube whose other end consists of a group of sensory cells called Lorenzini's ampullae, after the man who first described these odd sense organs in 1678. The word ampullae derives from their shape, which is similar to an *ampulla*, a narrow-necked bottle the Romans used in anointing themselves after bathing. To the modern eye, ampullae look like Coke bottles. Each ampulla is filled with a jelly-like substance that appears to react to either pressure changes or temperature fluctuations, or possibly both.

Scenting, seeing, sensing the slightest signal from pressures, vibrations, and temperatures in its watery kingdom, the shark is like a computer constantly at work on a single equation: **Life = Food.** Sharks do not always eat, and they do not devour all the food they see. Skindivers have seen sharks swimming through schools of fish without molesting them. But, in the hungry sea, the brain of a shark undoubtedly does not dwell for long on thoughts other than food.

Every shark is carnivorous, whether its prey be microscopic plankton or the giant sea turtle. Many sharks are gastronomically uninhibited. And their admirably stalwart digestive system apparently can take anything the shark happens to eat. Abundant amounts of gastric juices, liberally laced with hydrochloric acid, speedily break down edibles, and the speed of the process may account for the ravenous hunger of most sharks. In the opinion of some authorities, the digestive juices—strong enough to burn the varnish off a deck—can eventually dissolve even metallic objects the shark gulps down.

The Selachians have strange stomachs in keeping with their often strange diet. In some, and perhaps many or all species, the stomach is extensible, and it may be capable of turning inside out and everting, so that it extends beyond the jaws. (Inside-out stomachs occur when dead sharks are hung up by their tails, but it is not definitely known whether any live shark is capable of voluntarily inverting its stomach.)

Some sharks apparently are also capable of regurgitating what they don't want, and also preserving for some time what they do. A 14-foot Tiger shark that died in captivity in Australia was found to have in its stomach two intact Dolphin-fish (*Coryphaena*) about 4 feet long. The shark had been captured about a month before, and had been fed only horseflesh, so it had managed to keep the dolphins preserved for at least a month. Thirty-two fish, averaging 15 inches in length, were found packed—and undigested—in a 13-foot Tiger shark, also captured in Australia.

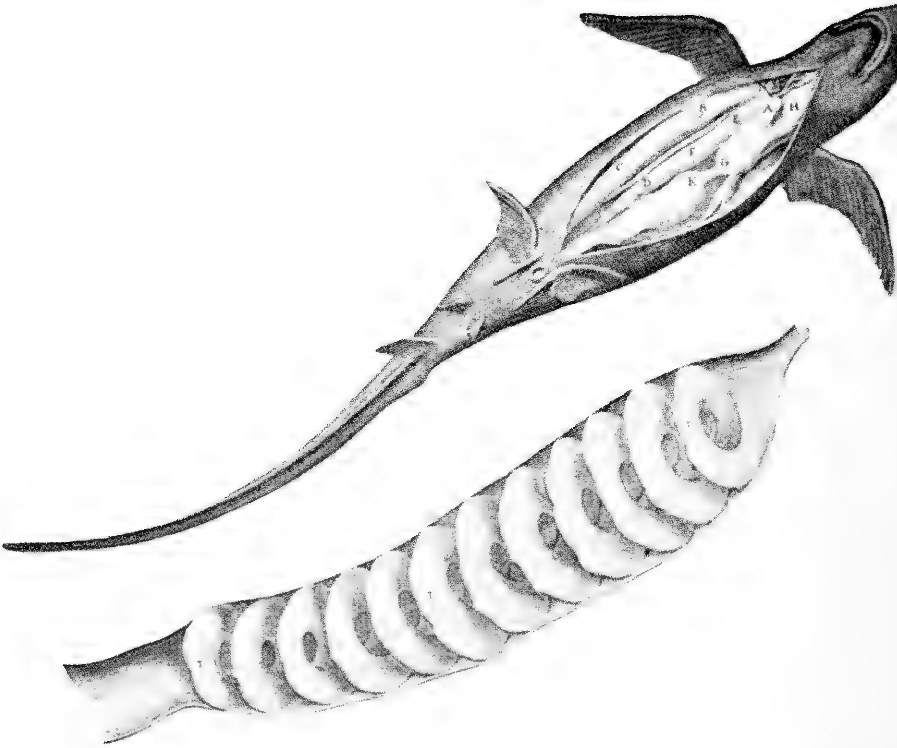
A primitive form of alimentary anatomy, called the spiral-valve intestine, possibly is the answer to how the shark is able to disintegrate horseshoes and to store dolphins, all in the same stomach. The simple digestive tract of the shark is shaped like a lazy Z. The food enters the mouth at the left end of the upper bar of the Z. From that point to just about the left end of the lower bar of the Z is the stomach, in which little digestive action takes place. The stomach seems, thus, to be little more than a storage pouch. But, as the food begins the last leg of its trip, along the lower bar of the Z, it enters the intestine, where the digestive process starts in earnest.

In the earliest vertebrates, the stomach was where food was sorted and the intestine was where food was broken down into simple substances that could be absorbed by the intestinal wall for circulation to body cells. Essentially, this primitive system is still present in the shark. The higher vertebrates, including man, have developed a convoluted intestine so that food passing through it can be exposed to as much intestinal wall as possible in a small area. The shark's intestine is a cigar-shaped tube. Food would sweep down it, with little chance for digestive action—except for the fact that inside the tube is the spiral valve.

The spiral valve is something like a carpenter's auger. The food spirals down it and thus its exposure to the surface area in the gut is greatly increased. The end-products of this spiraling process are spiraled faeces. Millions of years ago, ancient sharks also dropped such oddly shaped dregs. They were fossilized and became prehistoric curios that palaeontologists today call *coprolites;* a word meaning, literally, dung that has turned to stone, and which is used for any fossilized faecal matter.

Dr. Eugenie Clark, whose continuing research has produced many new facts about sharks, has proved that sharks can be trained. Prior to her recent experiments, little was known about the shark's capacity for learning, and the assumption was that the shark was of a low order of intelligence.

Dr. Clark trained a male and a female Lemon shark (*Negaprion brevirostris*) which had been in captivity for 4 months. They were kept in a pen near her laboratory dock. When the training began, pieces of



This is the first and best of the early published figures of the strange spiral valve in the large intestine of the shark. The shark is shown with abdomen slit open to show the viscera. The valve is shown with half of the intestinal wall removed. Anatomist Claude Perrault did an amazingly accurate job of portraying the valve, even though in the seventeenth century its function had not been clearly understood. Even today, this ancient drawing is valuable for illustrating simply the nature of the valve.

Claude Perrault, 1671

food were thrown to the sharks near a white plywood target which, when pressed, caused a submerged bell to ring.

On the third day of training, the food was tied to the center of the target; in order for the sharks to get it, they had to press their snouts against the target. When they got the food, the submerged bell rang. This went on for 6 weeks, until the sharks were conditioned to associate the target and the bell with food.

At the beginning of the seventh week, an empty target was lowered into the pen at feeding time. Now the shark had to bump the target, ring the bell—and then find food elsewhere in the pen. It was given 10 seconds to get the food. If the shark didn't find the food, it went hungry.

"The male quickly learned to press the target for reward food," Dr. Clark reported, "and by the end of the week both the male and the female Lemon sharks were successfully conditioned to pressing the empty target and returning for food."

There were also three Nurse sharks (*Ginglymostoma cirratum*) in the pen. They didn't do so well at associating the target with food. But both the Nurses and the Lemons did learn to steal. And, in the summary of how many times sharks successfully obtained food, a "stealing" factor had to be built in. A "steal" was recorded when one shark rang the bell and another dashed to the spot where the food was dropped. The Lemon sharks "earned" their food by ringing the bell 731 times and stole it from each other 108 times. The Nurse sharks became more adept at stealing than finding food. They earned food 106 times and stole it 118 times—either by sneaking it off the target without ringing the bell, or by snatching it from the others.

When colder weather chilled the water, the sharks lost interest in their schooling. When the water turned warm again, and the target was once more presented to them, the sharks went through their paces, even though they had not seen a target for 10 weeks.

There was no fighting among the sharks for food. In fact, one curious touch of what a non-scientist would call reverse chivalry was observed. Being a scientist, Dr. Clark put it this way:

"We have no evidence yet in explanation of the fact that the female refrains from pressing the target until the initial hunger of the male apparently is satisfied."

As any fish swims, water enters its mouth, beginning a breathing process that is similar to man's. Respiration in fish is essentially the same as respiration in any higher vertebrate: oxygen is absorbed into the blood and carbon dioxide is given off. We extract our oxygen from the atmosphere; the fish extracts it from air dissolved in water. We use lungs; the fish uses gills, and the Selachian uses gill slits. In each of the slits, or clefts, are gill-filaments richly supplied with blood vessels.

When the shark opens its mouth to inhale water, the clefts close. The water passes over the gill-filaments, carbon dioxide is released from the blood, and oxygen dissolved in the water is absorbed. In addition to their 5 to 7 sets of gill clefts, sharks almost invariably also have a less important respiratory organ, the spiracle. The spiracle, usually located just behind each eye on the shark, is believed to aid in aerating the blood destined for the eyes and the brain.

When a shark acts sluggishly in an aquarium, apparently because of a lack of oxygen, attendants take it into a shallow tank and "walk" the shark around it. The stroll causes water to flow into its mouth and through the gills, much as swimming would. As soon as the attendants feel the shark beginning to come out of its daze, they prudently leave the pool.

The shark is begotten in an embrace of the male and the female. The male grasps the female and their bodies entwine. In this union their young are conceived. Their union is an act fairly rare in the sea, where many fishes accomplish reproduction without even touching.

Aristotle saw sharks embrace, and wrote with amazing insight about their breeding and the prenatal development of their young. Not until the nineteenth century, however, was the copulation of sharks rediscovered by Louis Agassiz, an American marine biologist.

In more recent times, the breeding of sharks has been frequently seen and recorded. E. W. Gudger of the American Museum of Natural History gave a vivid account of the copulation of Nurse sharks (*Ginglymotsoma cirratum*):

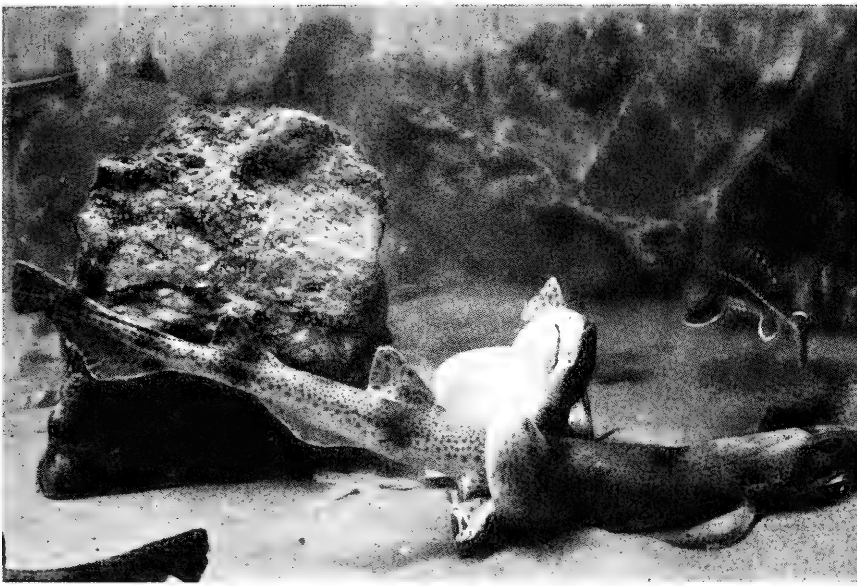
> Nurse sharks come into very shallow water to mate, and pairs, so engaged, are often seen. External signs of the breeding season may be shown by the tattered hinder edges of the pectoral fins of the females. This is due to the fact that the male, prior to copulation, grasps the posterior edge of one or the other of these fins in his mouth. Due to his smallness and the inferiority of his dental armature, the female not infrequently breaks away, tearing and scarring the edges of her fin in the escape.
>
> Once, however, that a secure hold is attained, she is flipped over on her back and the male then inserts his claspers in the lateral pockets of her cloaca, and the seminal fluid is transferred.

The breeding habits of sharks dramatically set them apart from the vast majority of Teleost fishes. Most fish reproduce differently: eggs and sperm are shed in the water, and there, with the dispassion of pollen borne on the winds, fertilization takes place.

Fertilization among Selachians is invariably by intercourse. The males perform intercourse with claspers (*mixopterygia*), appendages of the pelvic fins, which are supported by cartilage. Each male has two claspers, located between the two pelvic fins. Ordinarily, the claspers trail close to the fins and are often mistaken for part of the fins themselves. When copulation is to begin, however, the fins are erected at right angles to the body. Observation of such courtship is very rare, and much of the sex life of the Selachians is cloaked from man's eyes by the sea.

The shark's use of *two* claspers is not yet fully understood. The most modern theory is that only one clasper is used at a time. There is speculation, though, that both claspers are thrust into the female at the same time. The clasper is grooved, and along this groove passes the seminal fluid. The female has two body openings (which, in maiden sharks, are sealed by hymen-like membranes, another fact discovered by Aristotle). Whether singly or simultaneously, both orifices of the female appear to be used during mating. In some species, this may last for about 20 minutes.

Male and female sharks of the same species seem to be specially



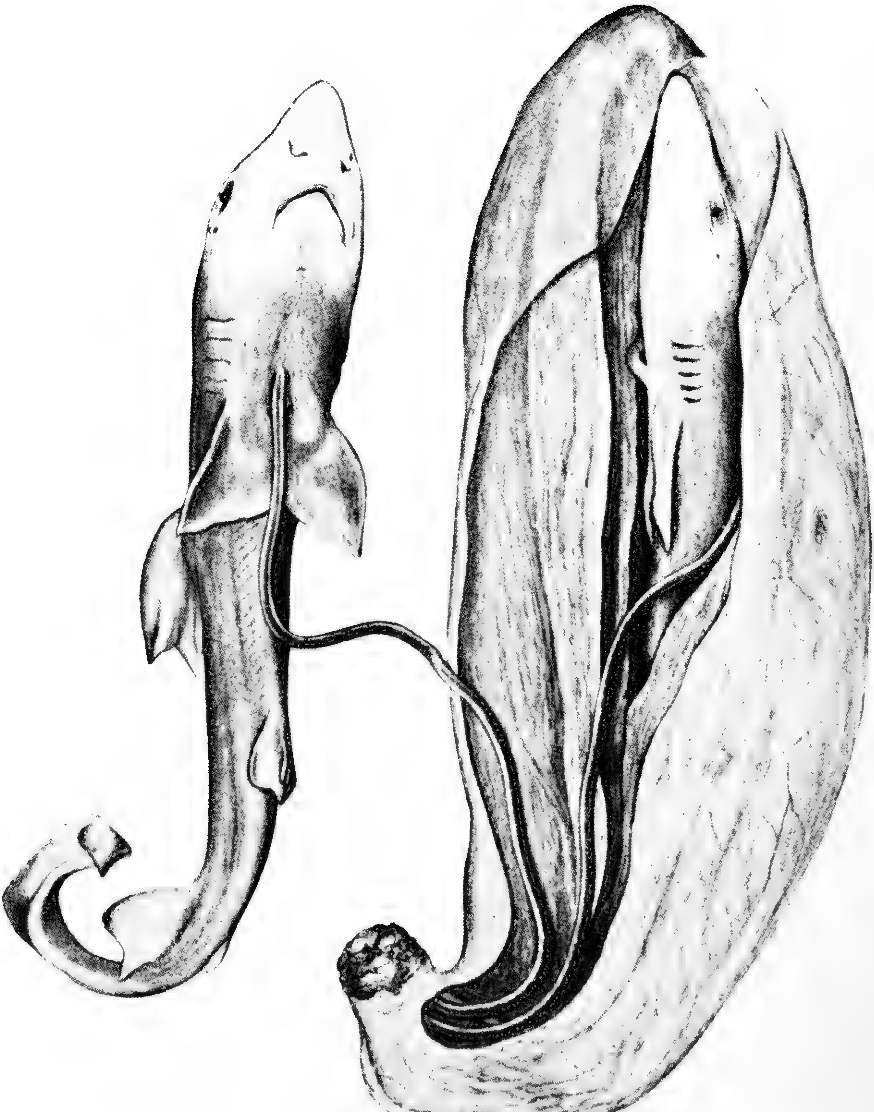
In this rare photograph, a pair of Cat sharks (*Scyliorhinus caniculus*) are shown in the act of mating at the Biological Institute, Helgoland, Germany. The male has wrapped itself around the female. Courtesy, German Institute of Fisheries

formed for each other sexually. Male claspers vary considerably in size and shape. Males of some species have claspers equipped with hook-like structures apparently used to aid in grasping the female. Females of these species are protected by thick layers of skin.

All Selachian young develop within the mother in ways that vary among species. Some sharks are oviparous, laying unhatched eggs; others are viviparous, producing live young nurtured in the womb; some are ovoviviparous, forming eggs that are hatched *within* the mother, who then brings forth her young alive.

In oviparous sharks, the fertilized eggs pass down the two oviducts to the shell gland where a capsule or envelope is formed around the eggs containing a semi-fluid substance (similar to the "white" of a chicken egg) that surrounds the eggs.

The richly variegated capsules—oval-shaped, pear-shaped, spiraled; amber, yellow, black, brown—are formed of a substance resembling keratin, the same ingredient that imparts hardness to animals' claws, hoofs, and horns. In sharks, the outer surface of the capsule is usually smooth or finely ribbed. The four corners of the capsule are drawn out to form long tendrils which coil themselves around rocks or other objects on the sea bottom. Not only do these tendrils act as anchors for the egg capsule, they also seem to aid in the delivery of the capsule from the mother. The tendrils project from the mother and coil around some



The Selachian yolk-sac placenta system is illustrated here with nearly full-grown foetuses (*Mustelus manazo*). Note the umbilical-like connection between the foetus and the placenta, a system which approaches—but is not exactly the same as—the mammalian placenta.

Courtesy, Einar Munksgaard from
Danish Scientific Investigations in Iran, 1944

object. The mother tugs against the pull of the tendrils, easing the passage of the capsule.

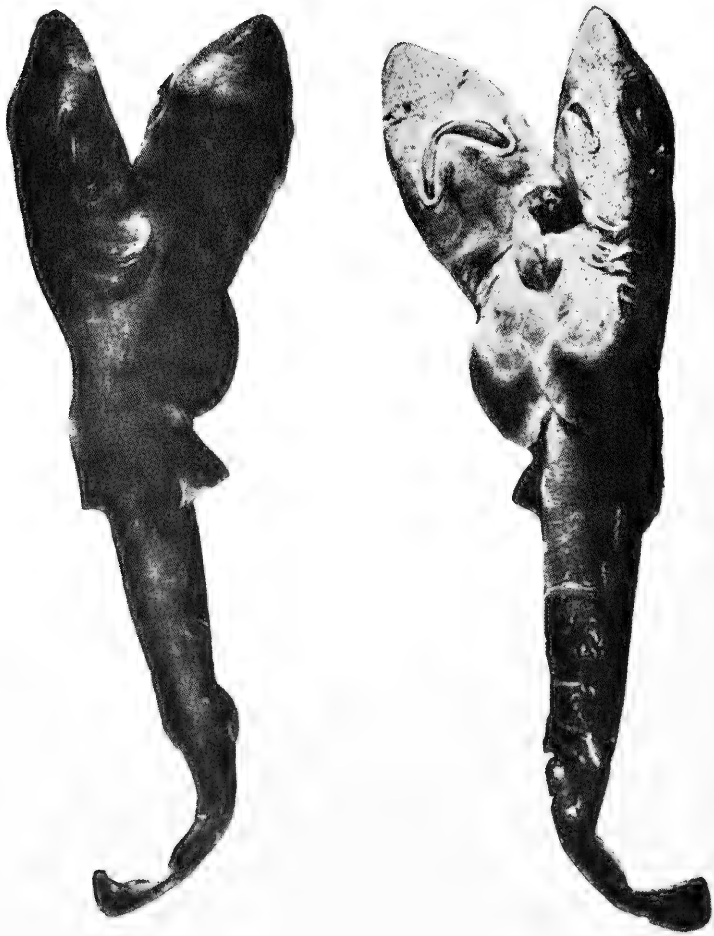
Whitley tells of an Australian shark, the Spotted Catshark (*Chiloscyllium punctatum*), that anchors its eggs with silky fibers that are looped around weeds. A story goes that the mother Catshark weaves the loop with her own lips, but Whitley believes it is far more likely that the mother forms the loop by swimming around the object to which she wants the egg capsule anchored. The Port Jackson shark of Australia (*Heterodontus portus-jacksoni*) lays spiraled eggs which sometimes are found so tightly wedged between rocks on the sea bottom that the only way to loosen them is literally by unscrewing them, as one would a corkscrew.

The majority of sharks are either viviparous or ovoviviparous, which means that one way or the other they give birth to living young. The viviparous shark, like the viviparous mammal, develops its young within itself. In nearly all mammals, the embryo and the mother are linked by an umbilical cord and placenta. Some sort of connection exists between the mother and the embryo in viviparous sharks, but this connection is not, strictly speaking, a placenta. Early in its development, the embryo feeds upon the yolky portion of its ovum. After a while, this part of the ovum becomes a distinct yolk-sac joined to the embryo by a long, thin neck. Eventually, the yolk-sac forms a close attachment to the womb, or uterine wall, and nourishment passes from the maternal blood stream to the embryo via the yolk-sac. This complex arrangement, which seems to be an evolutionary prelude to the more complex structure of the mammalian placenta, is called the yolk-sac placenta.

In ovoviviparous sharks, there is no connection between the yolk-sac and the womb. A temporary shell is formed around the new embryo. Then the temporary shell ruptures (usually it is rolled up in the uterus) and the embryo continues its development within the womb, nourished by secretions deposited by the mother.

The newborn pup enters the sea fully equipped to wrestle with its dangers. Even the Hammerheads (family *Sphyrnidae*) and the Spiny dogfish (*Squalus acanthias*), which bear spike-like quills in front of the dorsal fins, are born alive and fully formed without injury to the mother. The head of the newborn Hammerhead is pliable and the hammer-lobes fold back during birth. The Spiny dogfish's quills, or spines, as they are usually called, are covered with small knobs of cartilage when the shark is born. The knobs are sloughed off right after birth, so that the dogfish is able to use its weapons.

Whether the new shark emerges from an egg capsule or is born alive, it is fully prepared to be an adult, no matter how small. It knows no playful puppyhood, no parental care, no nest. It is a hungry, restless creature, the latest descendant of a primal, ageless breed.



Like other life forms, sharks produce abnormalities. This two-headed shark, shown in *left* and *right* views, was found in Botany Bay, New South Wales, Australia. A similar "sharkemese twin" impressed prehistoric New Zealand natives enough for them to draw a two-headed shark on a rock found near Waikari, New Zealand.

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

Chapter 10

Selachians Extraordinary

Along the shore of every maritime state in the United States and every coastal province in Canada; within and beyond the territorial waters of every nation that boasts a shore; around every island lapped by the sea; in the abyss and in the shoals of every ocean, cold or warm, on earth—and even in lakes and in rivers hundreds of miles from the sea—there are Selachians. Some are known as sharks, some as rays, some as skates; some are curious links between.

Their diversification is wondrous, for, while developing into innumerable species, the Selachians have managed to weave strong threads of similarity into their family tapestry. Often these threads are imperceptible to the untrained eye. But they are there. The Great White shark (*Carcharodon carcharias*) is a swift, graceful, and pelagic fish that roams the oceans with the arrogance of an invincible corsair. The "Sleeper" or Greenland shark (*Somniosus microcephalus*) spends much of its life languishing on the bottom of polar seas. A skate may be a small, inert, disk-shaped creature buried in the sand in shallow water. A ray may be a giant, diamond-shaped beast that leaps out of the sea. They are all Selachians.

How many Selachian species there are, no one truly knows. Within the past century, not one important ichthyological expedition in temperate or tropical seas has returned without reporting the discovery of new and therefore uncatalogued species. Some of these were later reclassified as more or less identical to previously reported species, but the rest were truly new discoveries. In their encyclopedic study of the shark, *Fishes of the Western North Atlantic*,[1] Henry B. Bigelow and William C. Schroeder reported in 1948 that 225 to 250 species of shark were known in the world, and 300 to 340 species of skates, rays, and their allies had been described. Ten years later, at a conference on sharks attended by shark experts from the United States, Australia, Japan,

[1] Memoir Sears Foundation for Marine Research, No. 1, *Fishes of the Western North Atlantic*, Part One (New Haven, 1948).

and South Africa, the number of species of sharks *alone* was set at "about 350."

During exploratory fishing cruises in the Gulf of Mexico from 1950 to 1955, the U.S. Fish and Wildlife Service vessel *Oregon* collected 630 species of fish. Of these, 62 species were sharks, skates, and rays—and 10 of these were described as "new species." Similarly, in 1944, Lionel A. Walford, then aquatic biologist for the Service's Division of Fishery Biology, reported "new species" in the Gulf of California, where sharks are so abundant that the gulf's largest island is named *Tiburon*—Shark—Island. "The Mexican sharks are not very well known to science," Walford reported. "Owing to their large size, they are poorly represented in museums, and then only by immature specimens. Many of the different species look very much alike, and are difficult to identify. Doubtless, several have yet to be described and named . . ."[2]

Some of the anatomical variations that ichthyologists seize upon to differentiate species may seem minor or minute to the non-expert. Bigelow and Schroeder remark, for instance, that it is sometimes difficult to identify some species of skates "without x-ray photographs to show the level at which the tip of the rostral cartilage terminates relative to the anterior rays of the pectorals." But it is of precision such as this that scientific knowledge is distilled.

As man's limited knowledge of the sea increases, it seems likely that discoveries of new Selachian species will also increase. These ancient fish, enduring the cataclysmic changes of the eons, have had more time and opportunities to proliferate than any land vertebrate.

Putting this vast group of greatly varied types into a reasonable

[2] The authors are not professional ichthyologists, and, in this work, they are not advancing any theories. They are extracting from the extensive materials that have been gathered from world-wide correspondence and from personal interviews with authorities in America and Europe, such information about the sharks and their relatives as they believe to be most reliable and of popular interest.

They have been in the laboratories of some of the great scientists in this field and have raised many questions to which at present there are no answers. Among them is the possibility of cross-breeding among closely related species of sharks, which might explain the small differences observed among specimens and some of the confusion in the scientific classification of very similar species reported in various parts of the world. Little is known about the breeding of sharks in general—or even where they breed. The authors have seen parts of shark jaws that for years have defied classification because of minute differences between them and species that *have* been identified.

It seems logical, in view of the lack of definite genetic knowledge about the Selachians, to presume that there is some interbreeding among them just as there is among breeds of dogs. If this can be used as a premise, the conclusions of Cousteau, Doukan, and others about the unpredictability of the behavior of any shark as an individual, rather than as a member of a species with set patterns of behavior, comes more clearly into focus. But individuals in any "pure strain" (if there is such) vary, too.

The authors leave further speculation—and research—to those more qualified than they.

scheme of classification is a difficult and often frustrating task.[3] The basis of any classification system is *relationship*, and always the classifier is faced with degrees of relationship. One way of stressing this degree of relationship is by gathering species with fundamental structural resemblances into various groups. One such group is the *family*.

Accompanying this text is a list of Selachian families. All the members of each family have characteristics in common and, in varying degrees, each family is somewhat more closely related to the families nearest it than to those at greater "distance" in this list (page 244).

Within the biological boundaries that encompass the entire Selachian super-family is a long array of species. Each species has found its own province in the great realm of the sea. Big or small, fleet or sluggish, cosmopolitan or parochial, each individual Selachian is living as the limitations of its specially adapted body compel it to live.

The species that are described have been selected to present an "Anthology of the Selachian." In the truest sense of the word, this is an anthology—a collection of some of the most interesting and most representative examples of a great natural assembly.

Most of the common species found in North American waters are included here, along with some that are uncommon and some that are found far from North American shores. Our selection has not been hedged by geographical or ichthyological boundaries, for we wish to present only a selection that will provide a sweeping view of a tremendous family.

It is an elusive family, too, still abounding in mysteries after centuries of observation. In two vast areas of the ocean—the numbing cold of polar seas and the profound depths—exists much life we know very little about. In these forbidding outposts of the sea, however, we know that some Selachians carry on their breed.

In Arctic waters, where the presence of salt allows temperatures to drop below the freezing point of pure water, the little Arctic skate (*Raja hyperborea*) drops eggs that incubate at 32°F. or below. Off the southern tip of South America, a hardy dogfish (*Squalus*, species unknown) has been reported venturing into the chill seas bordering on the Antarctic. In 1912, the body of an 8-foot shark was found cast up on the beach of Macquarie Island, some 800 miles from the Antarctic Circle. This shark, though known from only this one specimen, has been

[3] Financial support is needed to make possible the comparison of the preserved species of the larger fishes (and many of the smaller ones) for detailed study. Much of the confusion in the classification of sharks, skates, and rays is due to the cost of preserving specimens and making them available for comparison with those captured in other parts of the world. This is a project worthy of investigation and the support of some organization.

The Families of the Selachians

BATOIDS

Torpedinidae (Electric Rays)
Rajidae (Skates)
Potamotrygonidae (River Rays)
Dasyatidae (Sting or Whip Rays)
Gymnuridae (Butterfly Rays)
Urolophidae (Round Sting Rays)
Myliobatidae (Eagle Rays and Spotted Duck-Billed Rays)
Rhinopteridae (Cow-Nosed Rays)
Mobulidae (Devil Rays)

Links

Rhinobatidae (Guitarfishes)
Pristidae (Sawfishes)

SHARKS

Chlamydoselachidae (Frilled Sharks)
Hexanchidae (Six-Gilled Sharks and Seven-Gilled Sharks)
Carchariidae (Sand Sharks)
Scapanorhynchidae (Goblin Sharks)
Isuridae (Mackerel Sharks, Mako Sharks, Great White Sharks)
Cetorhinidae (Basking Sharks)
Alopiidae (Thresher Sharks)
Orectolobidae (Nurse and Carpet Sharks)
Rhincodontidae (Whale Sharks)
Scyliorhinidae (Catsharks)
Pseudotriakidae (False Catsharks)
Triakidae (Smooth Dogfishes)
Carcharhinidae (Requiem Sharks)
Sphyrnidae (Hammerhead Sharks)
Squalidae (Spiny Dogfishes)
Dalatiidae (Spineless Dogfishes)
Echinorhinidae (Bramble Sharks)
Heterodontidae (Horn Sharks)

Links

Squatinidae (Angel Sharks)
Pristiophoridae (Saw Sharks)

designated a species (*Somniosus antarcticus* Whitley, 1939). From these clues we know that Selachians have penetrated the most frigid seas on earth.

In 1954, off Dakar, French West Africa, over one of the ocean's deepest abysses, Lieutenant Commander Georges S. Houot of the French

Navy entered a bathyscaphe and dived to $2\frac{1}{2}$ miles. There, where the water pressure has a crushing force of 5,900 pounds per square inch, and where darkness is complete and eternal, a $6\frac{1}{2}$-foot shark glided through the beam of the bathyscaphe's light and looked at it with great protruding eyes. "Every time we have visited the bottom wastes in the bathyscaphe," Houot later reported, "we have seen at least one shark. Unless our luck has been phenomenal, this must mean there are thousands of them living in the world's dark basement."

About 150 species of sharks, skates, and rays are found in North American waters. Many species range far beyond the arbitrary boundaries set up for them by ichthyologists. Facts about Selachians are evasive, especially facts about where they may be found. In our Selachian biographies, we have tried to list the likeliest whereabouts of each. But, lured by a fleeing school of fish, or an errant oceanic current, or an unusual fluctuation of temperature, members of any species can stray far outside their normal home waters.

Many species are known by several names. One man's Sand shark is another man's dogfish, and one man's ray is another man's skate. There are quite different sharks that are known by identical names in different places. The scientific name of a species must be the only dependable label. Often, though, more than one scientific name has been applied to a species through the years, and the attempt to end the confusion scientifically has only added to it. However, one scientific name usually is satisfactory for scientists to identify each species. We have used those that are generally accepted for each species introduced.

No common shark, skate, or ray is generally known by its awkward scientific name, but only those less or little known. A common name evolves, and it sticks, usually because it is sharply descriptive—as Hammerhead is to Europeans and Americans. Less common names persist, however, and we have also listed many of them, probably at a certain peril. For these are aliases, and, like all aliases, they becloud identity. We have adopted, in fact, the standard police usage for aliases—*also known as*—when we list them.

THE BATOIDS

A creature shaped like a guitar . . . another that wields a slashing saw for a snout . . . another with electric-shock power as legendary as it is painfully real . . . another with a tail barb that can wound or even kill . . . another that soars up from the sea and hurtles down again with a crash made thunderous by an awesome, bat-shaped body that weighs thousands of pounds. These are some of the Batoids, less-recognized relatives of the well-known sharks.

These relatively younger members of the Selachian family are skates, rays, and their relatives, which are all grouped under the classification *Batoidei*. The Batoids appeared in more recent geological eras than the sharks, but they have been around for a long time. Their oldest known members can trace their lineage back to, at least, the Upper Jurassic Age in geological time, about 130 million years ago by some estimates.

Most Batoids are easily recognized by their disk-like shape. But this characteristic is not found in all Batoids. The Batoids can be divided into five major groups, each of which is further subdivided down to species. The groups are:

Electric Rays

Unlike any other Batoids, or sharks for that matter, these unique Selachians have highly developed electrical organs. (In this respect alone they are similar to the much-feared electric eel of South America.) They have a shark-like tail, although reduced in size.

Rays

Typically, rays are shaped like a boy's kite, complete with tail. In many species, the tail is armed with one or more barbed points (technically called spines).

Skates

They resemble rays at first glance. But their tails are lobed, none have poison stingers in the tail, and the tails are fleshier and heavier than in rays. Few grow to large size. They have fleshy, movable fins, usually attached to the anterior margin of each pelvic fin, on which they can "walk" across the bottom.

Sawfishes

Their long, narrow snouts are flat and each edge has a single row of large, pointed tooth-like structures, giving the snout the appearance of a double-edged saw. Sawfishes are not disk-shaped; their bodies are shark-like. They are classified among the Batoids because of certain anatomical details, such as gill slits on the underside of the body, which differentiate them from the sharks.

Guitarfishes

Their name discloses their shape. They are probably links between sharks and rays.

Like their close relatives, the sharks, the Batoids range the world. They are found in polar and tropical seas, near shore and at great depths. Some have infiltrated fresh waters. They have branched off into hundreds of varied species and some have developed somewhat peculiar techniques of survival. Always, however, they have remained Selachians. They are basically nothing more than flattened sharks. They breed like sharks, feed carnivorously like sharks, and, in their very skeletons, they carry the gristly substance which separates all sharkdom from the bony fishes: cartilage.

Most Batoids are sluggish bottom-dwellers, for their flattened bodies were developed for life on or near the ocean floor. (But not all. Certain huge pelagic species have been encountered in the Pacific and the Indian Oceans about which, unlike the Atlantic Mantas, we know little or nothing.) Since most of them have found their destiny on the ocean bottom, they have had to adapt their breathing to their environment. If they inhaled water while they rested on the bottom, they might scoop in sand which would injure the delicate gill-filaments within their underside gill slits. So they breathe in reverse, drawing in water through their spiracles. The spiracle, on the top side of the body, is equipped with a valve, and the water is drawn in, then expelled through the gill clefts on the underside. If a foreign object such as sand or a bit of seaweed is introduced in the spiracle, the bottom-dwelling Batoid has another trick up its spiracle—it spouts water and drives out the obstruction.

Batoids range in size from small rays only a few inches across to the huge Giant Devil ray (*Manta birostris*), known to grow to a breadth of 22 feet or more and a weight of more than 3,000 pounds.

No known Batoid has the sharp-pointed teeth found in many sharks. Batoids' teeth vary from thorn-like prongs on a broad base to rounded or plate-like, and they are usually arranged in bands or a kind of mosaic that sometimes resembles paving stones. This type of dentition is highly efficient for crushing the mollusks and crustaceans that are usually found in the bottom-dwelling Batoid's diet.

Let us now take a closer and more systematic look at the Batoids. First, the Electric Rays.

Family *Torpedinidae*—Electric Rays

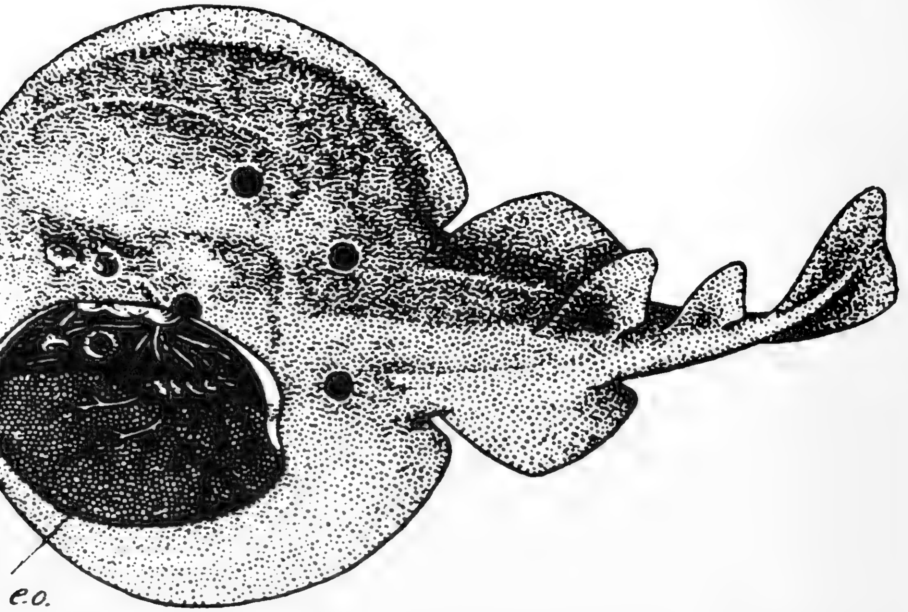
Set apart from all other ray families is that of the *Torpedinidae*—the Electric rays—which encompasses more than 30 species. Electric rays of various types are found in all the oceans of the world.

Electric rays so fascinated the ancients that the humble fish found its way into Etruscan vases, Roman mosaics, Egyptian murals, and Greek literature.

Our word *narcotic* comes from the Greek word for the Electric ray, *narke*. The Greeks believed that the "Numbfish" could bewitch both its prey and the fisherman angling for it. Because Socrates similarly bewitched—or perhaps numbed—his listeners with spellbinding oratory, he was compared by his colleagues to the Numbfish. And the ancient

Greeks well knew that the best way to get rid of superfluous hair was to apply the brains of the Numbfish, mixed with alum—on the sixteenth day of the moon, of course. They also believed that the best way to assure an easy delivery for a woman in labor was to put a Numbfish in the same room with her.

The fascination of the Electric ray has persisted through the years, and only in relatively recent times has its electrical-generating ability



This drawing shows a partially dissected Electric ray (*Torpedo*) which lays bare one of the electric organs (e. o.) with its nerve network. As many as 500,000 "electric plates" are found in an organ. Each plate is connected to the main nerve supply with a cluster of delicate nerve tendrils. The main nerve to which the organ connects terminates in a special lobe of the Electric ray's brain. Rudimentary electric organs have also been found in the tails of skates and rays. After Gegenbaur

been understood. The electric organs consist of two groups of highly specialized cells, one organ on each side of the disk-like body. These organs consist of muscle tissue in which the ordinary electrical-generating ability, found in any muscle, is greatly increased.

Each organ is made up of many columns, running vertically through the body and arranged like large honeycombs. Each column, made up of 375 or more disks, is filled with a jelly-like substance. The small disks produce the same effect as do the electrical plates in batteries, and, in fact, resemble the original voltaic pile—disks of silver and zinc separated by moistened cloth—which historically led to the development of the battery. Four large nerve trunks lead from a special "electrical lobe" in the Electric ray's brain to the electric organs. The nerve trunks branch out to form a complex network of fine filaments that connect with each of the small disks. Thus, the Electric ray has voluntary control over its unique organs, which it uses in defense and in stunning prey.

From the organic battery comes electricity as real as man-made electricity. Like the power that surges from 110-volt household outlets, the ray's electricity can produce a spark, make a bulb glow, deflect a compass needle, and, when connected to a telephone, carry audible sound. Repeated use of the powerhouse obviously tires the ray, which must use up energy to produce its electricity. Successive bursts of electricity become more and more feeble, and some time is required for the Electric ray to build up strength after it has emitted several shocks. The maximum recorded voltage emitted by an Electric ray (*Torpedo nobiliana*) is 220 volts. [The maximum of 550 volts was recorded for the so-called Electric eel (*Electrophorus electricus*) found in South America.] A newborn *T. nobiliana* can generate electricity the moment it leaves its mother's womb, though in the process of birth apparently the mother receives no shocks from her galvanic offspring.

