

A Sea Urchin's Garden

“We can scarcely hope ever to watch the habits of the deep-sea dwellers and see them in their natural attitudes, and we must be satisfied to imagine what these are by analogy with their shallow-water allies.”

—Alexander Agassiz, 1888

By JULIE ANN MILLER

Sea lilies crawl on featherlike arms. Brittle stars slither by tiptoeing rapidly on hundreds of little tube feet. These surprising behaviors, and an unexpected number and diversity of deep-water animals, were recently observed for the first time on the vast underwater mountains that support the Bahamas.

“We have found an incredible ‘Garden of Eden’ of echinoderms doing all kinds of incredible things,” says David L. Pawson of the Smithsonian Institution’s National Museum of Natural History in Washington, D.C. The echinoderm phylum includes starfish, sea urchins and their aptly named relatives — brittle stars, basket stars, sea cucumbers, feather stars and sea lilies.

A specialized underwater vessel made these explorations possible. It can perch on very steep underwater slopes, and its forward chamber, a clear plastic sphere, allows 180-degree visibility. The submersible, the Johnson-Sea-Link II owned by the Harbor Branch Foundation Inc. in Fort Pierce, Fla., can dive to 2,640 feet. It was equipped for the biological expeditions with a device for gently plucking animals off the sea floor, a laser-aimed camera for still photography and a sophisticated video camera specially designed for underwater operation. Led by John E. Miller of Harbor Branch, the Smithsonian biologists—Pawson, Porter M. Kier and Gordon L. Hendler—made three cruises in 1983 and 1984, with a total of 41 dives.

“The Bahamas are a unique area because of the incredibly steep rock profiles, which make it hard to study,” Pawson says. But the sharp slope makes for less bottom sediment, so it is a good place to find echinoderms that like to live on rocky, rather than muddy, surfaces. Down to depths of 1,000 feet, there is sometimes also a lacy, diffuse form of coral, which feather stars use as a perch or as protection.

Pawson says the biologists chose the area for study because geologists doing underwater explorations had occasionally brought back an interesting starfish or sea urchin, although no one had reported the abundance of echinoderms. Given the geologists’ focus, their relative blindness to animals was not surprising, Pawson says. “I saw more than a hundred species of echinoderms doing their thing, but I didn’t see one rock down there,” he quips.

The Bahamas expeditions were truly a bonanza to the scientists who study echinoderms. “We collected about 120 species,” says Miller. “A lot of these were very rare species that had previously been seen only one or two times. Five to 10 of the species are probably new to science.”

Most of these animals are small enough to be held in the palm of a hand, “although the arms may drape down quite a bit,” Miller says. Typically the animals span up to 12 to 18 inches with their arms extended. Only those larger than a half-dollar could be viewed consistently from the submersible.

“The most important aspect is that we could observe just what the animals are doing for a living,” Miller says. “This is the first time many of these animals have been seen in their own habitat.”

The newly observed at-home behavior of deep-water echinoderms was not always what one would expect from studies of the shallow-water varieties. “The most startling thing,” Pawson says, “was the way these animals move.”

Some echinoderms whose shallow-water relatives never seem to move at all actually turned out to be mobile in the depths. For example, scientists had believed that sea lilies, the only echinoderms attached to the seabed by a stalk, were completely sedentary throughout their adult life.

“But sea lilies placed on the ocean floor after removal from their perch often used their featherlike arms to crawl,” Miller says. He suggests these animals may be able to seek out a new rock and attach themselves using hooklike structures on their stalks.

Brittle stars, too, were seen to move in quite unexpected ways. These creatures, which have long, flexible arms that can break off, have been known to move with a rowing action. They throw



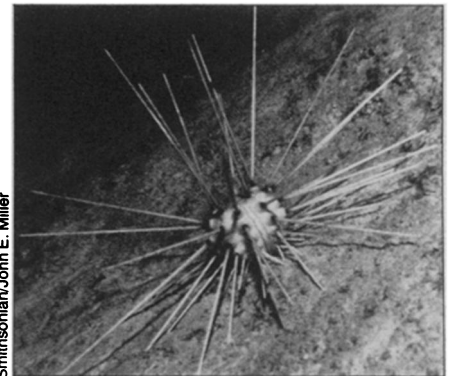
Smithsonian/John E. Miller

This starfish, photographed at a depth of 1,500 feet, is light tan with brown mottle and about 8 inches across from tip to tip.



