

# Sea Frontiers<sup>®</sup>



· SEPTEMBER-OCTOBER 1988

SEA TURTLES ON THE  
BRINK

THE FEARED  
TIGER SHARK

TSUNAMI WARNINGS

UNDERWATER MAGIC:  
UV PHOTOGRAPHY



# Sea Frontiers®

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Above: A loggerhead sea turtle, protected, but not safe - see page 297.

Front cover: Cruising coastal waters a tiger shark is an awesome sight. Not only a threat to swimmers and divers, but a vital part of a complex ecosystem, it should be treated with respect. Explore the alien world of the tiger shark in an article beginning on page 264.

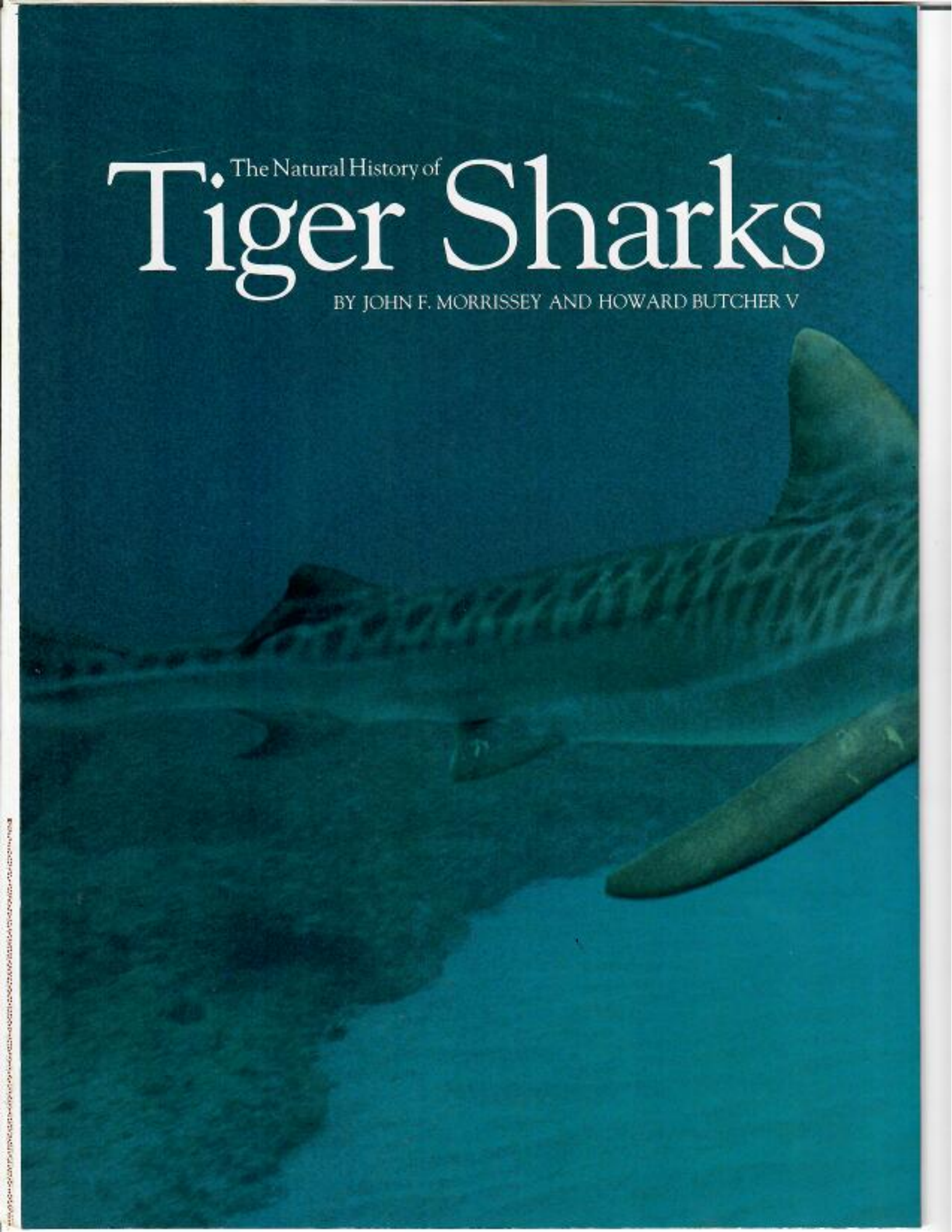
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The Natural History of  
**Tiger Sharks**