This ray, also known as the Torpedo ray, Torpedo, Numbfish, and Crampfish, is probably the largest of all *Torpedinidae*, growing to lengths of at least 5, and probably 6, feet. The heaviest ray recorded weighed an estimated 170 to 200 pounds. This Electric ray, commonly called the Torpedo, is found on both sides of the Atlantic, from Scotland to the Azores and tropical West Africa on the east; from Nova Scotia to North Carolina on the west. It is also found in the Mediterranean, around the Florida Keys, in the waters of Cuba, and has been reported in other areas.

The Torpedo's electrical shock is strong enough to stun a fisherman who handles one or a bather who steps on one. A fisherman in Provincetown, Massachusetts, reported that he has often received potent shocks "which have thrown me upon the ground as if I had been knocked down with an ax." Skin-divers have received painful shocks after spearing a Torpedo and then trying to pull out the metal shaft.

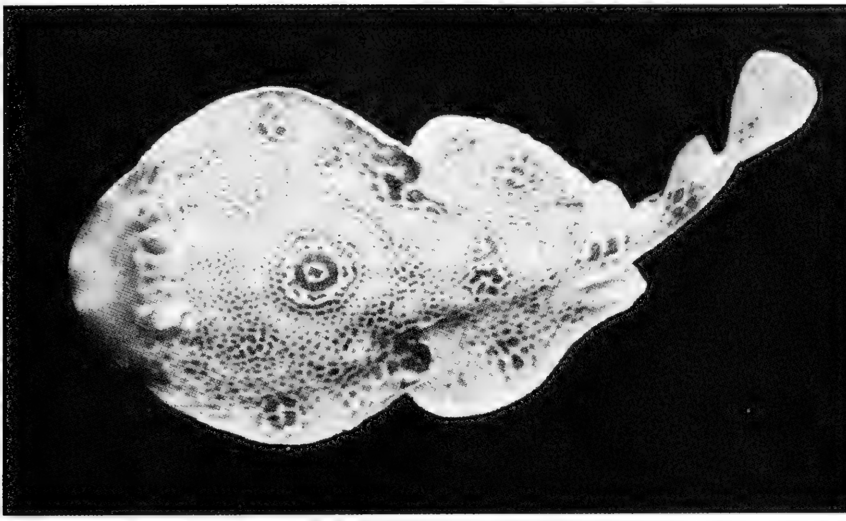
The Torpedo does not get its name from a predilection for darting through the sea like a torpedo. The name comes from the same Latin word which gives us *torpid*, and torpid is the word for Torpedoes. They spend much of their lives lying on the bottom, partially buried in the sand and mud, where their dark coloring aids their concealment. Apparently, Torpedoes stun their prey on contact. A 2-pound eel, a 1-pound flounder and a salmon weighing nearly 5 pounds were all found in the stomach of one Torpedo, and none of the victims had a mark on its body.

An Electric ray (*Torpedo nobiliana*).
Courtesy, Harvard Museum of Comparative Zoology

In an experiment to determine how the Torpedo uses its electric organ to stun prey, Dr. D. P. Wilson of the Plymouth Aquarium in England connected electrodes to a dead 9-inch Horse mackerel, which was pulled through an aquarium tank past a *Torpedo nobiliana.* The Torpedo pounced on the fish. As it enfolded the mackerel with its pectorals, the electrodes detected a strong shock. If the mackerel had been alive, presumably this shock would have been sufficient to render it helpless while the Torpedo devoured it.

One type of Electric ray, the Blind Torpedo ray (*Typhlonarke aysoni* Hamilton, 1902), has no eyes. It makes its way along the sea bottom around New Zealand on modified ventral fins that, in a weird way, resemble stumpy legs. The fins project at right angles to the body and their tips are covered with a thick skin. These "fins" are far better for moving over the ocean bed than for swimming through the sea.

A species similar to *T. nobiliana* (*Torpedo californica* Ayres, 1855) is found along the Pacific Coast of North America, from southern British Columbia to southern California.



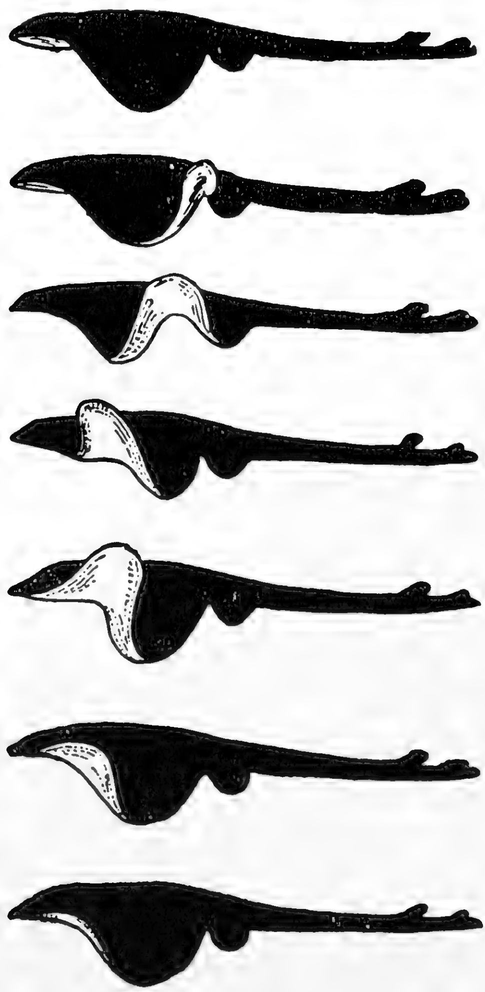
A rare Electric ray (*Diplobatis ommata*).
Courtesy, The New York Zoological Society

Because Electric rays of one kind or another are found throughout the world, they have many names. One of the printable ones is *Abubunsamu*, used on the African Gold Coast. It means "breaker of hands"!

Family *Rajidae*—Skates

In their own quiet, innocuous way, the skates have been responsible for nearly as much misinformation and nonsense as any other creature in the sea. Their curious egg cases, ranging in size from about 7½ inches long and 5½ wide to about 2½ by 1 inches, and found on beaches throughout the world, have been called "mermaids' purses," and the skates themselves have been used to perpetuate legends of sea monsters. Dried skates, cut and twisted into weird shapes by puckish sailors—and merchants—have long been sold as curios. Most of this was done by curio dealers—in the Far East in particular. The monstrosities were brought home (Europe, the United States) by sailors who bought them there. Sailors were seldom fishermen in ports where they could have caught them. Dr. Gilbert P. Whitley, the Australian ichthyologist, says that this trade has been going on for hundreds of years. The curios, peddled as Monkey Fish, Dragons, Basilisks, Mermaids, or Sea Eagles, are sometimes called "Jenny Hanivers" by seafarers.

Naturally malformed skates, whose pectoral fins failed to fuse with their heads while they were embryos, have fooled even ichthyologists. These mistakes of nature were sometimes hailed as strange new species. Actually, what causes these malformations is unknown. Like all animal



The "flying" movement of a typical skate is shown in this series of drawings. The wing-like pectoral fins stretch backward and end in points like the wings of swift birds. This flying movement has inspired the calling of some species "Sea Eagles" and "Sea Hawks."

After Marey

forms, Selachians produce occasional morphological oddities. Two-headed sharks have been reported—one, of an unrecorded species, was found in the river Nile. Albino sharks and Batoids are not unknown.

Skates (and rays) are highly specialized forms of sharks that have gone beyond the shark in developing modifications for living on the sea bottom. In the course of evolution, the cylindrical body of the shark became flattened, the pectoral fins became greatly enlarged, and their basal attachments gradually widened until they became united to the sides of the head. At last, the disk-like body of the skates and the rays was evolved.

This incredibly long evolutionary process is telescoped during the embryonic development of both the skate and the ray. The embryo goes through a number of shark-like stages until it concludes its gestation as a disk-shaped form. Malformed skates' development is arrested during their embryonic period, and they wind up looking like something in between a shark and a skate . . .

"Skates are described as mating ventral side to ventral side," Bigelow and Schroeder write,[4] "and pairs so engaged are sometimes hauled up on hook and line. It has been observed that the males and females of one of the larger European species (*Raja batis*) hold their disks flat while mating; but the female of the smaller *R. asterias* curves her pectorals ventrally, while the male, rolling the outer corners of his pectorals out of the way ventrally, then bends the fins inward around her back, which brings his alar spines (claw-like retractile spines on the dorsal side of the outer part of each pectoral) in position to fasten to her. At least for some of the larger species it is reported that only one clasper is introduced into the cloaca of the female at a time, but for other species it is said that both are introduced simultaneously."

[4] Memoir Sears Foundation for Marine Research, No. 1, *Fishes of the Western North Atlantic*, Part Two, Sawfishes, Guitarfishes, Skates and Rays (New Haven, 1953), p. 141.

Jenny Haniver is the seaman's name for a fantastic "monster" made by cutting and twisting dried skates into grotesque shapes. This is an old, old Jenny, which appeared in Gerner's *Icones Animalium*, published in 1560. The skate's head has been bent forward and its "wings" trimmed. From an old print

Skates are oviparous without known exception, and their oblong egg capsules are essentially the same as the oviparous sharks' capsules. But, instead of tendrils, the skate's capsules have stiff, pointed horns projecting from all four corners. The capsules are generally coated on one side with a sticky substance. Small pieces of shells, stones, or seaweed adhere to it and help to keep it on the bottom. Sometimes, too, the horns imbed themselves in the muddy or sandy bottom which the skate usually chooses for her hatchery.

Half buried in the sheltering silt of the sea bottom, or snugly moored to a staunch rock or other anchorage, the egg capsule becomes an incubator for the embryo developing within it. (*Raja binoculata* sometimes has seven!) The capsule will be the embryo's home for a long time—at least 4½ months, sometimes as long as 15 months. The tough, horny shell protects the embryo from predators, but, more important, the capsule provides its charge with the stuff of life itself: oxygen. Either by osmosis or by tiny perforations in the capsule, sea water enters and leaves, bathing the embryo with oxygen and carrying off carbon dioxide. Thus, in the early stages of incubation, the capsule acts as a natural sea environment for the embryo.

Nourishing albumen engulfs the embryo, which feeds upon it. The embryo's diet also probably includes some chemical nutrients carried in by the sea. In some species, a plug of albumen seals the slits in the shell. After a while, the albumen is absorbed, thus unsealing the slits. In other species, a delicate membrane temporarily seals the slits. When the slits (located in the horns of the skate's capsules) open, a current of water flows freely through the capsule. When its incubation is completed, the skate slips out of an incredibly narrow slit in the capsule and begins its free life in the sea.

Many skates, including some that are common on the Atlantic, Gulf, and Pacific Coasts, have electric organs in their tails. The output of these organs is feeble, and there is no record of a fisherman ever having been shocked by a skate. While the Electric rays (family *Torpedinidae*) can produce a potent shock, the puzzling electric organ in the skate is different from the Electric ray's. The skate's organ is linked by nerves to the *spinal* nerves; the Electric ray's electric organ is linked to the cranial nerves.

Although much is known of the electrical organs found in the *Torpedinidae* and other sea creatures with similar organs, little is known of the skate's electrogenic ability. However, recent studies of 22 species of skates in Japanese waters showed that every species had electrical tissue in its tail. Dr. Reizo Ishiyama, who made the study, has raised the possibility that all skates may eventually be found to have electrogenic capabilities—though for what use, no one yet knows.

Skates swim by undulating their pectoral fins in a graceful movement that more resembles flying than swimming. But the skate is usually a ground fish which often lies half-buried in the sand or mud. Since its mouth is on the bottom of its body, the skate appears not to be able to catch moving prey by dashing forward; it swims over its victim, then suddenly drops down upon it and devours it. The skate's usual diet includes crabs, shrimps, lobsters, clams, and smaller shellfish.

Skates are found in the warm, temperate, and boreal latitudes which gird the earth. They are particularly abundant from southern New England to New Jersey. On one memorable summer's day at Bradley Beach, New Jersey, 10,000 pounds of skates were pulled from the sea in one mighty lift of a large net.

They are also abundant in California waters. Phil M. Roedel and William Ellis Ripley of California's Bureau of Marine Fisheries reported in 1950 that great numbers were being taken in trawl nets, but fishermen threw them back. "The skates, like weeds, are very hardy and apparently thrive when returned to the water unharmed," Roedel and Ripley reported. "It is not uncommon, in areas worked for many years, to make trawl catches containing almost nothing else."

Anglers who reel in skates are frequently surprised—and disappointed—at what they have caught. For the skate has the habit of depressing the outer edge of its body when hooked, thus forming a kind of vacuum cup on the bottom. The angler has to use so much effort to dislodge the stubborn skate that he thinks he has a heavier fish than the lightweight he finally lands.

Although there is no evidence that any skates live permanently in fresh water, strays have been caught in river water far enough from the sea to be called fresh. A large skate was reported in 1883 to have been caught in the River Ouse near Bedford, England, some 60 to 70 miles from the sea. A report in 1929 said that one had been taken from the Yangtze River in China.

Skates, generally found in shallow water and in depths of less than 100 fathoms, also dwell in the great depths. At least seven species have been recorded in areas of the sea known as the *deep-abyssal*—below a depth of about 2,000 meters, or 6,560 feet.

About a hundred species of skates are included in the biggest genus (*Raja*) of the family *Rajidae*, making it the Selachian genus with by far the most species. Another 20-odd species are assigned to eight other genera, although some ichthyologists place one curious group in a separate family, the *Anacanthobatidae*. These odd-looking skates have snouts that flare into the shape of a spired mosque. Their pelvic appendages are leg-like.

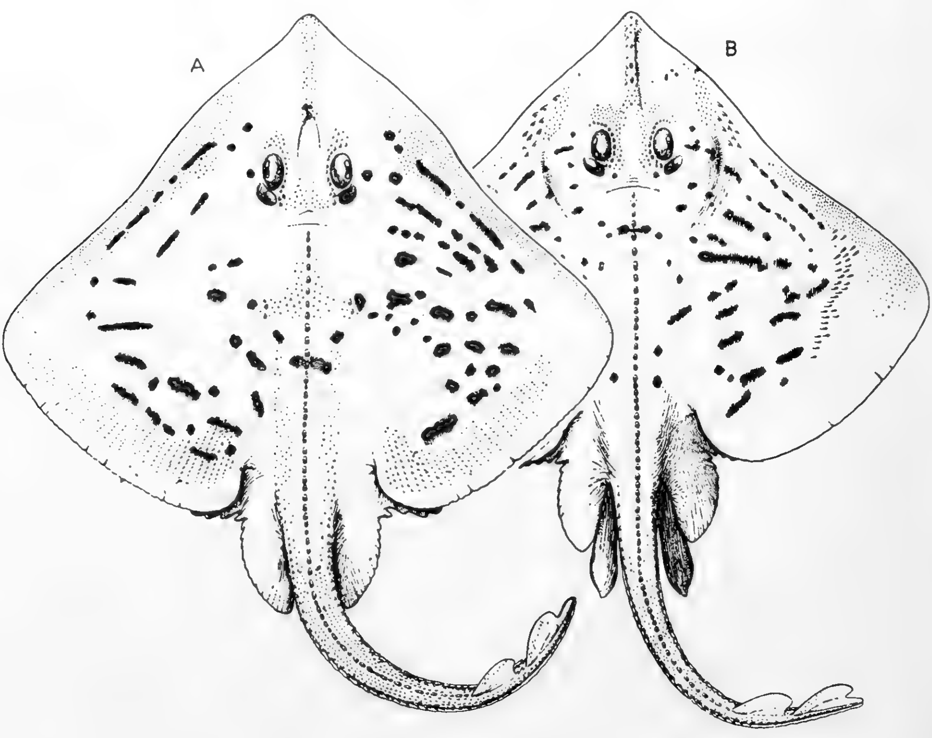
One species of this skate (*Springeria folirostris* Bigelow and Schroeder, 1951) has been found in the Gulf of Mexico, at 185 to 258 fathoms. Little is known about it. The largest reported by Bigelow and Schroeder was a male about 15½ inches long, but it was obviously immature, so the potential maximum size of this strange skate is not known. Nor are its habits or full range known. Other, more abundant skates include:

Brier Skate
(*Raja eglanteria* Bosc, 1802)
(Also Known as Clear-Nosed Skate, Summer Skate)

This skate, one of the most abundant from New Jersey to Virginia, is frequently caught close to shore, where it is believed to breed.

The Brier—so called because of a row of thorns that runs down the middle of its back—appears in April between the Chesapeake and the Delaware Bays. It is common around New York and New Jersey from mid-May to October. From July until September, it is usually off southern Massachusetts. In cold weather, it retreats as far south as Florida.

Its upper side is brown and its lower side white. The longest Brier on record was 37¼ inches long. The egg cases are 2 to 3½ inches long (not including horns), and 1½ to 2¼ inches wide.



Brier skate (*Raja eglanteria*): (A) female; (B) male.

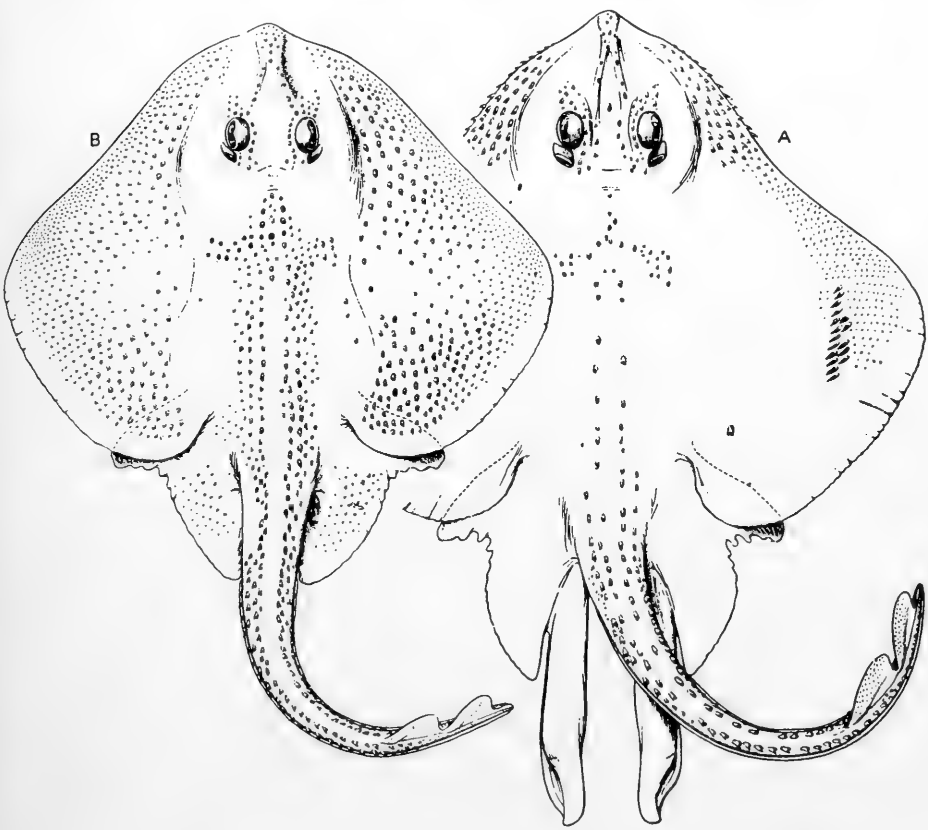
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953

California Skate
(*Raja inornata*)

One of the most abundant skates on the western coast of the United States, the California skate is found from the Straits of San Juan de Fuca (Washington) south to Cedros Island in Lower California. Small prickles line its mid-back, the larger ones on the snout and between the eyes, and it has three to five rows of prickles on the back of its tail. It grows to 2½ feet in length. It is pale above, and duskily mottled below.

Little Skate
(*Raja erinacea* Mitchell, 1825)
(Also Known as Hedgehog Skate, Common Skate, Tobacco Box Skate)

After a storm along the Atlantic coast, this small prolific skate is often found washed up on the beach. Not only is it familiar to Atlantic fishermen, it is also well known to zoological students, for the Little skate is one of the most popular subjects for the dissection table in zoology



A Little skate (*Raja erinacea*): (A) male; (B) female.
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953

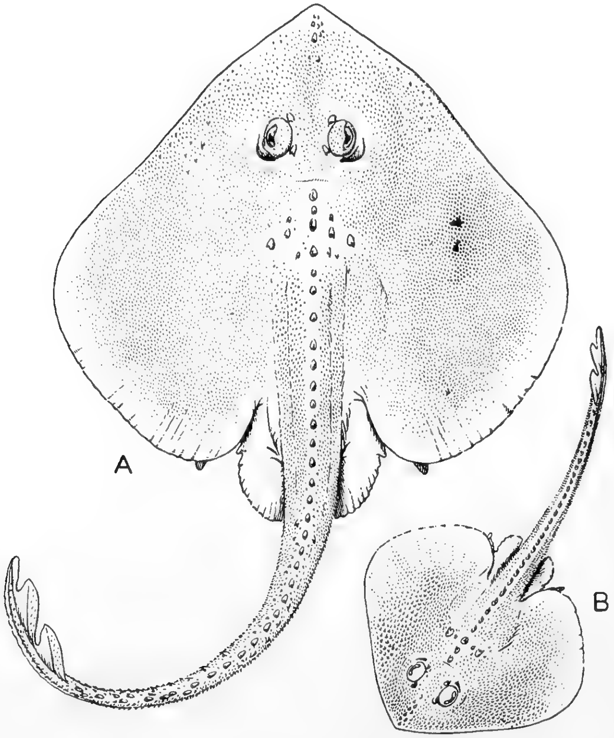
classrooms. Fishermen, who know it well as a shoal-water inhabitant, put it to use, too—by using it as bait in eel and lobster traps.

A trawler once hauled in an *average* of 98.8 pounds of Little skates *per hour* in Long Island Sound.

Mating takes place the year round. A study of Little skate embryos in their egg cases was made by scientists at the Bingham Oceanographic Laboratory of Yale University. It indicated that the embryos get out of their cases by wagging their tails. They seem to bore a slit in the case by tireless movement of their tails. When their 6- to 9-month hatching period is over, they slip out of this slit and are on their own.

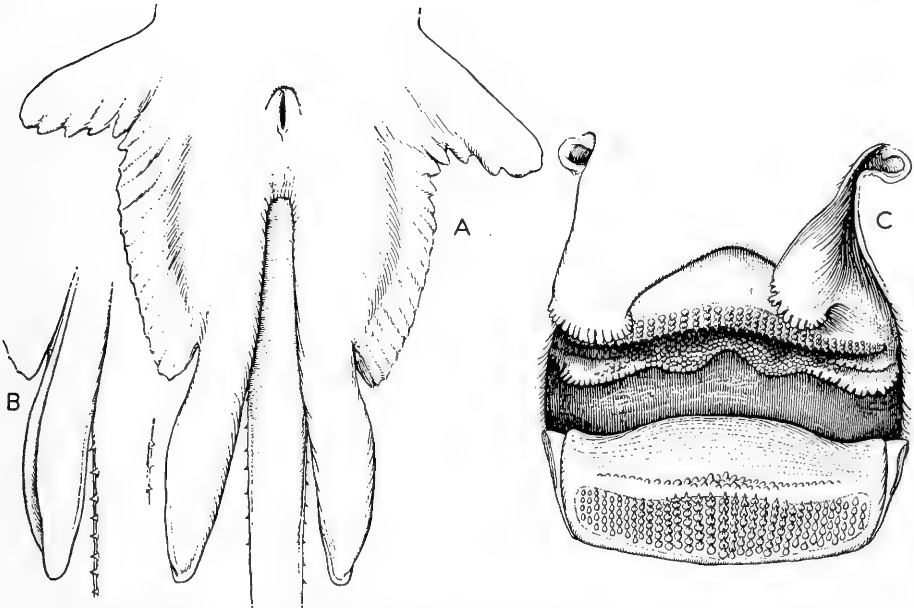
They live in shallow water close to shore along the western Atlantic, from North Carolina to Nova Scotia and the southern side of the Gulf of St. Lawrence.

The Little skate, at full maturity, weighs about 1½ pounds and is known to grow to 21 inches in length. Its tail and the mid-ridge of its back is thorny. Its upper surface is grayish or dark brown, usually with small, darker spots; its lower surface is white or pale gray. The Little



An abyssal skate (*Raja bathyphila*): (A) male; (B) newly hatched male.

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953



External features of the Barndoor skate (*Raja laevis*): (A) ventral view of male pelvic region; (B) side view of claspers; (C) mouth and teeth.

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953

skate's egg case is black, about 2 inches long (not including horns) and about 1 to 1½ inches wide.

Starry Skate
(*Raja stellulata* Jordan and Gilbert, 1880)
(Also Known as Prickly Skate)

A beautifully ornamented skate, whose upper side is a constellation of blacks spots, the Starry skate is found from northwest Alaska to southern California in fairly deep water. It grows to about 2½ feet in length.

Abyssal Skate
(*Raja bathyphila* Holt and Byrne, 1908)

The Abyssal skate dwells in the depths, and is rarely caught. The few specimens that have been brought to the surface were hauled from depths of a mile or more in the North Atlantic. It is known to grow to 18 inches in length.

A similar creature of the depths, the Deep-Sea skate of the Pacific (*Raja abyssicola* Gilbert, 1895), is known from a single specimen pulled from a depth of about 9,525 feet—some 1,000 feet less than 2 miles—in the Pacific, west of Moresby Island, British Columbia. It was a male 4½ feet long.

Barndoor Skate
(*Raja laevis* Mitchell, 1817)
(Also Known as Sharp-Nosed Skate)

The Barndoor skate, which reaches 5 and possibly 6 feet in length, is one of the few skates known to attack fish. In fact, a relative, the Spiny dogfish (*Squalus acanthias*), is included in its varied diet. It also eats herring and cod, and will take just about any kind of bait.

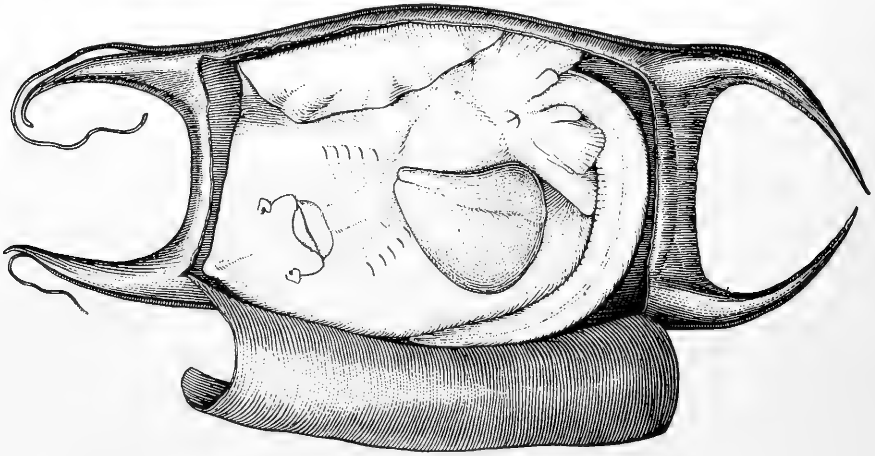
The Barndoor roams the Atlantic Shelf of the North Atlantic, from the Grand Banks of Newfoundland to North Carolina. Its yellowish or greenish-brown egg case is about 5 inches long and about 2½ inches wide.

It is a close relative of the Common skate (*Raja batis* Linnaeus, 1758) of the eastern Atlantic. The largest Common skate recorded in Great Britain was 7 feet across.

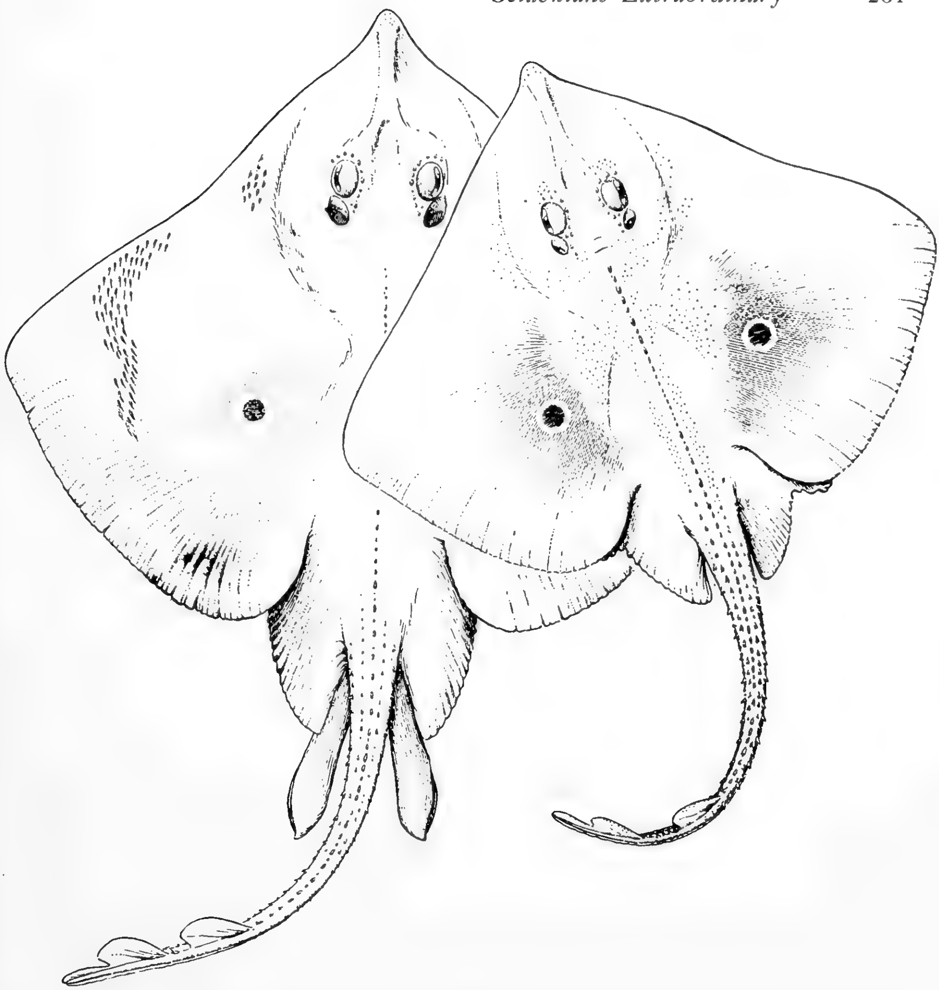
Two Pacific Coast skates are also similar to the Barndoor. The Big skate (*Raja binoculata* Girard, 1854) grows to about 8 feet in length and is found from northwestern Alaska to southern California. Its egg cases, sometimes a foot long, are unusual, for they contain up to seven eggs each. The Long-Nose skate (*Raja rhina* Jordan and Gilbert, 1880), found from southeastern Alaska to southern California, grows to about 5 feet. Its egg cases are 4 or 5 inches long and generally hold one egg.

Eyed Skate
(*Raja ocellata* Mitchell, 1815)
(Also Known as Big Skate, Winter Skate)

This skate gets both its common name (Eyed) and its scientific name (*ocellata*) from the eye-like spots scattered about the upper surface of its body.



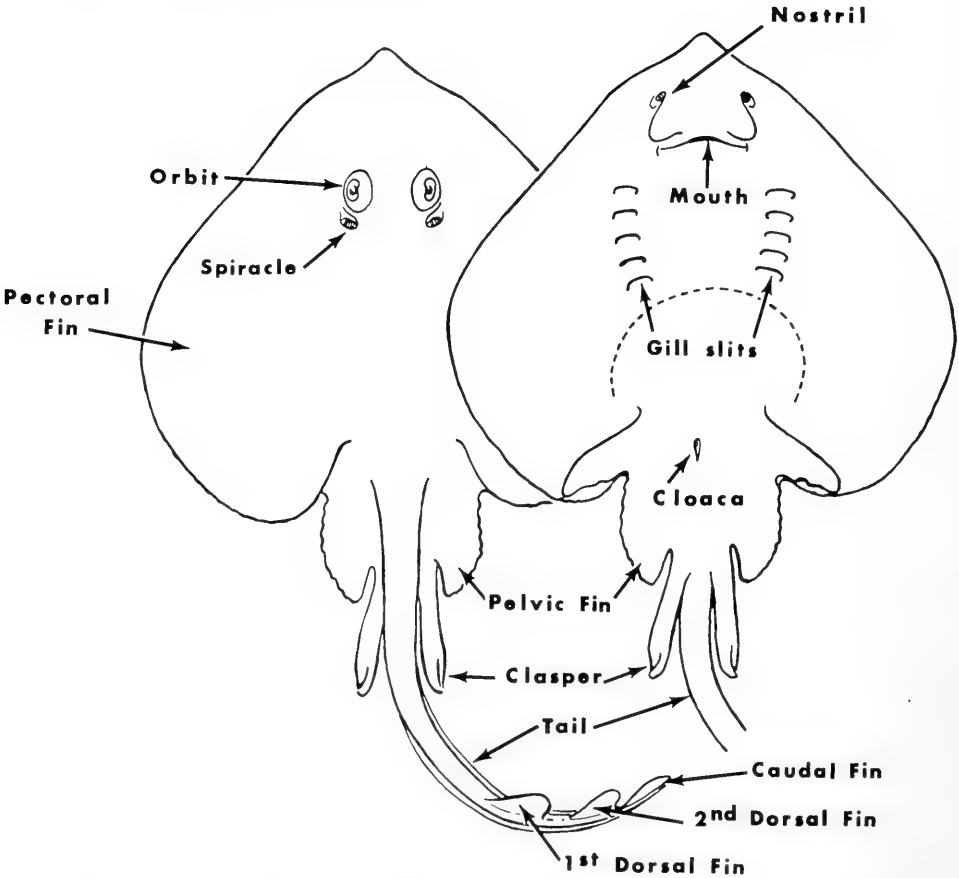
The egg-case of the Eyed skate (*Raja ocellata*). Embryo shown in egg-case.
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953



Texas skate (*Raja texana*). Male, *left*.
Courtesy, The Sears Foundation for Marine Research from
Fishes of the Western North Atlantic by Henry B. Bigelow and William C. Schroeder, 1953

It ranges through the continental waters of the western North Atlantic from northern North Carolina to northern Nova Scotia, the southern side of the Gulf of St. Lawrence, and the Newfoundland Banks. But its appearances are apparently based on its preference for relatively cool water—and sandy or gravelly bottoms. It tends to disappear from shallow water along southern New England in the early summer, and then reappears there and in New York waters in early autumn. This habit gives it another common name: Winter skate. In fact, more are reported caught in Massachusetts Bay during the winter than in the summer.

These skates grow to about 32 inches in length and 9 pounds in weight. Their greenish-brown or brownish-olive egg cases are about 2 or 3 inches long and 1 to 2 inches wide, excluding horns.



Outline of a typical Skate, as viewed from above (*left*) and below (*right*), showing principal external features. Courtesy, U.S. Fish and Wildlife Service

Texas Skate
(*Raja texana* Chandler, 1921)

This skate, which reaches a maximum known length of 20 inches, is spectacularly marked by a single eye-like spot on the upper side of each "wing" or pectoral.

It is known on the west coast of Florida and the coasts of Mississippi, Louisiana, and Texas.

THE RAYS

The rays have a much wider distribution than the skates in the salt and fresh waters of the world, and a wider diversity of forms to suit them to their environments. They are found at considerable altitudes in wholly fresh waters, in some cases thousands of miles from the sea. They are found living over great depths of the oceans. And they are distributed along the shelves of all the Continents. Their temperature range and salinity requirements seem to have been compensated for in their long evolutionary history.

Seen on the sea bottom, a ray appears to be an inert shape whose only movement is the persistent blinking of two odd, oblong objects that look like eyes: the spiracles.

But the ray is a creature of illusion. It does not always sprawl on the bottom; it often hovers, moves slowly, or even "flies" along, with its wing-like pectoral fins flapping like a bird, touching the sand or silt and fanning small crustaceans, starfish, and other food off the bottom so that they can be more easily eaten. Its eyes and spiracles are on the top of its body, and it is the spiracles, pulsating with each intake of breath, that appear to be blinking eyes. Its real eyes, ever looking up, never see bottom—and never blink.

All appearances of sluggishness vanish instantly when a ray suddenly sweeps up from the bottom and glides through the darkening sea, undulating its pectoral fins in an exquisite sequence of motions as graceful as the flutter of a silken veil in a gentle wind.

Rays resemble skates, but several rather technical differences set the two apart in the phylogenetic family tree of the Selachians. Among fishermen and non-experts, the two are often synonymous. Even their names are from the same root. *Skate* is a Norse word. The creatures the Norse called *skates* were christened *rays* (raie) by the French, *ray* meaning striped or streaked, a characteristic which doesn't apply to all species.[5] One way to differentiate them is to remember that *skates*, especially those commonly seen in North America, are generally long-nosed and *rays* are generally not long-nosed. But this is a very loose generalization with plentiful exceptions.

There is another difference between skates and rays, a difference more elemental than ichthyological classifications: as far as is known, skates are harmless. But some rays exist with most fearsome defenses.

Unlike the skates, which produce their young oviparously in egg cases, the rays are all believed to be ovoviviparous, bringing forth their young alive (after they have hatched from eggs within the mother). In some rays, there is a connection between the mother and the uterine-hatched embryo that is more direct than is found in ovoviviparous sharks. The female rays of this type have a uterus whose walls are densely lined with long filaments, called *villi*. The *villi*, passing into the spiracles of

[5] The "striping" actually referred to the many "raies" disclosed in the fin when served as a table delicacy which has been popular in France since time immemorial.

the embryo, carry a milky nutritive fluid which the embryo absorbs as food.

Some rays give birth to young fantastically large in comparison to the mother. The late E. W. Gudger of the American Museum of Natural History reported that "the size of these young, flat, wide-pectoral raylets, when ready for birth, is the thing that makes their parturition a matter of seeming impossibility."

Gudger reported the capture off Beaufort, North Carolina, of a ray (*Rhinoptera bonasus*) 24 inches wide, which, "on being clubbed on the head in the small boat to keep her quiet, gave birth to two young, each 8.5 in. long (tip of nose to end of ventral fin), and 13.5 in. wide." Another ray (*Dasyatis sayi*) from the same location was, Gudger reported, "36 in. wide by 35 in. long. From her were obtained two young of about equal size. The one measured was 14.75 in. wide and 5.75 in. long. In addition the tail was 9.5 in. long."

The female ray is able to accomplish the birth of such proportionally huge young because the flat-bodied embryos are tightly rolled; they resemble a cigar in shape. At birth, its passage eased by the milky uterine fluid in which it has been immersed, the ray pup leaves its mother's body—and immediately unrolls in the sea and swims away.

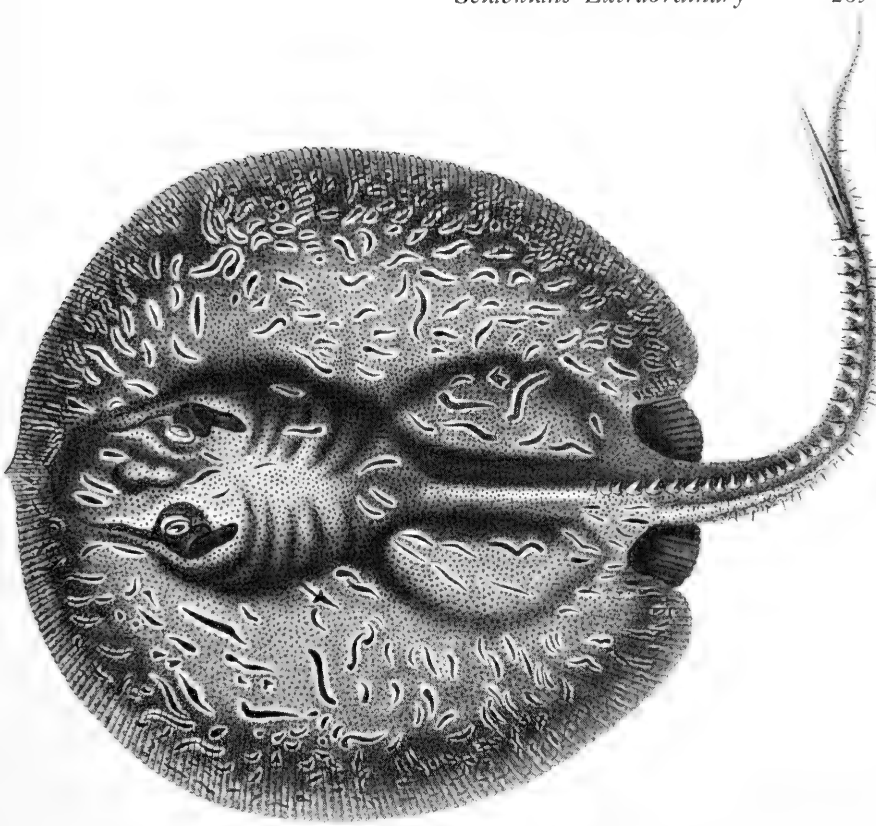
Family *Potamotrygonidae*—River Rays

So prevalent are Sting rays in fresh water that an entire family has been allotted to them. These River rays are not so well known as their salt-water kin because they often live in relatively unexplored jungle rivers, particularly in Central and South America, and in parts of East Asia and parts of Africa, where they are said practically to carpet some stretches of river bottom. While there are only a few identified species, they can be extremely abundant where they are found.