Smithsonian/John E. Miller

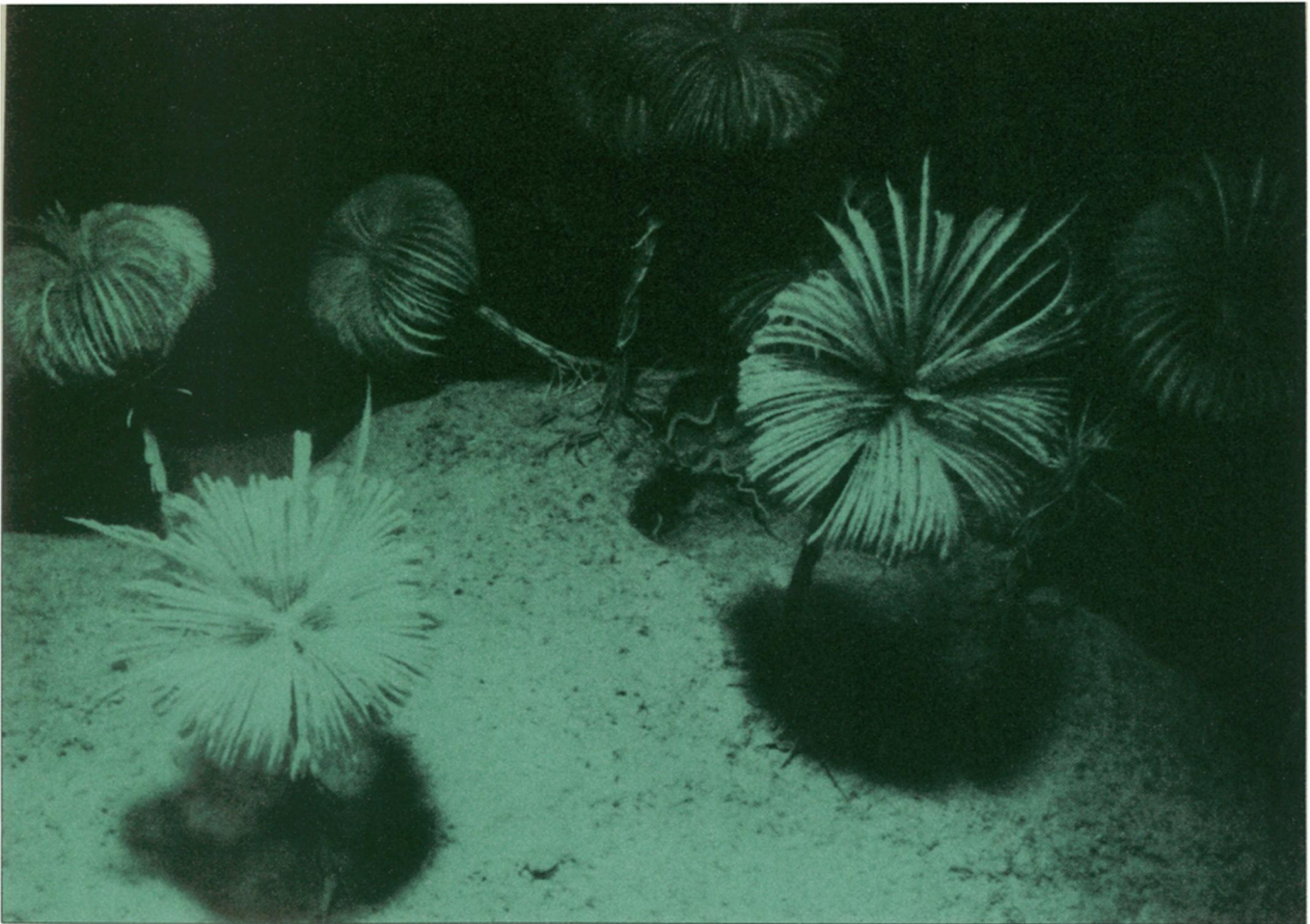
This sea lily, photographed at a depth of 1,900 feet, has its arms open wide for catching small animal prey drifting in the ocean currents. It is about 1 foot tall and has hooks at the base of its stalk to hold onto the bottom. At its base is a brittle star (the haze around its arms is made up of long, slender spines). Various echinoderms commonly perch on the base of stalked crinoids such as the sea lily.



