# Home Aquarium Sharks and Rays

**Tell me about keeping sharks and rays in the home aquarium.**

*By Scott W. Michael*

Of all the creatures that inhabit the oceans of the world, none evokes more of an emotional reflex than the shark. For centuries the word shark has been synonymous with fear because of the potential threat some species pose to human beings. For example, in 1558, Guillaume Rondelet, a prominent French biologist, wrote of the tope shark (Galeorhinus galeus), "This fish so longs to wound men in the thighs, the groin, the heels, or any exposed part, that it sometimes leaps on to dry land when it sees men with bare legs near the water..." This aggressive behavior, no doubt a product of Rondelet's imagination, is amazing when one considers that this fish reaches only 6 feet in length and generally eats small fish and squid. More than 300 years later, Henry David Thoreau penned, "I have no doubt that one shark in a dozen years is enough to keep up the reputation of a beach a hundred miles long."

Another long-standing misconception about sharks, and their kin the rays, is that they are primitive and, except for over-developed olfactory lobes (which are in part responsible for their extremely keen sense of smell), these animals are tiny-brained oceanic idiots. In fact, research on the central nervous systems of sharks and rays has shown that not only do many of the more "advanced" species have large brains relative to their body size (many fall within the range of birds and mammals), but the development of the brain divisions is similar to that observed in many mammals (Northcutt 1977).

Behavioral studies bear this out. Many sharks and rays have very complex behavioral repertoires and can learn simple tasks at a rate comparable to rats. As scientists piece together the puzzle of shark behavior, human emotion has begun to shift from fear to fascination. Today, many people appreciate the shark for what it is: an efficient, finely adapted super predator.

It is not surprising that many marine aquarists have at one time or another entertained the idea of keeping a shark in the home aquarium. The purpose of this article is to give some insight into the husbandry of these special animals, and to aid the aquarist in selecting a species that can be adequately cared for. We will not, however, limit our coverage to sharks but will also include their fascinating relatives, the rays. We will consider the aquarium system and care necessary to keep sharks and rays in a saltwater tank. In a second part I will provide a catalog of aquarium sharks and rays, with specific details on the biology and captive husbandry of these species.

Before beginning our discussion of shark and ray aquarium care, it is important that we understand something about the biology of these animals and how they differ from the more commonly kept saltwater species. Sharks and rays belong to the class Chondrichthyes (along with the chimeras) and the subclass elasmobranchii. The subclass elasmobranchii can be further divided into two groups; the selachians (sharks) and the batoids (skates, sawfishes, guitarfishes, stingrays, electric rays). The differences between these two groups are relatively insignificant and somewhat obscure. In general, rays are simply flattened sharks, with the gill slits under the body and the pectoral fins joined to the sides of the head. For brevity, I will use the terms shark, as well as elasmobranch, to apply to both groups.

How then do elasmobranchs differ from the coral reef fish that we normally encounter in aquariums? First, the shark's skeleton is composed of cartilage, whereas most other fish have skeletons composed of bone (these are commonly known as bony fishes).

Another more obvious difference is that male sharks have claspers, a structure not found in bony fish. Claspers, which are modifications of the pelvic fins, are used to inseminate the female. During mating, the male shark rotates its claspers forward and laterally and inserts one (in most cases) into the females cloaca. Sperm is then transferred from the male sex organs through channels in the claspers into the female's reproductive tract. These conspicuous organs make it easy to tell a male from a female, even in a newborn shark.

Another difference, and one that has practical applications for the aquarist, is that most bony fish are better at subtle maneuvering — they have greater fin mobility (e.g., they can rotate the pectoral fins) that enables them to perform more precise movements. A long-nosed butterflyfish, for example, can hang over a piece of coral, nimbly move forward and wrest a crustacean from between the coral branches and then move backward to its original position in the water. Although several of the more agile reef-dwelling sharks can "crawl" backward, they cannot execute such exact maneuvers.

Other characteristics that elasmobranchs possess that are not common to bony fishes include five to seven gill slits rather then one gill opening, and dermal denticles covering the body (some rays lack these), which give the skin a smooth feel when rubbed one way and rough when rubbed the other. Sharks lack a swim bladder (as do some bony fish), have no rib cage to support the internal organs and they all have a spiral valve (a structure also found in some primitive bony fishes) in the intestine to increase the absorptive efficiency of this organ.

We have briefly examined how sharks and rays differ anatomically from the bony fishes. But, what about the care and maintenance of elasmobranchs in aquariums? In many ways caring for a shark or ray is similar to keeping a lionfish or an angelfish, but there are several differences that should be considered to ensure the successful care of a shark. Let's review some of these specific elasmobranch care techniques in detail.