Typical of the wild and desolate areas where the River rays are found are the nameless tributaries of the Rio Putumayo, where it snakes along the Ecuador-Colombia border, hundreds of miles from the Pacific. There, wrote explorer Rolf Blomberg in *Buried Gold and Anacondas*,[6] "is the sting ray, whose habit is to lie hidden in the mud and sand on the river bottoms; great care must be taken not to tread on it. It has a long tail with poisonous serrated spines, and it is as skillful as a fencer in the use of this weapon. An encounter with a sting ray is a painful and sometimes really dangerous experience."

Primitive South American Indians who have never seen the sea are so familiar with the danger of stepping on a Sting ray that they drag their feet when they wade in rivers. The Sting ray's poisonous barbs

[6] Rolf Blomberg, *Buried Gold and Anacondas* (New York: Nelson, 1959).

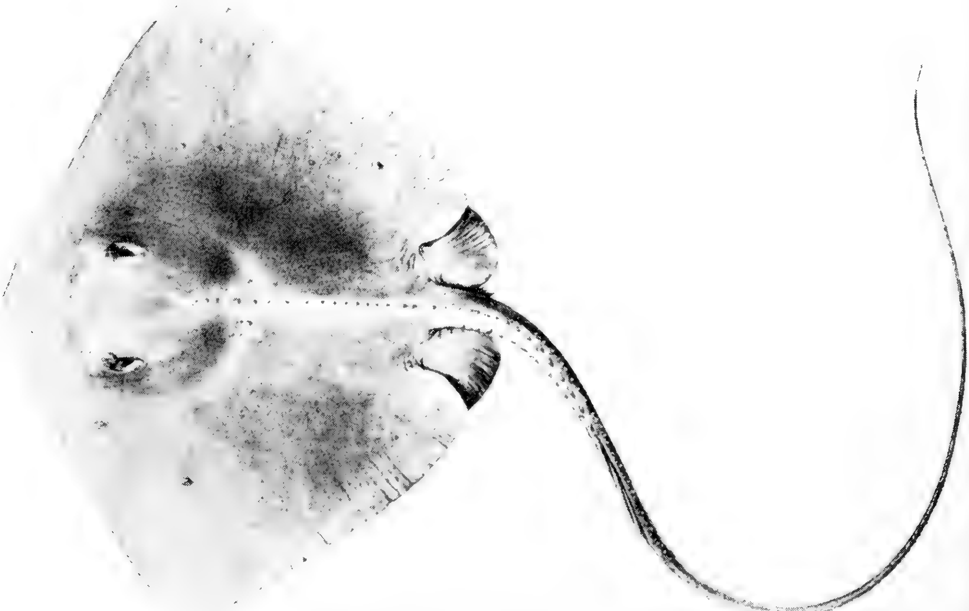


A South American Sting ray (*Trygon nistrix*).
Courtesy, American Museum of Natural History

are so well known that some Indian tribes tip their spears with the stings of the rays, just as Pacific islanders do.

Sting rays are similarly plentiful in the fresh waters of Thailand. In his study of the fresh-water fishes of Thailand, published by the U.S. National Museum in 1945, Hugh M. Smith reported a Sting ray, well known in the Indian Ocean and the Indo-Australian Archipelago (*Dasyatis sephen*), flourishing in fresh water. Though not strictly a River ray (this ray does not anatomically qualify for membership in the *Potamotrygonidae* family), Smith reported: "In the inner lake of the Tale Sap it is quite common at times and produces young in the strictly fresh waters of that 'inland sea.'" Another Thai Sting ray, identified by Smith as *D. bleekeri*, is so acclimated to fresh water that it is called *pla kaben nam chuet*—"the fresh-water ray fish."

One species of River ray, known as the South American Fresh-Water Sting ray (*Potamotrygon motoro*), is usually described by authorities as an extremely dangerous species. It has been found in the fresh-water



A Sting ray (*Dasyatis centroura*).
Courtesy, Harvard Museum of Comparative Zoology

rivers of Paraguay, in the Amazon River, and in other rivers south to Rio de Janeiro. But undoubtedly its riparian haunts extend throughout the innumerable and little-explored rivers that lace the whole of the equatorial rain forest of South America.

Family *Dasyatidae*—Sting Rays, Whip Rays

". . . There is nothing that is more to be dreaded than the sting which protrudes from the tail of the Trygon . . . a weapon five inches in length. Fixing this in the root of a tree, the fish is able to kill it: it can pierce armor, too, like an arrow, and to the strength of iron it adds the venom of poison."—Pliny's *Naturalis Historia.*

If Pliny was right, they aren't making Sting rays the way they used to. No modern Sting ray's stinger will wither a tree or pierce armor. But there is no doubt that the stinger can inflict painful and, occasionally, fatal wounds. According to some versions of the Odysseus epic, the long spear with which Telegonus killed Odysseus was tipped with a stinger provided by the sorceress Circe.

In his *Generall Historie* of Virginia, Captain John Smith, writing of himself in the third person, tells how he captured a Sting ray with "a most poisoned sting . . . which she stucke into the wrist of his arme near an inch and a half; no blood nor wound was seene, but a little blewe spot, but the torment was instantly so extreeme, that in foure houres had so swollen his hand, arme and shoulder we all with much sorrow concluded his funerall, and prepared his grave on an island near the mouth of the Rappahannock River by himself directed; yet it pleased God, by a precious oyle Dr. Russell at the first applyed to it with a probe, ere night his tormenting paine was so well asswaged that he eate of the fishe to his supper."

Stingers are such good defensive weapons that man has used them for that purpose. Spears tipped by one or more stingers have been used by Malayans, natives of many Pacific islands, hunters in South and Central American Indian tribes, and Australian aborigines. Frightful whips made from the thorny, stinger-bearing tails of an African type of Sting ray have been seen by explorers along the Congo and in tropical West Africa. In Ceylon, Sting ray tails were used, until recent times, as whips for punishing criminals. They were also used in the Seychelles Archipelago of the Indian Ocean to keep wives in order!

Sting rays are known and feared throughout the world. Huge schools of them invade many Australian beaches. They lie in the sand near shore, and when the tides retreat, the Sting rays (called Stingarees in Australia) also retreat, leaving behind numerous depressions in the wet sand. In 1938 an 18-year-old girl was killed in Auckland, Australia, when she was struck by a Stingaree whose sting, whipped by its powerful tail, stabbed her left thigh—and then her heart.

Some 30 species are known, all armed with one or more poisonous spines in their whip-like tails. Most Sting rays bear only a single sting, but several have two, or even three or more. The point, which may be 8 to 15 inches long, is covered by a thin sheath that is pushed back toward its base when it is thrust into a victim.

The stinger is hard and stiletto-shaped, with a sharp point. Its edge is fringed with tiny barbs that point back toward the base of the sting. Thus, when it enters, the barbs hold it in the wound and thwart easy

This tail of a Spotted Duck-billed ray (*Aetobatus narinari*) bears 4 stings. The ray was captured off Beaufort, North Carolina. This ray often has more than one sting, each of which can inflict a venomous wound. Photo, E. W. Gudger removal. Along both edges of the underside of the stinger run two deep grooves. Within the grooves flows the venomous secretion, whose composition, chemically speaking, is little understood. There is no doubt today—as there once was—that venom is secreted by the stingers. But there is debate as to how this venom is injected into the Sting ray's victim.

In his *Living Fishes of the World*,[7] Earl S. Herald, curator of the Steinhart Aquarium of the California Academy of Sciences, tells of a study of more than 4,000 California Round Sting rays (*Urolophus halleri*). The study showed that 45 per cent of the Sting rays had lost their sheaths—and venom glands. "The larger and older the Sting Ray is, the greater is the possibility of its having lost the venom glands and protective sheath," Herald wrote. "This explains why some people who have been stabbed by Sting Ray spines have received only mechanical injury without venom."

Herald's findings do not agree with those of Dr. Bruce W. Halstead, a physician who is director of the World Life Research Institute and who was an instructor in tropical medicine at the U.S. Naval Medical School.

Discussing the grooves of the stingers, Halstead writes in his *Dangerous Marine Animals:*[8]

> If these grooves are carefully examined, it will be observed that they contain a strip of soft, spongy, grayish tissue extending throughout the length of the grooves. The bulk of the venom is produced by this tissue in the grooves, although lesser amounts are believed to be produced by other portions of the integumentary sheath, and in certain specialized areas of the skin on the tail which lies adjacent to the spine. These grooves serve to protect the soft delicate glandular tissue which lies within them, and even though all of the integumentary sheath may be worn away, the venom-producing tissue continues to remain within these grooves. Thus, a perfectly clean-looking spine can still be venomous.

Venomous or not, Sting ray wounds are inevitably painful, dangerous —and surprisingly common. Halstead estimates that about 1,500 Sting ray attacks are reported in the United States each year. Most victims are attacked after stepping on a Sting ray lying partially hidden in the mud near shore. If Sting rays are believed to be around, the safest way to walk into the water is while shuffling your feet. In this way you not only eliminate the possibility of stepping down on a Sting ray, you also drive them away by stirring up the bottom.

Sting ray poison produces excruciating pain and even paralysis. Pierre

[7] Earl S. Herald, *Living Fishes of the World* (Garden City, N. Y.: Doubleday, 1961).

[8] Bruce W. Halstead, *Dangerous Marine Animals* (Cambridge, Md.; Cornell Maritime Press, 1959).

de Latil, a French naturalist, tells of two incidents that attest to the potency of the Sting ray's venom. One victim, "slightly scratched" on the thumb, suffered intense pain, high fever and, for three months, slight paralysis of the arm. Another, scratched on the arm, was in pain for two days.

The sting is purely a defensive weapon and is not used to stun prey, despite Pliny's claim that the Sting ray "lies lurking in ambush and pierces the fish as they pass." The Sting ray feeds principally on worms, clams, and crustaceans–indeed, it often feeds so well that it eradicates oyster or clam beds.

The best first aid for a Sting ray wound is to let it bleed for a few moments to flush out as much poison and sand as possible. Then wash the wound thoroughly, apply a mild antiseptic, and get to a doctor. Some old-time fishermen suggest applying very hot water as an immediate remedy for the pain. In a Florida case, Benadryl hydrochloride, penicillin, and an antitetanus drug were all administered by hypodermic 30 minutes after a man was struck on the left palm by a Sting ray. But the treatment had no apparent effect. The victim reported "soreness" about the wound for more than a month.

Sting rays have been seen in the open seas of the world's warm waters, and are plentiful in coastal shallows. Along some tropical shores, their abundance is graphically described by Bigelow and Schroeder as "in such great plenty that it may seem as though the bottom were almost paved with them."

They come in three shapes–round, kite, and diamond–but the tails of all species are usually, although not always, long and whip-like. The sting–or stings–are on the upper side of the tail, usually about one third the distance from its base.

Sting rays vary considerably in size. A small Atlantic species (*Dasyatis sabina* Lesueur, 1824) matures at about 10 inches and apparently grows to only 20 inches or so in width. One of the largest is the Captain Cook's Stingaree of New Zealand and Australian waters (*Dasyatis brevicaudata* Hutton, 1875). It is named after Captain James Cook, who saw so many Sting rays while exploring Australia in 1770 that he named one of the bays, a few miles south of what was to become Sydney, Stingray Bay (later changed to Botanists', and finally Botany, Bay).

Captain Cook's Stingaree, said to reach 14 feet in length and 6 to 7 feet in width, is often described as the biggest Sting ray in the world. But a rival for this title exists in Atlantic waters–a Sting ray (*Dasyatis centroura* Mitchell, 1815) which is known to reach 5 feet in width and 10 feet, 3 inches in length. A *D. centroura* caught in New Jersey was described by the highly reputable H. W. Fowler as nearly 7 feet across and, had its tail been complete, it would have been 13 to 14 feet long.

Lesser Butterfly ray (*Gymnura micrura*).
Courtesy, Harvard Museum of Comparative Zoology

The big *D. centroura* is found in the coastal waters of the western North Atlantic from Georges Bank and Cape Cod to Chesapeake Bay, to Cape Hatteras and possibly to Florida. The little *D. sabina* is commonly found in shallow waters of the western North Atlantic, from Florida northward to Chesapeake Bay. It is also prevalent in the Gulf of Mexico, and—like many Sting rays—enters rivers. It has been caught more than 200 miles up the Mississippi River, and in Lakes Ponchartrain and Borgne, Louisiana, and in the lakes of the St. John River, Florida.

Probably the most common Sting ray along the North American Atlantic Coast (*Dasyatis sayi* Lesueur, 1817) spends most of its time lying on the bottom near shore with only its eyes and spiracles exposed. It thus becomes a sort of aquatic land mine for the unwary wader who steps on it. These Sting rays, which grow to about 36 inches in width, are not always found on the bottom, however. During their annual migrations up the Atlantic Coast each summer, they often vigorously slap the surface of the water with their flapping pectorals and lashing tails. Sometimes a school of them will noisily sweep into a bay or an inlet, usually unnerving the bather who recognizes them. *D. sayi* is found from southern Brazil northward to Chesapeake Bay and Virginia, and sometimes New Jersey. It has also been reported occasionally as far north as Massachusetts.

The American Pacific Coast is prowled by the Diamond (or Rat-

Tailed) Sting ray (*Dasyatis dipterurus* Jordan and Gilber, 1880), which ranges from British Columbia to Central America. It grows to 6 feet or more. In a U.S. National Museum report, S. F. Hildebrand said of Sting rays of this type and size: "These rays are considered very dangerous by the fishermen, and cases are on record where they have caused severe injury, if not death, to persons hit by the stings."

FAMILY *Gymnuridae*—BUTTERFLY RAYS

Flapping its wide pectorals like wings as it courses upward from its normal haunts at sea bottom, the Butterfly ray has the look of grace and beauty that inspires its name. Its body is unusually colorful for a ray. Gray, brown, purple, or green markings lace its back like filigree. On the bottom, its colors change, darkening on a black background, paling on a light background. And there, on the bottom, prowling for food, sluggishly moving with the tides, it colors muted, the Butterfly ray is as dull to behold as a butterfly still locked in its cocoon.

The Lesser Butterfly ray (*Gymnura micrura* Bloch and Schneider, 1801), is known in coastal waters from Brazil to Maryland and occasionally is found as far north as southern New England. Off Galveston, Texas, and in the lower parts of Chesapeake Bay (where it is known under the misnomer of Sand skate), it is fairly abundant.

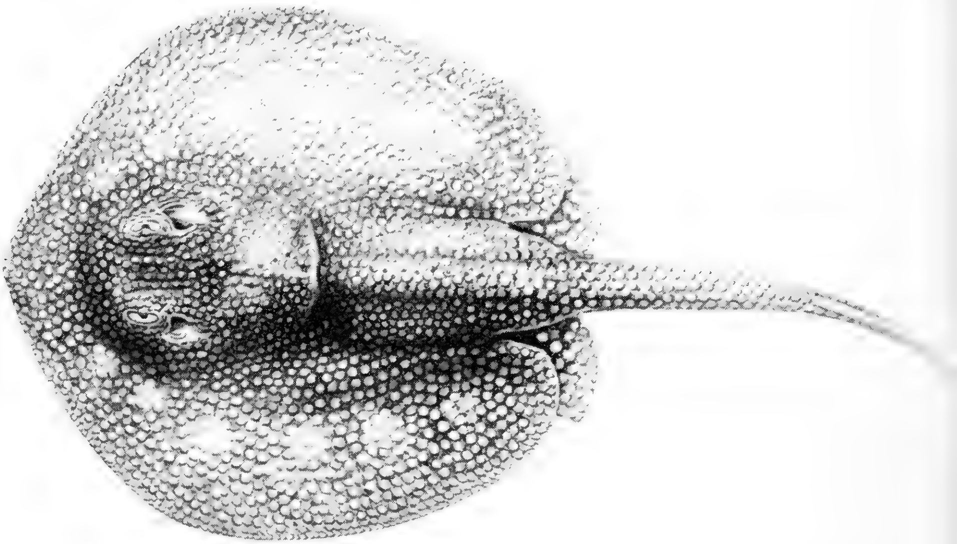
A Pacific Coast version (*Gymnura marmorata* Cooper, 1863) is called the Butterfly Sting ray because at the end of its diminutive tail there is a sting. *G. micrura* doesn't have a barb, but its rarer, larger Atlantic Coast relative, the Giant Butterfly ray (*Gymnura altavela* Linnaeus, 1758) has one or more. The Lesser Butterfly ray grows to a breadth of 3 to 4 feet; the Giant is believed to attain a breadth of more than 12 feet; the Butterfly Sting ray at maturity is 4 to 5 feet wide.

The family includes two genera: the *Gymnura*, whose species, found in the Red Sea, the Atlantic, the Pacific, and the Mediterranean, have no dorsal fins on their tail, and the *Aetoplatea*, whose species are found off South Africa, in the Red Sea, the Indian Ocean, and the East Indies, and have small dorsal fins. Another example of the curious ways in which Selachians develop minor, enigmatic differences.

FAMILY *Urolophidae*—ROUND STING RAYS

These Sting rays differ from the *Dasyatidae* in two basic ways: they are smaller (usually 30 inches long at most), and they have short, stout, and rather muscular tails. Sometimes they are classed with the *Dasyatidae*.

The Pacific Round Sting ray mentioned earlier in the description of venom (*Urolophus halleri*) is, strictly speaking, a member of this family. *U. Halleri*, the commonest California Sting ray, is found from Monterey



Round Sting ray (*Urolophus jamaicensis*).
Courtesy, Harvard Museum of Comparative Zoology

Bay to Panama Bay. It is one of about 19 *Urolophidae* members known in the Pacific.

The principal Atlantic Round Sting ray (*Urolophus jamaicensis* Cuvier, 1817) is very similar to *U. halleri*. It is known to grow to about 12 to 13 inches wide and about 26 inches long. *U. jamaicensis* is usually found in shallow waters with muddy or sandy bottoms. It gets its species name from its prevalence in Jamaican waters, where fishermen are said to dread it particularly. It is common in the Caribbean–West Indian area, among the Florida Keys, along both coasts of southern Florida, and it has been reported as far north as North Carolina.

Family *Myliobatidae*—Eagle Rays

The lozenge-shaped Eagle rays, a large family that has members in tropical and temperate seas throughout the world, bear venomous stings in their long, whip-like tails. They are large—some reaching 7 to 8 feet in breadth and weighing up to 800 pounds.

The Eagle ray of the western Atlantic (*Myliobatis freminvilli* Lesueur, 1824) is known to grow to about 3 feet in width. It is found from Cape Cod to Brazil, appearing in the northern end of its range in the warmer months.

A similar Eagle ray (*Myliobatis californicus* Gill, 1865), more commonly called the Bat ray or the Bat Sting ray, is found along the American Pacific Coast from Oregon to and into the Gulf of California. The

Pacific Eagle ray's appetite for oysters has inspired the erection of sea-bottom fences by Pacific oystermen. These fences are made by driving stakes about 6 inches apart so that the wide-winged rays cannot squeeze through. These hungry rays, equipped with pavement-like teeth well suited for crushing oyster shells, also attack clam beds. Lionel A. Walford, of the U.S. Fish and Wildlife Service, reporting on the Eagle ray's clam-digging technique, said that it "swims along the bottom until it meets the currents of water expelled by the siphons of clams. It then flaps its pectoral fins, creating a suction which digs out the clams. Sometimes it flaps along in this manner for considerable distances, leaving behind a barren trough."

Though Eagle rays are commonly not believed to be abundant along the Atlantic or the Pacific coasts of America, schools of several thousand have been reported at times in the waters of Lower California.

Studies of the embryo of *M. californicus* have solved the puzzle of how female Sting rays bring forth their sting-bearing young without being stung themselves. The pup's sting is pliable and covered with a sheath that is sloughed off soon after birth, so that, like all other Selachians, the newborn Eagle ray is immediately ready to defend itself.

The venom-bearing Duck-Billed rays are also included in the *Myliobatidae* family. The Spotted Duck-Billed ray (*Aetobatus narinari* Euphrasen, 1790), a big, speckled creature, is found not only on both sides of the Atlantic, but also in the Pacific and the Indian Oceans, and the Red

Spotted Duck-billed ray (*Aetobatus narinari*).

Courtesy, Miami Seaquarium

Sea. It weighs up to at least 500 pounds, is known to reach 7½ feet from wing-tip to wing-tip—and it carries as many as 5 stings at the base of its long tail.

Russell J. Coles, who studied the sharks and rays in North Carolina waters for many years, told of a Spotted Duck-Billed ray which "suddenly threw its body against me and drove its poisoned sting into my leg above the knee for more than two inches, striking the bone, and producing instantly a pain more horrible than I had thought possible that man could suffer." He treated the wound immediately and recovered.

Coles also reported that "in giving birth to its young, the female ray leaps high in the air." Although ichthyologists are generally skeptical about suggestions that these rays—or any other—find it necessary to leap into the air to give birth, there is no doubt about the Spotted Duck-Billed ray's prowess as a jumper. In fact, in Australia it is sometimes called the Jumping ray.

The Spotted Duck-Billed ray (also known as the Spotted Whip ray and the Spotted Eagle ray) seems to use its peculiar projecting mandible as a spade to dig out shellfish from sandy bottoms. With its powerful jaws, it cracks clamshells and extracts the clams so efficiently that it can swallow the clams intact. Like several other species of ray, the Spotted Duck-Billed sometimes lets out a sound resembling a bark when captured.

Family *Rhinopteridae*—Cow-Nosed Rays

The odd, bovine nose of these rays sets them apart from the other larger rays, though they have the familiar winged shape. All of the

Cow-nosed ray (*Rhinoptera bonasus*).
Courtesy, Harvard Museum of Comparative Zoology

species in this family, since they resemble one another so closely, are placed in a single genus, *Rhinoptera.*

The principal Cow-Nosed ray of the Atlantic (*Rhinoptera bonasus* Mitchell, 1815) grows to a maximum of 7 feet in breadth and has been reported to weigh as much as 100 pounds; generally, however, it is in the 25- to 70-pound range. It bears one or two barbs near the base of its long, thin tail. It is found along the coast of the western Atlantic, from southern New England to Brazil. Occasionally, large schools of Cow-Nosed rays appear at various places along its range. Another similar Cow-Nosed ray (*Rhinoptera brasiliensis* Müller and Henle, 1841) is found along the western South American coast. Other species are known in the coastal waters of the tropical and warm-temperate areas of all oceans.

A fatal attack by a Cow-Nosed ray (*Rhinoptera javanica*) was reported in 1936 by A. F. Umali of the Philippine Department of Agriculture and Commerce. Large numbers of these rays sweep into Manila Bay during their breeding season. During one of these runs, Umali reported, "a fisherman from Bataan succumbed to a wound inflicted in the region of the stomach by the spine of this ray."

Family *Mobulidae*—Devil Rays

Spangles of sunlight glitter on the silent blue of the sea. Suddenly, from out of the depths flashes a glistening giant, its huge, sleek body catapulting clear of the riven waters. With a thunderous sound, the giant crashes back to the surface and vanishes beneath it. The sea is silent again.

Those who have seen this sight will never forget it. They have seen a Giant Devil ray (*Manta birostris* Donndorff, 1798), a true monster of the deep, which grows to a breadth of 20 feet or more and often weighs more than 3,000 pounds. The Giant Devil ray, or Manta, and its smaller close relatives in the *Mobulidae* family, seem to have abandoned the bottomlands prowled by other rays for the more exhilarating life at or near the surface of the sea. Several of them have been seen at the same time, leaping as high as 5 feet above the surface, possibly to rid their huge bodies of hordes of parasites. Sometimes they somersault, breaking surface head-first, then revolving on edge in a spectacular cartwheel, with one pectoral fin emerging while the other is descending back into the sea.

The power that produces such awesome calisthenics also is summoned up when a Giant Devil ray is harpooned. One monster 22 feet in breadth towed a 25-foot motorboat more than 10 miles, with the boat's anchor dragging on the bottom part of the time. After 5 hours it was still alive, though four harpoons and several rifle bullets were imbedded in its body.

Texas, of course, claims the record for the number of boats towed by a Giant Devil ray. The record is based on an account of the harpooning of such a ray off Port Aransas. The ray, it's said, sped off with 14 boats strung out behind it.

The Devil ray family—so called because of their cephalic fins, which, when rolled and projected forward, have the appearance of horns—ranges the world. They are found in the warm-temperate zones of all oceans, and the Mediterranean. Of their common names—Devil ray, Devil fish, Manta—undoubtedly *Manta* is the best known in the English-speaking world.

Mantas throughout the world are similar in their habits. They leap; they live near the surface; they all apparently take in water for respiration through their mouths instead of through their spiracles, which are relatively small. This latter characteristic appears to set them apart from all other Batoids.

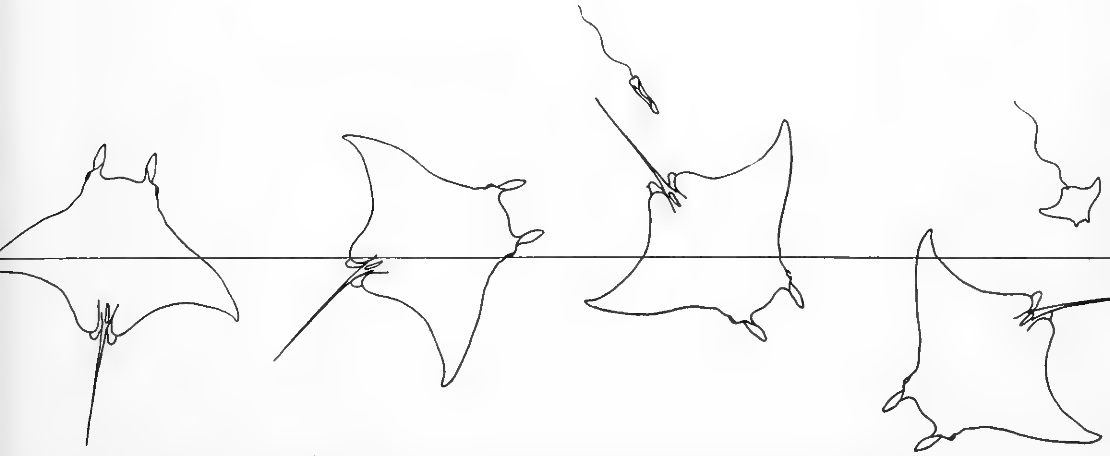
But there are also great differences between the half-dozen or so known species of Mantas. The family is divided into three genera on the basis of an odd distinction: *Mobula*, species that have teeth in both jaws; *Ceratobatis*, species that have teeth in the upper jaw only; *Manta*, species that have teeth in the lower jaw only (Also, both *Mobula* and *Ceratobatis* species have mouths on the lower surface of the head; *Manta* species have mouths at the end of and extending across the head.)

The Lesser Devil ray, or Manta (*Mobula hypostoma* Bancroft, 1831), is found in the coastal waters of the western Atlantic, from Brazil to North Carolina and occasionally to New Jersey. It has also been reported along the coast of Senegal, West Africa. It grows to a width of about 4 feet.

Russell Coles, in his many observations of Selachians along the North Carolina coast, frequently reported on these Lesser Devil rays. Once he saw several of them pursuing a school of minnows and "rushing right up on the sand . . . until their bodies were nearly half out of water; but in an instant they were off and scattered out to sea." Coles said that the Mantas kept their cephalic fins rolled until they neared the minnows. Then the fins "open, and, meeting below the mouth, form a funnel, through which the 'minnows' are carried into the mouth. On the instant that this rush is over these fins again close up tightly."

The cephalic fins which stick out from the Manta's head like stumpy arms are said to close instantly around anything that touches the front of its head. Reportedly, through this reflex action, a school of Mantas once supposedly affixed themselves to the posts of a fence that ran out into shallow water. Occasionally, too, they may grasp an anchor line in this way, possibly trying to clean off parasites. The grasping power of the cephalic fins is really quite limited and weak, according to those who have handled them, however. There is no known case of anyone being grabbed by the cephalic fins and dragged to his death. It is, however, possible that a harpooned Devil ray could upset a small boat, hurl its occupant into the sea, and fall upon him.

Mantas have been seen mating. Again we turn to Coles and his invaluable reports for an account. He once saw a pair of Lesser Devil rays (*Mobula hypostoma*), the male's back just showing above the surface, its wing-like pectoral fins curved upward; the white underside of the



This drawing by Russell Coles shows how a harpooned Manta somersaulted from the sea, and "violently ejected" an embryo. Then, as the embryo opened its pectorals and fell toward the sea, the mother "disappeared beneath the surface."

female just below the male. "Copulation," Coles reported, "was not accomplished by a vertical motion, but by a graceful, serpentine lateral curvature of the spine, as the male alternately advanced one of his *mixopterygia* (claspers) as he withdrew the other." The union was not continuous. Occasionally the two separated, swam around in leisurely curves or lustily leaped toward the sky, and then resumed their rhythmic mating.

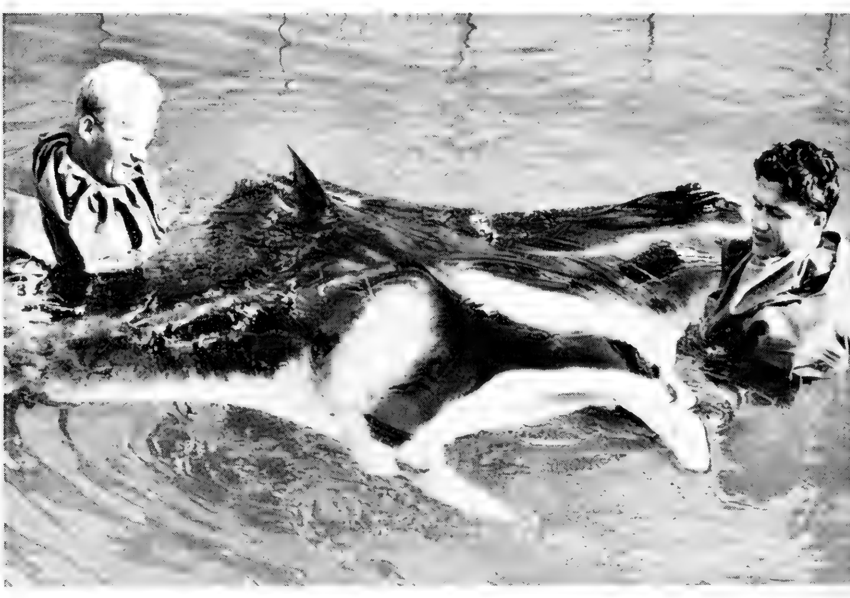
Manta young are said to be born, sometimes at least, during the mother's great leaps from the sea. Coles witnessed such a birth, which may have been brought on by the harpooning of the mother. (Some authorities believe that Selachian mothers may sometimes abort their young as a last, desperate act during or after capture. A more likely explanation of these death-throe births is that the captive was about to drop her pups anyway, and the shock of capture brought about a slightly premature birth.)

In the case Coles described, he said:

Almost immediately after being struck by the harpoon, the Manta made the sidewise revolution alongside the boat, and just before the tail had reached the perpendicular, an embryo was violently ejected to a distance of about four feet. The embryo appeared tail first, folded in cylindrical form, but it instantly unfolded and its pectorals, moving in bird manner, retarded its descent until the mother fish had disappeared beneath the surface. I was almost in the act of securing the embryo when it was swept below by a pectoral of the large male mate which was near the big female.

Mantas of the genus *Mobula* are divided generally into four species, distinguished by their possession or lack of a tail sting. *M. hypostoma* does not have one. The less common Atlantic species (*Mobula mobular* Bonnaterre, 1788) has one; it is found chiefly in the Mediterranean, and in the eastern Atlantic from Ireland to Spain, Portugal, the Azores, the Canaries, and tropical West Africa. Such a difference is also found in the two Pacific–Indian Ocean species: *M. japanica*, which has a tail spine, and *M. diabola*, which does not have one.

M. diabola (called the Ox ray, Smaller Devil ray, and Diamond fish in Australia) is the midget of the *Mobulidae* family, growing to only about 2 feet in width.



A Giant Devil ray (*Manta birostris*) is walked around a tank at the Miami Seaquarium to acclimate it to captive life. This young Manta, as it is also called, weighs 1,000 pounds. Its two common names stem from its physical characteristics. *Manta,* Spanish for "cloak," describes the ray's broad body. *Devil* comes from the horn-like cephalic fins, which form a funnel to channel food into its maw as it swims along the surface.
Courtesy, Miami Seaquarium

The giant of all modern rays (*Manta birostris*) is found in the tropical and subtropical waters of the oceans of both the Northern and the Southern Hemispheres. In American waters, it has been reported from Brazil to the Carolinas, and occasionally to New England and Georges Bank; along the American West Coast, it has been captured as far north as Redondo Beach, California.

Giant Manta rays are frequently tormented giants. Minute parasites infest the inner side of the Devil ray's horns, and large parasitic crustaceans, usually Isopods, lodge in its jaws. The German zoologist Hans Hass, who has closely observed many Devil rays underwater, believes that a type of parasite-eating Pilot fish swims in and near the Devil ray's jaws, serving as a living cleaner for its host and, in return for devouring the parasites, is not itself devoured.

The female Giant Devil ray apparently carries a single embryo, often of formidable size. The biggest embryos on record include one 50 inches wide and weighing 20 pounds, and another weighing 28 pounds which was 45 inches wide.

THE LINKS

Every old, established family has its eccentrics, and the Selachian family is no exception. Among the Selachians, sharks mostly look like sharks, and the skates and rays look like skates and rays. But there are four eccentric groups within the Selachian ranks. These groups—technically classified as families—include Selachians that do not look like typical skates or rays and yet do not look like typical sharks, either. They are apparent links—not missing, but present, for they are found today in all the oceans of the world.

We will introduce them—Guitarfishes, Sawfishes, Saw Sharks, and Angel sharks—by families. The first two are Batoids and don't look it, while the latter two are sharks and look equally misleading.

Family *Rhinobatidae*—Guitarfishes

Appearing part shark, part ray, the Guitarfish is really a Batoid and only seems to be hovering between the two great branches of the Selachian family. Little is known of its habits. The Guitarfish obviously gets its name from the shape of its head and moderately flattened body, which combine to give it the general appearance of a guitar. The French, who always seem to see things a little differently from everyone else think the Guitarfish looks more like a violin, and so they call it *violon de mer*. The musical-name theme has another variation in Australia, where some Guitarfishes are called Fiddler rays and Banjo sharks.

The Spotted Guitarfish (*Rhinobatos lentiginosus* Garman, 1880) is

A Guitarfish (*Rhinobatus lentiginosus*). Bottom view, *bottom;* top view, *top.*
Courtesy, Harvard Museum of Comparative Zoology

typical of the 30-odd known species of Guitarfish found in the coastal waters of most warm seas in the world. It is one of the commonest Guitarfishes found in the Atlantic, though so sparse is information about it that its full adult size is not known. It may grow to several feet in length, but the largest recorded specimen was 30 inches long. It ranges western Atlantic coastal waters from Yucatán to Cape Lookout, North Carolina. Another Atlantic species, the Southern Guitarfish (*Rhinobatos percellens* Walbaum, 1792), which closely resembles *R. lentiginosus*, is found from northern Argentina to the Caribbean, and has also been reported off tropical West Africa. A third Atlantic species (*Zapteryx brevirostris* Müller and Henle, 1841) which has been taken in Brazilian coastal waters, is noteworthy because its body is heart-shaped.

The commonest Pacific Coast Guitarfish is the Shovel-Nose guitarfish (*Rhinobatos productus* Girard, 1855), which is known to grow to about 4 feet in length. It is found from central California south to and into the Gulf of California.

Guitarfishes are found in the tropical and warm-temperate coastal waters of all oceans. They have also been reportedly found in fresh waters in Australia, though details are lacking on these incursions from the sea. The largest Guitarfish on record (*Rhynchobatus djiddensis* Forskål, 1775) is found in the Indian and the Pacific Oceans. It has been reported to reach 10 feet in length and 500 pounds in weight. Many Guitarfish grow to a maximum size of 5 or 6 feet.

Like the rays, the Guitarfish are ovoviviparous; unlike the rays, the

Guitarfish swim by propelling themselves with their tails. (Their pectoral fins are merely used as planes to raise, lower, or turn their bodies.) The underside, containing the gills, is flattened like a skate or a ray. This duality persists in its habits—sometimes, like a skate or a ray, it lies half-buried in the sand or mud; other times, it swims, though usually hugging the bottom.

Except for oystermen who accuse the Guitarfish of devouring oyster and clam beds by burrowing through them at a gluttonous pace, and ichthyologists who are intrigued by the Guitarfish's biological oddity, not many people are interested in the Guitarfish. Game fishermen look upon them with little interest, too, for often a hook and line is not even needed to get them; they lie in shallow water and can be plucked from the sea by the tail. They are scooped up in nets near shore by fishermen in India, where they are called Plowfish because their burrowing along the bottom often leaves furrows on the ocean floor.

FAMILY *Pristidae*—SAWFISHES

The Sawfish is one of the strange forms generated by the mysterious evolutionary forces which have molded so many other curious types of Selachians. Its long, flat snout resembles a saw with wide-spaced teeth. These teeth—16 to 32 on each side of the "blade," depending on the species—are actually specialized dermal denticles.

(Unlike the teeth found in the mouths of sharks, the saw teeth on the Sawfish's snout are deeply and firmly embedded in sockets in the hard cartilaginous "saw." This may be an evolutionary development, for the fossil remains of some prehistoric Sawfish do not have sockets for the saw teeth, which were then apparently only attached to the skin.) These saw teeth are sharp, and, according to reliable reports, can be lethal. Sawfish are particularly feared in Panama City Bay, where several

A Sawfish (*Pristis clavata*).
Courtesy, Harvard Museum of Comparative Zoology

fatal attacks on men have been reported. Dr. Francis Day, an eminent authority on the fishes of India, spoke long ago of a report that a bather was cut in half by the slashes of a Sawfish. A more modern eye-witness account of a Sawfish attack is given by the writer A. Hyatt Verrill:[9]

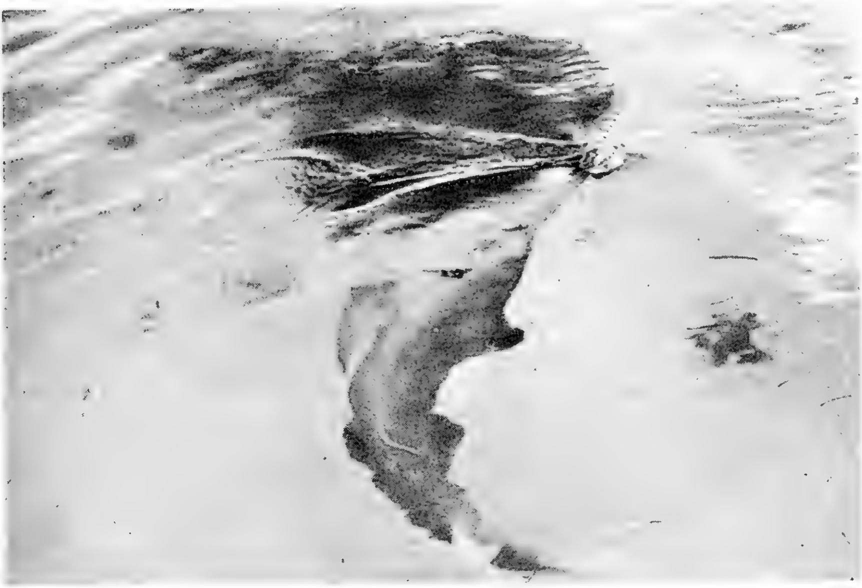
. . . While on the coast of Yucatán, one of my men waded into shallow water, armed with a small fish spear, in search of octopus which the natives consider a great dainty. Suddenly, he uttered a howl of pain, and, floundering about, jabbed downward with his weapon. A moment later, he came splashing ashore, a three-foot Sawfish impaled on his spear, and the calf of his leg torn and lacerated by the saw-teeth of the fish which had attacked him without the least provocation. In this particular case, the wounds were not serious, for the "saw" of the fish was barely eight inches in length while the teeth along its edges were scarcely larger than the blade of a small scalpel . . .

Verrill's companion was lucky. He was attacked by a mere baby, for 20-foot Sawfish with wicked-looking saws 6 feet long are not rare. Sawfish are reported from southeast Asia to grow to 30 feet in length, with saws accounting for one fourth to one third their length. An Australian species, the Green sawfish (*Pristis zijsron* Bleeker, 1851), is known to reach a length of 24 feet and is described as dangerous when cornered. A 17-foot Sawfish caught off the Texas coast weighed 1,300 pounds, and a West Indian monster of unrecorded length had an estimated weight of 5,300 pounds.

Speculation has been going on for centuries about the manner in which the Sawfish uses its weapon. The sixteenth-century naturalist, Olaus Magnus, Archbishop of Upsala in Sweden, reported that the Sawfish "will swim under the ships, and cut them, that the water may come in, and he may feed upon the men when the ship is drowned." And the eighteenth-century English naturalist, John Lathan, told of "a battle between several Sawfishes and a whale, when all of them attacking the whale at once, soon became victorious." Needless to say, further study was indicated!