Smithsonian/John E. Miller

This long-spined sea urchin, observed at a depth of 2,100 feet, is cream-colored with maroon at the base of the spines and circling the body. The body is the size of a tangerine, and the spines make the animal about 12 inches across from tip to tip.

Smithsonian/John E. Miller



A "garden" of sea lilies feed at a depth of 1,400 feet on the slope of the underwater mountains supporting the Bahamas

forward the arms on the leading side, grasp the bottom and then pull. In the depths of the Bahamas, however, the scientists observed two species of brittle stars that use a different motion. They propel themselves with a whiplike swimming style, moving all five arms up and down in synchrony.

One brittle star was even seen to employ a scooting motion. Holding its arms perfectly still, it slid across the bottom. Careful study of the videotapes revealed that the animal was actually tiptoeing rapidly on the hundreds of tube feet that cover the lower surface of its arms. Starfish, but not brittle stars, had previously

been known to use their tube feet for locomotion.

New uses for various structures of the echinoderm body were also discovered. One brittle star species with spines on its arms was seen to position the arms in a basket arrangement, apparently to entrap small creatures as food. Some of the deep-water sea urchins also have extremely long, slender spines, which the researchers think are used to keep the animal from rolling down the steep slopes of the undersea mountains.

A puzzling set of structures has been observed on yet another species of sea urchin: small, balloon-shaped sacs posi-

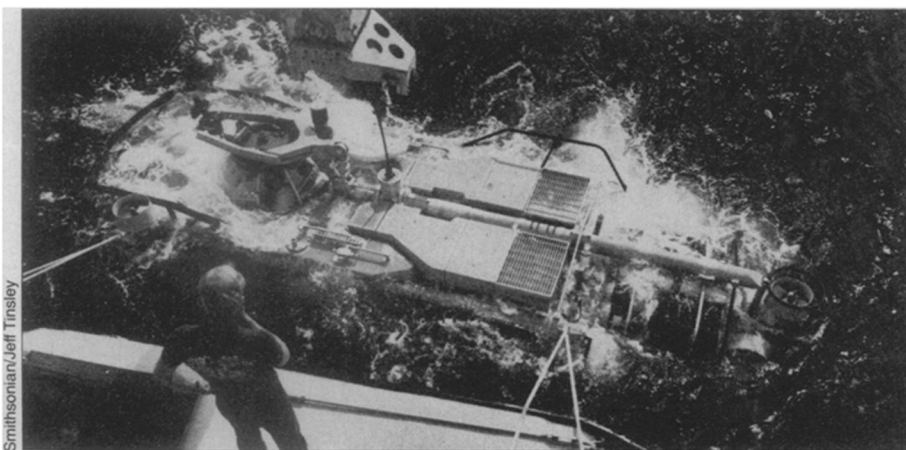
tioned on its spines. The sacs are made of connective tissue. "They seem like seedless grapes without the skin," Miller says. "When the animal crawls across the sloping bottom rapidly, the sacs wave erect as in a breeze. Maybe they lend some sort of buoyancy to keep the dorsal [back] side up as the animal crawls in its very clumsy manner."

The advantage of using the submersible, Pawson says, is that "you can look at an animal, photograph it, videotape it, pick it up, put it in a laboratory and then put all this information together.

"There are millions of things you can now do — a lot of simple experiments, in addition to more surveys. We could learn an incredible amount about how these animals live, eat and get around."

The scientists would like to make future dives, but are limited by the cost of using the submersible — about \$10,000 a day. "We feel as if we've just touched the tip of the iceberg," Miller says. "Why do we see so little evidence of predation? What do [the animals] eat? Where are their young?"

The group is now compiling a Bahamas echinoderm atlas, including several hundred color photographs, to inform other investigators of the animals' distribution, adaptations, evolution and behavior. Says Hender, "Looking at a brittle star specimen in a museum collection... well, how could you possibly imagine what those arms were doing when the animal was alive? Now we know!" □



Smithsonian/Jeff Tinsley

The submersible, attached to its mother ship by ropes and crane, prepares for a dive. A scientist can be seen looking out the windowed dome or "fishbowl compartment" of the vessel.