## The Tank

One inherent difference between the sharks available to the aquarist and most other reef fish available on the marine fish market is size. This is an especially important difference when you are considering a tank in which to house your shark. Most elasmobranchs need space to carry out their normal activities (feeding, moving). Therefore, when it comes to a tank for these fish, bigger is not only better, it is essential. If you cannot afford or don't have room for a big tank (100 gallons and up), you should give up the idea of maintaining most shark species for their entire life span.

The amount of time a shark will live in your aquarium is directly proportional to the size of your tank (a large tank will allow you to maintain your shark longer). Keep in mind when purchasing a tank that surface area, not volume, is the most significant consideration. Not only does increased surface area mean better gas exchange and more area for biological filtration (if an undergravel filter is to be used), but it also translates into more usable living space for your shark.

## The Filter

As with bony fishes, it is important to maintain good water quality to sustain the optimal health of your shark. There are a number of different filtration methods that can be employed to regulate the build-up of nitrogenous waste products. An undergravel filter, either set up in the conventional fashion or "reverse-flow" (pumping water down instead of up the lift tubes), will suffice. The popular wet/dry filters (most often used for keeping sensitive invertebrates) can also be used to maintain excellent water parameters. If you do use an undergravel filter, it may pay to silicon cement the uplift tubes to the undergravel plate — some shark species are very proficient at unseating these tubes, causing gravel to pour under the filter plate.

Canister filters filled with materials that provide good substrate for nitrifying bacteria growth will also ensure adequate biological filtration. For example, I have employed two large canister filters on a 60-gallon tank that was the temporary home to a juvenile nurse shark with good results. One advantage in using an external filter, such as a wet\dry or canister filter, is that there is less clutter to impede your elasmobranch's movement and it makes it easier to use finer substrate that is more suitable for rays to bury in.

## The Substrate

Another important item in the shark tank is the bottom material used as substrate. The ideal substrate for all sharks and rays is a small-size grade of coral sand, silica sand or "beach" sand. In fact, for some species that bury themselves or spend lots of time laying on the bottom, finer substrates are a prerequisite. The larger grades of crushed coral and dolomite can irritate the bottom surface of the animal and cause bacterial infections. You may have observed specimens with reddened "bellies," which is a result of irritation caused by such materials.

This is especially a problem with stingrays and electric rays. Sharks might also inadvertently ingest sharp pieces of substrate that can damage the digestive tract (Gruber and Keyes 1981). I have had success keeping many sharks in tanks with substrates consisting of the more readily available grade of crushed coral. These more durable animals include horn sharks, nurse sharks, bamboo sharks, epaulette sharks, wobbegongs and smooth hound sharks.

## Aquascaping

One of the most significant differences between a tank that houses bony fish and one that houses an elasmobranch is the

decor. In a typical reef fish aquarium, the goal is to try to duplicate the highly structured reef environment in order to create hiding places and to make the tank look like a reef. But in the shark tank, decor should be kept to a minimum. In the case of horn sharks, wobbegongs, nurse sharks, bamboo sharks and epaulette sharks (species that spend most of the daytime hours concealed in reef crevices), a coral cave or a rock ledge can make these sharks feel more secure and help them to settle in more quickly.

In contrast, more active species may collide with decorations and abrade or damage their skin, which can lead to lethal bacterial infections. Therefore, in the case of species such as the leopard shark, grey smoothhound shark and most rays, aquascaping should be excluded. Even in the case of inactive species, a more conservative approach to aqauscaping will provide increased room for movement.

Elasmobranch Problems

Unfortunately, as with the bony fishes, the untimely death of sharks in captivity is often the result of bacterial and/or parasitic infections. Elasmobranchs are hosts to a diversity of different parasites, including tapeworms, monogean flukes, copepods (there are more then 200 species that parasitize elasmobranchs), isopods and protozoans (including the dreaded Cryptocaryon irritans).

The symptoms of parasitic infestations include chaffing on the bottom of the tank, frequent yawning and skin discoloration (Gruber and Keyes 1981). Flukes and copepods can often be seen with the naked eye. Flukes appear as opaque, oval-shaped organisms on the body surface, whereas copepods often have armored heads and bodies with an elongate tail. Fluke outbreaks may lead to serious secondary bacterial infections that can kill captive elasmobranchs quickly. On the other hand, copepod infections usually do not become deadly with the same rapidity.

The most effective way to treat specimens with parasite problems is with dylox or by giving your shark or ray a formalin bath (1 milliliter of formalin per each gallon of water for one hour). Be sure to aerate the container while giving the bath. In less severe copepod infections, the parasites can be carefully picked off with tweezers or, even better, a cleaner wrasse can be employed as a biological control of crustacean parasites.