Not until a few years ago, however, did any scientist have an opportunity to study the Sawfish closely and extensively. The observations were made by C. M. Breder, Jr., on a Sawfish (*Pristis pectinatus* Latham, 1794) in a retaining pen at the Lerner Marine Laboratory on Bimini Island in the Bahamas. The Sawfish was fed small fish or pieces of larger fish. When food was placed on the bottom, the Sawfish swam over it and, like a skate, picked it up with its slit-like mouth. When food floated on the surface or fell down through the water, the Sawfish struck at it sidewise and impaled it on one of its saw teeth. Then it

[9] A. Hyatt Verrill, *Strange Fish and Their Stories* (Boston: L. C. Page & Co., 1948).



A Sawfish (*Pristis pectinatus*) in a retaining pen at the Lerner Marine Laboratory in Bimini strikes a floating fish with its "saw" and impales it. Note the wake of the "saw," which indicates the precise arc of the Sawfish's strike. (Photo by F. G. Wood.)
Courtesy, COPEIA

swam to the bottom, scraped the food off its "tooth" by rubbing it along the bottom and swiftly swam over it to devour it. A Sawfish's mouth is located on its bottom side, aft of the "saw."

But even a Sawfish can learn the ways of an arrogant mendicant. Breder reported:

> Within three weeks . . . the Sawfish had become more accommodated to life in captivity and changed its behavior considerably. When the time arrived for the feeder to appear, the fish would swim slowly about the surface, often in a vertical direction with about one-half of its "saw" protruding through the surface. This would be wigwagged back and forth in a manner that made various of the non-biological observers suppose it was beckoning to its keeper. When a fish was tossed to it, more often than not, it would lazily pass its saw over and about the fish with no effort at impalement, suggesting that it was merely investigating the offered food. Following this it would often simply swim over the dead fish and engulf it at the surface. Evidently in the intervening period it had learned that impalement was unnecessary and there was no danger of the fish swimming away. An hour's delay in feeding was all that was necessary to revive its original energetic attacks on food objects.

In the more demanding realm of the open sea, where fish have to work for their food, the Sawfish sometimes rises up amid schools of fish, slashing out with its saw to stun or kill its prey. Stories that the Sawfishes attack whales have no basis, and there is substantial scientific skepticism about tales of Sawfish "sawing" large chunks of flesh from the bodies of large fish. The fact is that when Sawfishes aren't attacking schools of small fish, they can be found grubbing around the bottom. They use their saws to poke in the mud and sand, and they often wear down the tips of their saw teeth at this task.

Sawfish bodies are long, their tails powerful—and they swim as sharks do, by swishing their tails and the aft part of their bodies. But they are classified as rays, primarily because their gill slits are on their underside. Sawfish bring forth their young alive. Many young are born at one time. In one female 15½ feet long, 23 young were found. The pup's needle-sharp saw teeth are encased in a membrane and the "saw" itself is like soft leather at birth. Soon after birth, the sheath is sloughed off, and the newborn Sawfish is able to slash—or grub—for food.

The Common sawfish (*Pristis pectinatus* Latham, 1794) is found in the Gulf of Mexico and in tropical and subtropical Atlantic waters, close to shore, from equatorial West Africa to the Mediterranean in the east; from mid-Brazil to northern Florida in the West. It is also found in the Gulf of Mexico and is occasionally reported as far north as New York. It is known to grow to at least 18 feet in length; a 16-footer weighed 700 pounds. It enters the St. Johns River of Florida quite frequently.

A larger, heavier, Atlantic species, the Southern sawfish (*Pristis perotteti* Müller and Henle, 1841), is believed to reach 20 feet in length—including a 4-foot saw—and some 1,300 pounds in weight. This Sawfish also has an apparent predilection for fresh water.

P. perotteti has been caught at Parintins, Brazil, some 450 miles up the Amazon, and it has taken up apparently permanent residence in Lake Nicaragua in Nicaragua, home of the notorious Lake Nicaragua shark (*Carcharhinus nicaraguensis*). Sawfish weighing up to 700 pounds have been caught in the lake, where they have also been seen giving birth.

In Thailand, Sawfish regularly swim up rivers. A 26-footer (*Pristis cuspidatus* Latham, 1794) with an 8-foot saw was caught in the Tachin River there, and a 46-footer (*P. microdon* Latham, 1794) was reportedly caught in the Chao Phya River, 37 miles from the sea.

The saws of the Thai Sawfish are popular votive offerings among Thai fishermen, who bring them to the temples, where they are exhibited to the delight not only of local gods but also of visiting ichthyologists, who have found them invaluable for determining the probable size, habitat, and species of local Sawfish.

The eastern Atlantic sawfish (*P. pristis* Linnaeus, 1785), which is also found in the Mediterranean, has been reported in the Zambesi River and several other rivers of Africa. One Australian species (*P. leichhardti* Whitley, 1945) is said to be found primarily in rivers rather than in salt water.

Family *Squatinidae*—Angel Sharks

A gaudy, flat-bodied shark with an ecclesiastical history, the Angel shark seems to be a shark which is morphologically on its way toward becoming a Batoid. If you can imagine a long line of various species of sharks gradually tending toward the flattened form of the skates and rays, the last one in the line would be the Angel shark. It is still a shark, but it appears close to losing its shark credentials and being transferred to Batoid ranks.

It is classified as a shark for several anatomical reasons, which include: its pectoral fins are not attached to its head; its gill slits are not wholly on the underside of its body, but curve upward to the sides of its neck; its sharklike eyelids are free (the upper eyelids of Batoids are not free).

Pious medieval observers of this shark's outline saw its pectorals as wings and its tapering body and tail as angelic robes. They named it an Angel. Later, it became a Monk. And finally it was dubbed a Bishop. (An Australian species, ornately dappled with denticles, managed to become an Archbishop.) Writing about this "blessed" shark in 1558, the early ichthyologist Rondelet imaginatively reported:

> In our time in Norway a sea-monster has been taken after a great storm, to which all who saw it at once gave the name of monk, for it had a man's face,

An Angel shark (*Squatina californica*).
Courtesy, Harvard Museum of Comparative Zoology

rude and ungracious, the head smooth and shorn. On the shoulders, like the cloak of a monk, were two long fins in place of arms, and the end of the body was finished by a long tail . . . I have seen a portrait of another sea-monster at Rome, whither it had been sent with letters that affirmed for certain that in 1531 one had seen this monster in a bishop's garb, as here portrayed, in Poland. Carried to the king of that country, it made certain signs that it had a great desire to return to the sea. Being taken thither, it threw itself instantly into the water.

Today's Angel shark is seldom mistaken for a bishop or even for a monk. But the fisherman in continental U.S. waters who catches an Angel shark may nevertheless be confounded, for it is relatively rare.

The western Atlantic Angel shark (*Squatina dumeril* Lesueur, 1818) reaches 4 or 5 feet in length; a 4-footer is known to weigh about 60 pounds. *S. dumeril*, usually seen close to shore, has been known to wander 75 or 80 miles offshore. It is found from southern New England to southern Florida, and along the northern coast of the Gulf of Mexico. It visits the mid-Atlantic coast of the United States in the summer. Its haunts include the waters of Chesapeake and Delaware Bays, and the bays of the southern shore of Long Island.

S. dumeril closely resembles its eastern Atlantic relative (*Squatina squatina* Linnaeus, 1758), although *S. squatina* has been reported to reach 8 feet and up to 170 pounds. *S. squatina* is said to be relatively plentiful in European Atlantic waters and in the Mediterranean.

There are about 10 known species, all generally grouped into one genus because of their similarity. The western Pacific species (*S. californica* Ayres, 1859) ranges from southeastern Alaska to Mexico, and possibly to Peru and Chile. Like *S. dumeril*, it is known to attain a 5-foot length and to weigh about 60 pounds. Other species are found in South African waters, and off Australia, Japan, and Korea.

Family *Pristiophoridae*—Saw Sharks

Although their saw-toothed snouts give them a seemingly indisputable close relationship to Sawfishes, the *Pristiophoridae*—the Saw sharks—are true sharks. The Sawfish is no more related to the Saw shark than it is to any other shark.

Despite the saw-snout resemblance between Sawfishes and Saw sharks, there are many differences between them. The Saw shark, for example, has its five or six gill openings on the sides of its body, the mark of the shark; the Sawfish's gill openings are on the bottom of its body, the mark of the Batoid. The mutual possession of a saw-snout is, however, a clear case of a parallel adaptation to life. One strange difference between their snouts is the Saw shark's pair of barbels, or feelers, that droop on either side of its saw (like a Fu Manchu mustache) and can trail the bottom when it is searching for food.

A Saw shark (*Pristiophorus nudipinnis*).
Courtesy, Gilbert P. Whitley

There are four known species of Saw sharks. Three species belong to the genus *Pristiophorus*, whose members have five gill openings. *Pliotrema* has only one known species (*warreni*), and has six gill openings. *Pristiophorus* species are found in the waters of South Africa, Australia, the Philippines, Japan, and Korea. *Pliotrema warreni* is found in South African waters.

Pristiophorus cirratus Latham, 1794, said to grow to more than 4 feet, is described as common in Australian waters. Gilbert P. Whitley, the Australian shark authority, reports that this Saw shark's saw-teeth "lie flat against the side of the snout before birth so that the saw shall not injure the mother."

A rule for the curious: *Pristids* (Sawfish) and *Rhinobatids* (Guitarfish) are "links" in a sense, but they are unquestionably Batoids by definition of the group for the following reasons:

1. Gill openings confined to ventral surface.
2. Edges of pectoral fins attached to sides of head anterior to gill openings.
3. Upper margin of orbit not free from eyeball (no free eyelid).

Likewise, the *Squatinids* (Angel sharks) and *Pristophorids* (Saw sharks) are true tiburoids (or Sharks proper) by definition of the group for the following reasons:

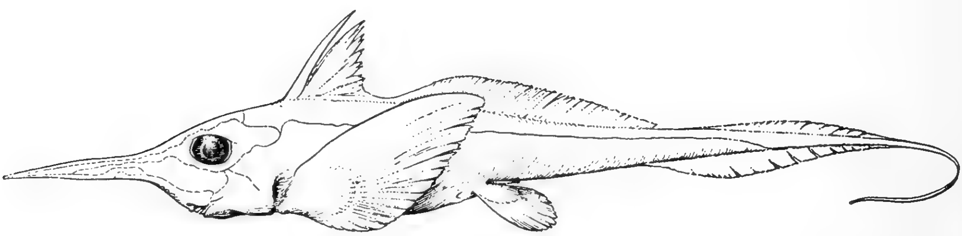
1. Gill openings at least partly lateral.
2. Edges of pectoral fins not attached to sides of head anterior to gill openings.
3. Upper margin of orbit free from eyeball (eyelid free).

These are the links, the curious, difficult-to-classify Selachians which, whatever else their role, serve as the interlocutors between their two branches of kinfolk, the Batoids—and the Sharks.

THE CHIMAERAS

The Selachians have a sort of natural "appendix"—a group of very strange animals known as the Chimaeras, a name derived from the old Greek work *Khimaros* meaning a goat, the female form of which was *Khimaira* (*Kim-eye-ra*). Primitive Greek mythology sported a bogey said to have a lion's head, a goat's body, and a serpent's tail, to which the name *Khimairon* was given, and this word in time came to be applied to any creature that seemed to be made up of parts of different known animals. Thus, it was readily applied to these fish by mariners.

The Chimaeroids (*Ky-meer'oids*) seem to form a bridge between the Selachians and the Teleosts, but there is strong evidence that, while



A Long-nosed chimaera (*Harriotta raleighana*).
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1953

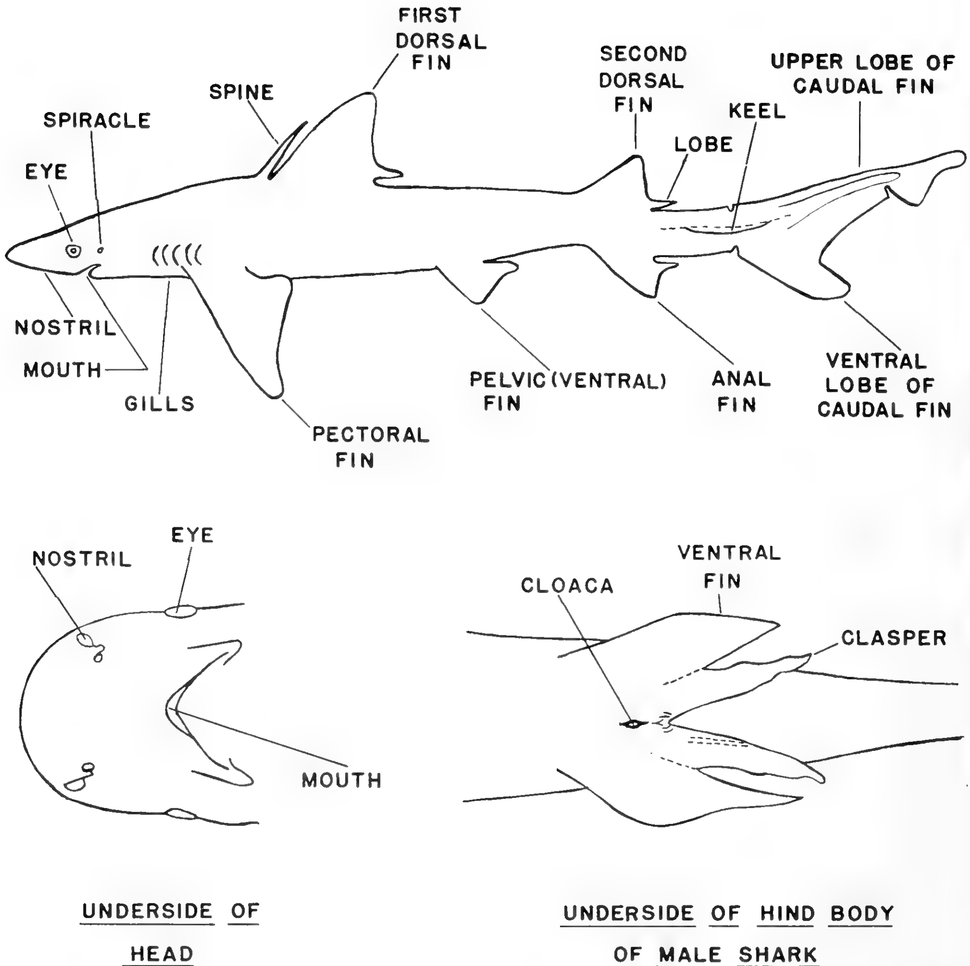
they are descended from the former, they are not the ancestors of the latter. These strange fish, called Ghost sharks, Spookfish, Ratfish, or Chimaeras, have the cartilaginous skeleton and claspers of Selachians, and the covered gill openings—the familiar gills—of Teleosts. The males also have a third clasper on their foreheads. This bizarre structure, unique among known fishes, is believed to be used in some way in mating, but its definite use is still an ichthyological mystery. All the Chimaeroids are oviparous, laying large (some are 16½ inches long) egg cases, some of which are tadpole-shaped.

According to most authorities, Chimaeras are not, as they seem to be, links between Selachians and Teleosts. The theory of their place in the phylogenetic spectrum is best stated by Bashford Dean, who made a long study of this odd breed. In 1908 he wrote:

> From an examination of their fossils, anatomy and embryology, the conclusion is reached that they are to be classed not as ancestral sharks, but rather as a group highly divergent from some early shark stem. The few undeniably primitive features which they possess are heirlooms from some Palaeozoic Selachian ancestor—features which modern sharks have not as well conserved.

Chimaeras, which are not known to grow to more than 5 feet, are usually divided into about 28 species distributed among three families. The most common family, *Chimaeridae*, encompasses short-nosed, long-tailed species possessing venomous spines in front of their first dorsal fins. The *Rhinochimaeridae* family is devoted to the long-nosed species. The third family, *Callorhinchidae*, includes the weird-looking Elephant fish (also waggishly called the Southern Beauty in Australia). All members of this family have flexible noses which resemble the elephant's trunk.

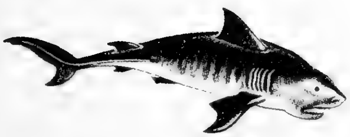
Bishopfish.
Courtesy, American Museum of Natural History



External features of sharks.

Chapter 11

The Sharks—Part One



Sharks they are, all of them—immense and tiny, coastal and pelagic, familiar and bizarre, sleek and cumbersome, rare and abundant. It is a vast and varied host, with its 350 or more species swimming in every sea.

But within this diversity there are clusters of similarity, groups of sharks that resemble one another enough to be placed in the same family. Some families are veritable clans, encompassing numerous species and spanning the seas of all the world. Other families can muster but one known species. Such is the case of the:

Family *Chlamydoselachidae*—Frilled Sharks

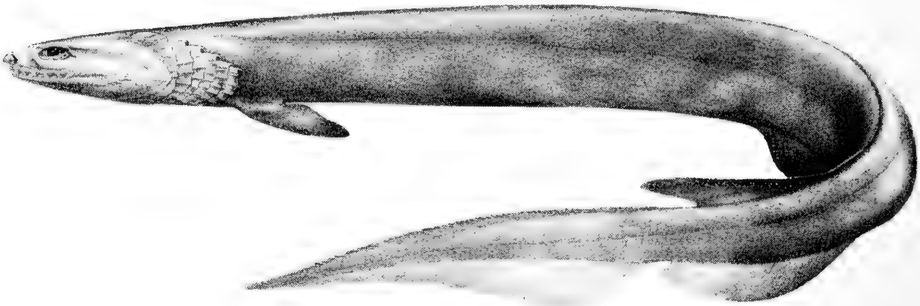
Dr. Samuel Garman, who made a virtually life-long study of the shark, once said of the Frilled shark that it "stands nearer the true fish than do the sharks proper." Because of its primitive form and look of antiquity, Garman considered it "the living representative" of the prehistoric *Cladodus*, which had vanished from the earth eons before.

Garman's nineteenth-century classification, since revised on the basis of modern knowledge of fossil sharks, dramatized the primeval nature of the Frilled shark, a six-gilled shark that is set apart from all other six-gilled species—and indeed from all other known modern sharks—by the exceedingly archaic arrangement of its first gill opening. This opening is a slit that extends continuously across its throat, from one side of its head to the other.

With its odd, frilled collar, its long, slender body and its reptilian head, the Frilled shark looks more like a strange sea snake than a shark—at least at first glance. Its single dorsal fin is small and is placed near its tail, which is practically a single long upper lobe; the lower lobe is almost invisible.

The only known species of Frilled shark (*Chlamydoselachus anguineus* Garman, 1884) has been found in the waters of Japan and in the eastern Atlantic, from Portugal to Norway.[1] Two have been caught off

[1] Two were caught in British waters within little more than a year, the magazine *Nature* reported in November, 1962. They were caught at depths of more than 1,600 feet.



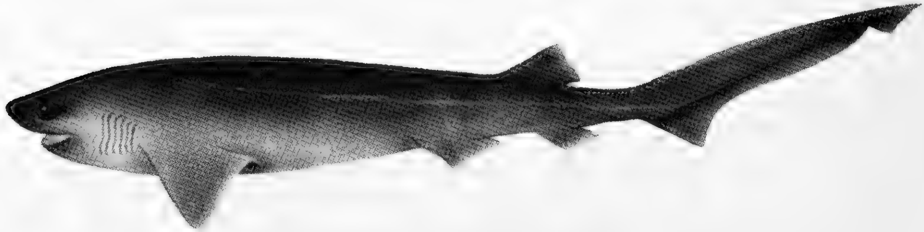
Frilled shark (*Chlamydoselachus anguineus*).
Courtesy, American Museum of Natural History

California. A deep-water shark which feeds on squid and octopus, the Frilled shark is ovoviviparous. The gestation of its young has been estimated to be as long as 2 years. The largest known specimen was nearly 6½ feet long.

Family *Hexanchidae*—Six-Gilled Sharks and Seven-Gilled Sharks

Like the Frilled shark, these sharks are primitive creatures. Their long, slim bodies still display vestiges of some features of most ancient species: six or seven gill slits—and a single dorsal fin. Of the many known species of sharks in the sea today, none resembles its primeval ancestors more than the *Hexanchidae*. Fossil remains of a shark almost identical to the Seven-Gilled have been recorded from the Jurassic Period, which means they last swam the seas about 150 million years ago, according to our current estimates of geological time.

The only known species of Six-Gilled shark (*Hexanchus griseus* Bonnaterre, 1780) is found throughout the world—in continental waters of both the eastern and the western Atlantic; the Mediterranean; the North American Pacific coast from northern British Columbia to southern California, and along the Chilean coast. It is also found in the waters of Japan and in the Indian Ocean.



Six-gilled shark (*Hexanchus griseus*).
Courtesy, Fisheries Research Board of Canada

A relatively rare shark in U.S. Atlantic coastal waters, the Six-Gilled is abundant enough in the Mediterranean to be considered a nuisance because it drives off more marketable fish.

It is a deep-water shark, but it has been seen swimming at the surface off the Irish coast. A 26-footer was once reportedly caught off Cornwall, England. Large Six-Gills, weighing as much as 1,600 pounds, have been hauled up from 700 fathoms off Cuba, where they are frequently caught. Normally, the Six-Gilled does not grow to more than 15½ feet.

The Six-Gilled is also known as the Cow shark, Gray shark, Mud shark, or Shovel-Nosed shark.

The experts do not agree on how many species of Seven-Gilled sharks there are. But there is general agreement that there are only two genera—*Heptranchias*, whose species have narrow heads, and *Notorynchus*, whose species have broad heads. Because the species attributed to each genus are so similar, some scientists believe that there are only two species, one for each genus.

Seven-gilled shark (*Notorynchus maculatum*).
Courtesy, California Bureau of Marine Fisheries

Using this division, we have the Narrow-Headed Seven-Gill (*Heptranchias perlo* Bonnaterre, 1788) and the Broad-Headed Seven-Gill (*Notorynchus maculatum* Ayres, 1885).

H. perlo is found in both the eastern and the western Atlantic and in the Mediterranean. Although relatively rare in U.S. continental waters of the western Atlantic, it is found from Portugal to the Cape of Good Hope in the east. This species, or one very similar to it, is also found off Japan in the north Pacific. The Seven-Gill of Australia (where it is called the One-Finned shark) is considered another species (*H. dakini*) by some scientists. It is said to have startlingly bright emerald-green eyes, and to grow to about 3 feet. *H. perlo* is believed to grow to 7½ feet, though 10-footers have been reported. Although comparatively little is known of its habits, it is believed to be a bottom-dweller in coastal waters both deep and shallow. Its name is sometimes Mud because of its dull brown or grayish coloring. It is also known as the Cow shark.

N. maculatum, known to grow to 10 feet and reputedly to 15 feet, ranges the North American Pacific coast from Alaska to California. This species, or one or more very similar to it, is found in the Mediterranean, off South Africa, in the Indian Ocean, and in the waters off Japan, China, Australia, and New Zealand. This Seven-Gill has a varied reputation. It appears frequently in San Francisco Bay, which seems to be a nursery where females drop their pups. In this area, fishermen consider it a nasty fish to handle, for it is pugnacious when caught. In South Australia, it is considered a dangerous shark; in New Zealand, it is looked upon as not dangerous.

Family *Carchariidae*—Sand Sharks

No one knows what makes one shark dangerous to man and another shark, though vaguely dreaded, not definitely indicted as a man-killer. Very few of all recorded attacks can be unquestionably pinned on any one species. So, for many attacks, the list of suspects is long, and after the name of several sharks the prudent man puts a question mark.

In this family, there are two species so closely related that distinctions between them often are not made. Yet they prowl seas half a world away from each other. One is known to have attacked bathers. The other, endowed with similarly rapacious teeth and a heritage of voracity, is only, to date at least, a suspect.

Gray Nurse Shark (*Carcharias arenarius* Ogilby, 1911)

The Gray Nurse is probably the most inappropriately named shark of all. It is often brown rather than gray—and, despite its benevolent name, it is a menace whose toll of known victims is a long one. (The name *Nurse* is believed to come from an ancient word, *nusse*, which means "great fish.")

In two of the most shark-infested nations of the world, Australia and South Africa, the Gray Nurse is dreaded as one of the most dangerous sharks in the sea.

Dr. J. L. B. Smith, an authority on the sharks of South Africa, wrote of the Gray Nurse[2]:

> Probably most shallow water attacks in South Africa are due to this shark, which also penetrates far up estuaries. The jaw of a ten-foot specimen would easily sever a human head or thigh; those of the largest would easily cut a man in half.

The Gray Nurse grows to a length of at least 15 feet. Its teeth, which fill its jaws row on row, are long, slender, and curved inward. After seeing a Gray Nurse seize a fish, Smith wrote:

[2] J. L. B. Smith, *The Sea Fishes of Southern Africa* (Capetown: Central News Agency, Ltd., 1953).

The upper jaw . . . shoots out, the inner teeth become erect in both jaws, and the snout forms a grotesque pointed hood over this projecting fang-lined cavity of horror, which can snap shut with bone-shearing force.

In Australia, Gray Nurse sharks have been seen lying on the bottom close to shore in neat rows in what Australians call "nurse grounds." Great schools of Gray Nurses are also seen in Australia as they chase shoals of fish toward the beach, there to be cornered and slaughtered.

The menace of the Gray Nurse is far from American shores, but it is somewhat less than comforting to realize that this brute has a very close American relative—the Sand shark (*Carcharias taurus* Rafinesque, 1810)—which is found in great numbers along some of the most popular bathing beaches of the East and Gulf Coasts of the United States.

It is worthy of note here that this is one of the variations in the reputations of sharks thought to be of the same species. The common and presumably "harmless" Sand shark of the U.S. Atlantic Coast is presumed to be the same as, or almost identical to, the much-feared Gray Nurse of Australia. The reputation of the former has been benign in U.S. waters until recently; that of the latter in Australia has always been fearsome. As far as the authors have been able to determine, there is not yet positive identification of the two species. With all of man's fears and fables about sharks from earliest history, it would seem time for some critical investigation to be undertaken to produce a classification that will have some reliability.

Sand Shark
(*Carcharias taurus* Rafinesque, 1810)
(Also Known as Sand Tiger Shark, Spanish Shark)

Voracious and quick to use its stiletto-like teeth, yet at times sluggish and torpid, the Sand shark has a Jekyll-Hyde reputation.

Fishermen know it as a shark with a wicked disposition when it is trapped in a net, but along the Atlantic Coast it has never been regarded as a menace to swimmers. Christopher W. Coates, director of the New York City Aquarium, says of the Sand shark, however: "They can bite like hell and we don't trust them."

A Sand shark (*Carcharias taurus*).

Courtesy, Harvard Museum of Comparative Zoology

In the first known Sand shark attack on a bather in the United States, a skin-diver was grabbed by a Sand shark in Long Island Sound in July of 1961. The victim, Bruno Junker, said that he was diving off Hart Island, near the western end of the Sound, when a 4-foot Sand shark seized one of his legs just below the knee. Junker managed to pry open the shark's jaws, cutting his hands on the creature's teeth. Junker, a skin-diver of 10 years' experience, positively identified the attacker as a Sand shark, a species he was familiar with—and a species he, like nearly everyone else, had assumed to be harmless.

Innumerable Sand sharks swarm off the United States Atlantic Coast during the summer months. From Delaware Bay to Cape Cod, they are among the most abundant summer sharks. They disappear from the seaboard as soon as the water temperature falls below about 67°F. Curiously, there is no increase in their numbers along the Carolina or Florida coasts in the winter. The year-round Sand shark residents of the east coast of Florida apparently do not migrate. The Sand sharks which do appear off the Delaware to New England coast in the warm months retreat to some unknown wintering ground.

Sand sharks feed on smaller fish, raiding schools of flatfish, bluefish, or menhaden in a veritable orgy of feasting. The indefatigable Carolina shark-watcher, Russell J. Coles, after seeing Sand sharks in action off Cape Lookout, North Carolina, reported:

> This shark works in a more systematic way in securing its food than any shark of which I know. On one occasion, I saw a school of a hundred or more surround a school of bluefish and force them into a solid mass in shallow water, and then, at the same instant, the entire school of sharks dashed in on the bluefish. On another occasion, with a large school of bluefish in my net, a school of these sharks attacked it from all sides and ate or liberated the school of bluefish, practically ruining the net.

Because many of the Sand sharks that are caught in Atlantic coastal waters in the summer are young, they are often only 3 or 4 feet long. This phenomenon, along with a tendency on the part of fishermen to call any small shark a Sand shark, has beclouded the facts about what a Sand shark really is and how big it really grows. They are known to reach at least 10 feet. (In South Africa, Smith identifies the Gray Nurse as *Carcharias taurus* and says it attains 15 feet in length, but Atlantic Coast specimens of *Carcharias taurus* have never been recorded larger than 10 feet, five inches.)

Fishermen frequently land Sand sharks, which are not very challenging game fish, incidentally. But one man's Sand shark is not another's. Small Dogfish, Dusky sharks, and Brown sharks, all of which are relatively common in waters frequented by the Sand shark, are often erroneously called Sand sharks. The mix-up is further complicated by the fact that some fishermen know the Sand shark itself as the "Shovel-Nose shark" or the "Dogfish shark."

The name "Spanish shark," still another befuddling name for the Sand shark, comes from the absurd notion that this shark of many names was originally a tropical shark driven into temperate waters by the cannonading during the Spanish American war! [*Spanish* was a popular adjective with old-time seafarers who associated many things that were strange and southern with the idea that they stemmed from the Spanish-dominated tropics. Thus they derived Spanish moss, Spanish oak, Spanish mackerel and Spanish (yellow) fever.]

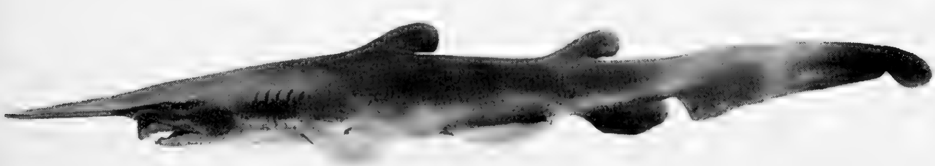
The Sand shark's upper body is light gray-brown, darkest along its back, snout, and upper sides of its pectoral fins, paling on its sides. Its belly is grayish white. It has many roundish or oval yellow-brown spots on its sides. No shark with which it could be confused has spots of this particular nature.

Sand sharks are found on both sides of the Atlantic. On the east, it is known in the Mediterranean, off tropical West Africa, around the Canary and Cape Verde Islands, and off West and South Africa. In the western Atlantic, it ranges from the Gulf of Maine to Florida and southern Brazil.

The Sand shark family has only one recognized genus, *Carcharias*. The various species, known—and usually feared—throughout the world may be merely variations on one world-wide species. In addition to *C. arenarius* and *C. taurus*, these other species include the Blue Nurse (*C. tricuspidatus* Day, 1888) of Indian, Chinese, and South African waters, and the common shark of Japanese coastal waters (*C. owstoni* Garman, 1913).

Family *Scapanorhynchidae*—Goblin Shark

When the weird-looking Goblin shark was found in Japanese waters and first described in the western world in 1898 by David Starr Jordan, president of Leland Stanford University, it was regarded by astonished scientists as a discovery comparable to the capture of a prehistoric Ichthyosaur which had somehow appeared in modern seas.



A Goblin shark (*Scapanorhynchus owstoni*).
Courtesy, American Museum of Natural History

We know today that the Goblin shark is a living representative of a shark that was presumed to have become extinct some 70 million years ago, and whose fossil remains have been found throughout the world. But we know little more than that. Only one species of Goblin (*Scapanorhynchus owstoni* Jordan, 1898) has been found in very deep waters off Japan, Portugal, and India. Its greatest known length is about 14 feet.

Family *Isuridae*—Mackerel Sharks, Mako Sharks, Great White Shark

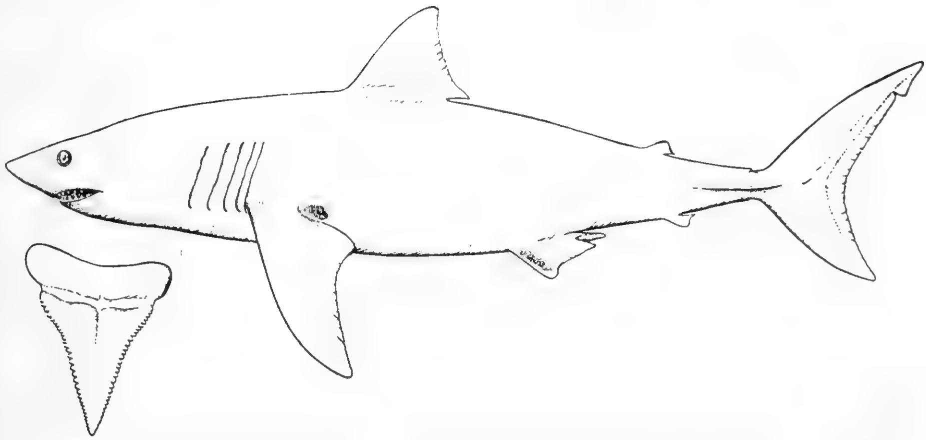
The sharks known commonly as Makos and Mackerel sharks are included in this family of large, stout-bodied species, which are usually classed in three genera—*Lamna*, *Isurus*, and *Carcharodon*. The most notorious member of this dangerous family is the Great White shark, whose large, triangular, serrated teeth set it apart from all other members of the family—and whose reputation as a man-eater is indisputable. It is known all over the world as the Man-Eater.

Great White Shark
(*Carcharodon carcharias* Linnaeus, 1758)
(Also Known as White Shark, Man-Eating Shark, White Pointer, White Death)

Baleful legends and true tales of horror follow in the wake of this hungry shark which cuts through the seas like a long knife. If the shark is king of the sea, the Great White is the king of kings, recognizing no claims of supremacy from any other creatures, be they sharks—or men. It is the most voracious fish in the open seas, and one of the biggest, growing certainly to 36 feet in length and perhaps to 40 or more feet.

With its rows of saw-edged, razor-keen teeth, sometimes 2 inches long; with its speed and its unerring scenting of prey, the Great White is an instrument of death as swift and sure as a guillotine. It strikes a victim with thousands of pounds of murderous impact. A Great White 21 feet long weighed 7,100 pounds. Imagine, then, the power of a 36-foot Great White lunging toward a man. If this nightmare is translated into the abstraction of physics, it is possible that even a mere 200- or 300-pound Great White can hurl itself toward prey with sufficient force to snap the largest human bones—after its teeth have bitten through the yielding flesh.

Great Whites frequently devour their prey intact. Other sharks from 4 to 7 feet long have been found entire in the bellies of Great Whites. A sea lion weighing 100 pounds was found in a Great White taken off California. The incredible discovery of the remains of a whole horse in a Great White captured in Australia was reliably reported. A Great White taken in Florida waters had in it two sharks, each of which was



The Great White shark (*Carcharodon carcharias*); with tooth.
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

6 to 7 feet long. They also eat sea turtles, easily crunching through the shells; and seals cleanly bitten in two have been found in their stomachs.

In 1959, a thirst-crazed elephant stampeded into the sea at Kenya, Africa. It was heading for an island off the mainland, where, apparently, it believed it could find water. The elephant never made it. Huge sharks swarmed around it, and in a frenzy of feasting, tore it to shreds. Fishermen who saw the massacre of the elephant did not identify the sharks. But some may well have been Great Whites, asserting their sovereignty over any creatures that come their way.

This is a shark whose lethal jaws have been known to seamen since ancient times. Jonathan Couch, in his *History of the Fishes of the British Islands*, summed up the beliefs of generations of seafarers by saying of the Great White: "It is to sailors the most formidable of all the inhabitants of the sea, for in none besides are the powers of inflicting injury so equally combined with eagerness to accomplish it." This reputed eagerness for human flesh is a claim not accepted by scientists. But the Great White's lust for food is so insatiable that any food—small fish, large fish, squid, other sharks, dogs, horses or men—is devoured indiscriminately.

Though the subject of countless sea yarns, the Great White shark has remained a mystery to ichthyologists. Nothing is known of its breeding habits, and its wanderings through the seas of the world seem almost random at times, as if each Great White were an individual, untrammeled by any zoning laws. Great Whites are known in all warm seas, including the Mediterranean, but they have been found in many northern waters in warm months. Reports of captures or reliable sightings have been made in the Gulf of Maine; in Massachusetts Bay; off Portland, Maine; within the Bay of Fundy; and around Nova Scotia. On the Pacific Coast, it has been taken at least as far north as Washington.

Great Whites are theoretically pelagic, but many have been taken in fish traps within a few yards of the beach in the vicinity of Woods Hole, Massachusetts, and on Cape Cod. They have been harpooned in 10 feet of water off Provincetown, Massachusetts, and even within 2 miles of a bathing beach in Boston harbor. A Great White once attacked a fisherman in a dory on St. Pierre Bank, south of Newfoundland. The species was determined by teeth left behind on the dory's scarred hull.

In southern waters, Great Whites are more frequently seen—and encountered. Many of the attacks on bathers have been blamed on the Great White in Australia, where this man-eater also bears the chillingly descriptive name of White Death.

A Great White 7½ feet long was caught in 15 fathoms 12 miles off Port Aransas, Texas, on February 9th, 1950. Seven days later, a second Great White, 11½ feet long, was caught in the same area. And 10 days later a third—this one 12 feet, 2 inches long—was caught there. Yet there had never been a previously reported catch in Texas waters. Similarly ominous appearances of this reputedly rare shark have been reported in California waters in recent years. Captures of these man-eaters off Florida and the West Indies have been infrequent, but reports of their presence have been disturbingly frequent. And always they carry the portent of death with them.

Sighted by someone who knows its sinister silhouette, the Great White is unmistakable. Its huge body, ranging in shade from gray to black above, is usually a glistening white below. Its blackish dorsal fin frequently protrudes above the surface as it cruises. (Drawings of the Great White sometimes show it twisting on its back to bite. The misconception has persisted that sharks must turn on their backs to bite. This is not true of any shark, with one qualification. Very large sharks, in confined areas or when excited, particularly the "rigid-bodied" pelagic sharks, such as the Great White, cannot turn quickly. Their bodies are too stiff. Under certain conditions, then, they may turn sideways, or even all the way over when attacking.)

Mako Sharks

(*Isurus oxyrinchus* Rafinesque, 1810)
(*Isurus glaucus* Müller and Henle, 1841)

Zane Grey, known to most people as a writer on the American West, was also one of America's greatest sport fishermen. He called the Mako "a premier sporting fish, as game as beautiful, as ferocious as enduring." Pound for pound, it is one of the strongest, swiftest of sharks. At 10 feet in length, a Mako may weigh more than 1,000 pounds, and it is believed that the Mako reaches a length of at least 13 feet. Zane Grey, incidentally, was not the only writer to match strength and wits with the Mako—in 1936, Ernest Hemingway caught a record Mako, weighing 786 pounds, with rod and reel off Bimini, the Bahamas.

The Mako's fight on the hook is tireless and fierce. It will leap again and again to shake off the maddening fetter that deprives it of its freedom. Often, in the open seas that it roams, the Mako will leap for the seeming joy of being alive and unvanquished. Its fighting instinct is so strong that it may hunt the Broadbill swordfish, rarely menaced by any marine enemy.

Two Halifax fishermen once came upon a battle between several sharks and a single swordfish. By the time they reached the scene of the fight, the swordfish's head, sword, and tail had been bitten off, and a pack of 8 or 10 sharks still swirled about it. As the fishermen hauled the remains of the swordfish into their boat, one of the sharks frenziedly attempted to leap into the boat after it, which sounds like an angry Mako.

Captain Nathaniel E. Atwood, a New England fisherman and amateur naturalist, exhibited before the Boston Society of Natural History in 1866 the jaws of a large shark believed to have been a Mako. "In the stomach of this specimen," he said, "nearly the whole of a full-grown swordfish was found, and some ten or twelve wounds in the skin of the shark gave evidence of the contest which must have occurred."

In more modern times, a 120-pound swordfish (*Xiphias gladius*) was found—with sword still attached—in the stomach of a 730-pound Mako taken near Bimini.

The Mako shark (*Isurus oxyrinchus*).
Courtesy, American Museum of Natural History

A duel between the razor-toothed Mako and the toothless swordfish would appear to be one the shark was sure to win. But the swordfish's sword is a weapon that can be wielded with incredible power. There are many documented cases of swordfishes' swords having been thrust through a foot or more of solid oak in the hulls of ships.

Captain Young saw the evidence of such a mortal duel:

> It was while we were shark-fishing around Warimos Island near Djibouti on the Red Sea. One morning a native came to me to report that a dead shark was on the beach. I ordered the men to drag it up to the station and skin it, since shark skins were what we were after.
>
> When they had the skin partly off, a man came running to bring me to see what they had found—18 inches of a Broad-Billed Swordfish sword in the vital organs of the shark.
>
> As I reconstructed it, there had been a swift, deadly fight. The swordfish had rammed the shark, and, unable to withdraw the sword from the shark's tough hide, had broken it off in the struggle and fled.
>
> The sword had entered the right side of the shark in the space behind the last gill-slit and just in front of the base of the right pectoral fin. It had gone in at this angle because the swordfish had attacked the right side almost head-on. The sword entered to the very hilt and obliquely penetrated the vitals of the shark.

