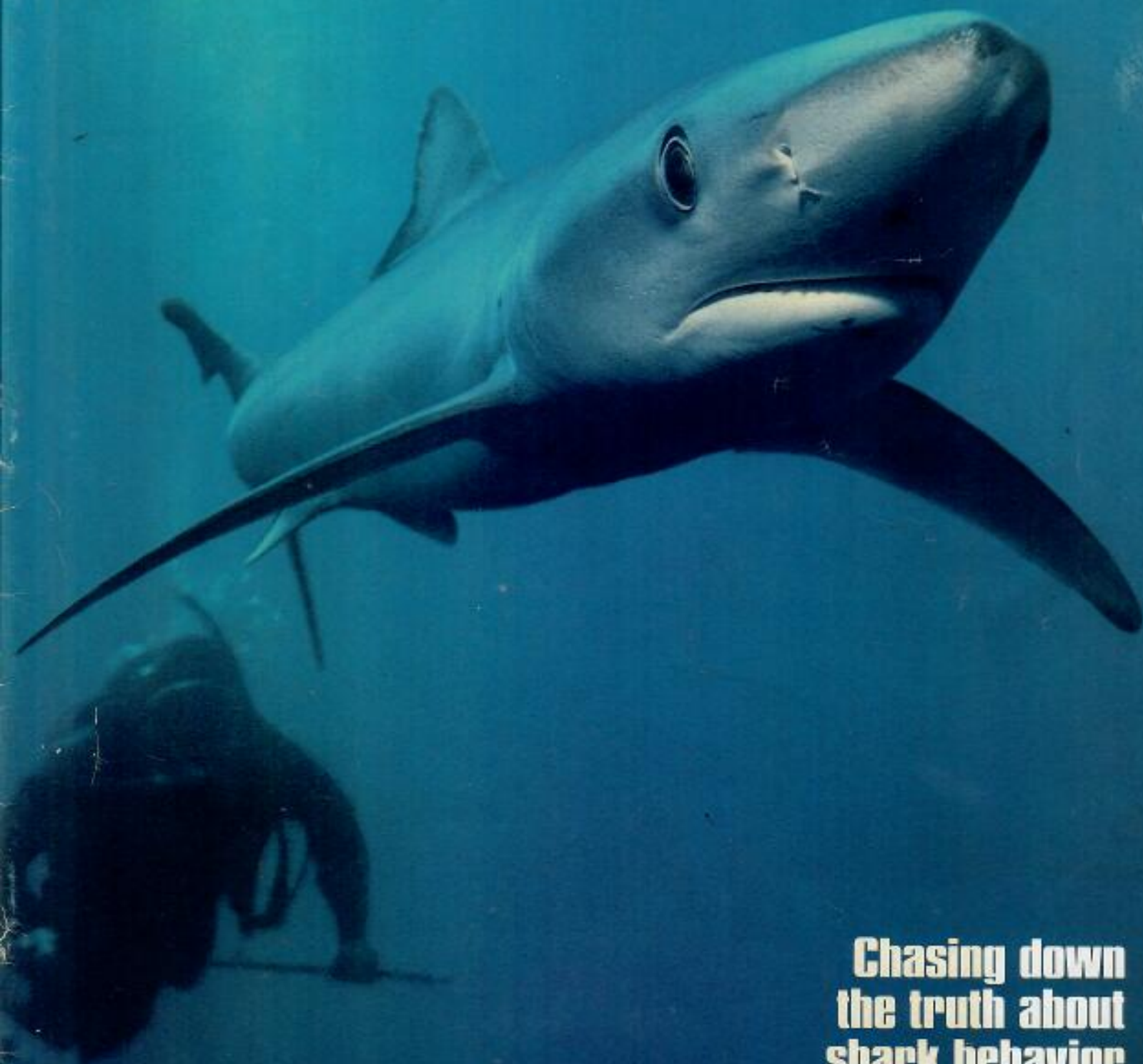


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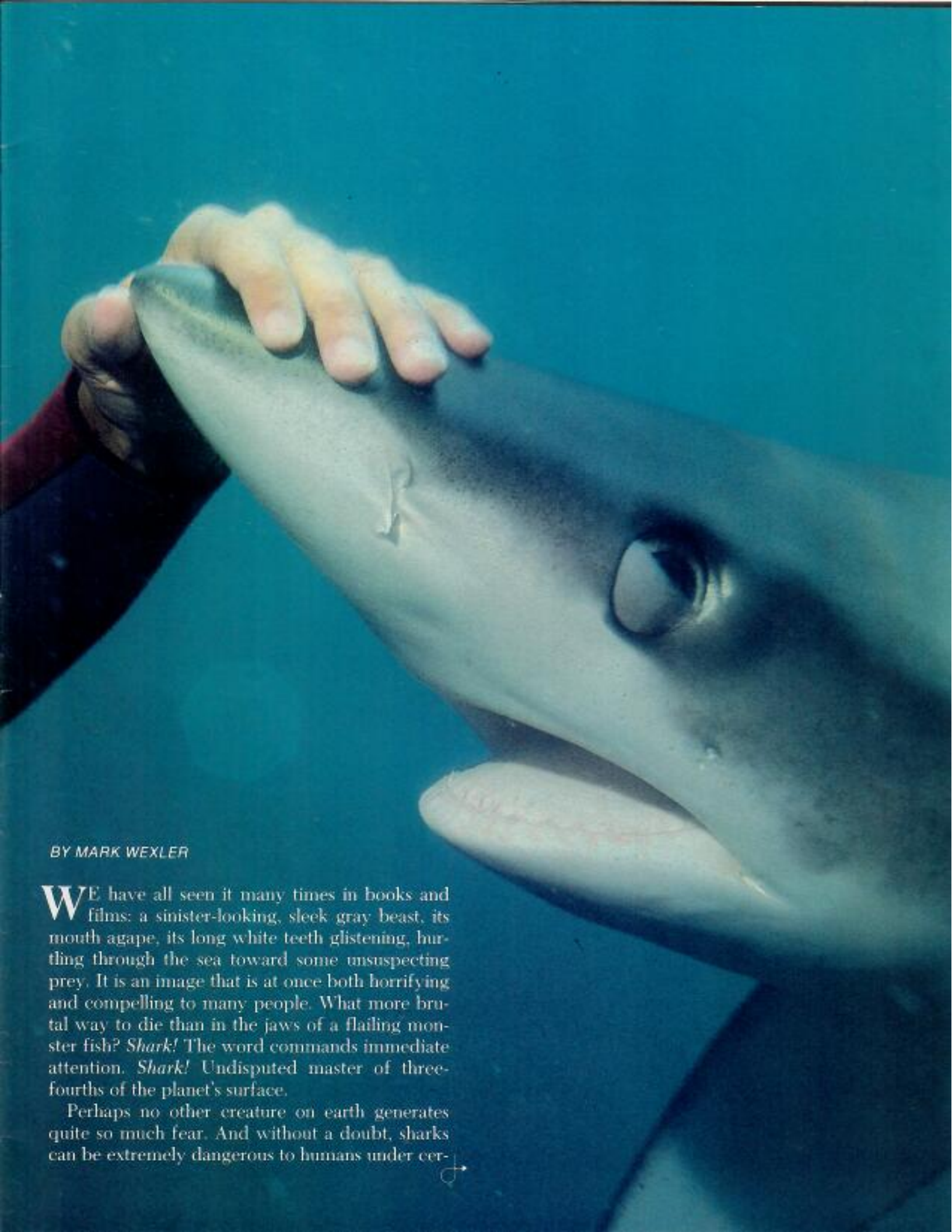
**Chasing down
the truth about
shark behavior**

See page 4

A close-up photograph of a diver's hand holding the snout of a shark. The diver is wearing a black diving mask with a red strap and a clear regulator. The background is a deep blue underwater environment. The text is overlaid in the bottom right corner.