BY JOHN F. MORRISSEY AND HOWARD BUTCHER V

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**A**t first, the shadow was mistaken for a patch of turtle grass because it was so large. As our boat, a Boston Whaler, got closer, the contours of the shadow became discernible, and it was clearly a very big shark. Howard Butcher and a group of Earthwatch volunteers, assistants to Dr. Samuel H. Gruber of the University of Miami, were checking a longline east of Bimini, Bahamas. The longline was set in shallow water and rigged for small- to medium-sized sharks.

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This shark was a huge tiger. It looked like an idle torpedo with fins, with the bulk of a small car. It lay motionless in the water except for the opening and closing of its mouth which ventilated its gills.

The line to which the tiger shark was hooked was frayed and almost broken. At the approach of the boat, the shark sluggishly began to swim and then, feeling the pull of the hook, lay down on the sand again.

Knowing the line was about to break, Butcher cut the engine on the Whaler so the shark would not get alarmed and flee. If the shark made



any serious attempts to escape, the line could easily break.

After making the Whaler fast to the main longline, Butcher put on his fins and mask and quietly got into the water. From there he could see it was a female tiger shark and that she had a swollen belly. She also seemed tired, probably from fighting the longline for several hours.

The crew in the Whaler handed Butcher a rope with a slip-noose on the end. He gently slid the noose around the shark's tail and tightened it. The female tiger shark had not yet moved. After Butcher got out of the water, the crew pulled in the tail rope, and the shark began thrashing about.

#### Up out of water

The longline was in 8 feet of water, so the shark was able to push off the sand with her tail. She lunged upward, displaying her white swollen belly as she stood up out of the water. Her head was broad and blunt and, at the height of her effort, the shark seemed to stand taller than the crew in the Whaler. Then she crashed sideways into the green water. The crew pulled the tail rope tighter, so that the shark lay alongside the boat with the hook line made fast at the bow and the tail rope at the stern. She slammed her tail into the side of the Whaler, and the boat rocked about with the desperate efforts of the shark. Finally, the shark became subdued and rested lethargically alongside the boat. She was measured at 12.5 feet in length and 5.5 feet in girth. She was the largest shark caught in an entire summer's longlining.

The tiger shark was first described for science in 1822 by Peron and Lesueur and named *Squalus cuvier* for the great French anatomist Georges Cuvier. During the almost 150 years that followed, eight additional names were given to this species. This was the result of both poor communication between turn-of-the-century taxonomists in different parts of the world and the misleading variations that exist within a species having a nearly cosmopolitan distribution. Today, the tiger shark is recognized as a single, worldwide species, *Galeocerdo cuvier*, although some Japanese scientists consider the Australasian tiger shark to be a unique species, *Galeocerdo rayneri*. Confirmation of their opinion must



All photographs by John F. Merrinsky except as noted

await a worldwide survey of variation within this species.

A common, wide-ranging fish, the tiger shark is found worldwide in warm temperate and tropical waters. It is a coastal animal with a wide tolerance for a variety of marine habitats. In the Western Atlantic Ocean, the tiger shark occurs from Massachusetts in the north to Uruguay in the south. On the Pacific coast of the Americas, it is found from Southern California to Peru. Its great tolerance to water temperature extremes is exemplified by records of its occurrence in the surface waters of the Caribbean Sea and the cold waters of Iceland. The tiger shark cannot be considered to be oceanic, although it does make oceanic journeys.

#### Swimming alone

The tiger shark is probably a nocturnal fish that often swims alone, or in

small groups of less than six individuals. It exhibits a localized, repeatable, daily pattern of movement. During daylight hours, it is found offshore in deeper waters and, at night, it moves inshore into shallow bays, lagoons, and estuaries. At Bimini, tiger sharks are frequently caught at night in water that is barely deep enough for them to swim in. It can be disturbing to discover a 12-foot-long specimen that was captured during the night on gear set in waist-deep water!