If you were treating a bony fish for a parasitic infection, you would probably use a copper-based medication, but copper can interfere with the feeding behavior of some sharks, "jamming" their keen electrical sense. The minute pores visible on the underside of the snout and around the mouth are openings to the small organs responsible for sensing electric fields. These electroreceptors are extremely sensitive to voltage gradients. With this sensory capability, a hunting shark can detect the weak electric field produced by a respiring flounder at a distance of several feet. A metallic ion, like copper, will jam these electrosensors. However, not all sharks are sensitive to copper. For example, wobbegongs, nurse sharks and epaulette sharks can be kept in water treated with copper with no apparent ill effects.

Probably the most common shark pathogens are viral and bacterial in nature. One of these bacterial infections, known as Vibrio, is initially visible as small, white lesions on the skin. These erupt into open sores, and, if prompt treatment is not administered, death is quick to follow. This infection has been effectively treated with chloramphenicol or tetracycline (Gruber and Keyes 1981). Sharks can also succumb to fin and tail rot, a bacterial infection also common in bony fishes. This is usually the result of a bad aquarium environment or improper handling and can be treated with nitrofurazone (Gruber and Keyes 1981).

Health problems as a result of nutritional deficiencies are also encountered in captive elasmobranchs. There are numerous stories of shark stomachs yielding odd contents, such as boots, nails, bottles and so on. Although many sharks feed on a wide range of animal prey, inorganic material is rarely included on the bill of fare of most sharks and rays. In their natural environment, the species generally kept in home aquariums will consume bony fish, squid, octopi, crustaceans, worms and clams.

When it comes to feeding sharks in captivity, a varied menu will help ensure that they receive a proper diet. Fresh seafoods, such as crab, shrimp, scallop and fish, are ideal staples for these animals. Problems can arise if you feed your shark only frozen foods. Frozen foods may be "stripped" of some of their nutritional value during the freezing process. Therefore, exclusive use of such foods can result in dietary deficiencies unless vitamin supplements are given. Vitamin B deficiencies in lemon sharks can result in curvature of the body, slight raising of the head and continuous circular swimming (Gruber and Keyes 1981). This problem can be rectified by placing vitamin B tablets in the fish's food.

Shark and ray "fasting" is another problem related to nutrition that is especially common in newly acquired specimens. Live glass shrimp, fiddler crabs and mollies can be offered to encourage new animals to begin feeding. If these delicacies are

not eaten, anorexic specimens can be enticed to feed with fresh seafood impaled on the end of a piece of thin, rigid plastic tubing. Place the food right in front of the fish's sensitive nose, but do not be aggressive in the presentation (i.e., hit the shark in the face with the food) or the food will be refused. With wobbegongs, lightly touch the barbels in front of the mouth — this will usually trigger a feeding response.

Many sharks and rays are nocturnal. Thus, presenting food at night may aid in starting food intake. One method that I have used is to make incisions in a small goldfish, bury its tail in the sand and turn off the lights for the evening. In the morning, promptly remove any fish remains. Note that it is not uncommon for some of these animals to go through a one- or two-week settling in period during which they will not accept food. As long as they are in good health when purchased, these animals should not be adversely affected during this adjustment period.

Sometimes cessation of feeding will occur in long-term tank residents if the water temperature drops (nurse sharks have been reported to stop feeding at temperatures below 68 degrees Fahrenheit) or if the water quality deteriorates. The sudden refusal to eat may have no apparent reason. There are reports of captive sharks that stop eating for several months, only to resume feeding as suddenly as they stopped (Clark 1963).

Besides death due to disease and dietary deficiencies, shark mortalities may also result from aquarist negligence. Smaller sharks can be injured or killed by being sucked up filter intake tubes. It is important to place strainers on siphon tubes when keeping juvenile sharks. Juvenile bamboo sharks, because they are available at a small size and are of a slender build, are especially prone to this type of accident.

Unstable ledges or caves can result in a shark being crushed. Some of these animals are proficient diggers and can topple poorly structured rock work. Sharks will sometimes ingest pieces of aquarium equipment carelessly left in the tank, and this can impede feeding or cause damage to the internal organs. For example, I had to extract the suction cup from a heater holder from the gullet of a customer's nurse shark.

Another unusual cause of death in sharks, documented in public aquariums, is the laceration of the intestine as the result of other sharks biting it (Howe et al. 1989). How does one shark bite the intestine of another? When defecating, sharks will sometimes envert the posterior portion of the alimentary tract out of the cloaca. At this time other sharks may chase the defecating animal and bite the protruding intestine. Aquarists who keep more then one shark in the same aquarium should be aware of this behavior.