Facing up to our fears about sharks

Only now are we
beginning to understand what
motivates their behavior



BY MARK WEXLER

WE have all seen it many times in books and films: a sinister-looking, sleek gray beast, its mouth agape, its long white teeth glistening, hurtling through the sea toward some unsuspecting prey. It is an image that is at once both horrifying and compelling to many people. What more brutal way to die than in the jaws of a flailing monster fish? *Shark!* The word commands immediate attention. *Shark!* Undisputed master of three-fourths of the planet's surface.

Perhaps no other creature on earth generates quite so much fear. And without a doubt, sharks can be extremely dangerous to humans under cer-

tain conditions. But our fears of these powerful fish are far out of proportion to the actual dangers they pose. Along the coasts of North America, the odds that a swimmer will be assaulted by a shark are estimated to be only about one in five million. While attacks do occur, "riding to the beach in a car remains far more hazardous than swimming once you get there," observes H. David Baldrige, a U.S. Navy scientist and shark expert.

Such assertions, however, do little to dispel our anxieties about sharks. "Everybody likes to be scared," notes John McCosker, director of the Steinhart Aquarium in San Francisco, California. "That's why horror movies are so successful. But to me, the scariest thing about sharks is our own ignorance about them. We still know very little about their feeding drives, or what motivates other aspects of their behavior, and thus we can't predict how they will react around us. And it is that unpredictability which makes them so scary." Indeed, we may know less about sharks than any other group of animals — an ironic situation, considering that sharks are the most common, far-ranging, large aquatic creatures (over 100 pounds) in the world.

In recent years, as more and more scientists have invaded the realm of sharks, some of the mysteries surrounding these dreaded predators have begun to vanish. The more we study sharks, the more we realize how much we have underestimated their capabilities. We now know that sharks are much more sophisticated than the simple, insatiable eating machines we long thought them to be. Researchers at Woods Hole Oceanographic Institute in Massachusetts, for instance, have found that a great white shark burns up energy so efficiently that it may occasionally go three months without eating. Other sharks, biologists have discovered, have the highest sensitivity to electric fields of any creatures ever studied. Apparently, they are capable of orienting themselves to the earth's weak magnetic field.

Surprisingly, compared to many other forms of wildlife, sharks may lead relatively peaceful lives. "Numerous species of mammals, birds, reptiles, even some other fish, are much more aggressive than sharks," says Donald R. Nelson, a marine scientist at California State University in Long Beach. In other animals, he notes, aggressive behaviors

The jaws we fear most belong to the great white shark, a species we have only limited knowledge about. Creatures like this 17-foot, 3,000-pound fish, being fed by a researcher off Australia (right), may have a higher sensitivity to electric fields than any other animal ever studied.

Previous page: off the coast of California, a diver comes face to face with a blue shark. The fish's eyelid is partially closed for protection. Though sharks are common in U.S. waters, they rarely attack people.

are most obvious when the creatures are defending territories, mates or offspring. "None of these behaviors have yet been observed in sharks," adds Nelson. "Is this because they do not exist, or because sharks in the wild are very difficult to observe?"

Little more than a decade ago, there were only 250 scientifically described species of sharks in the world. Today, we know that there are at least 350. In size, they range from the deepwater, ten-inch dwarf shark to the largest fish in the sea, the whale shark, which often exceeds 40 feet and 15 tons. Only about 30 species have been known to attack humans. In U.S. waters, the great white, tiger, dusky, blue, mako and bull sharks are considered the most dangerous. While such creatures are relatively numerous, assaults on people are few and far between.