The feeding habits of the tiger shark perhaps have done more than those of any other shark species to perpetuate the myth that all sharks are swimming garbage collectors. The catholic diet of the tiger shark led one

8 feet=2.4 meters  
12.5 feet=3.8 meters  
5.5 feet=1.7 meters  
12 feet=3.7 meters





**Hooked, a large tiger shark in shallow water is a striking sight. Most of the sharks caught by the Earthwatch volunteers were considerably smaller (above).**

researcher to speculate that this species has perhaps the least specialized diet of all sharks. Certainly, its feeding behavior is nearly legendary. Included in the often-repeated list of items found in the stomachs of tiger sharks are all types of marine reptiles, various marine mammals, grass, carrion, dogs, marine and terrestrial birds, cows and horses (presumably from local slaughter houses), fish, conch, sharks, cephalopods, billfish, and an amazing variety of inedible junk including nails, wood, tools, tar paper, and an unopened can of salmon. In truth, the ingestion of inedible items by sharks is, like many behaviors of sharks, highly exaggerated.

When examining the stomach contents of tiger sharks at Bimini, we have found an impressive variety of edible items including birds, stingrays, gastropod mollusks, lobsters, and fish, but no inedible trash. The actual occurrence

of garbage in the stomach of any shark species is very rare. In our research experience, only two sharks examined had non-prey items in their stomachs, the strangest being a tiger shark that had an empty birth-control-pill container in its stomach. This shark was captured by a sportfisherman off the coast of New York, and it was not pregnant!

After measuring the girth of the tiger shark that was caught on the longline, the writers began to suspect that she was pregnant. We tagged her at the base of her dorsal fin and then administered an intramuscular injection of tetracycline hydrochloride. This drug will become incorporated in her vertebral column and can be used as a time mark in age and growth studies in the event of her future recapture.

After administering the shot, we both got in the water to examine the shark more closely. We discovered that fetal membranes were protruding from her vent, indicating that she was definitely pregnant, and that in the struggle

of her capture may have already released some pups.

Reproduction in sharks is a rather complicated process that can bear a remarkable resemblance to human reproduction, and includes a wide variety of strategies from the embryonic spectrum. Internal fertilization occurs in all sharks and is accomplished with the aid of two intromittent organs that are actually modified extensions of the pelvic-fin skeletons of male sharks. After fertilization, development of the embryo occurs in three different manners.

A few species of sharks are egg-laying (or oviparous). In this least specialized and primitive pattern of reproduction, a tough, leathery egg case is formed around each fertilized egg. These egg cases are then deposited on or near the seafloor and are subject to all the hazards of the ocean without the benefit of parental care and protection. Surviving egg cases will hatch after a few months.

Some species of sharks give birth to live young which were nourished via a yolk-sac placenta and an umbilical cord during their development (viviparous). This reproductive pattern is amazingly similar to that found in most mammals, including humans.

The young of most sharks, however, "hatch" from a thin egg case while still in the uterus of the mother shark (ovoviviparous or aplacentally viviparous). Then they are nourished by a variety of sources during their continued development. Some ovoviviparous sharks are nourished solely on yolk reserves, as if they were still inside an egg capsule. Other ovoviviparous sharks ingest a "uterine milk" that is secreted by the endometrium of the uterus. And finally, some young ovoviviparous sharks eat other eggs and/or unborn siblings in the uterus soon after "hatching" within the mother. This oviphagous or egg-eating behavior is unique among vertebrates and represents perhaps the earliest known form of sibling rivalry.

#### Midwife to a tiger

When Butcher first touched the pregnant tiger shark near the vent, she responded violently and slammed her



tail against the Whaler. Eventually, after gentle coaxing, she permitted him to help in the birthing process. The first baby was 32 inches in length. It came out fully formed, with eyes that were blue, unlike the adults of the species. Eventually the pup died despite efforts to swim it through the water and force water over its gills. Two more pups were birthed and eventually died. The pups were apparently premature and were being aborted by the mother as a result of the stress of capture. Estimating that there were as many as 60 more pups within the pregnant shark, we decided to release her before she lost any more babies. Prior to this event, it was thought that tiger shark pups were a smaller size at birth and that pregnant females reached full term in spring and early summer as opposed to late summer. Where the tiger shark normally gives birth is still a mystery.

The tiger shark is a member of one of the largest shark families, the gray sharks or Carcharhinidae, and differs from all other family members in that it is ovoviviparous (all other carcharhinids are viviparous with a yolk-sac placenta). The female of the species typically gives birth every two years in late spring and early summer to 10 to 82 pups after a 13- to 16-month gestation period.