The Mako is a shark of many names, both scientific and common. The Mako of the Atlantic, *I. oxyrinchus*, is also known as the Sharp-Nosed Mackerel shark. The Mako of the Indo-Pacific and South Africa (*I. Glaucus*) is called, in various places, the Bonito, Blue Pointer, Blue Porpoise, and Snapper. In Australia and New Zealand, *I. glaucus* even has another scientific name—*Isuropis* or *Isurus mako* Whitley, 1929. The fact is that both *oxyrinchus* and *glaucus* are very close relatives. And wherever or however they are known, they are regarded as superb game fish. Taking no sides in the name-calling, the International Game Fish Association recognizes both as *the* Mako shark.

Besides being indomitable fighting fish, both species are suspected of attacking men. In Australia, the Mako has also been accused of several unprovoked attacks on small boats. In one such incident, four men in a rowboat off the Bellami Reef, New South Wales, Australia, were fishing when a school of sharks suddenly charged toward the boat. The men rowed frantically, but one of the sharks smashed into the boat, ripping a hole in it and hurling the four men into the water. One man struck out for shore. He got about 20 yards before he was pulled under by a shark. Two of the others later disappeared and were never found. The fourth man lived.

Like some other ovoviviparous sharks, Makos probably begin their voracity in the womb. The embryos hatch from eggs while still in the mother's body. In the next stage of their development, the embryos are nourished by their yolk-sacs and by the nutritive fluid that surrounds them in the mother's oviduct. After the yolk is absorbed, they apparently continue their prenatal feeding in a bizarre way. As they lie free in the oviduct, they devour the unfertilized eggs that are near them. As many as 10 well-fed young are born at a time.

Like all shark pups, the Mako young are fully formed when they begin their life in the sea. Because some well-meaning but inaccurate observer ages ago saw the birth of Makos and did not understand what he saw, he started the myth that the mother Mako shark protects her young by letting them swim into her body when danger approaches. The story has persisted to this day, and it is just as ridiculous now as it was when it began. As a matter of fact, if new-born Makos know what's good for them, they'll swim away from their ravenous mother as fast as they can, for Mako mothers have been known to eat their young.

I. oxyrinchus is pelagic in the tropical and warm-temperate waters of both the northern and the southern Atlantic. It is also found in the Mediterranean. In summer, many migrate northward along the continental shelf as far as southern New England, and sometimes Newfoundland. *I. glaucus* is found off southern California, Japan, Hawaii, Australia, and New Zealand.

Mackerel Sharks
(*Lamna nasus* Bonnaterre, 1788)
(*Lamna ditropis* Hubbs and Follett, 1947)

The Mackerel shark also contributes generously to the pool of name confusion that many sharks swim in. In England it is called the Porbeagle, a word possibly coined from the *por* of *porpoise*[3] and *beagle*, an old English word for small dog. In the Gulf of Maine, where it is abundant, *L. nasus* is known as a Blue shark, because of its bluish-gray upper coloring, which changes abruptly to white below. The Mackerel is often—and erroneously—called a Mako, for it somewhat resembles one and is a swift swimmer.

But its accepted common name, Mackerel shark, is fitting, for it pursues and catches these fast-swimming fish. It is usually to be found following the migrations of the mackerel.

Fast, sleek, and growing to about 12 feet, the Mackerel shark is generally considered to be dangerous, though no positive indictment of man-eating has been lodged against it. In South Africa it is looked upon as a good shark to keep away from. A similar Australian species, also known as Mackerel or Porbeagle, is likewise regarded as dangerous.

[3] *Porpoise*, itself, is a corruption of *Porcus Piscis* (fat fish).

The Mackerel shark (*Lamna nasus*).
Courtesy, Harvard Museum of Comparative Zoology

Its scientific name, *Lamna*, incidentally, comes from a Greek word for a man-eating monster Greek parents threatened to sick on naughty children to make them behave.

L. nasus is found in the continental waters of the northern Atlantic, on the eastern side from the North Sea to South Africa, and on the western side from the Newfoundland Banks to New Jersey, and perhaps South Carolina. It is also found in the Mediterranean. A similar Pacific species (*Lamna ditropis*) is abundant in the waters of the Pacific Northwest, from Alaska to northern California, and is common off southern California. It is sometimes called the Salmon shark in Alaska because of its depredations on that fish. On the western side of the Pacific, it is found in temperate seas.

Family *Cetorhinidae*—Basking Sharks

One wintry day in 1939, the bleached bones of a huge animal were found on a beach near Provincetown, Massachusetts. The skeleton was about 25 feet long and, though its huge skull looked fish-like, the bones of stubby legs were attached to the strange creature. Soon the cry of "*sea serpent!*" went up on Cape Cod . . .

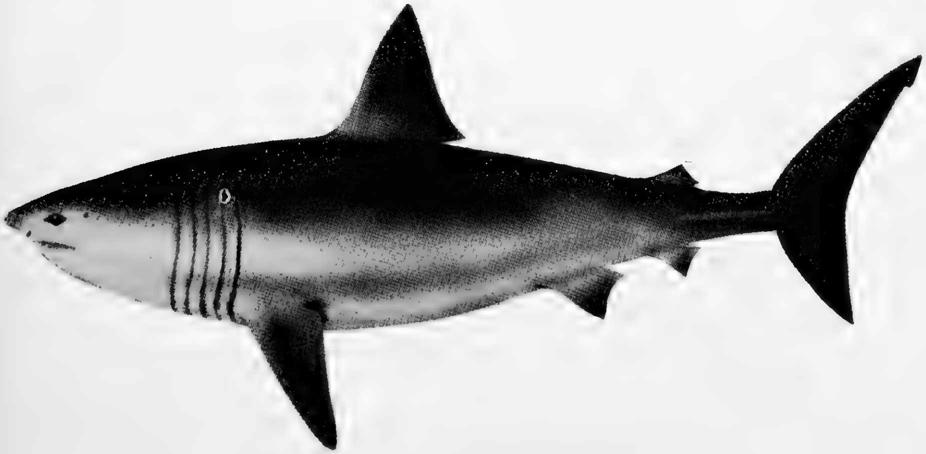
What lay on the beach that day were the remains of a Basking shark (*Cetorhinus maximus* Gunnerus, 1765), a mighty fish second in size only to its colossal but actually distant relative, the Whale shark (*Rhincodon typus*). The Basking shark is also known as the Elephant shark, Bone shark, Sailfish shark, and Sunfish.

When the body of a Basking shark washes ashore, the natural decomposition of its great bulk produces a kind of metamorphosis from which emerges the outline of a "sea serpent." For, all that is left after decomposition is completed are the cartilage of the oblong skull, the long backbone, the remains of the big pectorals and, if it is a male, the 3-foot-long claspers. Because of their location on the skeleton, the pectorals and the claspers look like the "legs" of the sea serpent.

As they swim behind each other, their dorsal and tail fins high above the surface, Basking sharks have inspired tales of living sea serpents. Shark-hunter P. Fitzgerald O'Connor, in his book *Shark-O!*, tells of seeing numerous Basking sharks "head to tail in one long sinuous line . . . as far as the eye could see and further." The long line moved slowly. The sharks did not appear to be eating. "It seemed to us in that evening light," O'Connor wrote, "that some basic animal force was indeed at work—that every shark in the area must have been brought to this particular part of the coast at this particular hour by some irresistible urge in its being."

O'Connor, fishing in the Little Minch of the Scottish Hebrides, caught two sharks from this school and discovered that the snouts of each were a "mass of raw bleeding flesh, skinned for a good twelve inches back from the tips . . . by the continuous grinding against the sharp denticles on the hide of the beast in front."

Basking sharks grow to a length of 40 and perhaps 50 feet. Their weight is measured in tons. A 30-footer landed in 1931 in Monterey, California, weighed 8,600 pounds. Much larger ones have been landed and weighed—in stupendous pieces—recently in Scotland. Writing of the problems of dissecting such ponderous specimens, Dr. L. Harrison Matthews, director of the Zoological Society of London, and Dr. H. W. Parker of the British Museum, remarked: "Woe betide the anatomist who inadvertently punctures the stomach and releases something like a ton of semi-digested plankton." They gave these weights to chunks chopped from a 29-footer: head, 1 ton; liver, 1,850 pounds; fins, 1 ton; tail, ½ ton; skin, 1 ton; meat and back, 3,000 pounds; guts, ½ ton; contents of stomach and intestines, ½ to 1 ton. Total: not quite 7 tons!



The Basking shark (*Cetorhinus maximus*).
Courtesy, Fisheries Research Board of Canada

The Basking shark feeds by cruising through the sea with mouth agape and scooping in a continual torrent of water which is strained for food by gill rakers. It is usually a sluggish monster. It gets its name from its habit of lying on the surface, back awash and first dorsal fin riding the water like a small black sail. Sometimes the tip of its tail, and more rarely its snout, also break water.

Occasionally, the Basking shark leaps from the sea, a lifting feat of unimaginable strength. This leaping habit may be prompted by a mating urge or by a more prosaic desire to get rid of the vast colonies of parasites that infest its massive body. (The blood-sucking sea lamprey (*Petromyzon marinus*) is known also to prey upon the Basking shark.)

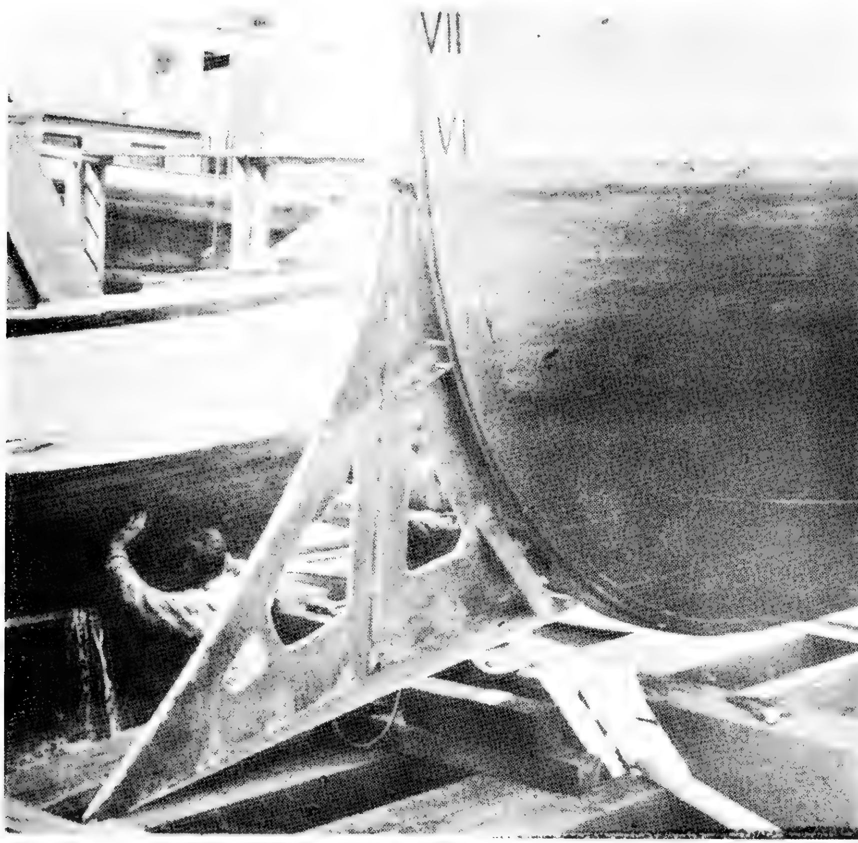
The Basking shark is looked upon as a menace in some parts of the world, a boon in other places—and a mystery wherever it happens to appear and disappear. It is a menace along the coast of British Columbia, Canada, where schools of Basking sharks harass salmon fishermen, and in Newfoundland, where fishermen's cod traps are destroyed by the great sharks when they blunder into them and try to escape.

The Basking sharks are not after the cod or the salmon; they are merely competing with the commercial fishes in a search for food, for Basking sharks seem to be exclusively plankton-eaters. As they swim through a fishing ground, they tear up valuable nets, ruin trolling gear which accidentally wraps around them—and they scare the devil out of fishermen.

The fishermen in Canada appealed to the government for aid. The federal Department of Fisheries went after the Basking sharks with harpoons, but the sharks would not be driven away. Next, firing squads took to the sea and peppered the huge, easily approached sharks with rifle bullets. The bullets had little effect. Finally, the Department of Fisheries devised a new weapon—a vessel fitted with a pointed steel ram honed to razor sharpness. The vessel sped into schools of Basking sharks and cut them to pieces. As many as 18 were slaughtered at one fishing ground in a single day.

Of the countless Basking sharks landed by commercial shark-hunters, not one female is known to have carried an embryo. In fact, the only mention of a Basking shark embryo in scientific literature came in the year otherwise known for the signing of the United States Declaration of Independence. The most widely accepted theory is that Basking sharks are viviparous, conceive their young while basking at the surface, and bring them forth in the sunless privacy of the deep—after a gestation of possibly 2 years or longer.

In Colonial times, Basking sharks were abundant in the Gulf of Maine, and many were caught off the tip of Cape Cod to provide oil for the lamps of the colonists. But the great sharks have long since



In the war the Department of Fisheries of Canada waged on the Basking shark, this pointed steel ram was used to kill the huge marauders of the British Columbia fishing grounds. The ram is fixed on the bow of the Fisheries Protection vessel *Comox Post.* Eighteen Basking sharks were killed in one day with this knife-like ram.

Courtesy, Department of Fisheries of Canada

vanished from New England waters, except for occasional strays. When they do appear, it is nearly always in the warmer months of the year. They disappear in winter, probably to wintering grounds on the sea bottom, where, perhaps in some sort of hibernation, they await the warmth of spring. This theory is based primarily on the fact that Basking sharks caught in early spring usually have small livers, indicating that they had spent the winter in a place where food was scarce, or that they had not been feeding for a considerable time.

The Basking shark is usually described as "harmless." We suppose the elephant might be similarly described—by people who don't hunt elephants. But those who have hunted the Basking shark will attest to its awesome might and potentially lethal attempts to shake off the men who try to capture it. A mere 6-ton Basking shark weighs about as much as two elephants or a dozen horses. When it leaps clear of the surface and crashes down, its falling body may send up a splash as high as, or higher than, a three-story house.

One calm day off the west coast of Scotland, a yacht suddenly disappeared in a great splash of spray. All that was found were odd pieces of wreckage and the bodies of the crew. Everything was covered with thick, foul-smelling slime. A marine biologist who examined the clues to the mysterious disaster established that the black slime was identical with the ooze that coats the thick hide of the Basking shark.

The Basking shark's body is grayish-brown or nearly black above, shading to a paler shade below, and its skin is studded with close-set, thorn-like denticles.

It is found in all temperate and boreal waters, centering west and south of Iceland, along western Ireland, among the Hebrides, and off southwestern Norway. In the Pacific, between November and February, it ranges around Monterey and San Simeon Bays, California. It is also known off Peru, Ecuador, Australia, New Zealand, Japan, and China. *Cetorhinus maximus* is generally believed to be the only species of Basking shark.

FAMILY *Alopiidae*—THRESHER SHARKS

(Also Known as Fox Shark, Sea Fox, Swingletail, Thrasher, Whip-Tailed Shark)

A sea bird, injured or sick, is floundering on the surface. Suddenly, out of the sea rises a sinuous scythe that slams down upon the bird, killing it instantly. In the next moment, the sea bird is swallowed by the wielder of the scythe—a Thresher shark (*Alopias vulpinus* Bonnaterre, 1788).

The startling death of the sea bird was seen by reliable eyewitnesses who have added this incident to the long list of accounts of how the

Thresher shark (*Alopias vulpinus*).
Courtesy, Harvard Museum of Comparative Zoology

amazing Thresher shark gets its food. The Thresher's prodigious tail—often as long as the rest of its body—is apparently its principal means of obtaining food, for its jaws and teeth are relatively weak. A Thresher has been seen lashing a small fish again and again to kill or stun it so that it could be swallowed. It is the only shark known to use its tail in this way.

The Thresher pursues schools of mackerel, bluefish, shad, menhaden, bonito, and various herrings. When it nears a school of fish it splashes the water with its tail, driving the fish into a close-packed crowd and making smaller and smaller circles around them. Then, when the fish are jammed together in a frightened mass, the Thresher darts among them, mouth agape, and swallows them. Sometimes Threshers, working as a team, herd the fish between them and, at the moment of slaughter, share the meal. The Thresher's odd form of preying is very efficient. Twenty-seven mackerel were found in one 13½-foot Thresher.

Threshers have supposedly joined with swordfish to attack whales—the Thresher beating the whale with its tail and the swordfish stabbing it. This tale has about as much foundation as stories about snakes that form themselves into hoops to roll downhill. Tall stories about the Thresher slapping whales to death probably are based on long-range observations of genuine attacks on whales by the vicious Killer whale (*Orcinus orca*), which has a high dorsal fin and, as it clings by its teeth to its struggling victim, raises great splashes.

Threshers are known to grow to 20 feet or more, including tails. They weigh up to 1,000 pounds. The Thresher is a pelagic fish, but it often comes near to shore when it is corralling prey. Threshers seem to stay near the surface, and they have been seen making spectacular leaps out of the sea.

Around the end of June, when the porgies are running near Block Island, Rhode Island, Threshers are usually the most common shark found in those waters, to the chagrin of commercial fishermen whose nets are often ruined by struggling Threshers which have blundered into them.

The range of *A. vulpinus* extends from Ireland to the Cape of Good Hope and the Mediterranean on the east, and from Nova Scotia and the Gulf of St. Lawrence to northern Argentina on the west. It is also found in the Pacific and the Indian Oceans, but ichthyologists are not certain whether these reports involve *A. vulpinus* or the similar Thresher known in the Pacific (*Alopias pelagicus* Nakamura, 1935). Along the eastern Pacific, Threshers are found from British Columbia to Chile. Elsewhere in the Pacific, they are also known around Japan, Korea, China, the Hawaiian Islands, New Zealand, and Australia.

The Thresher's enormous tail distinguishes it from all other sharks.

At least two species of the Big-Eyed Threshers inhabit deep water, *Alopias superciliosus* Lowe, 1840, in the tropical and sub-tropical Atlantic, and *Alopias profundus* Nakamura, 1935, in the Pacific. The huge eye of these species, one fifth the size of the head, is typical of the sort many deep-sea fishes develop.

Family *Orectolobidae*—Nurse and Carpet Sharks

Side by side, forming a colorful, gently rippling carpet on the sea bottom, lies a school of unusually beautiful sharks, so lethargic that even an approaching bather will usually not bother them. These are the Nurse sharks (*Ginglymostoma cirratum* Bonnaterre, 1788) of the At-

Atlantic Nurse shark (*Gynglymostoma cirratum*).
Courtesy, Harvard Museum of Comparative Zoology

lantic—the only species of the vast *Orectolobidae* family that is found in the Atlantic.

The edge of the sea is the little world of the Nurse shark. It is begotten there in the shallows, often in the sight of man. It is born there, one or as many as 26 pups emerging into the sun-warmed tepid waters. It lives there, close-packed in schools of a couple of dozen. It feeds quietly there, lazily devouring the squids, shrimps, crabs, spiny lobsters, sea urchins, and small fishes that wander by.

Nurse sharks are no kin to the dread Gray Nurse (*Carcharias arenarius*) of Australia. They are sluggish, bottom-dwelling sharks—most of them small.

Even the humble Nurse shark, however, can be dangerous. At Rock Harbor in the Florida Keys in July of 1950, Warren Rathjen, a student at the Marine Laboratory of the University of Miami, was looking for seaweed specimens in muddy water 3 feet deep, about 50 feet from shore. As he bent over, something grabbed the back of his right thigh. Rathjen whirled around and seized the creature that was tenaciously biting him. He ripped from his thigh a 2½-foot shark which slithered out of his grasp. Because of Rathjen's knowledge of sharks, there is little doubt that he was attacked by a Nurse shark. But the doubt did linger, for, after all, there had never been even a suspicion that the sluggish Nurse shark would attack a man.

Never before our day, however, have so many skin-divers been in the underwater world, tweaking the tails of "harmless" sharks and even trying to ride them. In Florida and West Indies waters, the Nurse shark is encountered by skin-divers more often than any other shark. And because of its benign reputation, divers have been overly familiar with it.

At least 12 known attacks—usually savage gouges on the hand or the leg—have been positively traced to the Nurse shark in recent years.

Wobbegong (*Orectolobus maculatus*).
Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940. After Muller and Henle

Practically all of the attacks were provoked. None was fatal but all have been painful, and several have resulted in severe injuries.

A typical incident occurred in 1958 off Miami Beach, Florida, when skin-diver John Bowers grabbed the tail of a 5-foot Nurse, hoping to hitch a tow for a thrilling underwater ride. Bowers got no tow. Instead, the shark turned on him and seized his right thigh so tenaciously that it would not release its grip even after another skin-diver fired a speargun at it. The spear went right through the shark, apparently without disturbing it. Bowers was helped into a boat, the shark still clinging to him. It took 10 minutes to pry loose the shark's jaws.

At least seven of the attacks occurred in Florida waters. Nurses which have bitten divers ranged in size from *18 inches* to 9 feet. (Nurse sharks grow to a fair size: lengths of 10 to 12 feet are not unusual. A Nurse 8½ feet long weighs from 330 to 370 pounds.)

In Australia, the *Orectolobidae* are represented by several kinds of beautifully colored sharks, all usually called Wobbegongs, the aborigines' name for one of the species. The coloring is as practical as it is beautiful, for it blends in with the rocks and the weeds of the sea bottom, where the Wobbegong lies, well camouflaged. A fringe of fleshy barbels or

A Zebra shark (*Stegostoma fasciatum*).
Courtesy, Central Fisheries Department of Pakistan

feelers—a family characteristic of the *Orectolobidae*—grows around its mouth. The largest Wobbegong (*Orectolobus maculatus* Bonnaterre, 1788) grows to 10½ feet.

The Nurse shark of American waters has similarly varied colors—yellow to grayish brown, sprinkled with dark spots and sometimes dark bars. It is found close to shore on both sides of the Atlantic in warm waters. It is common around Cuba, Jamaica, and the Florida Keys. It also lazes along Pacific shores from the Gulf of California to Panama and Ecuador. It is sometimes called the Carpet shark.

Another brilliantly colored member of the *Orectolobidae* family is the Zebra shark (*Stegostoma fasciatum*), which grows to about 11 feet. Unlike the Nurse shark, which is ovoviviparous and brings forth live young, the Zebra shark is oviparous. Its oblong egg capsules are equipped with bunches of tendrils that attach themselves to objects on the bottom, thus keeping the capsule anchored while the embryo within it develops.

Family[4] *Rhincodontidae*—Whale Shark

Until one April day in 1828 when some intrepid African fishermen harpooned the largest fish they had ever seen, the Whale shark was a phantom—occasionally seen and marveled at, frequently the subject of sea-monster tales, but never caught and examined by a man of science. The fishermen who brought in the first Whale shark known to modern man first sighted it as an immense dorsal fin knifing the surface in Table Bay, Cape of Good Hope, South Africa. They approached the giant cautiously, but they learned to their astonishment that its size was not a harbinger of ferocity. They harpooned it easily, and not until the harpoon was in it did the colossal shark show any inclination toward flight.

Somehow, the native fishermen managed to get it to shore, where, luckily, Dr. Andrew Smith, a surgeon to British troops in South Africa,

[4] There is only one known representative of the family: *Rhincodon typus* Smith, 1829.

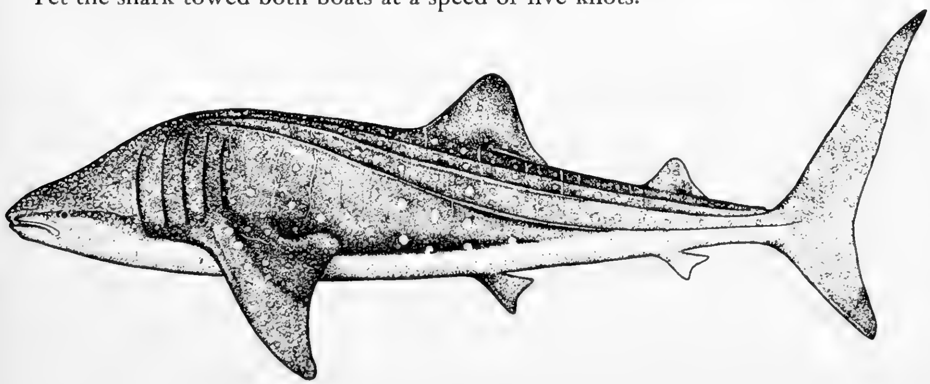
was able to examine it, buy its skin for £6, and forward it to the Museum National d'Histoire Naturelle in Paris.

Dr. Smith's Whale shark was a small one, a mere 15-footer. In the years to come, more Whale sharks would be caught, and man would learn much about them. But the immensity of the Whale shark will always awe man. Whale sharks have been measured at 45 feet, and 60-footers have been creditably reported. In 1912, a Whale shark nearly 40 feet long and weighing about 13½ tons was caught off Knight's Key, Florida. An enterprising promoter skinned it and stuffed it—a job that took several months—and then toured the country with it, billing it as "The Only Creature of the Kind in the World."

The Whale shark is still a good drawing card. More than 100,000 persons thronged to a beach in Mangalore, India, in 1959, when a Whale shark 32 feet long was landed after taking 16 men on a fantastic ride. The huge fish was encountered in the Arabian Sea by a party of fishermen who were learning modern fishing techniques from G. S. Illugason of the United Nations Food and Agriculture Organization.

The Whale shark happened along in the middle of a class on how to catch *small* fish. Illugason, his two assistants, and 13 Indian fishermen were in two steel-hulled boats, one 32 feet long and the other 27 feet long. When the Whale shark was spotted, classes were temporarily suspended and Illugason decided to try for it with the only available equipment—an unbarbed 2½-foot iron hook and 2-inch manila line. Illugason reported:

> We sailed alongside while I waited for a chance to jab the hook through the fin. Our chance came when the shark tried to swim under our boat. I got the hook through the dorsal fin. And now started a fantastic sailing trip. Our two steel boats were secured together by a rope. Both our engines were stopped. Yet the shark towed both boats at a speed of five knots.



The Whale shark (*Rhincodon typus*).

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

A 5-ton, 32-foot Whale shark (*Rhincodon typus*), caught by UN fishing instructor G. S. Illugason and his crew in the Arabian Sea, is inspected by residents of Mangalore, India. It was towed ashore after an epic, 7-hour struggle.
UN Food and Agriculture Organization Photo

The shark pulled the boat for about 20 minutes. Then the line snapped, and the shark swam away, carrying the hook and 90 feet of line. "Then the fish came to the surface again," Illugason continued. "I was able to get a nylon line through the eye of the hook. The shark turned to the open sea, towing us with it."

After 3 hours, the giant began to slow down; by then, most of the fight was out of it. After winding 16 more lines and a steel wire around the upper lobe of the tail fin, the fishermen towed the shark home to Mangalore. Their catch weighed more than the fish many fishermen could catch in a lifetime: 5 tons.

Because of their enormous size, Whale sharks are almost impossible to weigh accurately. The Knight's Key specimen weighed an estimated 26,594 pounds.[5] Even this incredible weight is not the greatest a Whale shark can attain. Dr. E. W. Gudger, who made a lifelong study of Whale sharks, believed that 32 feet was about the *average* length of the Whale shark, and that there was reason to believe that some reached a length of 70 to 75 feet. The weight of a 75-footer could be, on the basis of smaller Whale sharks' known weight, as much as 20 tons.

[5] The weight was estimated by this formula, according to Dr. Gudger: Length in inches multiplied by square of the girth in inches and divided by 800 gives the weight in pounds. The shark was 38 feet (456 inches) long and had a 216-inch girth. The weight: 26,594 pounds, give or take a couple of ounces.

Though captured and beached, Whale sharks are comparatively rare —about 90 have been recorded by marine scientists—they have been seen traveling in schools, and are well known to fishermen in many areas of the world. They are described as common around the Philippines and are well known in Havana waters. (One was caught about 5 miles west of the mouth of Havana harbor. It was weighed piecemeal. Its total weight was approximately 9 tons. Its heart weighed 43 pounds and its liver 900 pounds.)

Numerous collisions between ships and Whale sharks have been recorded in log books throughout the world. A typical report from the skipper of a schooner, after a collision with a Whale shark near Cape San Lucas, at the tip of Lower California, follows:

> The vessel was struck on the starboard side by an immense shark. The wheel was wrenched out of the hands of the man at the wheel. The tail of the fish rose 8 feet above the rail of the ship and about 14 feet above the waterline. The engine was stopped [since] the fish struck the propeller. The fish was distinctly seen when it went astern, was of a mottled color and was at least 30 to 35 feet long. After going into drydock, it was found that considerable damage had been done to the hull and rudder of the ship.

Whale sharks seem to wander into the path of a ship; they certainly don't appear to attack it. Perhaps they are drawn by a fatal curiosity. Their predilection for being rammed by ships is enough of a recognized maritime hazard for the U.S. Navy Hydrographic Office to have devoted the entire back of its June, 1948, issue of *Pilot Chart* of the North Pacific Ocean to records of collisions between ships and Whale sharks.

There might not have been a book titled *Kon-Tiki* if a Whale shark's habit was one of charging into vessels instead of being bumped by them. The disquieting presence of a Whale shark gave the scientists on the *Kon-Tiki* several bad moments. As author Thor Heyerdahl told it in one of the great books of the sea,[6] he had just finished a swim off the bow of the raft when a cry of "*Shark!*" rang out. Dead astern was a fish with "the biggest and ugliest face" the men aboard had ever seen. Heyerdahl said that the fish had the face of a sea monster "so huge and so hideous that, if the Old Man of the Sea himself came up, he could not have made such an impression on us."

The *Kon-Tiki* scientists had little to fear. Whale sharks are so monumentally sluggish that men have literally walked all over them. Conrad Limbaugh of Scripps Institution of Oceanography was once with a group of skin-divers who happened upon a Whale shark. "We clambered on the shark, looking it over closely, even looking into its

[6] Thor Heyerdahl, *Kon-Tiki* (Chicago: Rand McNally & Co., 1950).

On February 11, 1905, the *Illustrated London News* published this drawing, based on a sketch of Captain J. C. Robinson of the *Armadale Castle.* It clearly shows a Whale shark impaled on the ship's bow, but the headline called it a "Sea Serpent." The story said: "During a recent voyage of the *Armadale Castle,* when the vessel was in latitude 3 deg. south, the stem's perpendicular struck a large fish close to the head, and held it prisoner for about 15 minutes. The monster was not less than 57 feet in length, and must have been 8 feet in diameter. It was beautifully marked and Captain Robinson was sorry he could not lasso and preserve it. There was keen controversy among the passengers as to its species, some arguing for a whale, some for a shark. As Mr. Rudyard Kipling was on board and saw the sight, it has been suggested that the creature should be called *Piscis Rudyardensis.*"

Courtesy, American Museum of Natural History

mouth," he reported. "It showed no signs of concern except when we bothered its face. Then it slowly dived out of sight. But it would return to the surface, and we would climb aboard again."

Stories of the Whale shark's indolence are many. Yet a fish of such gigantic size can be dangerous because of its very immensity. A 31-foot Whale shark that blundered into a pound net off Fire Island, New York, in 1935 struggled with its captors for 3 hours before it was subdued. When thrashing to free itself, a Whale shark could easily kill a man or two with a flip of its mighty tail. However, no such incidents are on record.

The Whale shark usually feeds on crustacea and tiny fishes that are drawn into its enormous mouth, a cavern big enough for a man to crouch in. Its tiny teeth are many—15,000 in one whose minute molars were laboriously counted. The teeth are packed into a band that runs along the inner surface of each jaw just inside the lips. These teeth are not used for biting or crushing food, but merely for holding whatever happens to be scooped into the mouth.

The pattern of the Whale shark's hide shows up clearly in this photograph, which shows William Beebe pursuing a 42-footer during a New York Zoological Society expedition in the Eastern Pacific. This shark was found off Lower California. But it was not captured. Courtesy, *Zoologica*

As the Whale shark swims, a steady current of water passes into its mouth and out the long gill slits on either side of its head. But, as the water flows through the gill slits, it is strained by gill rakers whose combs are closely spaced. The tiny food particles and the small fish swept into the Whale shark's maw are thus trapped inside and diverted to its gullet. The food must be small because the Whale shark's throat is very narrow and makes an almost right-angled turn to the stomach. This bottleneck would seemingly prevent the passage of any large fishes —or a man who might stray into the Whale shark's path. A large shark, supposedly identified as a Whale shark, caught in the Philippines, had in its belly 47 buttons, 3 leather belts, 7 leggings, and 9 shoes. The deductions possible from this find range from suspicions that the shark was another species, that it had happened upon the remnants of a haberdashery washed out to sea, or that the shark happened upon a motly group of men with a puzzling number of feet and legs.

Little is known about the Whale shark's breeding habits. The clues are sparse, despite more than a century of observation. In 1910, a female examined in Ceylon had 16 egg cases in one of her oviducts. In 1955, J. L. Baughman of the Texas Game, Fish and Oyster Commission reported the discovery of an egg case in 31 fathoms of water 130 miles south of Port Isabel, Texas. The egg case contained a perfect embryo of a Whale shark, readily identified by the conspicuous checker board pattern of white dots and bars on its back. Baughman's discovery of the

The only embryo and egg case of the Whale shark (*Rhincodon typus*) known to have been recorded was reported by J. L. Baughman of the Texas Game and Fish Commission in 1955. The huge egg case with a perfect embryo inside was found off the Texas coast. The ruler gives a concept of its size. Note that the embryo has the distinctive marking of the Whale shark. Courtesy, Texas Game and Fish Commission

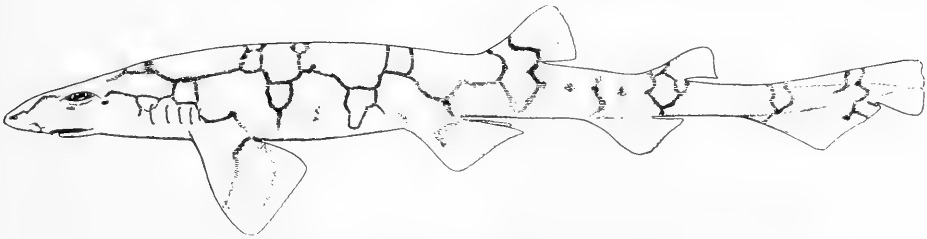
king-sized egg case (27 inches long by 16 inches wide) finally proved that the Whale shark brings forth its progeny via egg capsules.

Whale sharks are pelagic in the tropical seas of the Atlantic, the Pacific, and the Indian Oceans. But they have been caught as far north as Long Island, New York, and one collided with a ship about 380 miles east of Cape Cod, Massachusetts.

FAMILY *Scyliorhinidae*—CAT SHARKS

This is a vast and perplexing family. Ichthyologists do not agree on how many species there are—except to say that there are many and that they range the oceans of the world. Their common names are confusing. Some sharks which the British call *Dog*fish are actually members of this *Cat* shark family. And the same bewildering semantics apply to one of the sharks called Dogfish in the United States!

The Cat shark, going under the name of Dogfish in U.S. Atlantic

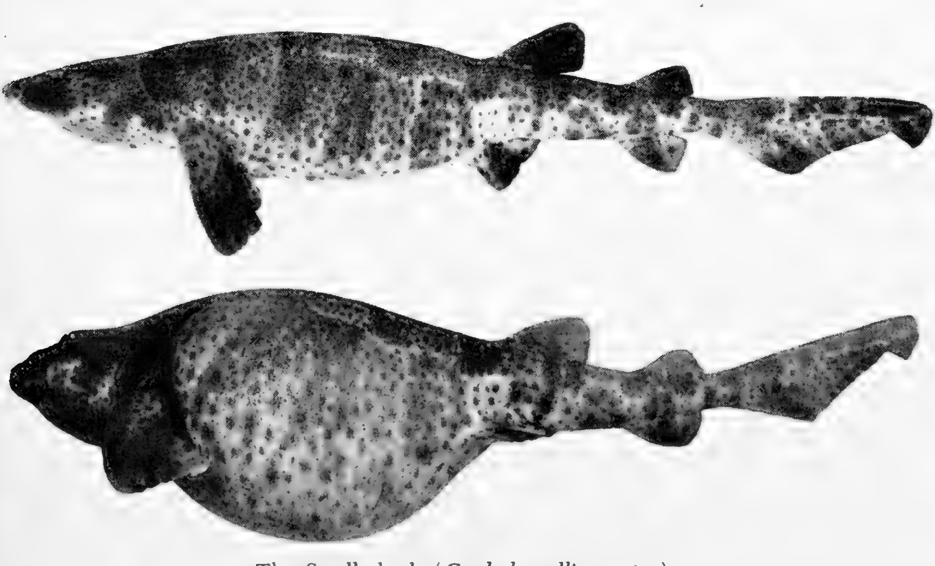


A Chain dogfish (*Scyliorhinus retifer*).
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

waters (*Scyliorhinus retifer* Garman, 1881), is the "Chain dogfish," so called because its body is criss-crossed by narrow dark stripes which give it the appearance of being wrapped in chains. *S. retifer,* which grows to about 2½ feet, is found at or near the bottom along the continental shelf from Cape Lookout, North Carolina, to northern New Jersey. Like all other known members of the *Scyliorhinidae* family, it is oviparous. Its brownish-amber egg cases are about 2 inches long.

What the Britons call the Lesser Spotted dogfish is *Scyliorhinus caniculus* Linnaeus, 1758. The Britons' Large Spotted dogfish is *Scyliorhinus stellaris* Linnaeus, 1758. Both are found in the European Atlantic and the Mediterranean.

Three sharks, distinctive because of their peculiarities, are also members of this family: the Swell shark (*Cephaloscyllium uter*), relatively



The Swell shark (*Cephaloscyllium uter*).
Courtesy, California Bureau of Marine Fisheries

common in southern Californian inshore waters; and the South African Skaamoong sharks (*Haploblepharus edwardsi* and *Holohalaelurus regani*). The Swell shark fills its belly with air when taken from the water, and swells out like a balloon. It sometimes floats on the surface this way for several days. The Skaamoong sharks, also called "Shy Eyes," curl their tails over their eyes as if to shield them when they are taken from the water.

Australia has a variety of Cat sharks, whose often startling color patterns can be visualized in their names: Black-Spotted, Marbled, and Draughtsboard (American translation: Checkerboard). The Australian Swell shark (*Cephaloscyllium laticeps* Dumeril, 1853) "can live more than one day out of water," Whitley reports.

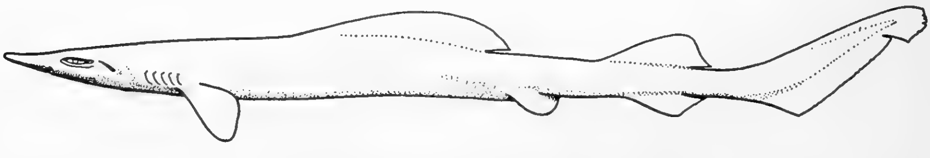
Most Cat sharks are small, rarely growing to more than 2 or 3 feet. In silhouette, many of them resemble some of the Nurse or Carpet sharks (*Orectolobidae*). But there is a slight though highly significant difference between the two families. The mouth and the nostrils of the Cat shark are generally separate and not joined by a groove, as are the mouth and the nostrils of the *Orectolobidae*. This seemingly inconsequential difference means, in effect, that the Cat sharks have taken one step closer to the higher species of shark.

Family *Pseudotriakidae*—False Cat Sharks

On February 8, 1883, a strange shark was washed ashore at Amagansett, Long Island. The shark was not quite 10 feet long, and, at first glance, it appeared to be a Nurse shark. On second glance, it appeared to be a Cat shark. But under closer scrutiny, it did not look like any other shark ever seen by its finders, who were members of the crew of the Amagansett Life-Saving Station.

Luckily for science (but not so fortunately for those scientists saddled with the task of classifying sharks), the odd shark was preserved and its exact measurements taken. Its most unusual feature—the one that removed it from all known shark species—was its long, low first dorsal fin, which was about as long as its tail fin.

Until that chilly day in Amagansett, only one other such shark had been recorded by science. That one had been found in Portugal. For



A False Cat shark (*Pseudotriakis microdon*).

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

want of a better, more precise common name, the Amagansett shark was dubbed the "Small-Toothed Nurse shark."

Since 1883, fewer than a dozen of these odd sharks are known to have been taken in the Atlantic. All catches have been strictly by chance. One, for instance, was found in a pound net hauled up off Manasquan, New Jersey.

These rare Atlantic sharks are called today False Cat sharks (*Pseudotriakis microdon* Brito Capello, 1867). A similar Pacific species (*P. acrages* Jordan and Snyder, 1904) has also been found in Japanese waters.