"There will probably be no more than 3 dozen shark attacks *worldwide* this year," says Baldrige, who has analyzed the results of more than 1,600 recorded incidents, compiled between 1940 and 1974 by the U.S. Navy. Baldrige's study shows that only about one-fifth of all present-day attack victims are killed. (In contrast, some 2 dozen Americans die every year from bee and wasp stings.) Apparently, most sharks do not like the taste of human flesh. Often, in fact, the attacking fish may have been motivated by something other than the need to feed. Last summer, for example, Ted Best, a 19-year-old snorkeler, was searching for sea shells off the coast of Pensacola, Florida, when two mako sharks approached. "On other occasions," he recalls, "the sharks have always minded their own business. This time it was different. No sooner had I picked up a shell than I saw one coming at me. When it hit my leg, I didn't think how bad the bite might be. I just remember looking into the shark's eyes, and it looking back into mine. I'll never forget that." Best

At Creditage (Ocean Film Ltd.); pages 4-5: Howard Hall







David Doubilet

A hefty harvest, this 27-foot basking shark will produce a ton of meat for these two fishermen from the Japanese village of Nakiri. The gigantic fish feeds primarily on plankton. Millions of pounds of sharks are eaten annually throughout the world, yet we know little about their populations.

walked away from the encounter with a clean wound and minor blood loss.

Though only a few sharks attack people every year, we humans exact a heavy toll on the fish themselves. Because of the stigmas attached to eating sharks, their meat is sold under a variety of euphemistic names around the world. At one time or another in the United States, it has been served under such aliases as "whitefish," "steakfish" and "grayfish." According to United Nations statistics, the worldwide harvest of sharks in 1976 amounted to about 675 million pounds. "If the average shark in this catch weighed about the same as the average human being — say 150 pounds — the harvest would be the equivalent of sharks eating 4.5 million people!" exclaims Leonard Compagno, a researcher at the Tiburon Center for Environmental Studies in California.

The moral of the story, according to

Compagno, is that sharks "have a helluva lot more to fear from us than we do from them. Large numbers of sharks do not necessarily mean that the animals have a high reproductive rate, no more than large numbers of the now extinct passenger pigeon meant that they reproduced in legions. We just don't know how many sharks there are, yet we continue to harvest them in huge numbers. On a long-term basis, I think that some sharks are going to be in serious trouble; some species may already be there."

Unlike most other fish, in which fertilization takes place after the female has deposited her eggs in the water, sharks are fertilized internally. Mating can be a violent affair. In some species, the males, which are commonly one-third smaller than the females, hang onto their mates with their teeth. That's why many female sharks are unusually thick-skinned. The females are also capable of storing sperm for months at a time, until their eggs are mature. Sharks generally have long gestation periods.

What's more, most species bear live young, which means that their litters are relatively small for fish. At times,

the young nurtured inside the womb of some species become vicious predators long before they emerge. Occasionally, they cannibalize their less advanced siblings inside the uterus. While probing the organs of a sand tiger shark, Florida scientist Stewart Springer was once bitten by a yet unborn embryo. After they are born, the pups — as young sharks are called — receive no parental care. They emerge as miniature replicas of their parents, ready to begin hunting down their own prey — the efficient products of millions of years of evolution.

Because shark skeletons are made of cartilage rather than true bone, many geologic records of their prehistoric existence have not survived the test of time. We do know, however, that their ancestors ruled the primordial seas more than 300 million years ago. (*Homo sapiens*, on the other hand, did not appear until about one million years ago.) Since then, the world's continents have changed shapes dozens of times, and most other animals have evolved into their present form. Many sharks, though, have hardly changed at all.

Contrary to popular belief, not all sharks rely on their sense of smell to

locate prey from long distances away. Instead, many of them have a highly acute sense of hearing. A shark picks up sounds by means of a series of vibration detectors located along its sides. These detectors enable the fish to sense unusual or rapid movements several hundred feet away. Thus, when a swimmer flails in the water in an effort to scare off the predators, he or she is actually causing intense vibrations that may attract the fish.

While most other fish have thin skins protected by a coating of scales, sharks have thick hides covered with sharp objects called dermal denticles. Each denticle is like a miniature tooth: its surface is tipped with a layer of dentin, and it contains nerve cells and blood vessels. These denticles give the shark's hide a sandpaperlike roughness that can tear a swimmer's flesh.