## Feeding

Many of the sharks readily available to the aquarist can grow to more than 3 feet in length. Because most aquarists cannot provide suitable housing for such large specimens, the shark inevitably outgrows the aquarium (or checkbook) of its owner. You can delay the inevitable by not overfeeding your shark. In nature, most sharks eat very little and grow slowly. Studies conducted both on captive and wild sharks have shown that to maintain good health a shark eats only 3 to 14 percent of its total body weight (t.b.w.) in food per week (Clark 1963).

As an example, consider Skipper, a 336-pound grey nurse shark (Eugomphodus taurus) that used to live at the Taronga Park Zoo in Sydney, Australia. This shark ate from 170 to 200 pounds of fish each year, which calculates to be only 0.9 to 1.1 percent of its t.b.w. in food per year. Skipper's food intake varied from 0.3 percent t.b.w per week in the colder months to 3 percent in the summer (Whitely 1940). Let's consider a more applicable example. A nurse shark I kept weighed approximately 12 ounces. A 2-inch goldfish tips the scales at about 0.1 ounce. If this shark must consume 5 percent of its t.b.w per week, it would need only six 2-inch goldfish each week.

The amount you feed your shark will also vary depending on the species and the water temperature. The inactive types (e.g., the wobbegongs) can be fed once or twice a week, whereas more active species (e.g., leopard shark) should be fed more often. Also, the lower the water temperature, the less you will have to feed a shark (remember Skipper above), because these animals maintain the same body temperature as the surrounding water. Their metabolism increases as water temperatures rise. Finally, remember to remove uneaten food immediately to avoid pollution problems.

## Tankmates

When considering tankmates for a shark or ray, two things must be considered. First, will the prospective addition injure your shark or ray? Most aquarists don't think of other fish as being a threat to a shark, but triggerfish, large angelfishes, wrasses and pufferfishes may maim your shark or ray, and groupers will eat them if they are small enough to be ingested.

Examples of bony fish inflicting mortalities include a blue angelfish (Holacanthus bermudensis) that blinded a horn shark by nipping its eyes, and a queen angelfish (H. ciliaris) that bit and caused the death of a chocolate-chip ray. It was also reported to me that butterflyfish will nip and damage wobbegongs in captivity (M. Brown, personal communication).

Care must be exercised when mixing shark species in the same tank. Nurse sharks and wobbegongs will eat other elasmobranchs — even members of their own species — that are small enough to be swallowed. Although a relative rarity in elasmobranch populations, aggression between species could be a problem in captivity. For example, adult male wobbegongs are reported to fight during the breeding season (Whitely 1940), and I have observed aggression between male round stingrays during the mating period.

The more obvious thing to consider when selecting shark tankmates is whether the animal selected is potential prey for your shark. Smaller fish can become food for many sharks, and the more voracious species (e.g., wobbegongs, nurse sharks) will consume or maul relatively large tankmates, such as moray eels (another predator often selected to be kept with a shark). Smaller anemones, crabs and shrimps, clams, sea stars and urchins may fall prey to a hungry shark, although larger crabs are good scavengers to include to clean up the leftovers. Some of the cleaner shrimps and cleaner wrasses can be kept in a shark tank, and will even be allowed to pick at the shark's skin, but they should be introduced before the shark to reduce the likelihood that they will be mistaken as food.

Reproduction In Captivity

There is a lack of information available on the reproductive behavior of sharks and rays, but a lot of what is known has come from aquarium observations. Yes, breeding certain sharks and rays in the larger home aquarium is a real possibility! There are several elasmobranch species available to the aquarist that have mated in captivity, and although most of these mating events have occurred in large public display tanks, some have reproduced in relatively small public aquariums (200 gallon tanks).

Probably the most ideal candidate for captive breeding is the epaulette shark. This species has reproduced consistently in a number of public aquariums (J. West, personal communication). Several of the bamboo shark species have also mated and laid their leathery egg cases in captivity with regularity. The yellow, round and chocolate-chip stingrays do well in captivity. They mature at smaller sizes and should be considered as good candidates for aquarium reproduction.

The courtship and mating behavior of elasmobranchs can be as complex as that seen in the bony fishes. One universal trait is that the male bites the female to elicit her cooperation and to hold her during mating. The male will usually grasp one of the female's pectoral fins in his mouth and then either wrap the posterior part of his body around her so that a clasper can be inserted (bottom dwelling sharks) or flip under the female so they are belly to belly, at which point intromission occurs (stingrays). In the round stingray, a species I have studied, copulation lasts from three to more than 11 minutes. In the horn shark, mating may last as long as 35 minutes (Dempster and Herald 1961). Captive shark and ray breeding programs can give us insights into the biology of these little-known animals and can help reduce collecting pressure on wild animal populations. Therefore, I would encourage those of you with larger tanks to give it a shot! In part two we will look at the best species for life in captivity.

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