Most of the False Cat sharks have been caught in deep water—one was taken at a depth of nearly 5,000 feet. The assumption is that they are rare, deep-water sharks, prowling the depths in a range that includes at least Iceland (where three have been recorded) and the Cape Verde Islands (where one was taken).

Family *Triakidae*—Smooth Dogfishes

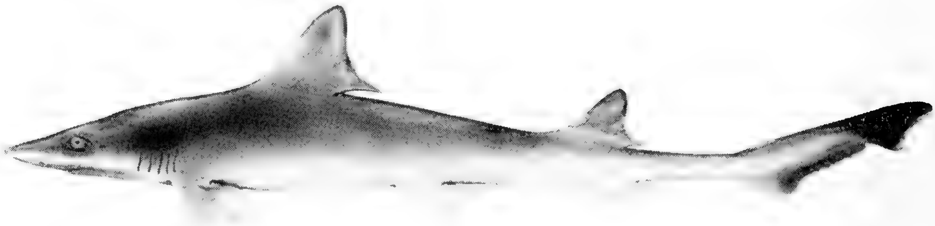
The 30-odd species in this world-wide family are a kind of link between the Nurse and the Cat sharks and what are sometimes called the Requiem sharks (*Carcharhinidae*), which have achieved a development higher up the shark spectrum. *Triakidae*, though usually small (5 feet or less), have the bodily outline of the typical shark, but their teeth are typically small, blunt, and pavement-like, as are the teeth of Nurse and the Cat sharks. Some of the most abundant sharks on both the Atlantic and the Pacific coasts of North America are members of this family.

In the Atlantic, the Smooth dogfish (*Mustelus canis* Mitchell, 1815) is second only to the Spiny dogfish (*Squalus acanthias*) in abundance along the southern New England and mid-Atlantic coasts.

Someone once calculated that 10,000 Smooth dogfish could devour 60,000 lobsters, 200.000 crabs, and 70,000 other fish in a single year. If 10,000 Smooth dogfish were all the harassed fishermen had to contend with, they would have no problem. Like the Spiny dogfish, however, the Smooth dogfish can be counted in the millions.

Around May 10th of each year, almost with the storied punctuality of the swallows coming back to Capistrano, Smooth dogfish arrive at the entrance of Long Island Sound. This is the beginning of a summer sojourn along the coasts of New Jersey, New York, and southern New England. Between early May and mid-July, their young are born—hungry little sharks 13 to 14 inches long. Many of these newborn are scooped up in nets along the coast of southern New England.

The Smooth dogfish embryo is nourished by a complex yolk-sac placenta, a prenatal system close to that of man. The Smooth dogfish's reproductive system, its intriguing sensory system, its small size (maxi-



A Smooth dogfish (*Mustelus canis*).
Courtesy, Harvard Museum of Comparative Zoology

mum length, 5 feet), and its abundance—all are attractions which make it a popular specimen for laboratory study in zoology and biology classrooms. For this reason, large numbers are caught each year and preserved, making this slender, graceful little shark a species which has been intently studied for years.

Like the Spiny dogfish, the Smooth dogfish is sensitive to temperature changes, and its migrations seem to be governed somewhat by water temperature. These Dogfish winter between the southern half of North Carolina and the offing of Chesapeake Bay. A sudden chill in these winter waters will occasionally kill Smooth dogfish. Their summer visit along the coast from Delaware to Cape Cod ends abruptly, and they withdraw almost simultaneously from all points on the coast when the water cools.

The Smooth dogfish stays fairly close to shore and is normally found in waters of less than 10 fathoms (60 feet). It is aided in its bottom-search for lobsters and crabs by its ability to change its color shading to blend with the background, to an extent unusual for sharks. Its range of color change spans tints from pearl to dark gray.

Mustelus canis itself ranges from Cape Cod, and occasionally the Bay of Fundy, southward to Brazil and Uruguay in the western Atlantic. It is well known along the coasts of Great Britain, where it is called the Smooth Hound. It is found in the Gulf of Mexico and has been reported in the Calcasieu River of Louisiana, as far inland as Prien Lake. In South African waters, it is known as the Hound. (Apparently, they earned their canine common names from their habit of traveling in packs, or, to be piscatorial, schools.) A species similar to *M. canis* (*Mustelus norrisi* Springer, 1939) is found in the Florida Keys and off the west coast of southern Florida. Two species (*M. mustelus* Linnaeus, 1758, and *M. asterias* Cloquet, 1819) are known in the Mediterranean and the eastern Atlantic.

Along the North American Pacific coast, three Smoothhounds are known: the Gray, the Sicklefin, and the Brown.

A Leopard shark (*Triakis semifasciata*).
Courtesy, California Bureau of Marine Fisheries

Gray Smoothhound (*Mustelus californicus* Gill, 1864)

Common in the shallow waters of southern California, it ranges from northern California to Lower California. It grows to about 2½ feet. Its teeth—blunt, pavement-like, and without points—distinguish it from the Brown Smoothhound, whose teeth have sharp points.

Sicklefin Smoothhound (*Mustelus lunulatus* Jordan and Gilbert, 1882)

A 5-foot, 8½-inch Sicklefin was recorded in San Diego, believed to be the northern limit of its range, which takes it as far south as Colombia. It differs principally from *M. californicus* by having slightly longer pectoral fins.

Brown Smoothhound (*Triakis henlei* Gill, 1862)

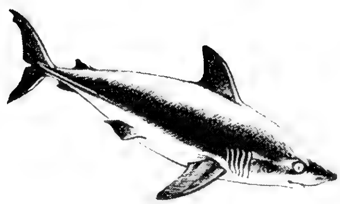
Studies have shown that this is the most abundant shark in San Francisco Bay, making up an estimated half of the total shark population. It may well be the most abundant shark along the entire California Coast. It grows to about 38 inches.

The Leopard shark (*Triakis semifasciata* Girard, 1854) is also a member of this family. The Leopard, a small shark whose maximum known length is around 5 feet, was, until recently, invariably described as "harmless"—a reckless word to apply to *any* shark. The Leopard has not been called harmless by anyone who knows of an inexplicable unprovoked attack a 3-foot Leopard made in 1955 on a skin-diver in Trinidad Bay, California. The skin-diver managed to fight off the little shark, and was not seriously injured. The shark was positively identified because the Leopard has well-defined markings: a black crossband and black spots along its back and sides. Sometimes its undercoloring is iridescent.

The Leopard, common in shallow waters along the southern California coast and in bays farther north, is found from Oregon to Magdalena Bay, Lower California.

Chapter 12

The Sharks—Part Two



The largest family of sharks is the *Carcharhinidae*, whose 60-odd species, classed in about 15 genera, encompass the familiar sharks found throughout the world—and many that are feared. The sharks of this family are sometimes known as *Requiem* sharks because of their reputation for causing death. The funereal name still persists in the French word for shark, *requin.*

The physiological oddities found in many of the sharks already mentioned—the flat bodies, the unusual arrangement of fins—are not found in these species, for they are all "typical sharks."

The genus with the most species is *Eulamia* (*Carcharhinus*)[1]. The sharks of this genus begin our roll of the Requiems.

Family *Carcharhinidae*—Requiem Sharks

Brown Shark

[*Eulamia* (*Carcharhinus*) *milberti* Müller and Henle, 1841]

(Also Known as Sandbar Shark, New York Ground Shark)

As the summer's heat drives throngs of bathers to the cooling waters of the Atlantic Ocean shore from New England to Florida, schools of Brown sharks head for the same waters. European relatives of the Brown shark also enter the warm lagoons of the Mediterranean—and even prowl the canals of Venice, startling gondoliers and their blissful passengers.

One August day in 1916, Edwin Thorne, a sports fisherman who hunted sharks as a hobby, cruised the waters of Great South Bay, Long Island, between Lindenhurst and Great River. He reported seeing at least 200 Brown sharks on that one day. As many as 14 of these 6- to 8-foot sharks have been harpooned in Great South Bay in a single day. (It is called the Sandbar shark because of its habit of appearing as it crosses a sandbar, then disappearing again on the other side.)

[1] *Eulamia* and *Carcharhinus* are both used by reputable classifiers to designate the genera of certain species of the *Carcharhinidae*. *Eulamia* seems to be generally accepted, currently.

The summertime meanderings of the Brown shark take it into the busiest harbor in the world—the bustling, sprawling 650 miles of navigable waterfront that is the Port of New York. The Brown shark also enters the shallow waters of bays and river mouths. It is probably the only sizable shark that regularly visits the small bays on the populous north shore of Long Island.

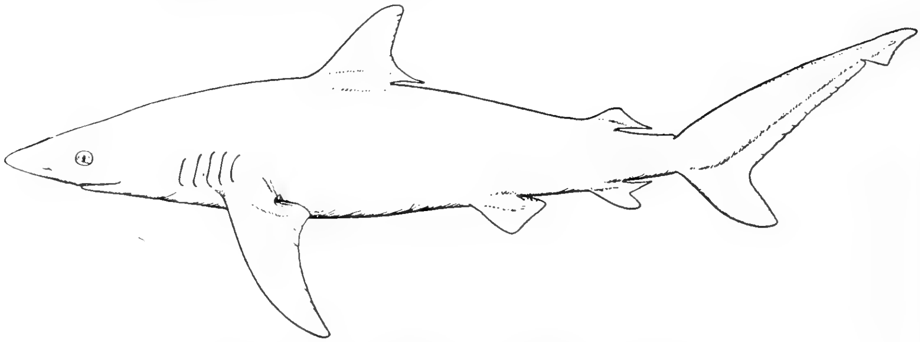
Its appearance in Great South Bay, on Long Island's south shore, and in other sheltered waters around Long Island, seems to be inspired by a habit of bringing forth its young in protected waters, rather than in exposed ocean shore waters. In these shark nurseries, schools consisting almost exclusively of female Brown sharks appear each summer. Their young—about 8 to 12 in each litter—are born from June to August in the Long Island bays. Births also apparently take place in September in Chesapeake Bay, which may mark the southern boundary of the Brown shark's maternity ward on the Atlantic coast during these months.

The pups grow into sharks that weigh about 100 pounds at 6 feet and about 200 pounds at 7 to 8 feet. They are brownish gray or slate gray above, shading to a pale tint of the same color or whitish below.

The Brown shark inhabits the western Atlantic, from southern New England to southern Florida and southern Brazil. It is found in the Gulf of Mexico.

The Gambuso shark (*Carcharhinus azureus* Gilbert and Starks, 1904) of the Pacific also resembles the Brown shark enough to be a twin. The Gambuso ranges from southern California to Ecuador. [The Pacific coast also has another shark, colloquially known as the Brown shark, but it is a completely different species of another family. This Brown shark (*Apristurus brunneus* Gilbert, 1891) is found from Alaska to southern California. It grows to about 3 feet and is usually hauled up from very deep water. One was caught in British Columbia's Howe Sound at 1,020 feet.]

Brown shark (*Eulamia* [*Carcharhinus*] *milberti*).
Courtesy, Harvard Museum of Comparative Zoology



Dusky shark (*Eulamia* [*Carcharhinus*] *obscurus*).
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

Dusky Shark

[*Eulamia* (*Carcharhinus*) *obscurus* Lesueur, 1818]
(Also Known as Shovelnose Shark, Dusky Ground Shark)

The Dusky shark is called a man-killer by one expert, and is dismissed as harmless by another. Its Latin species name, *obscurus*, would seem to fit this shark. Although known as a distinct species since 1818, the Dusky is still an enigma, and a confusing enigma at that, for it is often mistaken for the Brown shark.

The two sharks do superficially resemble each other. But the Dusky, which grows to at least 12 and perhaps 14 feet, is bigger than the Brown shark. The Dusky is slimmer, presents a different silhouette and does not have the same coloration. The Dusky is bluish, leaden gray or pale gray above and white below. The lower surfaces of its pelvic fins are grayish and sooty toward the tips.

The Dusky is found on both sides of the Atlantic, at sea and close to shore, on the western side from southern Massachusetts to southern Florida; on the eastern side from the Mediterranean coast of Spain to South Africa. It is also a Gulf of Mexico resident.

Small Black-Tipped Shark

[*Eulamia* (*Carcharhinus*) *limbatus* Müller and Henle, 1841]
(Also Known as Spot-Fin Shark, Black-Tip Shark, Carconetta)

Schools of Small Black-Tipped sharks have been seen swiftly skimming along the surface, far at sea. Occasionally, a shark will leap startlingly into the air, do as many as three spectacular somersaults, and fall back into the sea.

These stunts have endeared the acrobatic little Black-Tipped to game fishermen. But their performance on the hook is not consistent: it varies from vigorous to merely resolute. Anglers trolling for tarpon have found this out, for they often hook Small Black-Tipped sharks instead.

The Small Black-Tipped shark feeds on smaller fishes, such as menhaden in the Atlantic and sardines in the Pacific, and Sting rays, whose stingers are often found imbedded in the sharks' jaws. A relatively small shark, rarely growing to 7 or 8 feet, the Small Black-Tipped is itself sometimes a meal for the larger oceanic sharks such as the Tiger shark.

The conspicuously black-tipped fins of this shark are seen in tropical and sub-tropical seas. In the western Atlantic, it ranges from the Gulf of Mexico and southern Brazil to North Carolina and sometimes to New York and southern New England. In the eastern Atlantic, it is found off tropical West Africa, in the waters around the Cape Verde Islands, and around Madeira. In the eastern Pacific, it is found from Lower California to Peru. This or a very similar species has also been reported off China, India, and Madagascar, and in the Red Sea.

Dark gray, dusky bronze, or ashy blue above, its trim body is pure white or yellowish white below, with a band of dark upper color extending backward along each side, and the pale color of its lower parts extending forward. Its pectoral fins are black-tipped. The dorsal and anal fins and the lower lobe of the tail fin are black-tipped in the young, but the color usually fades with age. Its eye has been described as catlike: greenish yellow bisected by a black band.

Large Black-Tipped Shark
(*Carcharhinus maculipinnis* Poey, 1865)

On May 31st, 1944, Mary Ann Shands, aged 15, was swimming in waist-deep water off Mayport, Florida, near Jacksonville. Suddenly, something slashed the calf of her leg. She looked down and saw a shark, which darted away. Its fins were tipped with black.

Subsequent investigation by Stewart Springer of the U.S. Fish and Wildlife Service established beyond a doubt that the attacker was a Large Black-Tipped shark only 5½ to 6½ feet long. Its size and species

Small Black-tipped shark (*Eulamia* [*Carcharhinus*] *limbatus*).
Courtesy, Harvard Museum of Comparative Zoology

were determined by the imprint of the wounds. A Large Black-Tipped shark's maximum length is about 8 feet.

Because of its resemblance to *Eulamia* (*Carcharhinus*) *limbatus*, the Large Black-Tipped shark has long been confused with its slightly smaller relative. It travels in schools and has the same habit of leaping that the Small Black-Tipped displays. It frequently follows shrimp trawlers feeding on trash fish that are thrown overboard. It is found in the Gulf of Mexico, and off Cuba, Puerto Rico, and southern Florida. A similar Black-Tipped shark is known in Australia, India, and South Africa.

The two kinds of Black-Tipped sharks can be distinguished by the fact that the *Small* Black-Tipped has larger eyes and shorter gill slits than the *Large* Black-Tipped.

White-Tipped Shark

[*Pterolamiops* (*Carcharhinus*) *longimanus* Poey, 1861]

In 1956, the *Andrea Doria*, en route to New York from Europe, collided with another ship 60 miles off Nantucket Light and sank 40 fathoms to the bottom of the Atlantic. Today the once proud Italian luxury liner is a barnacled den for thousands of fish—and a hunting ground for sharks.

Skin-divers Peter R. Gimbel and Joseph Fox visited the *Andrea Doria* a little more than a year after she sank, and met the sharks that are her sentries. One made a feint at Gimbel and he drove a knife into its snout. It had white-tipped fins that glimmered in the darkness. It, and probably its companions, were White-Tipped sharks, ocean-roaming wanderers hardly ever seen near land.

The White-Tipped is another of the many sharks we know little about. The research vessel *Atlantis* spotted several hundred White-Tipped sharks about 50 miles off the Massachusetts coast in June of 1941. A recent U.S. Fish and Wildlife Service report said that the White-Tipped was responsible for most of the damage to tuna caught on long-line fishing gear in the Gulf of Mexico, and was one of the most abundant sharks in the warm waters of the North Atlantic. It is believed to grow to 12 or 13 feet in length, but most of those that are caught are around 8 feet.

The Fish and Wildlife report on observation of White-Tipped sharks in the Atlantic noted a curious association: "On several occasions we have seen one or several 'dolphins' (*Coryphaena hippurus*) [the fish, not the mammal] . . . swimming with the shark. They are generally to the rear or one side of the shark." Eight to ten fish were seen accompanying one shark.

In the Gulf of Mexico and the Caribbean, the White-Tipped is feared, but, since its shoreline appearances are rare, its sinister reputation to date rests upon mere suspicion.

The White-Tipped shark's coloring is not always so distinctive as its name implies. It body is light gray or pale brown to slaty blue above; yellowish or dirty white below. The tips of its dorsal fins are sometimes pure white and sometimes grayish.

The White-Tipped is known to range the warm waters of the Atlantic, the Gulf of Mexico, the Caribbean, and the Pacific. [The Australian so-called "White Tip shark," found also in the Indian Ocean, the Red and the Arabian Seas, and around many Pacific island groups, is quite another species, *Triaenodon obesus*, a member of the family *Triakidae*].

Bay Shark
(*Carcharhinus lamiella* Jordan and Gilbert, 1882)

This big shark, which grows to at least 12 and probably 15 feet, was once so common in San Diego Bay that it became familiarly known as the Bay shark. In recent years, for reasons unknown, it has been more often found at the southern end of its range, which dips down to the central western coast of Mexico.

The Bay shark is certainly a potentially dangerous shark. It closely resembles the Bronze whaler (*Carcharhinus ahenea* Stead, 1938) of Australia. The Bronze whaler, like the Bay shark, is of a golden bronze color. Australians say that its body gleams in the water "like a bright new penny," albeit an unlucky one.

Whalers

Several species of dreaded sharks are called *Whalers* in Australia and New Zealand. The common name was given these voracious sharks by old-time whalemen whose catches were invariably attacked by swarms of sharks. *Whaler* is also a loosely applied common name for some sharks found in South African waters.

The Common whaler or Black whaler of Australia (*Carcharhinus macrurus* Ramsey and Ogilby, 1887) is described by Whitley as "very

Black whaler (*Galeolamna* [*Carcharhinus*] *macrurus*).

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

dangerous to man, a proved attacker of human beings." One of the largest on record—12 feet long, 890 pounds—was caught in 1936 by Zane Grey off Bateman's Bay, New South Wales. "Of all the attacks on human beings recorded from Australian waters," writes T. C. Roughley,[2] "there have been two occasions only when some portion of the body of the person attacked has been found in the stomach of a shark captured shortly afterwards; both were Black Whalers."

The South Australian whaler or Cocktail shark (*Carcharhinus greyi* Owen, 1853) is found in the waters of southern and southwestern Australia. Little is known of it, except for the fact that it appears to be a relatively small shark which frequently ascends the Swan River, near Perth, Australia. Its river-swimming habits have earned for it the additional common name of Swan River whaler.

Other species include the Brown and the Bronze whalers which are rated as potentially very dangerous. A 14-foot Bronze whaler killed a spearfisherman off Normanville Beach, south of Adelaide, in December, 1962.

Silky Shark

(*Carcharhinus floridanus* Bigelow, Schroeder and Springer, 1943)

This shark, common in both the Atlantic and the Pacific Oceans, is another of the larger—8 to 10 feet—of the *Carcharhinid* family, and a good example of how little we still know about sharks.

Despite its abundance and its size, it was not scientifically pinned down until 1943 in the Atlantic and 1953 in the Pacific. "That a shark so common, so large and so easily recognized should have continued unknown for so long casts an unflattering light on the scientific knowledge of the group to which it belongs," say Bigelow and Schroeder.

Fishermen have long known it in Puerto Rico, Cuba, and around southern Florida in the Atlantic, and offshore in the warm waters of the Pacific. It is called the Silky shark because its denticles are so small that its skin feels smooth to the touch.

The Silky shark is sometimes confused in the Atlantic with a similar big shark (*Carcharhinus falciformis* Müller and Henle, 1841). But the Silky shark's pectorals are much longer, its eye is smaller, and the tip of its snout is narrower. Both sharks have a ridge that runs down the back between the first and second dorsal fins.

Cub Shark

(*Carcharhinus leucas* Müller and Henle, 1841)

(Also Known as Bull Shark, Ground Shark, Requiem Shark)

From May through July, drawn by one of those strange stirrings of instinct that govern the realm of nature, female Cub sharks converge

[2] T. C. Roughley, *Fish and Fisheries of Australia* (Sydney: Angus and Robertson, 1951).

in the tawny waters at the mouth of the Mississippi River and there bring forth their young.

Brackish waters, where the flow of the river mingles with the salt of the sea, are a favored nursery for the Cub shark. It roams shoal waters, loiters around wharves and docks, patrols passages between islands, and explores estuaries that empty into the sea. The fisherman of these parts who prefers the steady wharf to the rolling deck will catch a Cub shark more often than any other species of shark.

The Cub shark is believed to reach at least 10 feet in length and may weigh up to 400 pounds. A slow swimmer that rarely shows itself at the surface, it scavenges for most of its food, and will indiscriminately take practically any offal that is tossed into the sea. When such effortlessly obtained food is not available, however, the Cub shark will pursue prey, which it can dispatch with the efficiency that is a *Carcharhinid* hallmark. A Manta ray (*Mobula*) consumed by one captured Cub shark had been bitten into five precise pieces.

Attendants at the Miami Seaquarium on Key Biscayne, Florida, regard Cub sharks as extremely savage—more so than any other species on exhibition. One of the names it is known by in the Gulf of Mexico—Requiem shark—is evidence of the long-held suspicion that the Cub shark will attack men. The Cub shark's fresh-water form, the Lake Nicaragua shark (*Carcharhinus nicaraguensis*) is a notorious man-killer. In Florida waters, Cub sharks have been suspected in many reported attacks. They grow to 10 feet and about 400 pounds in weight, so there is no question of their being able to practice the habit of anthropophagy.

The Cub shark ranges the western Atlantic from southern Brazil to North Carolina and occasionally as far north as New York. It is abundant in the West Indies and the Gulf of Mexico, and it is one of the most numerous sharks in the waters off the Texas coast.

Carcharhinus is only one of the genera in this big family. Here are several other sharks which belong to other genera, but which are members of the family *Carcharhinidae.*

Lemon Shark
(*Negaprion brevirostris* Poey, 1868)

The Lemon shark stays close to shore and occasionally pokes into the mouths of rivers. Its favorite haunts are among the Florida Keys, on the southern and southwestern coasts of Florida, where it is one of the most common of the larger sharks, and up the west coast as far north as Tampa and Pensacola.

It is found, too, in the coastal waters of the western Atlantic, from northern Brazil to North Carolina, and, as a stray, in New Jersey. It is suspected—but not absolutely convicted—of attacks on bathers in Florida. It is known to grow to about 11 feet.

Lemon shark (*Negaprion brevirostris*).
Courtesy, American Museum of Natural History

Yellowish brown, dark brown, or bluish gray above, its sides are yellowish or greenish olive, shading to white, pale yellow, or grayish yellow below. It has a bluntly rounded snout. The Lemon resembles the Cub shark, but it can be distinguished from the Cub by its coloring and the fact that its dorsal fins are practically the same size. The Cub's second dorsal fin is less than one half as large as its first dorsal.

Great Blue Shark
(*Prionace glauca* Linnaeus, 1758)
(Also Known as Blue Whaler, Blue Shark)

The suspicion has been accumulating for centuries that this long, slim, blue shark should be indicted as a man-killer, but there is no positive record of a Great Blue's being caught in the act. Many a seaman, from the age of sail until the present, would attest to the Great Blue's man-eating habits, however. Certainly the Great Blue has the necessary equipment—sharp, saw-edged teeth, and the size—a length of 15 to 20 feet, at least. It has also frequently shown its rapacity before the eyes of men.

Here is an eyewitness description of Great Blue sharks swarming around captured whales during a whaling expedition:

> Whenever a whale was killed, the sharks would uncannily begin to congregate, like hyenas round a dead lion, assembling so rapidly that the sea would be fairly alive with them by the time the whale had been towed alongside the ship. The hungry troop would then file silently and slowly along the whale's length, fondly rubbing tail fins against his black bulk, and doubtless anticipating the feast of the "cutting in." During the execution of this process, when the water for an acre around the ship was stained a ghastly yellow from outpouring blood, the scrambling sharks would make the sea a living mass as each fish tried to bury its teeth into the exposed surfaces of dark red muscle. Now and then a shark would flounder right on top of the whale, and cling there until a descending blubber spade had put an end to its ambitions . . .

This description did not come from an excited landlubber or a whaler spinning a yarn. The authors of this 1916 report were two highly re-

Great Blue shark (*Prionace glauca*).
Courtesy, Harvard Museum of Comparative Zoology

spected marine scientists: Doctors John Treadwell Nichols and Robert Cushman Murphy.

The Great Blue is probably one of the unidentified villains of many sea stories about ravenous sharks. Sailors claim, for instance, that a Great Blue will appear astern of a ship when a man aboard dies, and will ghoulishly trail the ship until the body is committed to the sea. Nichols and Murphy told of a voyage aboard a whaler when a seaman died. Two or three Great Blues, about 7 feet long, and another species of shark, did appear at the vessel's stern that day. "The old, old maritime conviction that these hated brutes had come expressly for the body was breathed about the ship," the scientists reported. "But . . . the sharks paid no attention when the dead man was consigned to the waters, and they followed uninterruptedly in our wake for several days."

Though an oceanic shark, the Great Blue occasionally noses into shore in its ceaseless search for food. It is the most abundant large oceanic shark of the Atlantic. Nichols and Murphy told of seeing "hundreds—even thousands" in relatively small areas of the Atlantic. In an hour's run 4 to 10 miles off Block Island in 1943, 28 were counted, and 150 to 200 were seen from a single boat in one day.

Along the North American Pacific coast, it is found both on the high seas and in waters close to shore from British Columbia to the Gulf of California. When warm currents bathe California's bathing and skin-diving mecca of Monterey Bay, numerous Great Blues sweep in. They are easily spotted, for they often swim with both their dorsals and their tail fins exposed. Sometimes they even "bask" at the surface. They are easily identified by the big, sickle-shaped pectoral fins, as long as their heads, and by their striking, dark indigo-blue color, which shades to snow white on their undersides. Their sleek form, their long, graceful pectoral fins, and their coloring make them one of the most beautiful of sharks.

The Great Blues may be the most abundant of the pelagic sharks of the Pacific. On U.S. Fish and Wildlife Service tuna fishing explorations in the Pacific, as much as 46 per cent of the catch has been stolen or mutilated by sharks, especially Great Blues. The catch of one expedition included 6,000 sharks. Of these 2,500 were Great Blues, more than any of the other eight species caught. Not only were Great Blues the most abundant, they were also the most widely distributed sharks. On a map charting the domains of various species of sharks in the Pacific, the realm of the Great Blue appears as a huge shadow that stretches along the coast of North America and extends outward, beyond mid-Pacific.

They are common, too, off the west coast of Africa, and, in the warm months, off the south and west coasts of England, north to Scotland. British sports fishermen catch thousands of Great Blues every year off Looe, Cornwall. (The English don't call the Great Blue great; "Blue shark" is their British name.)

Practically all of the Blue sharks caught off Cornwall are gravid females that have migrated there to drop their pups. Just the opposite is true of the catch on the western side of the North Atlantic—these are almost invariably males. The separation of the sexes at calving time has been observed among many species of sharks, possibly because these species practice cannibalism.

The Great Blue includes exotic fare in its diet—flying fish and sea birds resting on the surface. But it is not too proud to scavenge offal from ships it sometimes follows for days or weeks.

Like most oceanic sharks, the Great Blue brings forth her young alive, and prolifically. A Great Blue less than 10 feet long can give birth to 50 young, each about 1 foot in length.

Tiger Shark
(*Galeocerdo cuvieri* Lesueur, 1822)
(Also Known as Leopard Shark)[3]

The Tiger shark is generally considered to be one of the most dangerous sharks a man can encounter. At least two Tigers caught off Florida had parts of human bodies in them. The men may or may not have been alive when the Tigers found them.

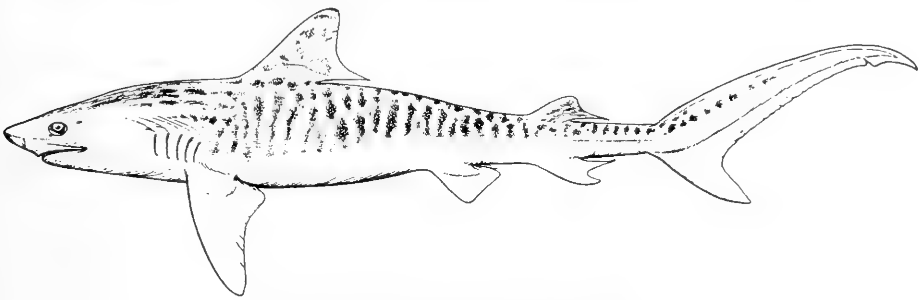
In the West Indies, the Tiger is feared as the most dangerous of the many types of sharks that prowl those waters. In Australia, many attacks on bathers have been blamed on Tigers. In India, the Tiger is accused of man-eating along both the eastern and the western coasts.

Cannibalism is so often practiced by voracious Tiger sharks that some observers of the Tiger's ruthlessness believe that smaller Tigers deliberately give wide berth to their bigger relatives. On a Tiger shark hunt in Philippine waters, a U.S. Fish and Wildlife Service vessel's crew

[3] The true Leopard is vastly different in size, shape, and species from the Tiger shark (*Galeocerdo cuvieri*). But, unfortunately, the Tiger is sometimes referred to as a "Leopard," in still another case of confusing Selachian name-calling.

saw a demonstration of the Tiger's cannibalism and rapacity. A large female Tiger shark ate a smaller one struggling on a hook. Then, still hungry, she immediately grabbed at a baited hook and was captured herself. Tigers caught on this cruise had in their bellies turtles, squid, crabs, sea birds, poisonous sea snakes, other sharks—and an unlucky black cat.

Tigers caught in the Gulf of Mexico off Texas had cormorants and small migratory birds in their stomachs. A 14-footer landed at Durban, South Africa, had inside it the head and forequarters of a crocodile, the



Tiger shark (*Galeocerdo cuvieri*).

Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

hind leg of a sheep, three seagulls, two (unopened) two-pound cans of green peas, and a cigarette tin.

The omnivorous Tiger bites with a rolling motion of its powerful jaws, so that its big, saw-edged teeth chop large prey into several pieces. In this way, a twelve-foot Tiger was able to devour another shark 10 feet long. A Tiger seen in Australia with a portion of a Thresher shark's tail protruding from its jaws was probably in the process of chopping the Thresher into bite-size pieces.

Many incredible items have been found in the stomachs of sharks of undetermined species. Though the items have been reported, the species of shark often has not been given. Knowing what identified Tiger sharks *have* eaten, however, it seems likely that Tigers were often the gluttons that gobbled down such morsels as these: dogs (often harness and all), boots, sacks of coal, a bag of potatoes (some of which had sprouted), beer bottles—and, in a single shark, three overcoats, a raincoat, and a driver's license. Also, a pair of old pants, a pair of shoes, a cow's hoof, the horns of a deer, twelve undigested lobsters, and a chicken coop with a few feathers and bones left inside!

The eating habits of certain sharks may astound ichthyologists, but at least one shark—a Mackerel—managed to baffle oceanographers, too. This one swallowed a drift bottle, released by the Fisheries Research Board of Canada through its biological station at St. Andrews, New

Brunswick. The bottle was one of many thrown in to get information on ocean currents. The shark that took to the indigestible bottle was landed by a fisherman about 150 miles off the western tip of Nova Scotia.

Australia's sharks have consumed what Whitley calls, with considerable understatement, "curious meals." Some of the meals he describes include a half-dozen hens and a rooster, apparently from a coop that had washed into the water; the brass casing of an 18-pound shell, and, in one shark: a full-grown spaniel with the collar on, a porpoise's skull, and the remains of sea birds.

The list of human remains found in sharks is long and grisly. In 1949, a young woman in western Australia was attacked by a shark which tore off her left arm above the elbow. Several days later, a large shark was caught near the scene of the attack. In it was found the woman's arm, with a ring still on one of its fingers. The ring was returned to her, and she resumed wearing it on her remaining hand.

Author-explorer Adrian Conan Doyle tells of seeing a shark in Zanzibar that had within it a bag of money and a human skull.[4] Usually, the identity of such victims is never determined, nor can it be learned whether they were consumed as corpses or as living men. But sometimes bathing suits, dental work, bits of clothing or fingerprints can lead to the discovery of who they were, at least, if not how they died.

The story is told in Pensacola, Florida, of a shark that was caught there many years ago. In it was found a man's leg, the foot of which still wore a new shoe. A fisherman had left port a few days before and never returned. Before he went to sea he had bought a new pair of shoes. The shoe on the leg in the shark was one of them. On this evidence, the leg—and the shoe—were buried as the only remains of the vanished fisherman.

There are at least two well-verified stories of sharks gulping down explosives. One dynamite dinner was reported by two Puerto Rican fishermen in a shark they caught shortly after several mysterious bombings in San Juan. A $500 reward had been posted for information leading to the capture of the bombers. The shark-catchers claimed the reward, but they didn't get it. What the shark had swallowed was an explosive charge used two months before in blasting operations around the entrance to San Juan harbor. Another explosive-fancying shark gulped a depth charge released by a U.S. Coast and Geodetic Survey ship which was making soundings in the Pacific. The charge, about the size of a coconut, was fixed to explode some seconds after it entered the water. Several seconds after it entered the shark, it went off, establishing for all time that there is at least one sure way to kill a shark.

[4] Adrian Conan Doyle, *Heaven Has Claws* (New York: Random House, 1953).

A 13-foot, 1,200-pound Tiger shark (*Galeocerdo cuvieri*) is examined by Honolulu businessman Bill Wills, who offered awards for shark catches in Hawaiian waters. This shark was caught in the waters off Nanakuli, Oahu, Hawaii.

Courtesy, Honolulu *Star-Bulletin*

Sharks also eat sharks. Dr. Russell J. Coles, describing sharks he caught off Cape Lookout, North Carolina, told of finding in one Tiger shark 11 chunks of shark meat, weighing 1 to 5 pounds each, and representing at least three shark species.

The Tiger, brilliantly striped when young, is born in beautiful birth robes. Norman Caldwell, an Australian naturalist, gave a vivid description[5] of the richly hued raiments of the embryos found in a Tiger nearly 12 feet long. "What drew our attention most," Caldwell reported, "were the babies. They were very much alive and struggling to work their way free of water-filled sacs that contained them. Those sacs had as many colors as Joseph's coat. As each baby shark came forth, long swaddling clothes of shot silk were wrapped around the small embryo. The colors were wonderful, being interwoven into the long streamers." Broods of 30 to 50 embryos are common, and 82 young were found in one 18-footer caught off Cuba.

The Tiger, known to reach 18 feet in length and reputed to grow to 30 feet, weighs 1,000 to 1,300 pounds at 13 to 14 feet. It is one of the commonest large sharks found in the tropics, particularly in the Caribbean and the Gulf of Mexico. It is also found along the Atlantic coast in the warm months. It often appears close to shore, and sometimes enters river mouths and enclosed sounds. Its appearances have been rare along the coast of southern California. Extremely large Tiger sharks—up to 30 feet—have been reported in the Indian Ocean.

The Tiger is usually a slow-moving shark, but, when alerted to a meal by its keen senses, it becomes a fast, determined swimmer. Its habit of prowling in shallow waters for food makes it a definite menace to bathers. It is found in all tropical, subtropical, and frequently in temperate seas.

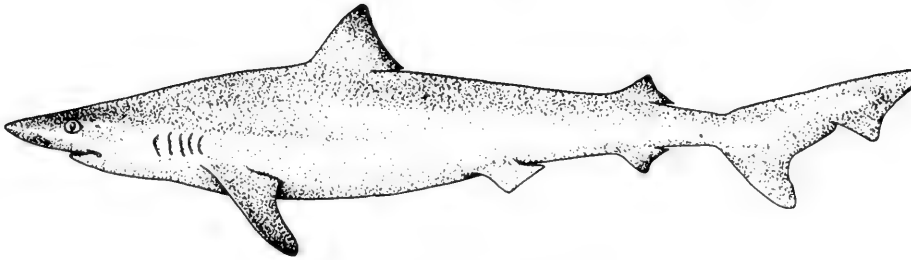
Young Tigers, up to 5 or 6 feet long, have dark brown spots or stripes on their sides. But these "Tiger" markings usually fade with growth, and the color of its body turns gray or grayish brown, lightening on the sides and belly.

Soupfin Shark

(*Galeorhinus zyopterus* Jordan and Gilbert, 1883)

Chinese shark fin soup connoisseurs in California prized the fins of this shark so highly that it became known as the Soupfin shark. During World War II, however, the discovery of high-potency vitamin A in the Soupfin's liver touched off a great demand for it, and gave it a new name: the Oil shark.

[5] Norman Caldwell, *Titans of the Barrier Reef* (Sydney: Angus & Robertson, 1938).



Soupfin shark (*Galeorhinus zyopterus*).
Courtesy, California Board of Marine Fisheries

For a time, fishermen made so much money from this shark's liver that they dubbed it "gray gold." If an accounting were to be made, however, it would undoubtedly show that, in the long run, the Soupfin has cost the fisherman more money than it has earned him. It seeks inshore waters from northern British Columbia and Alaska to central lower California, and wherever it goes it attacks netted fish or feeds upon fishes sought by fishermen—from sardines and anchovies to mackerel and salmon.

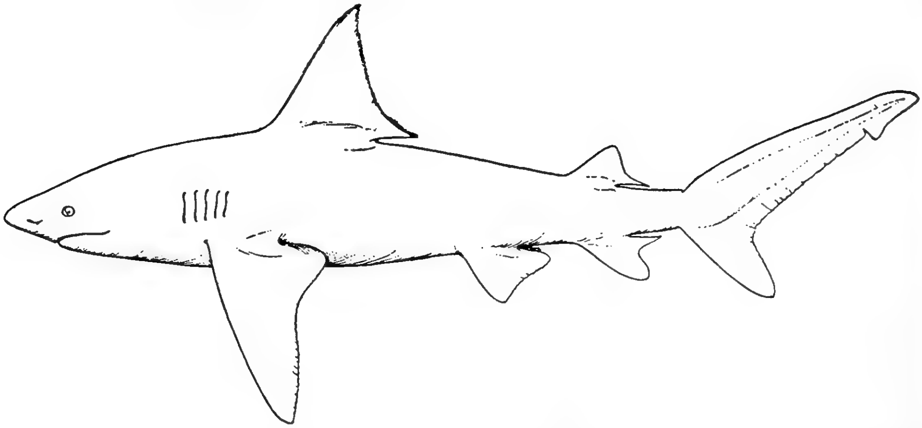
Males are seldom caught. A study of some 5,000 Soupfins caught off California showed that only 31 were males. Females are heavier and longer than males—6½ feet compared to 6 feet; 100 pounds compared to 60 pounds.

The same or a very similar species is known in England as the Tope, Penny dog, Toper, Miller's dog, or Rig. The School shark of Australia (*Galeorhinus australis* Macleay, 1881) is also very similar to the Soupfin.

THE LAKE AND RIVER SHARKS

A single known species of shark, the Lake Nicaragua shark (*Carcharhinus nicaraguensis* Gill and Bransford, 1877), has fully adapted itself to life in fresh water. This large shark, now believed identical with *C. leucas,* the Cub shark, known to reach 8 feet in length and reported to grow to at least 10 feet, lives in Lake Nicaragua, the great lake of that Central American country, whose only connection with the sea is the winding, rapids-filled, 130-mile San Juan River, which flows into the Caribbean on the eastern coast of Nicaragua.

The Cub shark (also known as Ground or Bull shark) is itself a roamer into fresh, or at least brackish, waters. It has also been found in the Miraflores Locks of the Panama Canal, where the waters of numerous lakes mingle with the waters of two oceans. It has been taken in Lake Yzabal, Guatemala, and has been reliably reported in the Atchafalaya River of Louisiana, 160 miles from the sea. Also, Cub sharks allegedly



The Lake Nicaragua shark (*Carcharhinus nicaraguensis*).
Courtesy, The Sears Foundation for Marine Research from *Fishes of the Western North Atlantic* by Henry B. Bigelow and William C. Schroeder, 1948

have been caught far inland in the roadside canals that lace south central Florida.

Sharks are not the only oceanic dwellers in the 100-mile-long Lake Nicaragua. Tarpon are found there, as are the shark's close relatives, the Sawfish, and the inevitable companions of sharks, remoras. Lake Nicaragua's sharks, known to scientists only since 1877, seem to be a particularly nasty breed. In the spring of 1944, a single shark attacked three persons near Granada, the lake's principal town. Two of the victims died. Natives say that at least one person a year is claimed by the sharks. Numerous dogs have been devoured by the sharks, which are locally renowned for their voracious appetites. They will readily seize meat or fresh-fish bait.