Sharks are also equipped with several rows of teeth. They can replace those that are lost within a matter of days. While humans go through only two sets of teeth in a lifetime, sharks go through a new set every few months. Researchers have estimated that some of them lose as many as 30,000 teeth during their lives. Behind those teeth are powerful jaws armed with elastic muscles, which enable the fish to distend its mouth and swallow huge pieces of food. In Australia, one 11-foot tiger shark was found with an entire horse's head, intact, inside its stomach.

Undoubtedly, the most infamous jaws of all belong to the great white shark, the gigantic predator that roams throughout the world's temperate seas. In many areas, the great white has been responsible for most of the shark attacks on people. While some of those attacks appeared to be aggressive acts, scientists believe that, quite often, they were a case of mistaken identity on the part of the fish. Great whites prefer to eat marine mammals, which may explain why some surfers and divers have been assaulted off the coasts of California and Oregon. In recent years, federal and state protection efforts have enabled seal, sea lion, elephant seal and sea otter populations to surge along the West Coast. Wearing black wet suits, divers may resemble those creatures. "If you look like a seal and go swimming in a shark's dining room, you're taking the chance of offering yourself up as the main course," says Baldrige.

Many divers never see the great white



Doudt's surfboard bears a lasting scar from the attack by a great white shark.

"I escaped the jaws of death"

In November 1979, Kenny Doudt, a 28-year-old carpenter from Seaside, Oregon, was surfing with some friends when a great white shark attacked him. It was the first time in recorded history that a great white had seriously assaulted a human off the coast of Oregon. The attack, which lasted only a matter of seconds, left Doudt with a massive wound from which he has since fully recovered. Today, he is alive and well, and surfing once again in Oregon. Following is his first-person account of the incident:

IT was a classic day along the Oregon Coast: the sun was peeking through the clouds and the surf was breaking at regular intervals. The air temperature was only about 35 degrees, but the water was about 20 degrees warmer. I arrived at a place called Cannon Beach with a friend, Jack Bird. We put on our wet suits and gloves, and paddled out toward the breakers. Three other surfers were already out there.

Before long, I had caught three waves and was beginning to forget the cold and enjoy myself. I looked over at another surfer, Steve Absher, and said: "Believe me, the next good wave that comes, I'm going to get it." And, in fact, as I paddled out to catch a breaker, I got a lot more than I ever expected.

I never saw the shark coming. By

the time I heard it leave the water, it was too late. It approached me from the left, and it instantly sandwiched me onto the fiberglass board. The top half of its jaws locked into my back, the bottom half into the surfboard. I was too stunned to be scared. Later, scientists told me that the shark was probably female, as females are usually more aggressive. They estimated its size at about 15 feet.

As soon as it attacked, the shark tried to drag me underwater. But the buoyancy of the surfboard quickly brought me back to the surface. Fortunately, I was paddling at the moment of attack, and my left arm was raised above my head, which prevented it from being ripped out of its socket. Like a dog playing with a bone, the shark began flailing me from side to side. My body was halfway out of the water.

Steve Absher had seen the shark attack, and he started paddling toward me as fast as he could. He was about ten yards away when we looked each other straight in the eyes. I remember thinking that he was the last person I was ever going to see.

Then, just as quickly as it had grabbed me, the shark let go. I had escaped the jaws of death. The entire incident had lasted only about 15 seconds, but it seemed as if my whole life had passed before me. By this time, the water all around me was stained with blood. I saw my surfboard floating a few feet away. I reached for it and began paddling as hard as I could. The next thing I knew, I was lying in knee-high surf, and people were running toward me. Jack Bird had also seen the attack, and he had gone ashore for help.