The pups are between 20 and 35 inches long when they are born. These young sharks grow rapidly after birth. One research team estimates that a newborn tiger shark may grow 15 to 20 inches during the first six months of its life! This rapid growth rate slows as the shark ages, but it is still one of the fastest growth rates currently known among sharks. Maturation occurs in 7 to 10 years at a total length of about 10 feet, with females maturing later and larger than males.

#### How big is big?

The maximum recorded size of the tiger shark is unknown and is surrounded in a plethora of extraordinary estimations and exaggerations. It is certainly the largest member of the family Carcharhinidae and is one of the ten largest sharks. Although large tiger

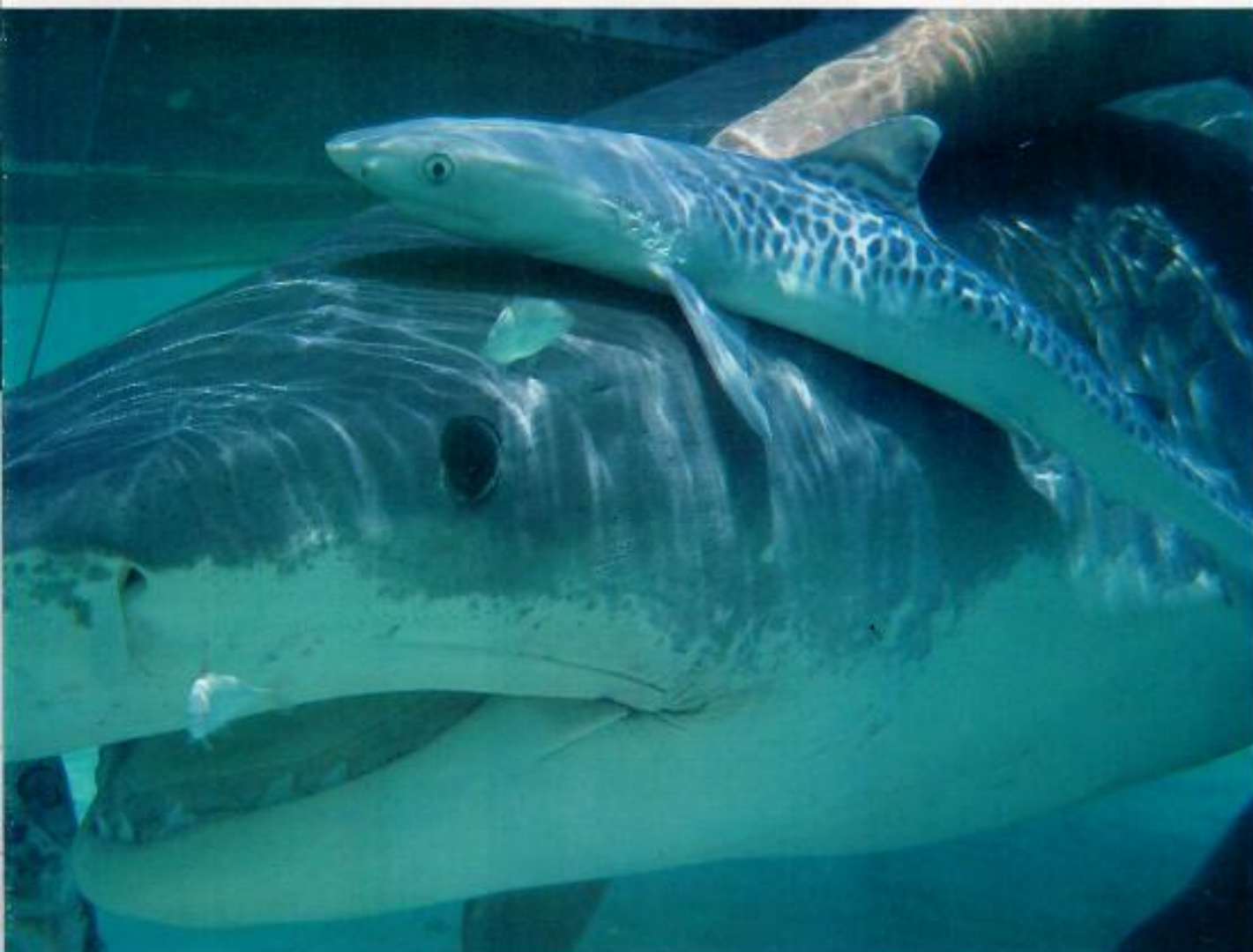
32 inches=81 centimeters  
20 inches=51 centimeters  
35 inches=89 centimeters  
15 to 20 inches=38 to 51 centimeters  
10 feet=3.0 meters