Between Lake Nicaragua and much smaller Lake Managua is an erratically flowing river, the Tipitapa. Waters of Lake Managua, which is about 15 feet higher than Lake Nicaragua, are believed to flow into Lake Nicaragua underground. But about once every decade or so, the normally dry riverbed of the Tipitapa is coursed by water from Lake Managua. Thus, at these times, the water connection between the two lakes is indisputable. Yet neither sharks, sawfish, nor tarpon have ever been reported in Lake Managua.

The two lakes, like much of the western portion of Nicaragua itself and the entire Central American isthmus, lie on a restless part of the earth's crust. A string of 23 volcanoes, many of them still active, runs down the western side of Nicaragua. One of the active peaks, Concepción, rises from the island of Ometepe in Lake Nicaragua. Another volcano in the long line of peaks, Coseguina, literally blew its top in 1835, exploding with a roar heard in Bogotá, 1,100 miles away, and spewing volcanic ash 150 miles out to sea. In 1931, a massive earthquake leveled Managua, the capital of Nicaragua. And 2,000 to 5,000 years ago, near Managua, a volcanic eruption left a memorial to its victims. Cast forever in hardened mud are the footprints of humans, a deer, a cat, and other animals that fled the eruption. The mud changed into stone, leaving the prints as stark as they were on the day they were made.

From evidence such as this, geologists have spun the theory that Lakes Nicaragua and Managua were once part of a huge bay of the Pacific, which was sealed off when the earth erupted long in the past. When the cataclysmic writhing of the earth ceased, the bay had vanished. In its place was a thick arm of earth with the Pacific on one side of it and two lakes on the other. Trapped within the lakes, according to this theory, were numerous sea fishes. As rivers flowing into the newly formed lakes gradually freshened them, some of the marine fish—the sharks, sawfish, and tarpon, at least—adapted themselves to fresh water and survived.

But why have sharks appeared only in Lake Nicaragua? The geologic theory does not answer this. Nor does it answer the claims of natives (never adequately investigated by ichthyologists) that *two* kinds of sharks live in Lake Nicaragua—reddish-bellied *tintoreros* and white-bellied *visitante* or *immigrante*. The natives around the lake insist that the *visitante* are smaller and livelier than the *tintoreros* because the *visitante* have had to enter the lake by making their way up the rapids of the San Juan River, the lake's link to the sea.

Despite the sandbars and the rapids that make the San Juan a difficult river to navigate, a shark could struggle up the river and into the lake. In fact, even today natives fear the shark of the river as much as they fear the shark of the lake. And the San Juan was long navigable, even to ships. Though virtually impassable to ships today, the San Juan in the nineteenth century formed part of a circuitous route, little known to readers today, to the gold fields of California. Gold-hunters from the East Coast of the United States, rushing to join the forty-niners, took ships in the States that deposited them at the mouth of the San Juan on the Caribbean coast. There they boarded riverboats operated by Commodore Cornelius Vanderbilt, journeyed up the San Juan to Lake Nicaragua, and crossed the lake. At the western side of the lake, they boarded stage coaches that carried them to the Pacific coast of Nicaragua, where they embarked for California. As recently as 1882, at least, a good-sized ship was able to navigate the San Juan. In that year, the steamer *Victoria* was built in Wilmington, Delaware, sailed down to the mouth of the San Juan, made its way up the river, and entered the lake.

If ships could do it, why not sharks?

But if the existence of sharks in Lake Nicaragua is explained by the river route, the mystery is still not fully solved, for there is no obvious explanation of what lured them into the lake.

Sharks have given birth when captured in the lake, but whether they breed there is not definitely known. Certainly they have been prolific. A woman who caught sharks for a living reported in 1953 a catch of 2,008 of them in 6 months. A fisherman at the same time told of catching nearly 7,000 in 8 months. Only two, he said, were *tintoreros.* These may sound like fish stories, but it is a matter of record that so abundant —and notorious—were the sharks of Lake Nicaragua that a bounty on them was posted by Granada authorities. In recent years, sharks have not been as plentiful in the lake. Perhaps the bounty-hunters are fishing them out. Or perhaps the rapids and the silt in the San Juan are inexorably forming a barrier to the lake.

The Lake Nicaragua shark is usually cited as the only shark that lives in fresh water. But sharks have been seen, with varying degrees of certitude, from the tranquil Derwent River in Tasmania to the busy Hudson River in New York. The farthest upriver appearance of a shark in the Hudson occurred in 1925, when a 700-pounder of unidentified species was washed up on the shore near Marlboro, New York, some 50 miles north of New York Bay. The shark apparently had been struck by a steamboat. In 1933, New York City police flashed a teletyped shark alarm to all precincts and to New York State communities along the Hudson as far north as Poughkeepsie. The alarm followed the sighting of at least one shark by several fishermen, off the West 42nd Street docks, exactly six blocks west of Times Square.

In the headwaters of the Amazon, near Iquitos, Peru—2,300 miles from the mouth of the great river—a shark of an unknown species has been caught. In landlocked Paraguay, sharks have been reported. In the rivers that flow through the sparsely explored or unmapped jungles of South and Central America, explorers have heard tales of sharks.

A little tropical Atlantic *Carcharhinid* shark, the Sharp-Nosed shark (*Scoliodon terrae-novae*), has been known to stray a couple of miles up the Pascagoula River in Mississippi, but it is normally found only in coastal waters, as is the Pacific coast Sharp-Nosed (*Scoliodon longurio*).

A close relative, *Scoliodon walbeehmi*, lives in the Indian Ocean. This shark's peregrinations into fresh water, however, are more venturesome than those of the Sharp-Nosed. In Thailand, as a matter of fact, it is best known as a lake fish. It feeds on the young turtles of the Lake of the Tale Sap, and is common in the Patalung River, which flows into the lake.

Sharks were once pursued up the Perak River in Malaya by an American physiologist who, oddly enough, was studying the human kidney. He reported that sharks, including known man-eaters, went as far as 200 miles up the river. He believed that the shark's ability to adapt to fresh water was somehow related to the presence of urinary constituents in its blood. In man, those constituents may occur as the result of a kidney disorder, and produce a toxic condition, uremia. Find how and why the river-traveling shark can endure uremia, the physiologist believed, and you will find a secret of man's body that man does not know. The shark-tracking physiologist did not prove his theory, nor did he discover why sharks go upriver. In fact, hardly anything is known about the factors which produce the disquieting appearance of sharks in fresh water, anywhere in the world.

The river shark theory offered along the Ganges River and its tributaries in India is a starkly simple one: sharks go up the river to get easily obtained food—men, although mostly cadavers. Pilgrims bathing in the sacred waters of the Ganges have been attacked by sharks during their devotions; sharks have struck down as many as 20 river bathers in a single year, killing half of them. So prevalent are the Ganges River sharks that they have been recognized as a species, *Carcharias gangeticus*. The great naturalist of India, Francis Day, said that this shark "seldom loses an opportunity of attacking the bather." Day also noted that the dead, cast into the rivers for burial in sanctified waters, were frequently devoured by sharks. In a two-month period in 1959, sharks killed 5 persons and mauled 30 others near the mouth of the Devi River of India.

The ferocious Ganges River shark resembles the familiar Sand shark (*Carcharias taurus*) of the Atlantic and the Mediterranean and the dread Gray Nurse (*Carcharias arenarius*) of Australia. Although the Ganges shark has been marauding in the rivers of India for centuries, little is known about it. Life is cheap in many of this shark's riparian haunts, and if a bather meets his death in the Ganges shark's jaws, that death will not be reported so extensively as would a death by shark in, say, Florida.

The Ganges shark (*Carcharias gangeticus*).

Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

How many rivers this shark ascends is not definitely known, but its range encompasses the Indian Ocean, and it has been reported in Japan. Any river that empties into the seas prowled by the Ganges shark could be a likely avenue for a lethal foray.

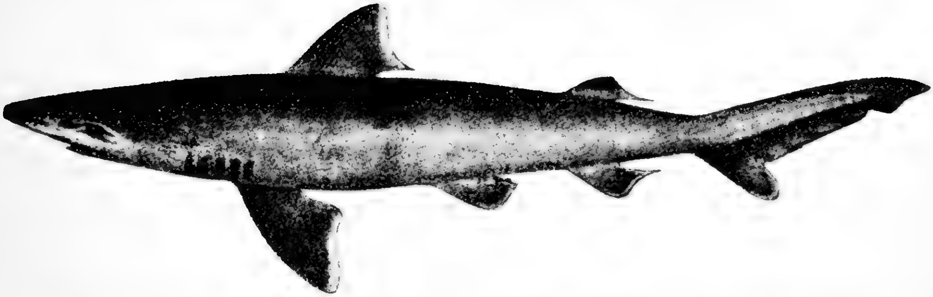
Another large shark whose predilection for rivers is recognized in its name is the River shark (*Carcharinus zambezensis*) of South Africa, which has been caught 120 miles up the Zambezi River. This shark, which grows to at least 8 feet, has an ugly reputation not only in the river that gives it its name, but also in many other rivers along the south and the east coasts of Africa. The 1961 Shark Research Panel Report includes mention of an attack 150 miles up the Limpopo (Crocodile) River in Mozambique. The African River shark does not live exclusively in fresh water. It is also found—and feared—in the seas along the coasts.

Sharks, sawfish, and rays have been found in several Australian rivers, but there is no evidence of sharks taking up permanent residence there as the Lake Nicaragua shark apparently has done. In New Guinea and Papua, sharks have been caught in several rivers and at least two lakes: Lake Sentani, New Guinea, 250 feet above sea level and linked to the sea by a 40-mile river which is practically unnavigable; and Lake Jamoer, New Guinea, about 200 feet above sea level. The Lake Jamoer sharks have been described as closely related to the Lake Nicaragua sharks, though little is known about the New Guinea species. Nor is it known definitely whether or not these sharks are as vicious as those of Lake Nicaragua.

But it is known that of sharks which have ventured up rivers elsewhere in the world, some have been killers . . .

Bored by the hot, oppressive dullness of an outpost of empire named Ahwaz, Iran, a British soldier with nothing more exciting to do decided to take his ambulance down to the river and wash it. He drove the ambulance into the Karun River, which flows through Ahwaz, and stopped near shore. He took off his shoes and socks and climbed down into the water, which was about a foot deep.

As he started to wash the ambulance, which was caked with the dirt of a town 90 miles from salt water, his right ankle was seized with a force that pulled him off balance. Thrashing in rapidly reddening fresh water not as deep as a bathtub, the soldier began fighting for his life against a shark. He lashed out with his fists, but the shark's hide tore his hands and arms, and he was bitten repeatedly. He kicked, but the shark hung onto his leg. Then, as suddenly as it had appeared, the shark disappeared, leaving the soldier lying in the absurdly shallow water. The soldier's right leg was hideously gouged. His right arm was torn open. His left hand and forearm looked as if they had been raked by a sharp fork.



Many sharks of this type, identified as *Carcharias menisorrah* (Mueller and Henle, 1841) are caught in the Persian Gulf. It is possibly the same species that enters the Ahvaz and Tigris Rivers, and penetrates as far as the city of Baghdad.

Courtesy, Einar Munksgaard from *Danish Scientific Investigations in Iran*, 1944

That British soldier, who survived, was one of 27 men, women, and children attacked in the Karun River near Ahwaz from 1941 to 1949, a period during which authentic records on shark attacks were kept by Allied military authorities. About half of the attacks were fatal, and most began as had the attack on the ambulance driver—a lunge at the ankles in very shallow water, close to shore.

The Karun River, like the storied Euphrates and Tigris, empties into the northern end of the Persian Gulf, which is more sheltered from the open sea than Long Island Sound. A truly pelagic shark would have to travel from the Arabian Sea, up the Gulf of Oman, into the Persian Gulf, then across the Persian Gulf and up the mouth of the Karun—just to begin its journey to Ahwaz! Yet the appearance of ferocious sharks in the Karun is far from extraordinary, and similarly savage sharks are found in both the Euphrates and the Tigris. In Baghdad, some 350 miles from the sea, sharks are so well known that they have entered into legends; the sharks come to Baghdad, it is said, to feast upon the city's melons. In Khorramshahr, below Ahwaz on the Karun, the story goes that the sharks linger under the date-palms to eat the dates falling from the trees!

They also attack people—and this is no legend. In a report on fishes of the Persian Gulf, H. Blegvad, a Danish marine biologist, said:

> Every year several people, especially children, fall victims to these sharks. I think the big sharks do not find the same abundance of food in the rivers as in the sea; this may explain that they are more voracious in the fresh water than in the sea, where the pearl divers do not fear the sharks.

Man-killing sharks are also known in Australian rivers.

On November 27th, 1921, Herbert Jack was wading out to his dinghy moored about 10 yards from a bank of the Bulimba Reach of the Brisbane River, in Brisbane. He carried his 8-year-old son, George, on his back. Just before they reached the boat, a shark grabbed Jack's right hip. He beat the shark off and turned for shore, but it attacked him again, slashing his arm as he tried to strike it. During the battle, George slipped from his father's back. When George disappeared, so did the shark, and the boy was never seen again.

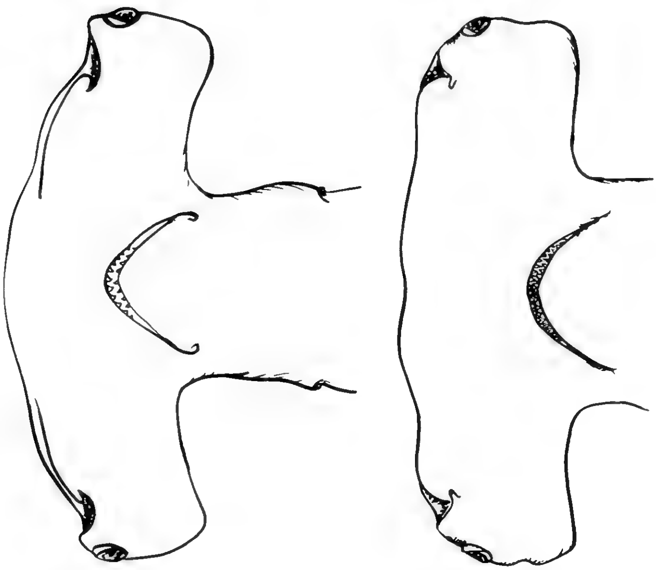
East Hills lies on George's River in New South Wales. It is a town 20 miles from the mouth of the river. One day, 15-year-old Wallace McCutcheon dived into the river to retrieve a tennis ball. As he was swimming back to shore, a shark struck at him. The shark did not follow through on its cursory thrust, and the boy reached shore. He and several other astounded persons along the river saw several other large sharks prowling about.

Not quite a year afterward, 19-year-old Richard Soden was racing several other boys across George's River, about 2 miles upriver from East Hills. Soden, a strong swimmer, was in the lead when he suddenly disappeared. The other swimmers saw a large dorsal fin. Soden bobbed to the surface. His companions towed him to shore. His left leg was horribly mutilated, and he was dead before he reached the river bank.

Soden was killed about 4:30 in the afternoon. At 8:15 that same night, 3 miles upriver from the fatal attack—thus some 25 miles from the sea—13-year-old Beryl Morrin and several other children were playing in 4 feet of water no more than 10 yards from the river bank. Beryl screamed and thrust her arms up out of the water. Both of her hands were gone. Swift application of tourniquets saved her life, but the lightning-like attack had so mutilated her arms that both had to be amputated, one below and the other above the elbow.

The vicious, river-raiding sharks of Australia, India, and the Middle East seem to be confined to tropical and subtropical zones. But, until more is learned about what lures sharks into fresh water, every tropical and temperate river mouth would seem to be a potential gateway for a Selachian visitor. In the summer of 1960, for example, so many sharks were reported in the Delaware River (U.S.A.) that state police patrolled river beaches, warning startled swimmers and water-skiers to get out of the water because of sharks. At least one shark, a 7-foot, 225-pounder of undetermined species, was caught off New Castle, Delaware—some 30 miles from the mouth of the river.

A Great White shark was reported near the mouth of the St. Croix River, the boundary between Maine and the Canadian province of New Brunswick, in 1953. The shark had not penetrated the St. Croix very far, but the report of a shark in a far northern river raises an interesting possibility. For, now that ocean ships can sail 2,347 miles into the interior of the United States and Canada—from the Gulf of St. Lawrence and up the St. Lawrence Seaway as far as Duluth, Minnesota—it is not im-



Underviews of Hammerhead sharks show the distinctive profiles of these unusual species. *Left* is the Common Hammerhead (*Sphyrna zygaena*), *right* is the Great Hammerhead (*Sphyrna tudes*). Courtesy, Scottie Allen

possible that some day a Great Lakes species will be added to the unending list of sharks.

Sharks are known to invade, if not permanently inhabit, numerous other fresh waters. They have been reported in Japan and the Philippine Islands, and, as exploration continues, may be expected to be found in more of the rivers of Africa, South and Central America, the East Indies, and northern Australia. A shark, similar to the Ganges shark, if not identical, goes at least 40 miles up the Rewa River on the island of Suva in the Fiji group. It will attack waders in shallow water and is much feared.

Most, but not all, of the fresh-water-invading or -inhabiting sharks are below 30° of latitude on either side of the Equator, with their prevalence increasing in the zones where there appears to be a narrow range in the seasonal water temperatures.

FAMILY *Sphyrnidae*—HAMMERHEAD SHARKS

The Hammerhead, with its flat head tipped on either lobe by seemingly malevolent eyes, looks like an omen of evil and, to a bather close enough to see the Hammerhead charging toward him, this shark may be a last, lethal apparition. Three Hammerheads were landed in one net at Riverhead, Long Island, one day in 1805. In the largest of them the body of a man and a tattered striped cotton shirt were found. Ever since that day, the Hammerhead has been named a potential killer.

Unlike many of the known dangerous species, however, the Hammerhead is disturbingly plentiful. There have been 30, even 40 embryos found in Hammerheads. Their breeding grounds are believed to exist in at least two areas popular with bathers—Hawaii and Long Island. In Australia, the Hawaiian Islands, Florida, California—wherever the Hammerhead's strange profile has loomed—it has been classified as extremely dangerous. Yet, considering its abundance and murderous notoriety, its known depredations upon bathers are surprisingly few. A Hammerhead killed a man in the Virgin Islands in 1963. Hammerhead attacks have been recorded also from Florida, Australia, and British Guiana.

Russell J. Coles, describing cannibal sharks he caught off Cape Lookout, North Carolina, told of a 13-foot, 10-inch female Hammerhead which had "just eaten four of her own species from my net, two of which had been swallowed whole, except the heads . . ." Despite their forbidding stingers, Sting rays are frequently eaten by their cousins, the sharks. Hammerhead sharks seem to find them delectable, and apparently have developed an immunity to the poison secreted in the ray's sting. One captured Hammerhead was particularly gluttonous. An almost perfect skeleton of a Sting ray was found in its stomach, and imbedded in its jaws were more than 50 stings.

The cosmopolitan range of the Hammerhead was recognized as far back as Oppian's time, for the ancient poet wrote:

The monstrous Balance-Fish,[6] *of hideous Shape*
Rounds jetting Lands, and doubles every Cape.

The prolific, ubiquitous Hammerhead appears in several distinct species, and each species has its own peculiarities.

Hammerhead
(*Sphyrna diplana* Springer, 1941)

The head, though generally mallet-shaped, is scalloped. The shark grows to at least 8 feet and is so common off the southeastern Florida coast that as many as 19 have been taken in a single day in the same area. It ranges the tropical and warm-temperate Atlantic, the Gulf of Mexico, and probably the Mediterranean.

Bonnet Shark
(*Sphyrna tiburo* Linnaeus, 1758)
(Also Known as Shovelhead, Shovel-Nosed Shark, Bonnet Nose)

Its head isn't hammer- or mallet-shaped, but shovel-shaped. Between the months of June and October it is one of the most abundant species

[6] It was called *balance-fish* because of the fancied resemblance of its head to a balance scale.

A Bonnet shark (*Sphyrna tiburo*).
Courtesy, Harvard Museum of Comparative Zoology

of shark found along the coast of South Carolina; 40 were once taken in one day with seines on Galveston Island, Texas. A relatively small shark, rarely growing more than 5 feet in length, the Bonnet usually loiters around shore and sometimes appears near wharves. It ranges from southern Brazil to the southern shores of North Carolina, and occasionally strays to New England. On the Pacific coast, the Bonnet cruises from southern California to Ecuador. It is also found in the Gulf of Mexico.

Great Hammerhead
(*Sphyrna tudes* Valenciennes, 1822)

This is the largest Hammerhead in the Atlantic and possibly the largest Hammerhead in the world. It is known to grow to 15 feet. It is found throughout the world, from the warm waters of the Atlantic to the Gulf of Mexico and the west coast of Central America; from Hawaii to Australia and Indo-China; along the shores of India and in the Gulf of Arabia. In India, it is sometimes called the Horned shark because the projecting lobes are looked upon as horns by natives who are more familiar with cattle, presumably, than with carpenter's tools.

Common Hammerhead
(*Sphyrna zygaena* Linnaeus, 1758)

A fast, lively shark, the Common Hammerhead has been seen chasing Sting rays, which appear to be one of its favorite meals. One of these Hammerheads once put up such a fight when hooked that it died of exhaustion. It eats other sharks, and is known to have attacked men and boats. In the summer, great schools of these Hammerheads migrate northward along the Atlantic seaboard. Many linger around Charleston, South Carolina. Others visit Maryland, New Jersey, and New York waters, sometimes entering New York harbor. Most of the sharks in these annual warm-weather migrations are small and were probably born shortly before the summer trek began. Dozens of little Hammerheads—each about 30 inches long—are found in nets along the outer shore of Long Island in August. Hammerheads are also in New York waters from July to October. They disappear suddenly when the water temperature falls below 67°F. Where they go after that is not known. Common Hammerheads, which occasionally grow to 13 feet in length, also roam the eastern Atlantic, from Portugal and occasionally the British Isles to South Africa. They are also found in the Gulf of Mexico, along both sides of the Pacific, and in the Indian Ocean.

Why do Hammerheads have hammerheads? One unproved theory is that they use their variously styled flat heads as steering planes, similar to the diving planes of the hulls of submarines. By moving their heads agilely they can quickly turn, dive, and ascend. The Hammerhead's head is also, in effect, a big flat nose, since grooves for scent detection run along its entire leading edge.

Family *Squalidae*—Spiny Dogfishes

The many species in this family have two features in common. Projecting before each dorsal fin is a quill-like spine. Further, none of these sharks has an anal fin. The most common species—indeed, one of the most abundant of all sharks—is the Spiny dogfish (*Squalus acanthias* Linnaeus, 1758), also known as the Piked dogfish, Skittle-dog, Thorndog, Codshark, and Spur dog.

Like a seething carpet flung by some nemesis of fishermen, gigantic schools of Spiny dogfish descend upon fishing grounds, where they devour or mutilate netted fish, eat both bait and captives on hand-lines, tear nets to shreds, and raid lobster pots. In some fishing grounds, Spiny dogfish bring fishing to a stop until, their ravenous hunger satisfied or all the fish that survive have fled, they move on in search of more prey.

Damage to gear and loss of fish cost our fishermen millions of dollars a year, since fishermen in the United States and Canada cannot sell the Spiny dogfish except for fertilizer and such oil as may be had from

A Spiny dogfish (*Squalus acanthias*).
Courtesy, Harvard Museum of Comparative Zoology

their livers. Since 1956, Canada has been trying to eradicate Spiny dogfish from British Columbia waters. About $140,000 a year is spent on bounty payments of 12 cents a pound for dogfish livers, which are delivered to oil plants where the liver oil is rendered in an attempt to get back some of the money allotted to the bounty program. These marauders are cursed by Pacific coast fishermen from Southern California to Alaska.

In 1938, a campaign was launched to reduce the Spiny dogfish population in Placentia Bay, near St. John's, Newfoundland. About 10,391,000 pounds of Spiny dogfish—some two to three million of them—were caught, but a government report on the dogfish drive said that the catching of these millions of dogfish did not result in "any apparent diminution of the supply."

When packs of these voracious sharks invade a fishing ground, virtually no other kind of fish can be caught. A long-line with 700 hooks strung along it was once set off Cape Breton, Nova Scotia. When the long line was hauled up, 690 hooks had Spiny dogfish on them. This abundant shark is probably the most prolific shark in the sea. Twenty-seven million Spiny dogfish were taken in one season off the coast of Massachusetts alone; 20,000 were once caught in a single haul off the Cornwall coast of England; Long Island fishermen used to measure their catch of Spiny dogfish in wagonloads. When their abundance is at its peak, an average trawler can take in 6,000 to 8,000 of them in a day. Years ago, dogfish were dried, stacked, and burned as fuel by Cape Codders, who found the dogfish far more plentiful than the local trees.

After gorging on the fisherman's hard-won catch and then tearing his valuable nets, the Spiny dogfish has a *coup de grâce* for the fisherman who carelessly reaches into the tattered net to grab the vandal. The Spiny dogfish's weapons are the dorsal spines or quills (remember the ichthyodorulites?) which the little shark brings into play by curling its body into a bow, exposing the length of the spines, and then lunging forward. The spine—which is slightly poisonous—can inflict a painful injury. Fishermen have been laid up for several days after being stabbed by a Spiny dogfish. The shark is amazingly accurate with its unusual weapon, which is used only in defense. If you put a finger lightly on its head, it will immediately bend into a bow and strike so skillfully that the spine of its back dorsal will prick your finger, but not even scratch its own skin. (Dr. H. Muir Evans, a British physician who has made a study of venomous apparatus of fishes, says ichthyodorulites he has examined are structurally similar to the poisonous spines still borne by several modern species of sharks and rays.)

The alternating dark and light rings on the second dorsal spine have been used to determine the age of Spiny dogfish. The rings result from periods of fast growth during the summer months (light rings) and periods of retarded growth during winter months (dark rings). It will come as no comfort to the fisherman to know that the counting of these rings has indicated that some Spiny dogfish may live to an age of about 30 years. (The Spiny dogfish is one of the very few sharks whose age can be even guessed at. A shark's age and life-span are two more of its many mysteries.)

David H. Graham, of New Zealand, tells of finding fully formed dogfish in a mother he caught. Graham placed them in a laboratory tank, where they lived for several months and grew to lengths of about 13 inches. But, he said, "They lost the skin and flesh from the tip of their noses through bumping into the ends of the aquarium tank, which no doubt contributed to their untimely end."

In the United States and Canada, the predaceous little sharks are hated by fishermen, and with reason, but they find a good market as food in many areas of Europe.

Robbed of his catch, his net ruined, and finally his hand bleeding and stinging, many a fisherman has wreaked a cruel vengeance upon his tormentor. The avenger breaks the dogfish's flat snout with a quick upward blow, then tosses the maimed shark back into the sea. Unable to dive because of its injury, the dogfish lurches along near the surface, doomed to starve or fall prey to a larger fish.

Spiny dogfish, which grow to 2 or 3 feet in length, apparently are born in wintering grounds far off shore. This species is ovoviviparous, and gestation lasts 18 to 22 months. While the four to six embryos in the average litter are developing, a new set of eggs is growing in the ovary to replace them.

When the temperature of the water along the United States Atlantic coast reaches about 43°F. in the spring, the Spiny dogfish begin to appear. By the time the temperature rises to about 59°F., they either move out to deeper, cooler water, or head northward, sometimes at a speed of 8 miles a day. Their meanderings seem to be bound by this relationship to temperature, for, as northern waters drop below 43°F., they head southward again, until finally, they head for the deep, offshore water where they winter. They are driven by temperature demands quite similar to those of the mackerel, which dogfish frequently massacre in fishermen's nets.

The Spiny dogfish is a scourge on our side of the Atlantic, heading from Caribbean to subarctic waters in search of prey. As mentioned, it lives off Europe also. It similarly ranges the Pacific, from San Diego to the Aleutian Islands on the west coast, outward to the Hawaiian Islands, beyond to Japan and northern China, southward to New Zealand, Australia.

The family *Squalidae* is represented in Australian and New Zealand waters by several species, including the peculiar Prickly dogfish (*Oxynotus bruniensis* Ogilby, 1893). Relatively rare, the Prickly dogfish is instantly identified by its odd shape—its first dorsal sweeps upward like a sail—and its extremely rough skin. It grows to about 2 feet. A common Australian dogfish, called the Piked dogfish or Skittle-dog (*Squalus megalops* Macleay, 1881), is often filleted and sold as a food fish. It usually grows to about 2 feet.

In the dark unknown of the deepest seas, many types of tiny sharks live like fabled dwarfs. We see hardly more than fleeting glances of many of them. Their lives in the nether world of the deep are cloaked in eternal shadow. Some of them bear that ghostly glow that marks many creatures of the abyss—luminescence. Others are as dark as the gloom that shrouds them. But all that have been seen have the classic, graceful lines of the typical shark.

Some of them are members of the family *Squalidae;* others are classified with the *Dalatiidae*, the Spineless dogfishes. *Squalidae* found in the depths include:

Squalus fernandinus Molina, 1782—This shark is so rare—and so small—that one of the few known specimens in the western Atlantic was fortuitously found in the stomach of an albatross caught off Argentina. The shark was not quite 14½ inches long. It is known to inhabit the polar regions and the cool-temperature latitudes of the southern hemisphere.

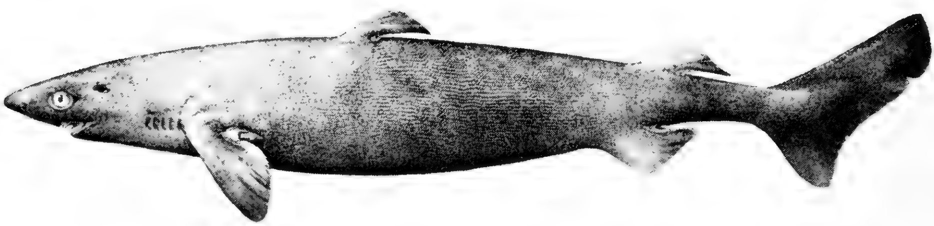
Etmopterus hillianus Poey, 1861—About 2½ inches long at birth, it is known to grow to about 12½ inches. It is found in the West Indies, and from southern Florida to the mouth of Chesapeake Bay. It is sometimes called the Black-Bellied dogfish. One female was caught bearing four young 3½ inches long.

E. hillianus may be luminous, as are some other *Etmopterus* sharks, including one known as the Lantern shark in South Africa because of its luminous belly, and another, known only in the northern parts of the Gulf of Mexico. The latter, *E. virens*, is a pretty little shark with a brown body striped with pale bluish gray and marked on the belly with bright green iridescence. *E. virens* is believed to grow to no more than about 11½ inches. In fact, a 9-inch female of this tiny species was found

A tiny shark (*Etmopterus hillianus*) measuring only 1 foot in length when full-grown
Courtesy, Harvard Museum of Comparative Zoology

bearing a 1¼-inch embryo that was nearly ready for birth! It is commonly known as the Green dogfish.

Another member of this family, the Portuguese shark (*Centroscymnus coelolepis* Bocage and Brito Capello, 1864), may be a record-holder among sharks of the deep. Marion Grey, of the Chicago Natural History Museum, an authority on deep-sea fishes, says the Portuguese shark "is apparently the deepest-living shark known." The deepest known record for the Portuguese shark is 2,718 meters (8,917 feet).[7] The Portuguese shark, which grows to about 3 feet, is found on both



The Portuguese shark (*Centroscymnus coelolepsis*).
Courtesy, Harvard Museum of Comparative Zoology

sides of the North Atlantic. It was once fished off Portugal. Another deep-water species, the Black dogfish[8] (*Centroscyllium fabricii* Reinhardt, 1825), is often found in the same waters frequented by the Portuguese shark. It grows to about 2½ feet.

Family *Dalatiidae*—Spineless Dogfishes

One of the smallest sharks ever recorded—a 6-incher—and one of the largest sharks—a 1 tonner—are found in this family, which includes about eight species. The *Dalatiidae* differ principally from the Spiny dogfishes on the basis of dorsal spines. *Dalatiidae* sharks do *not* have a spine in front of the second dorsal, nor, in most cases, in front of the first dorsal either.

Greenland Shark
(*Somniosus microcephalus* Bloch and Schneider, 1801)
(Also Known as Sleeper Shark, Gurry Shark)

Huge as it is—up to 24 feet long, more than 1 ton in weight—the Greenland shark is so ridiculously easy to catch that Eskimos are some-

[7] However, sharks (not identified) have been seen at much greater depths. They have been observed near the bottom on the deepest French and U.S. dives—Atlantic and Pacific.

[8] Neither the Black dogfish nor any of these tiny sharks is the so-called "Black shark" found in some home aquaria. The tropical fish fancier's "Black shark" sold as a rare fish and proudly displayed as a shark is a fresh-water teleost (*Morulius chrysophekadion* Bleeker, 1865) found in Java, Borneo, Sumatra, Cambodia, Indo-China, Laos, and Thailand. In Thailand, it is called the *pla ka,* or crow fish, in allusion to its black color. The only people who call it the "Black shark" are tropical fish buyers—or sellers.

times ashamed to admit that they fish for it. Greenland sharks have been hauled up from depths as great as 3,960 feet, and a solitary Eskimo in a tiny kayak will often do the pulling on a light hand-line.

Peter Freuchen, the famed arctic explorer, provided the authors with a first-hand description of the hunting of the Greenland shark. In Thule, he said, the bait the natives used was wood! He explained:

They had harpooned some sharks that came to the surface while people were cutting up walruses. In one of the sharks they found a piece of wood. From that they got the idea that sharks were crazy about wood, and on this they based

The Greenland shark (*Somniosus microcephalus*).
Courtesy, Harvard Museum of Comparative Zoology

their hunting methods. They tied some stones to a piece of wood so that it would sink. Then they lowered it down into the water, with long hunting lines, through a hole in the ice, and dragged it very, very slowly up again. The sharks followed the "bait" up and were harpooned at the surface.

In the Upernivik district, there were two other ways of catching sharks through the ice. One way was with "ice hooks"—big hooks fastened with a chain about three feet under the ice. The bait was blubber.

The other way, the one that was used the most, was to have hooks at the bottom of the sea. The hooks were very simple. People made them out of the usual hooks bought in the store. They were made in such a way as to prevent the sharks from spitting them out. The hooks were joined together by melting lead over the shaft. Attached to the hooks were about three feet of chain, at the end of which was an iron crosspiece. About ten feet of rope was attached to the hooks. Its thickness was not important; it was there because a shark would tear the regular line to pieces with its file-like skin . . .

Two—and occasionally three—sharks are sometimes caught on the same hook, according to Freuchen, because the first shark swallows the hook and, while hanging there helplessly, is eaten by another. "It happens time and time again that you get two sharks on the same hook because the second has just eaten so much of the first one he gets the hooks in him as well," Freuchen said.

"If you want to eat him," he added, "you must boil the meat three times—lest the poison in it get you. If a dog drinks the first water the shark meat was boiled in, the dog will die of poison."

Other Greenland fishermen say that the meat of the shark will make a dog drunk and sleepy. Why, no one knows. Also unknown is how the legendarily lethargic Greenland shark is able to capture fish by lying on the bottom waiting for them to swim by. Good-sized cod and salmon have been found in Greenland sharks, as have seals—and a reindeer (without horns).

Dr. Bjern Bjerland, of the Norwegian Directorate of Fisheries, may have an answer to part of this one. Tiny luminous crustaceans fix themselves in the Greenland shark's *eye*, and may act as lures for fish. This still leaves the reindeer unexplained.

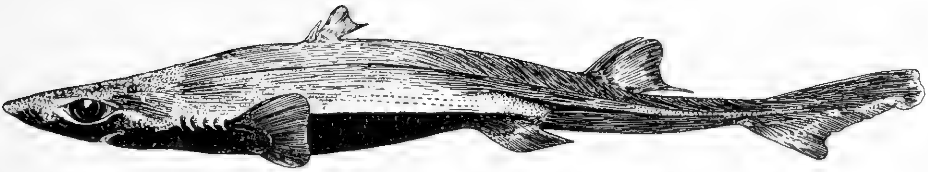
This sluggish shark, able to withstand the rigor of freezing water, is believed to be the only large shark found in arctic waters. A close relative (*Somniosus pacificus* Bigelow and Schroeder, 1944) is found in the north Pacific and the Bering Strait, and a third (*S. rostratus* Risso, 1826) is found in the Mediterranean. An 8-foot shark similar to the Greenland shark was found cast up on Macquarie Island, a few hundred miles from the Antarctic Circle. The body of this solitary shark, mentioned earlier, shows that southern polar seas are within the possible range of a species resembling the Greenland shark. The Macquarie Island shark (*Somniosus antarcticus* Whitley, 1939) remains today the only recorded antarctic species.

The Greenland shark itself can also survive in water at least as warm as 53°F. In the eighteenth century, when Atlantic Right whales were being killed off the Massachusetts coast, Greenland sharks flocked to the scene of the whale slaughters. When whaling stopped, so, apparently, did the unusual southern exposure of the Greenland shark.

Numerous large eggs—as many as one and a half barrels of them in a single female—have been discovered repeatedly in Greenland sharks. Though no laid eggs were ever dredged up, the assumption was that the shark laid eggs, possibly without egg cases, in the chill mud of arctic sea bottoms. The mystery was cleared up in 1954 when a fisherman caught, near the Faroë Islands, a 16-foot Greenland shark which carried ten young. The fisherman's find finally established, after decades of speculation, that the Greenland shark brings forth its young alive.

The Greenland shark has been fished for by Norwegians for centuries, not only in Greenland where as many as 30,000 are caught a year, and along the rim of the arctic, but also in Norway itself, for it enters the fjords, often destroying the gear of commercial fishermen who are after tusk and halibut. These sharks are sought primarily for their liver oil.

In its wanderings south of the Arctic Ocean, it dips into the White Sea of Russia, skirts the British Isles along the North Sea coast, and sometimes enters the English Channel (one was caught at the mouth of the River Seine). In the western Atlantic, it is found from Greenland to the Gulf of Maine. Its Pacific relative (known as the Sleeper shark)



A luminous shark, *Acanthidium molleri.*
Courtesy, Sydney and Melbourne Publishing Co. from *The Fishes of Australia* by G. P. Whitley, 1940

ranges from Alaska to, occasionally, southern California, and, on the Asiatic side of the Pacific, lumbers along from the Bering Sea to northern Japan.

The Luminous Shark
(*Isistius brasiliensis* Quoy and Gaimard, 1824)

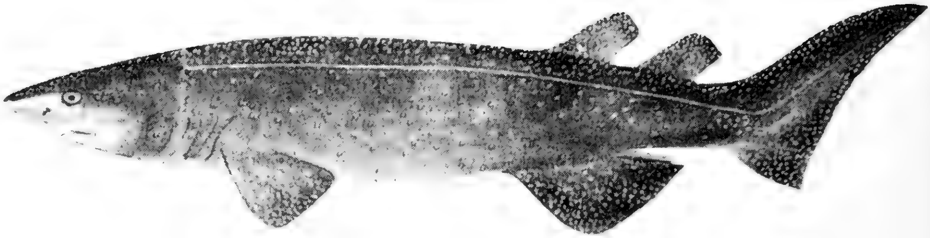
A small shark noted for its brilliant luminescence, the Luminous shark grows to about 18 inches and is found, usually far at sea, in the warm waters of the Pacific, the Atlantic, and the Indian Oceans. Despite their small size, they are as fierce as any pelagic shark. In an account of a nineteenth-century whaling voyage, F. D. Bennett wrote:

> They fought fiercely with their jaws and had torn the net in several places . . . When the larger specimen, taken at night, was removed into a dark apartment, it afforded a very extraordinary spectacle. The entire inferior surface of the body and head emitted a vivid and greenish phosphorescent gleam, imparting to the creature, by its own light, a truly ghastly and terrific appearance. The luminous effect was constant . . . When the shark expired (which was not until it had been out of the water more than three hours), the luminous appearance faded entirely from the abdomen, and more gradually from other parts, lingering the longest around the jaws and on the fins.

Even smaller than the Luminous shark is a rare species (*Euprotomicrus laticaudus* Smith and Radcliffe, 1912) which was discovered only in this century when a male and a female were hauled from a depth of 1,020 feet in Batangas Bay, Luzon, Philippine Islands. The male, slightly larger than the female, measured 6 inches and appeared to be fully developed. Their tiny, jet-black bodies and white fins were typical shark forms in miniature. *Acanthidium molleri* is still another luminous form, caught by Dr. Whitley at 130 fathom depths near Sydney, Australia. Its sides are luminous.

Family *Echinorhinidae*—Bramble Shark

Only one species (*Echinorhinus brucus* Bonnaterre, 1788) is known in this family. The hide of the Bramble shark (also known as the Spiny shark, Spinous shark, and Alligator shark) seems carpeted with brambles.



Bramble shark (*Echinorhinus brucus*).
From the author's collection

Actually, its prickly hide is covered with unusual denticles, each of which is topped with one or two small spines.

