Venom Runs Thick in Fish Families, Researchers Learn

By DENISE GRADY

One moment he was reaching for the telephone, the next he was out cold.

William Leo Smith, then a 20-year-old college student, woke up on the floor of the pet shop where he worked, blinking up at a ring of worried faces and feeling as if he'd been stabbed in the hand.

Actually, he'd been stung by a fuzzy dwarf lionfish — a dead one, no less. Someone had thrown it away, and Mr. Smith did not notice it when he tried to retrieve a telephone that had fallen into the same trash can. A row of spines along the fish's back, armed with venom, jabbed him.

Today, a dozen years later, Mr. Smith is Dr. Smith, an ichthyologist at the American Museum of Natural History in New York, with an abiding curiosity about venomous fish. They are, he contends, undercounted, misunderstood and sadly unappreciated — an untapped resource for “bioprospecting” to find drugs among their thousands of venoms. Not many of the venoms have been studied, even though they can play havoc with crucial functions like blood clotting, nerve and muscle activity, blood pressure and heartbeat.

Although previous researchers estimated that there were about 200 species of venomous fish, Dr. Smith and Ward C. Wheeler, a curator at the museum, recently published a study suggesting at least 1,200. Many carry their venom in spines and barbs, some in fangs. Though the 1,200 species are not new, scientists did not know they were venomous. Now, biologists may need to rethink some of their old ideas, Dr. Smith said. “With very few exceptions, everything we thought was wrong,” he said.

The study, published in June in The Journal of Heredity, analyzed and compared DNA sequences from 233 species and used the results to create a new family tree for spiny-rayed fishes. That group includes many types of toadfish, scorpionfish (lionfish are a type of scorpionfish), surgeonfish, rabbitfish, jacks, stargazers and saber-toothed blennies.
The family tree shows how the species are related, and which evolved from the same ancestor. Based on the tree, the researchers predicted which species should be venomous. Then, to test their predictions, Dr. Smith dissected 102 specimens, looking for venom glands and delivery systems like spikes, fangs or sharp fins.

Of the 102 species he examined, previous research had suggested that 26 were venomous. But the new analysis predicted that 61 would be venomous — and the dissections bore that out.

“The world of vertebrate toxins will need some reordering,” Dr. Wheeler said.

Dr. J. Andres Lopez, an ichthyologist at the Florida Museum of Natural History in Gainesville, said the study was the first effort in almost 20 years to understand the evolutionary relationships among venomous fish. He said the new family tree could help guide researchers who want to study particular types of venom.

“In a way, it’s a call for the biologists interested in the biological properties of animal toxins to go out there and start exploring this,” Dr. Lopez said. There are huge information gaps in ichthyology, Dr. Smith noted, and every year biologists find 200 to 300 species that had not been known before.

“We really don’t know anything about fish,” Dr. Smith said.

Most venomous fish come from the Indo-Pacific, off eastern and southern Africa, Australia, Polynesia, the Philippines, Indonesia and southern Japan. About 50,000 people a year suffer from stings, or envenomations, with an array of symptoms like pain, fainting, blisters, fever, convulsions, breathing trouble and sometimes even death.

Venomous fish tend to be either flamboyant, with intense colors to warn their enemies, or “complete camouflage experts” that bury themselves in the sand, “and if you step on them, you’re nailed,” Dr. Smith said.

Apart from obvious uses like defense and hunting, Dr. Smith said venom might also have evolved because it helped bottom-dwelling fish to kill bacteria trying to invade their skin.

The most dangerous venomous fish is the stonefish, which buries itself and has a venom that can be deadly. The spikes on its back are “basically, hypodermic needles,” Dr. Smith said, adding that the stonefish actually has control over whether to shoot its venom, which it does when frightened or provoked. Other species, like the lionfish, cannot release the venom unless something strikes their spines.
Lionfish, though not native to North America, have made themselves at home in the ocean around Florida and have begun working their way north, even as far as New York, off Fire Island, in late summer. They are pretty, and popular with some aquarium owners. Dr. Smith figured they probably took hold in American waters after being imported by wholesalers in Florida, kept in outdoor pools and then washed into the ocean by a hurricane.

Lionfish are also ornery, Dr. Smith said. They will dart at scuba divers and slam their venomous spines right into the facemask. Web sites warn that lionfish will even spike the friendly hand that cleans out their tank. If the spines puncture flesh, they break off and leave painful fragments in the skin along with their chemical weapon.

The pain can be intense. The best treatment is to immerse the wound or run it under very hot water for at least 30 to 40 minutes. The idea is not to wash away the venom, but, essentially, to cook it. Made of protein, venoms can be broken down by heat.

One of Dr. Smith’s favorite venomous fishes is the stargazer, which buries itself and can fire electric shocks as well as venom. In some cultures it is a delicacy (cooking destroys the venom, and so does the human digestive tract), and Dr. Smith has seen it for sale in fish markets in Chinatown in Manhattan, with the electric organ carefully ripped out by fishermen.

Dr. Smith bought a small stargazer recently from a pet supplier, and he keeps it in an aquarium in his lab at the museum, where it hides under a pile of sand until he gently digs it out (with a probe, to avoid being shocked) to show visitors its scowling snout before it can furiously rebury itself.

“They’re the meanest things in creation,” he said delightedly. “I was so excited to get it. It’s the worst pet on earth.”
Biologists are taking a new look at venomous fish like the lionfish, above, the stonefish and the stargazer.