The pregnant tiger shark, fetal membranes protruding from her vent, may have spontaneously given birth to some pups as she struggled on the longline. Reaching an arm inside the shark, one of the writers tried to help her give birth. The pups, however, though large and with the characteristic markings of young tiger sharks, did not survive. To give some of the estimated 60 additional pups a chance, the pregnant shark was released.





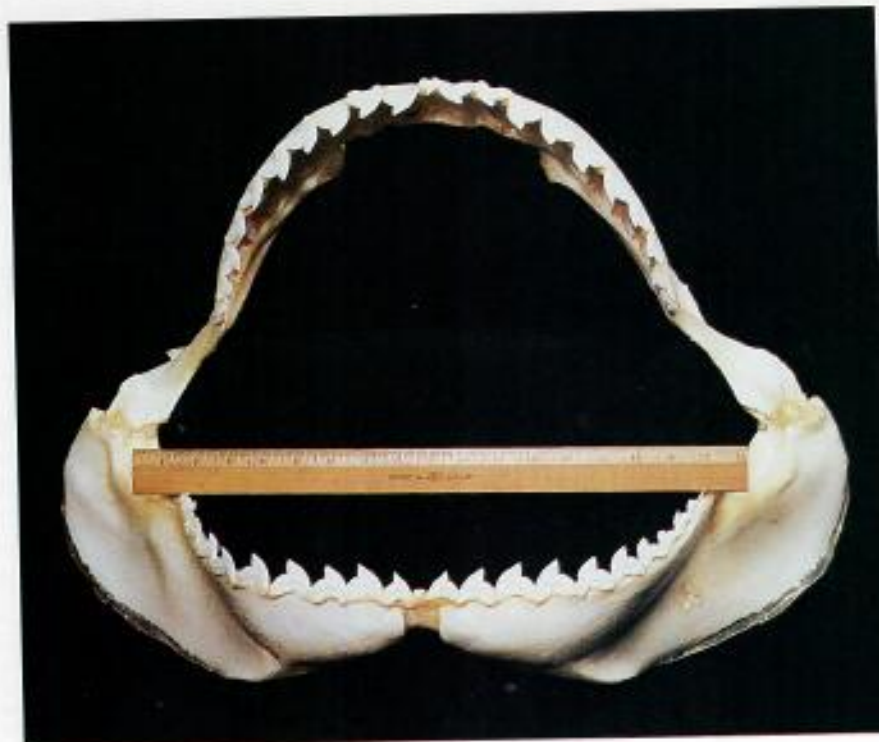




Bristling with teeth, the jaw of a 14-foot tiger shark is the business end of a powerful and successful predator. Individually, the razor-sharp serrated teeth have heavy, oblique bent cusps or crowns, and deeply notched margins. Like many sharks' teeth, those of a tiger shark are unique, allowing loose teeth to be identified to species. These teeth came from an 11-foot 11-inch tiger shark that weighed 586 pounds.



William Hudson/University of Miami



sharks of 12 feet are fairly common, most do not exceed 14 feet. However, unsubstantiated reports of tiger sharks 20 to 30 feet in length are frequently encountered.

Do truly giant tiger sharks really exist? There is some speculation that the tiger shark could attain this enormous size if it was an infertile waif, like the "giant" 6-inch sargassumfish (*Histrio histrio*) of Bermuda waters. This little fish spends its days riding along in a mat of floating sargassum seaweed and is normally less than 3 inches long. However, an infertile member of this species may spend a greater portion of its caloric intake on growth rather than on reproduction. This excess energy enables it to achieve a much greater size

12 feet=3.7 meters  
 14 feet=4.3 meters  
 20 to 30 feet=6.1 to 9.1 meters  
 6 inches=15 centimeters  
 3 inches=7.6 centimeters



than is normally encountered. Perhaps this phenomenon also occurs in other species such as the tiger shark. The largest reliably measured tiger shark was an 18-foot-long specimen from Cuba, although the French researcher Pierre Fourmanoir wrote in 1961 that he had seen a photograph of a 24-foot-long female tiger shark from Indo-China.