Soon, I heard the wail of a siren and then two paramedics were on top of me, trying to stop the bleeding. The shark's teeth had penetrated five inches into my back. They had severed and shattered four ribs. My heart, lungs and a kidney were exposed, and the muscles that run from my armpit to the middle of my buttocks had been torn apart. Later, as I was recovering from surgery at a hospital in Portland, I asked my doctor how many stitches the wound had required. "I don't know," he replied. "I stopped counting when I got to 500."

until it's too late. "Apparently, there is something distasteful about our species that interrupts the feeding sequence, for if the prey were a pinniped, the shark probably would continue with its meal," observes John McCosker. During the past two years, however, two people have been eaten by great white sharks off the coast of Chile. "What this may mean," adds the scientist, "is that there are varying races of great whites." In California and Oregon, some 40 people have been bitten by great whites over the past 50 years. Only 5 of them died, all from blood loss.

Not long ago, while studying great whites from a submerged cage off Australia's Great Barrier Reef, McCosker observed an unusual behavior. "We would hold horse meat out of the cage for a shark, and at the last instant, the creature would turn its snout and attack the cage. Occasionally, the shark would ignore us altogether and instead bite the propeller or the magnesium plates on the bottom of our boat." Recently, scientists have discovered that great whites, as well as many other species of sharks, have an acute sensitivity to electric fields, picked up through pores on the bottoms of their snouts. A white shark relies on this electric sense to locate its prey at the last second before it attacks.

"Once a great white has made the decision to attack, it usually doesn't change its mind," says McCosker. "As it rockets toward its prey, it opens its snout, rolls back its eyes to protect them, and is virtually blind during the split second of assault. However, we humans tend to confuse the situation by adding all kinds of new electric fields to the fish's environment. That's why the shark I observed attacked the cage instead of the bait at the last second." That may also explain why a great white shark, seeing the silhouette of a diver or a surfer from a distance and perhaps mistaking him for a seal, may attack "blindly" and then spit out its human prey.

The pores through which a shark detects electric fields are attached inside the head to Coke-bottle-shaped organs, filled with a jellylike substance that may react to pressure or temperature change. These organs are called "Ampullae of Lorenzini," after the European scientist who first described them in the late 1600s. Not long ago, a former Woods Hole biophysicist, Adrianus Kalmijn,

Among the oldest living creatures on earth, sharks began to evolve more than 300 million years ago. Since then, the fish have developed into an incredible variety of shapes and sizes. Scientists have now identified about 350 different species, including these odd-looking scalloped hammerheads swimming together in a vast school in the Gulf of Mexico (right). The whale shark, dwarfing a diver (below, left), is the largest fish in the sea, often growing to more than 40 feet and 15 tons. A newly discovered species nicknamed "Megamouth," this specimen (below, center), being attended to in Hawaii, was hooked when it swallowed a boat anchor. It apparently subsists on plankton. The angel shark, meanwhile, resembles a ray in shape. It is a bottom feeder that blends into the ocean floor (below, right).

found that small dogfish sharks can detect electric voltages as low as five nanovolts — the equivalent of the voltage that would exist between two tiny penlight batteries separated by 2,000 miles of wire! From a distance, a shark may pick up the trail of some prey through its vibration detectors. Then, as it moves in for the kill, it relies on its ampullae to home-in on the creature.

Over the years, scientists have experimented with everything from chemical dyes to electronic devices in an effort to find an effective shark repellent. After learning that the fish usually avoid a venomous sea snake, one Australian researcher painted his wet suit with bands that emulated the snake's coloration. Then, with a trench coat on, he jumped into the water amid a group of feeding sharks and flashed his wet suit at them. The sharks fled that time, but on another occasion, they showed no response at all to the flasher. Other devices, such as a chain-link metal diver's suit and an inflatable plastic "shark screen" bag that a swimmer climbs into, have proven more reliable. However, the perfect, foolproof repellent does not yet exist.

"It's been suggested that the only guarantee against shark attack is a life sentence in Leavenworth Prison," jests McCosker. But seriously, he adds, "sharks are such sophisticated, magnificent creatures that we should admire, not fear them." In the end, perhaps the greatest thing we will have to worry about in regard to sharks is not what they can do to us, but rather what we, in our ignorance, are doing to them. ■

Mark Wexler is managing editor of this magazine.



Clockwise from top: Howard Hall (2); David Doubilet (2)