Its known appearances in American waters are extremely rare. A 62-inch, 100-pound shark, believed to be a Bramble shark, was caught off Santa Barbara, California, in 1939, and a 6-foot, 5-inch Bramble was caught in a gill-net off Los Angeles County in 1944. Two more were taken off San Diego in 1947. Only two western Atlantic records of it exist: in December, 1878, a 7-footer was washed ashore at Provincetown, Massachusetts, and in 1898, a Bramble shark nearly 10 feet long was caught near Buenos Aires.

The Bramble shark is far more common in the eastern Atlantic, from tropical West Africa to Ireland and the North Sea, and in the Mediterranean. It has also been reported off South Africa, around the Hawaiian Islands, Japan, Australia, and New Zealand, and in Arabian waters.

Family *Heterodontidae*—Horn Sharks

A Horn shark (*Heterodontus japonicus*).
Courtesy, American Museum of Natural History

This last family in the long shark line is linked with an ancient form that swam in Jurassic seas. There is something oddly prehistoric about the appearance of these bullheaded sharks that bear, before each dorsal fin, a stout spine that resembles a horn; and indeed they are a most archaic group anatomically.

The Port Jackson shark (*Heterodontus portjacksoni* Meyer, 1793) of Australian waters belongs to this family, as does the Pacific Horned shark (*Heterodontus francisci* Girard, 1854), found from Morro Bay to Cape San Lucas, Lower California, and into the Gulf of California. Some eight other species are found in the eastern Pacific, and off East Africa and the East Indies. Horn sharks are not known in the Atlantic or the Mediterranean. The Port Jackson shark is also called the Bullhead and the Oyster Crusher (it lives on mollusks and crustaceans) in Australia. In California, it is sometimes called the Pig shark because of its porcine head. Horn sharks grow to about 4 feet.

Horn sharks lay egg cases that are equipped with spiral flanges, giving them a screw-like appearance. The egg cases, measuring about 4 by 2 inches, are sometimes eaten by female Horn sharks. And, to complete the cannibalism, Horn sharks are sometimes eaten by Tiger sharks (*Galeocerdo cuvieri*).

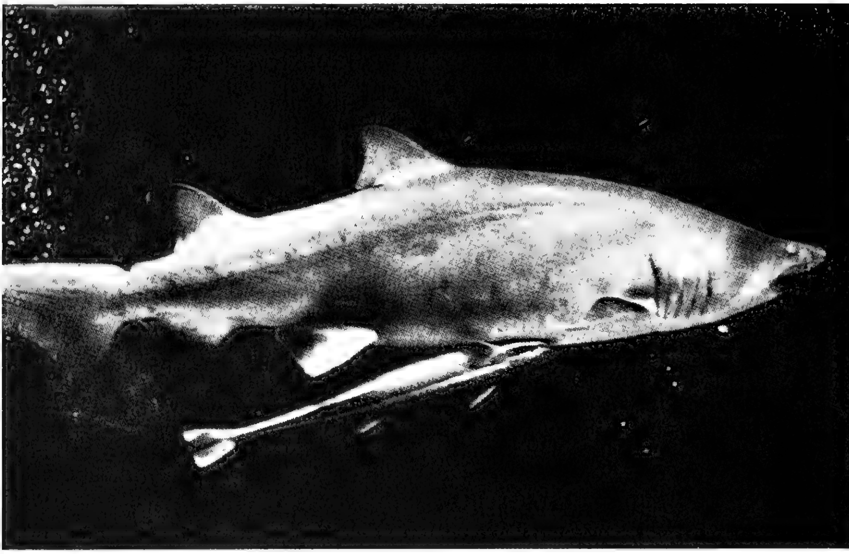
THE COMPANIONS OF THE SHARK

Two bony fish—the remora and the pilot fish—are closely associated with many species of Selachians. Though these fish are not related to any Selachians, and are true Teleosts, they are included here because they are often found with Selachians.

The big shark is often the host of a colony of followers, some of them freeloaders at the shark's meals. These vagabonds—remoras and pilot fish—are apparently never molested by the shark, and they do not seem to do anything for the shark, to earn their immunity.

Instead, they eat the crumbs that drop when the shark, a coarse feeder, dines. The coexistence of the shark and its smaller companions is called *commensalism*—literally, eating from the same table.

The Remora (Family *Echeneidae*), or Sucker Fish, is a fish of ancient legend. The Greeks called it the "ship-holder," and its present-day name comes from a Latin word meaning "a delay." The historian Pliny said that the Emperor Caligula was fatally delayed on his voyage to Antium by remoras, which held his ship despite 400 oarsmen's efforts to free it. Mark Antony's defeat at Actium was blamed on remoras that kept his ship fast when Antony ordered it into battle. We also have it on the word of Ben Jonson that a remora can "stay a ship that's under sail."



A Remora attached to a Sand shark.
Courtesy, New York Zoological Society

The remora's reputation as a ship-holder is based on its ability to stick, particularly to sharks. It attaches itself by a kind of suction cup. Its first dorsal fin has modified to form an oval plate on the top of its head. The surface of the plate is ridged, like the sole of a boot. When the remora decides to attach itself to a shark, it merely swims upward so that the disk comes in contact with the shark's belly or side. Then, by muscular action, it raises the ridges and rim of the disk, creating a partial vacuum.

When the shark feeds, the remora detaches itself by relaxing its disk muscles, and swims off for the crumbs. Then, its meal finished, it re-attaches itself to the shark and awaits its next meal. It can latch on while the shark is moving by the use of tiny barbs on the disk. The barbs act as hooks while the remora gets in position to use its suction mechanism. Four or five remoras may attach themselves to a single big shark. Remoras are not true parasites; they do not suck blood or injure the shark, though they are erroneously referred to as sucker fish. Some sharks, however, are infested with hordes of real parasites, ranging in size from the microscopic to the hideous Isopod crustaceans that inhabit the shark's gills, mouth and skin, and are so big that *they* have parasites. One type of shark parasite is so large, in fact, that Australian aborigines call it "the shark's wife." Some remoras may aid their hosts by feeding on these parasites.

There are several species of remoras. One (*Echeneis naucrates*), which grows to about 3 feet, is usually found on sharks in warm seas. Another (*Remora remora*) reaches a length of 1½ feet. A third (*Remora brachyptera*), which grows to about 1 foot in length, has been found attached to swordfish. It also reportedly frequents the mouths and the gill cavities of larger sharks. Remoras have also been found attached to Manta rays, sunfish, sea turtles, whales, and even ships. Remoras do not freeload all the time. Hauled by a shark into a school of small fish, a remora sometimes will detach itself and go off hunting on its own. But it hurries back.

Christopher Columbus reported seeing natives in the New World using a strange fish that was tethered on a line and sent out to attach itself to a sea turtle, which was then hauled in on the tether. The natives were using a remora to fish with. In some parts of Australia and

Remoras are used for hunting by native fishermen from Australia to Central America. Natives in Zanzibar attach a leash to a coupling on the tail (as shown in the illustration). The Remora then seeks out a large host-fish and, when it firmly attaches itself, the fisherman pulls in the leash—with the Remora and the big fish it is stuck to.
After Holmwood

China, in Zanzibar and Mozambique, the technique is still used by native fishermen. In Madagascar, native sorcerers place dried pieces of the remora's disk about the neck of an unfaithful wife so that she will return to her poor husband—and stick to him.

The Pilot fish (*Naucrates ductor*), the zebra-striped little companion of the shark, has no family relationship to the remora *or* the shark, and gets its name from its habit of darting ahead of a shark as it approaches prey. This habit led to stories about how the tiny pilot leads the great shark around, as a seeing-eye dog leads a blind man.

The shark needs no pilot to guide it, but the Pilot fish certainly uses, if not needs, the shark. Like the remora, the Pilot fish feeds on the scraps from the shark's table. But it is not equipped to attach itself to the shark. Instead, several Pilot fish swim in front of the shark, often within inches of its jaws, appearing to ride a minute pressure wave set up by the big fish, or else maintain an almost constant position near the shark's pectoral fins.

When a shark is caught, the Pilot fish skitter off, if they have time to escape, and immediately seek another shark. But, the association of Pilot fish and shark is a curiously intimate one. A sober scientist noted that, though Pilot fish occasionally may dart away from their shark to get morsels of food, they "hurry back again like children afraid of losing their nurse." When a shark has been hooked and is being hauled out of the water, its Pilot fish excitedly swim around its ascending body almost as if they are fretting about the loss of their big, bountiful, protective companion.

We have herein collected numerous reports of species of sharks, skates and rays from all over the world. To catalogue all such reports is far beyond the scope of this book. No one knows how many species exist, and no one has any real certainty as to the number of species that may inhabit or visit the coastal and offshore waters of any continent.

The accompanying tables give a capsule description of the most common sharks, skates, rays, and "links" found in U.S. waters. The tables were prepared by J. R. Thompson and Stewart Springer of the U.S. Fish and Wildlife Service. In their own introduction to these tables,[9] they aptly explain the difficulty of keeping track of the innumerable species of sharks that inhabit the oceans of the world. They remark:

> Obstacles to the study of cartilaginous fishes are many. Most of these fishes are pelagic, and many of them inhabit the open waters of the high seas where large ocean-going vessels are needed for their study. Many species are confined to relatively great depths where collection is difficult and expensive. Even those species that inhabit shallower, coastal waters require special collecting and handling techniques. They are difficult to keep in captivity, and their collection and study as living animals is quite expensive . . .

[9] In *Sharks, Skates, Rays, and Chimaeras,* Fish and Wildlife Circular 119, U.S. Government Printing Office, Washington, 1961.

This Great Hammerhead (*Sphyrna tudes*) with her 22 pups was captured in the Gulf of Campeche by the trawler *Silver Bay* while under charter to the Bureau of Commercial Fisheries, U.S. Department of the Interior.

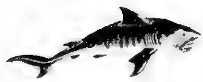
Photo by Joaquim Rivers, U.S. Bureau of Commercial Fisheries

MAXIMUM SIZES OF COMMON SPECIES OF SHARKS

SPECIES		Maximum Length (Measured—U.S. Coasts)	Maximum Length (Recorded—World)	Traditional Maximum Size from Literature
Common Name	*Scientific Name*			
Six-Gill shark	*Hexanchus* sp.	15 ft., 5 in.	—	26 ft., 5 in.
Sand shark	*Carcharias taurus*	10 ft., 5 in.	12 ft., 3 in.	15 ft., 11 in.
Porbeagle	*Lamna nasus*	10 ft.	12 ft.	12 ft.
Salmon shark	*Lamna ditropis*	8 ft., 6 in.	8 ft., 6 in.	12 ft.
Mako	*Isurus oxyrinchus*	10 ft., 6 in.	12 ft.	12 to 13 ft.
White shark	*Carcharodon carcharias*	18 ft., 2 in.	21 ft.	36 ft., 6 in.
Basking shark	*Cetorhinus maximus*	32 ft., 2 in.	45 ft.	40 to 50 ft.
Thresher shark	*Alopias vulpinus*	18 ft.	18 ft.	20 ft.
Nurse shark	*Ginglymostoma cirratum*	9 ft., 3 in.	—	14 ft.
Whale shark	*Rhincodon typus*	38 ft.	45 ft.	45 to 50 ft.
Chain dogfish	*Scyliorhinus retifer*	1 ft., 5 in.	—	2 ft., 6 in.
Leopard shark	*Triakis semifasciata*	5 ft.	—	5 ft.
Smooth dogfish	*Mustelus canis*	4 ft., 9 in.	—	5 ft.
Tiger shark	*Galeocerdo cuvieri*	13 ft., 10 in.	18 ft.	30 ft.
Soupfin shark	*Galeorhinus zyopterus*	6 ft., 5 in.	6 ft., 5 in.	6 ft., 5 in.
Blue shark	*Prionace glauca*	11 ft.	12 ft., 7 in.	25 ft.
Bull shark	*Carcharhinus leucas*	9 ft., 10 in.	—	10 ft.
Whitetip shark	*Pterolamiops longimanus*	11 ft., 6 in.	—	12 ft.
Sandbar shark	*Eulamia milberti*	7 ft., 8 in.	—	8 ft.
Dusky shark	*Eulamia obscurus*	11 ft., 11 in.	—	15 ft.
Bonnethead	*Sphyrna tiburo*	3 ft., 7 in.	—	6 ft.
Great hammerhead	*Sphyrna mokarran*	18 ft., 4 in.	—	15 ft.
Spiny dogfish	*Squalus acanthias*	5 ft., 3 in.	—	5 ft.
Green dogfish	*Etmopterus virens*	0 ft., 11 in.	—	—
Midwater dogfish	*Squaliolus* sp.	0 ft., 7 in.	—	—
Greenland shark	*Somniosus microcephalus*	16 ft., 6 in.	21 ft.	24 ft.
Sawshark	*Pristiophorus schroederi*	2 ft., 10 in.	—	—
Angel shark	*Squatina dumeril*	4 ft., 5 in.	—	—

MAXIMUM LENGTH AND WIDTHS OF COMMON SPECIES OF SAWFISHES, GUITARFISHES, SKATES, RAYS, AND CHIMAERAS

SPECIES		*Maximum Length*	*Maximum Width*
Common Name	*Scientific Name*		
Smalltooth sawfish	*Pristis pectinatus*	18 ft.	—
Largetooth sawfish	*Pristis perotteti*	22 ft.	—
Atlantic guitarfish	*Rhinobatos lentiginosus*	3 ft.	—
Shovelnose guitarfish	*Rhinobatos productus*	4 ft.	—
Lesser electric ray	*Narcine brasiliensis*	1 ft., 6 in.	—
Atlantic torpedo	*Torpedo nobiliana*	5 ft., 11 in.	—
Big skate	*Raja binoculata*	6 to 8 ft.	6 ft.
Barndoor skate	*Raja laevis*	—	5 ft.
Little skate	*Raja erinacea*	1 ft., 9 in.	1 ft.
Roughtail stingray	*Dasyatis centroura*	—	7 ft.
Diamond stingray	*Dasyatis dipterurus*	6 ft.	—
Atlantic stingray	*Dasyatis sabina*	2 ft., 9 in.	1 ft., 4 in.
Gulf dwarfskate	*Breviraja sinus-mexicanus*	1 ft., 2 in.	0 ft., 7 in.
Spiny butterfly ray	*Gymnura altavela*	4 ft., 8 in.	6 ft., 10 in.
Smooth butterfly ray	*Gymnura micrura*	—	3 ft., 6 in.
Spotted eagle ray	*Aetobatus narinari*	—	7 ft., 7 in.
Bat stingray	*Myliobatis californicus*	—	4 ft.
Atlantic manta	*Manta birostris*	17 ft.	22 ft.
Chimaera	*Hydrolagus affinus*	4 ft., 1 in.	—
Ratfish	*Hydrolagus colliei*	3 ft., 2 in.	—



Appendix: Selachian Cookery

Dr. Samuel Johnson's *Dictionary of the English Language* defined oats as "a cereal eaten by people in Scotland and by horses elsewhere." Shark might be defined as a fish eaten by millions of people from England to Japan but wastefully thrown away by many American fishermen.

The American angler who catches a shark may bring it home, if only to impress the neighbors with his catch. Rarely does his catch reach the dinner table, as a bluefish or a halibut would. Many species of sharks—and most skates and rays, too—are delicious if the fisherman (or his wife) knows how to prepare them.

The paramount rule of shark cookery is: **do not delay.** If the shark can be served fresh, *serve it right away*. If the shark is to be salted, *salt it right away*.

One way to prepare shark meat for food is to cut fillets of the light portion of the meat about 9 by ½ inches thick and wash them thoroughly in salt water. Then either place the fillets on ice or in a refrigerator for about 24 hours to remove the "sharky" smell and taste. Next, soak them in a clean brine for two hours. They can now be cooked the way you would cook any kind of fillet.

Dr. Eugenie Clark, the well-known ichthyologist, in a letter to the authors states:

> As for preparing shark meat, I have eaten it raw and cooked almost every way: steamed, boiled, broiled, breaded and deep-fried, etc. Once I served "shark fingers" to a group of guests. I also prepared snook "fingers" and put the shark fingers on one half of the serving platter and snook fingers on the other half. I told the guests I was serving them snook fingers and "fingers" from another kind of fish. I asked them if they could tell the difference. Some of the guests couldn't tell the difference, and others thought the shark fingers were better than those made from snook.
>
> Young sharks or embryo sharks make the best eating. The large sharks are stringy but can be made into a fine fish paste the way the Japanese prepare *kamaboko*. Since working with sharks closely and getting to know them as individuals, I'm starting to think of them more in terms of pets and do not eat shark meat as often as I used to.

Dr. Clark said that she made no special efforts to rid the shark meat of any odor, for she found that "the slight odor of fresh shark meat disappeared shortly after cooking began and there was not a trace of 'sharky odor' by the time the meat was thoroughly cooked."

Sand sharks and almost all kinds of small sharks are edible. Hammerheads, very large sharks, and the dark meat of any shark should not be eaten.

Although the recipes that follow were prepared specifically for shark, the shark chef can use any recipe applicable to large fishes, whether fresh, salted, or smoked.

Salted, smoked, or kippered, shark is delicious. It may also be salted and dried, flaked or shredded. In some parts of the meat, the layers of connective tissue are quite close together. These parts may be run through a meat chopper and used for fish balls.

Shark Chowder

2 pounds shark
½ pound salt pork
2 small onions
1 quart sliced raw potatoes
Few sprigs of parsley
1 quart milk
Salt, pepper to taste

Wash the shark thoroughly, cover with cold water, and boil until tender. Flake the fish or cut it into small pieces. Save the water. Cut the salt pork into small pieces and fry until crisp, then remove the pork scraps. In the fat fry the sliced onions, then add the potatoes and a little parsley and cook until done, adding a little water if necessary. When the potatoes are soft, add the hot milk and the flaked fish, salt and pepper, and heat through. Split Boston crackers or pieces of pilot bread may be placed in the chowder, or served with it.

Shark Marseillaise

2 large onions
2 pounds shark
2 tablespoons olive oil
4 tomatoes
1 clove garlic
1 pinch saffron
Salt, pepper to taste
½ glass water or fish stock

Chop the onions fine and fry in the olive oil. Add the tomatoes cut into small pieces, the garlic, saffron, salt and pepper, and the water or fish stock. Place the fish, cut as usual, in the mixture, and allow to boil fast for 15 to 20 minutes. Keep the kettle covered tightly. Remove the fish and place on some slices of French bread which have been browned in the oven. Boil the liquid down a few minutes so that it will not be watery, correct the seasoning, and pour over the fish.

Shark Patties

1 cup ground shark	1 tablespoon butter
2 cups potato or cornmeal mush	1 egg
⅛ teaspoon pepper	

Wash the fish and shred fine in cold water. Wash, pare, and cut potatoes into pieces of uniform size. Cook fish and potatoes in boiling water for 20 minutes, or until potatoes are soft. Drain, add the butter and the pepper, and mash fine with a fork. As soon as cool, add the egg, well beaten, and salt if necessary. Shape into patties by tablespoonfuls, leaving the outside rough, and fry in deep fat.

Fried Shark, New England Style

2 pounds shark	Few sprigs parsley
½ cup fine cornmeal	1 lemon
½ pound fat salt pork	Salt, pepper to taste

Cut the fish as usual, season well with salt and pepper, and roll in the cornmeal. Fry the fat salt pork in a shallow frying pan, and when crisp remove and keep hot. Place the fish in the pan and fry to a nice brown on both sides. Serve on a hot platter, with the salt pork over it, and garnish with parsley and slices of lemon.

Fried Fillets of Shark Orly

2 pounds shark	Few sprigs parsley
½ cup flour	1 lemon
2 eggs	Tomato sauce
Bread crumbs	

Cut the fish into fillets, season well, and roll in flour; dip in beaten eggs and roll in bread crumbs. Fry in deep fat to a nice brown color. Drain and serve garnished with parsley and slices of lemon, with a sauce boat of tomato sauce on the side.

Shark Sauté Meunière

2 pounds shark	2 lemons
½ cup flour	Few sprigs parsley
2 ounces butter	Salt, pepper to taste

Cut the fish into slices ½ inch thick, season well with salt and pepper, roll in flour, and fry in butter. Remove from the pan and place on a hot platter, squeeze the juice of 1 lemon over it, add a little more butter in the pan, and when it stops foaming and is a light brown color, pour over the fish. Sprinkle with chopped parsley and serve very hot with quartered lemon.

The following recipes call for **smoked shark:**

Shark Cutlets

1¾ cups flaked smoked shark
½ tablespoon chopped onion
2 tablespoons finely chopped red peppers
3 tablespoons butter
⅓ cup flour
¾ tablespoon salt
¼ tablespoon paprika
1 cup milk
Sprigs parsley
Egg–bread crumb mixture

Wash the smoked shark and boil for 20 minutes. Flake it. Cook the onion and the red peppers with butter for 5 minutes, stirring constantly. Add the flour, mixed with salt and paprika, and stir until blended. Add the milk gradually, bring to the boiling point, add the flaked shark, and spread on a platter to cool. Shape, dip in egg and crumbs, and fry in deep fat, then drain on brown paper. Arrange on a serving dish, garnish with sprigs of parsley, and serve with Epicurean Sauce.*

[*Epicurean Sauce]

1 tablespoon tarragon vinegar
2 tablespoons grated horseradish
1 teaspoon mustard
½ teaspoon salt
Few grains cayenne
1 cup whipped cream
3 tablespoons mayonnaise

Mix together the vinegar, horseradish, mustard, salt, and cayenne; add the whipped cream and the mayonnaise dressing. Beat thoroughly.

Shark à la Newburg

1 pound smoked shark
¼ cup butter, melted
Dash of pepper
Few gratings of nutmeg
2 tablespoons lemon juice
⅔ cup thin cream
2 egg yolks

Soak the fish in warm water for ½ hour, then slowly bring to a boil and boil for 1 minute. Drain and add to the melted butter and cook for 3 minutes. Add the seasonings, lemon juice with cream and yolks stirred into it, and cook until thickened, stirring constantly.

Baked Smoked Shark

2 pounds smoked shark
2 cups milk
1 tablespoon flour
1½ tablespoons butter
⅛ teaspoon pepper

Wash the smoked shark and soak overnight in cold water. Place in a shallow baking pan, and pour the milk over it. Bake for 20 minutes in a moderate oven, stirring into the milk, at the end of 15 minutes, the flour, butter and pepper. When thoroughly done, place the fish on a platter and pour the sauce of choice around it.

Shark Salad

2 cups smoked shark
2 cups cooked potatoes
1 tablespoon onion
1 cup celery
2 tablespoons green pepper
2 cups mayonnaise
Salt, pepper to taste

Wash the smoked shark and boil until tender. Shred when cold, and add to the potatoes, which have been diced. Then put in the minced onion, celery, and green pepper. Mix thoroughly and add the mayonnaise, stirring slightly. (The addition of 3 hard-boiled eggs gives an even more nutritious and palatable salad.)

In Tahiti, pieces of shark cut in cubes are eaten raw as are other white fishes without adding anything but lime juice to taste.

The following recipes call for **salt shark:**

Salt Shark Chowder

½ pint picked salt shark
1 pint raw potatoes
1 large white onion
Salt and cayenne pepper to taste
1 pint milk
Few tablespoons rich cream

Pare and thinly slice the potatoes and the onion. Place the fish, potatoes, onion, and 1 cracker, crushed fine, in a hot buttered baking dish. Add the seasoning, cover with hot water, and boil gently for 20 minutes. Add the hot milk and cream and let boil up. Serve with crackers or toasted bread.

Salt Shark au Gratin

1 pound shark
1 tablespoon butter
1 tablespoon flour
1 cup boiling water
2 tablespoons grated cheese
Bread crumbs

Boil the fish gently for 2 hours, putting it over the fire in tepid water; let cool and mince fine. Make a drawn-butter sauce by cooking together 1 tablespoon each of butter and flour and stirring them into a cup of boiling water until the sauce is thick and smooth. Stir the fish into this, add pepper to taste, and mix with the cheese. Turn into a baking dish, sprinkle with crumbs, bits of butter, and a little more grated cheese, and brown in the oven.

Salt Shark en Casserole

1 cup shark	1 cup milk
1 tablespoon butter	Bread crumbs
1 tablespoon flour	

Pick into small pieces 1 cup shark, which has been soaked overnight. Melt the butter, add the flour, and gradually pour in the milk, which has been heated. Cook until of a creamy consistency and add the fish. Spread crumbed bread on the bottom of the casserole, dot with little pieces of butter, add a dash of pepper and possibly a little salt, and pour in the creamed fish while hot. Cover with bread crumbs, dot with butter, and bake in a hot oven until brown.

The "wings," or fleshy pectorals, of skates and rays are popular fish dishes in Europe. The skate is particularly prized. Some French gourmets say that if the "wings" are allowed to stand for a couple of days, they improve in flavor.

Raie au Beurre Noir (Rayfish in Black Butter)

Recipe served everywhere in maritime France (and on the French Line).[1] Cut the ray into portions and cook it in ⅛ liter of vinegar and 2 liters of water, salt, slices of carrots and onions, thyme, bay leaf, a little garlic, some black pepper in seeds, parsley and celery. Once cooked, take off the black skin. Then sprinkle with a little vinegar, some capers, parsley and chopped chervil and pour over black butter at time of serving.

The ray could be served "Provençale," too, or boiled with caper sauce.

Fried Skate (or Ray)

3½ pounds skate or ray wing	Flour seasoned with salt
Vinegar court bouillon[2]	Pepper
Nutmeg	4 tablespoons butter

Strain off the bouillon. Cut skate or ray into serving pieces. Simmer the fish in 1 quart of court bouillon for 15 minutes. Dry thoroughly and roll the pieces in the seasoned flour. Fry them in hot butter until brown. Be careful when turning as they may fall apart.

[1] Also, for over 20 years at a French restaurant on West 49th Street in New York, on one day a week.

[2] If vinegar court bouillon is not made up, simmer a mixture of 1 cup vinegar, 2 quarts cold water, 1 tablespoon salt, 2 small sliced carrots, 1 large sliced onion, 2 bay leaves, 2 cloves, 1 dozen peppercorns, and 1 teaspoon thyme for 30 minutes.

Boiled Skate Parisienne

3½ to 4 pounds skate (or ray) wings
⅔ cup vinegar
2 cups cold water
1 tablespoon salt
2 small carrots, sliced thin
1 cup caper sauce*
2 medium-sized onions, sliced thin
½ teaspoon pepper
2 cloves
2 bay leaves

Place all the ingredients except the fish in a pot and bring to a boil and simmer 30 minutes. Strain the liquid and simmer the fish in it for 20 to 30 minutes or until quite tender. Remove the skin and serve at once with caper sauce.

[*Caper Sauce]

3 tablespoons butter
1½ tablespoons flour
⅔ cup hot water
½ teaspoon lemon juice
½ cup washed and drained capers

Melt half the butter and blend with the flour. Gradually stir in the hot water. Boil for 5 minutes and stir in the lemon juice and the rest of the butter, followed by the capers.

Dutch Ray Sauce

H. Koster, deputy director of the great Dutch fish market at Ijmuiden, passes along this old Dutch fishermen's recipe for a sauce to be used with ray:

4 small teacups water
1 small teacup vinegar
3 tablespoons flour
Milk to taste
Pepper to taste
1 egg

Dress flour with part of the water until it is smooth and has no lumps. Put this into heated water just before it boils. Let it boil for a few moments. Add vinegar and milk to taste. Take sauce from the fire and whisk yolk of egg through it. When serving, add pepper to taste.

The Shark Fin Dish

"To the Chinese, cooking is entirely an art," writes F. T. Cheng in his *Musings of a Chinese Gourmet*. Dr. Cheng, former Chinese Ambassador to the Court of St. James's, is one of Free China's most distinguished men. A former judge of the Permanent Court of International Justice, he is a Fellow of University College, London, and a member of the Permanent Court of Arbitration and the Panel for Inquiry and Conciliation of the United Nations. Diplomat, jurist, philosopher and scholar, he writes:

"Chinese cooks derive their knowledge more from experience than from books, and trust to the hand, the eye, the nose, the tongue and often to the ear as well, rather than depend on the scale or the watch."

Their food, he points out, may seem exotic to the Western palate. But the food is also immensely rich, both in nutrition and taste. Of shark fin, he notes, 100 grams contain 384 calories and high percentages of proteins, calcium, and phosphorus. "Well prepared, it is not only most delicious to the palate, but also most wholesome to the system."

He judges the shark fin of the Philippines, the "Manila Yellow," the best for preparation of The Shark Fin Dish. His instructions for its preparation:

1. Soak the fin in cold water for 3 days to soften it.

2. Simmer for 4 to 5 hours until its skin comes off and the fin (the inner cartilage) can be removed. The water must be changed every 15 minutes during the first hour, and every 30 minutes during the following hours.

3. Gently clean the fin so that nothing remains except the translucent cartilage crescent itself.

4. When it is absolutely clean, place it, intact, on a net made of fine silver wire so that it will not loosen and fall apart during subsequent stages of preparation. (Dr. Cheng points out that a rack or net of bamboo is sometimes used. But this is inferior, for an infinitesimal trace of a bamboo taste may be imparted to the fin.)

5. Simmer the fin again for three-quarters of an hour with 2 slices of green ginger, a few pieces of spring onion, and 1 glass of wine, preferably sherry. Change the water twice.

6. Put the fin in a double boiler with ¼ pound of ham and pork and the meat of 1 fresh chicken. Add 1 glass of wine, preferably sherry, and 2 cups of water. Cook over a medium fire until the fin is tender—about 3 hours. (If the fin is overdone, it will melt.)

7. Remove the fin carefully and place it in a pan. Discard the juice it was cooked in. Pour over it a previously prepared bouillon consisting of a cut-up fresh chicken and 3 ounces of cut-up lean ham, all cooked without water in a double boiler. Cook this combination of fin and concentrated bouillon for about 10 minutes. Add a teaspoon of soya sauce. Serve hot. (The last stage should be so timed that The Shark Fin Dish can be served immediately.)

Dr. Cheng calls this dish *Hung Shau*. Few amateur chefs would attempt it. Shark Fin Soup is a challenge even in its simplest form. For the less adventurous cook who does not want to cope with the cleaning of a shark fin, the cartilaginous fibers are available in gourmet specialty houses in packaged form. Using this pre-cleaned, packaged shark fin (it looks like anemic spaghetti), here is a simplified Shark Fin Soup recipe provided the authors by Y. K. Kealoha of the Ke-Aloha Hawaii House in Miami:

Simplified Shark Fin Soup

6 ounces dried shark fin
¾ pound lean pork
Pork bones
2½ pound chicken (fryer)
2 tablespoons cornstarch

Rinse the shark fin and soak for 4 hours in 8 cups of warm water. Pour off the water, rinse again and drain. Place in a pot, add 6 cups of warm water, bring to a boil, and simmer for 1 hour. Pour off the water and repeat the process. Drain. Bring the pork, pork bones, and 8 cups of water to a boil and simmer for 15 minutes. Add the chicken and simmer for 30 minutes. Remove the chicken, pork, and pork bones. Remove the breast meat of chicken and shred. Add the shark fin to the stock and simmer for 1 hour. Add the shredded breast meat (and, if desired, some finely shredded Virginia ham), salt, and a mixture of 2 tablespoons cornstarch and 2 tablespoons water. Simmer for 5 minutes. Serves 6.

Here is another recipe from the Home Economics Department of the Honolulu Gas Company. It adds a Pacific flavor to the soup:

Shark Fin Soup (Hawaii Style)

½ pound shark fin
½ chicken
½ pound lean pork
4 dried scallops
¼ cup lean ham (diced)
16 cups water
2 egg whites
¼ teaspoon gourmet powder
Salt to taste

Soak and clean the shark fin as usual. Parboil and rinse in cold water. Repeat 3 times. Drain. Boil the chicken, pork and dried scallops in water over a low flame for 1 hour. Take out the chicken and the pork. Discard the scallops. Add the shark fin and boil for 1 hour. Shred the chicken meat and the pork and add with the ham to the shark fin. Beat egg whites and stir into the soup. Add salt and gourmet powder. (A small amount of cornstarch and minced green onion may be added.) Serve very hot.

Shark Fin Soup Supreme

Madame Grace Chu is a product of Old China. She left China when the Communist régime took power, and lives today in New York City, where she teaches advanced classes in Chinese cookery. In her advanced classes, however, she only *speaks* of The Shark Fin Dish. It is, to her, a work of art that amateur chefs can no more attempt than amateur painters can attempt the Mona Lisa.

First, then, *Shark Fin Soup.* It began, in Old China, with the acquisition of the finest fins. They came from Calcutta, and they were costly—so costly that they had no price. An agent for the host procured them, as a jeweler would procure, with painstaking care, a rare gem. The finest fins were those sold as a set from one shark, and only these fins—the tall first dorsal, the sleek pectorals, the lower lobe of the tail—would do. Within these fins is the ambrosia which is the essence of the soup: delicate, translucent cartilage.

Today, a cook may buy the cartilage alone, packaged in plastic instead of a fin. But in preparing true Shark Fin Soup, one starts with the fins themselves. Even before they reach the rare market that sells them, the fins have undergone days of preparation. The fins are sliced off when the shark is skinned. Every bit of meat is trimmed off to prevent rotting. After the fins are trimmed, they are washed and usually left overnight in sea water. Then they are spread on chicken wire racks set up 2 or 3 feet above ground. During the first few days of the drying period, the fins must be taken in during the night to protect them from the evening dampness. They must also be sheltered from rain, which would spoil them. It takes about 14 days, in good weather with plenty of sunshine, for the fins to dry properly.

The dried fins are sold by retailers with the gelatin intact, and the price makes shark fins one of the most expensive delicacies on earth.

Today, in New York City, the cost of preparing four servings of Shark Fin Soup is about $15. In a fine Chinese restaurant, the management must be notified several days in advance if one is planning to order Shark Fin Soup. The price varies, in a somewhat inscrutable way, depending on the size of the table and, it almost seems, the character of the diners. There is still a ritualistic aura around Shark Fin Soup, even in the New World. A price of $10 a serving is not unusual.

To be prepared exquisitely, Shark Fin Soup takes at least 4 days. The fin is daintily bathed for 2 days and 2 nights in water of a critical temperature. What that temperature is can better be gauged by the eye and the hand of a chef than by a thermometer. The water must be warm enough to cleanse the fin of sand and bits of flesh, yet it cannot be so warm that it melts the gelatinous cartilage within.

Even after 2 days and 2 nights of gentle bathing, the fin emits a terrible smell. To remove the smell, the fin is wrapped with raw chicken and pork chops in a cheesecloth bag and steamed for about 4 hours. The chicken and the pork chops are thrown away, and the fin is steamed again with new chicken and pork chops.

Now it is ready. A broth of chicken stock has been prepared in advance. The cartilage is removed from the fin and shredded into the chicken stock. The shark fin admittedly has virtually no taste. Its role in the soup is to impart a faint, new essence, which is only a shadow of a taste.

The Shark Fin Dish is a highly refined version of Shark Fin Soup. It begins with a crucial decision by a rare chef. He must select a fin, the finest among the finest, whose cartilage will not break up during the long and cautious cleansing process. This extraordinary fin is cleansed and purified with the chicken and the pork chops. Then, at the fin's moment of profound purpose, the cartilage is removed from it, intact. If the chef has selected well and prepared it perfectly, the cartilage looks like a shimmering, golden-yellow fan. This fan is gently placed in a broth of chicken stock, where it is cooked for about ½ hour. It is at this critical stage in the creation of The Shark Fin Dish that a chef can be driven mad. For, if he cooks the delicate cartilage too harshly, it will melt and disappear before his eyes.

After this courageous cooking, the fan-like cartilage is placed on a silver platter. Around it, arranged as skillfully as the setting of a precious stone, are mushrooms, chestnuts, snow peas and other foods, chosen more for their color and texture than their taste. A delicate soya sauce is sometimes added to the shark fin, again more for a touch of color than for flavor.

"It is beautiful to behold," says Madame Chu. And in those words is the true essence of The Shark Fin Dish, for it is a food not merely to be eaten, but to be contemplated as a work of art: a part of a great shark caught at great peril, bought at great price, cleansed with great care, cooked with great skill, and presented to a guest with great homage.

Japanese fishermen probably haul in for sale more sharks than any other fishermen in the world. The authors are grateful to Professor Mamoru Oshiba of Himeji University of Technology in Japan, for his efforts in gathering the information that follows.

Through Professor Oshiba's efforts, we have obtained from Professor Wataru Shimizu of the Department of Fishery at Kyoto University a thorough description of shark cookery in Japan. Professor Shimizu says that the flesh of a big shark is not relished in Japan because of its taste and offensive odor. But the smaller sharks—most of them dog-fish—are eaten in various ways.

The body of a *Hoshizame* (*Mustelus manazo*)[3] is chopped up, fresh, and boiled in water. It is eaten with a vinegar-and-bean paste. The

[3] Scientific names are given as they are used in Japan, where scientific nomenclature does not fully agree with Western classification.

Hoshizame is also sometimes salted and dried and then cooked the same way. Another of the 90-odd species of shark known in Japanese waters, *Nezumizame* (*Vulpecula marina*), a Thresher shark, is boiled and sometimes roasted. It is particularly relished around Tokyo. Shark ovaries are used to make *atsuyaki*, a kind of fish-paste. They are also used to make a special kind of cake. The ovaries are also used as substitutes for eggs.

The flesh of the *Aburazame* (*Squalus sucklii*) is the principal ingredient of *chikuwa*, a fish-cake product that looks like a sausage with a hole through it. *Chikuwa* is a popular Japanese fish product. About 150,000 tons—worth some $41 million—is produced a year.

But it is *kamaboko* that gets most of Japan's sharks. According to Masabumi Yoshioka, treasurer of the Kanetetsu Company in Kobe, and Akiyoshi Okada, the factory manager, their factory alone produces 12,000 tons of *kamaboko* a year.

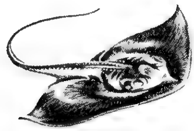
Like the shark itself, which figures in Japanese legends back to the dimmest remembered time, *kamaboko* has a long history. A short time before the feudal age in Japan, people began roasting crushed fish flesh on bamboo skewers. Because its shape resembled the top of a cattail, it was called *kamaboko*, or "cattail head." At the end of the feudal age, just before the Meiji Restoration in the nineteenth century, *kamaboko* began to appear in shops throughout Japan, and its popularity has been increasing ever since. About 420,000 tons of *kamaboko* are now produced in Japan each year.

Kamaboko is made by crushing the flesh of fish. Then it is mixed with cornstarch, potato starch, salt, saccharin, dulcin, and vitamin additives. After it is shaped into a round or rectangular form of about the thickness of a pancake, it is steamed or roasted.

Shark is not the only kind of fish used in making *kamaboko*. Sea eels, croakers, and flatheads are among the fish used. But two types of *kamaboko*—called *ampei* (shaped like a flat box) and *haben* (shaped like a flat ball)—use shark exclusively. In a somewhat frank description, Mr. Yoshioka and Mr. Okada say these pure-shark *kamaboko* are "as elastic as crude rubber." The *Yoshikirizame* shark (*Prionace glauca*) is one of the sharks used most frequently in making *kamaboko*.

According to Professor Kenichi Kagawa of the Himeji University of Technology, shark fishing in Japan has been on a constant rise, from 152,869 tons in 1950 to 346,444 tons in 1957. But, perhaps because of the constant fishing, fishermen report that sharks are becoming less numerous in Japanese waters. Kazuhiko Suzuki of the Japanese Department of Fishery says that, with the development of oceanic fishing for sharks, methods will be perfected to keep sharks fresh during long fishing trips. He also points out that some parts of the shark which were formerly thrown away are now being used and have been found to be very valuable. For this reason, he predicts a continual increase in Japanese shark consumption.

Curiously, Japanese palates are not so attracted to shark fin as are Chinese palates. Centuries ago, the Shoguns who ruled Japan established an office in Nagasaki to handle the business of *fuka-hire*—shark fins. But at that time *fuka-hire* was primarily exported to China for shark fin gourmets, and even today in Japan *fuka-hire* is known as a "Chinese meal."



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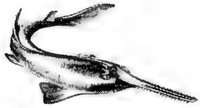

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is a newspaperman of distinction. Formerly with the *Bridgeport Herald*, of Bridgeport, Connecticut, he was also on the Sunday staff of the *New York Daily News*. His keen reporter's eye and flair for descriptive writing have made an immense contribution to the many and strange items of information encompassed in this volume. He lives in Bethesda, Maryland, and is on the staff of *The National Geographic* magazine. Mr. Allen is also the author of *The Quest: A Report on Extraterrestrial Life*, published by Chilton.

CAPTAIN WILLIAM EDWARD YOUNG

was the doyen of living shark fishermen. (He passed away just as this book was going to press.) He hunted sharks, rays and skates in almost every ocean of the world for over sixty years. His immense knowledge, all first-hand, was the central edifice of *Shadows in the Sea*.

End leaf photo: Winslow Homer's "The Gulf Stream,"
The Metropolitan Museum of Art, Wolfe Fund, 1906

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