Regardless of the record length, the average tiger shark does reach a very large size. This fact, as well as various aspects of its natural history, helps make the tiger shark the most feared shark in the Caribbean and in French Polynesia. The tiger shark is second only to the white shark (*Carcharodon carcharias*) in confirmed attacks on humans and boats. Its deserved reputation and the high number of attacks on humans is perhaps due to three factors: the tiger shark is one of the largest coastal sharks, it enters very shallow water, and it has a broad prey spectrum. Hence, the tiger shark is a very large predatory animal that takes a variety of prey and swims in shallow waters that may be frequented by humans. Fortunately, the tiger shark, like all other species of sharks, does not include humans as a regular component of its diet.

The tiger shark is distinguishable from other sharks by its large size and striking color pattern, which in the young consists of vertical black spots and bars. Young tiger sharks are sometimes called leopard sharks because of these marks which merge and fade in larger specimens, and are absent in adults. It is also characterized by its large, bluntly rounded head, ridged back, large slitlike breathing hole (spiracle), caudal keels, and long labial furrows extending from the corners of the mouth to just below the eyes. The teeth of tiger sharks are uniquely shaped and are similar in both jaws.

The above features distinguish the tiger shark from all other species of sharks. The presence of spiracles, large labial furrows, and an ovoviviparous mode of reproduction is considered to be primitive and suggests that the tiger shark is perhaps the most primitive carcharhinid. These characters and additional features of the skull, or

chondrocranium, led one researcher to suggest that the tiger shark may be closer to the common ancestry of all carcharhinid sharks than any other member of this large family. However, the tiger shark also possesses a number of derived features such as caudal keels, serrated teeth, a short snout, and a high vertebral number. These and other derived features suggest that the tiger shark is specialized away from its common origin with other carcharhinid sharks.

#### Man bites shark

During this century, the tiger shark has been subjected intermittently to commercial fishing pressures. Products from the tiger shark include its liver, which contains high concentrations of vitamin A-rich oil, its hide, which has 6 to 10 times the tensile strength of oxhide, and its fins, which are used to make soup. However, like most other species of sharks, the tiger shark is extremely susceptible to overfishing, primarily due to its humanlike life-history strategy. Like humans, sharks mature late, live long lives, and produce relatively few well-formed young.

The tiger shark lives perhaps 25 to 40 years after it reaches maturity. Hence, with a two-year reproduction cycle, a female only reproduces 10 to 20 times during her lifetime. Although the tiger shark has a rather large litter when compared to most other carcharhinid sharks (for example, the average litter size among gray sharks is about 15), this number is insignificant when compared to the millions of eggs produced each year by many bony fishes. In addition, high natural mortality for tiger shark pups is suspected. It has been suggested that the long, skinny body and low caudal-fin angle of the young tiger shark prevent the pup from being a good swimmer. It is hypothesized that the young tiger shark is a slow, inefficient swimmer that is captured by predators more easily than other gray shark pups. One research team submits that the rapid growth rate of the newborn tiger shark is an attempt to reach a large size quickly to reduce predation pressure.

The humanlike life-history strategy of tiger and other sharks (slow growth, late maturity, large size, and few young produced each year) makes them extremely susceptible to overexploitation

and emphasizes the need for increased understanding of their natural history through basic biological research. Information must be gained regarding their reproduction, age and growth, feeding behavior, longevity, and metabolic needs. Only then can humans develop an intelligent management plan for sharks, a presently underutilized but expanding fishery.

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**John F. Morrissey** earned his B.A. and M.A. degrees in biology at Hofstra University in Hempstead, New York. His graduate research concerned the jaw anatomy of sharks. He is working on his Ph.D. degree at the University of Miami Rosenstiel School of Marine and Atmospheric Science. His doctoral research is on the activity patterns of juvenile lemon sharks. His other interests include the morphometrics of all sharks. This is his second article for *Sea Frontiers*.

**Howard Butcher V** is a recent graduate of Allegheny College with a B.A. in English. He has been a shark enthusiast since his early youth. Although he occasionally writes for science magazines, his major work is in fiction and he is currently working on his first novel.

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#### Related reading:

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