Sea Frontiers 23(2) 84-89 Mar.-April 1977

Deep-Water Corals

By Stephen D. Cairns

The term *stony coral* usually brings to mind images of elkhorn coral, brain coral, or star coral, all of which are colonial and commonly found on the warm, shallow-water West Indian coral reefs. It might surprise many people, however, to learn that, in the Atlantic Ocean, there are almost twice as many species of deep-water corals that live at temperatures approximating polar conditions, far below the depth that light penetrates, and where there is often very little food. They have adapted to the cold, dark abyssal conditions by eliminating the symbiotic algae common in shallow-water coral species, by slowing their metabolism, and by often assuming a solitary growth form. Instead of forming a massive head with millions of individual mouths, or polyps, as star coral does, for example, a deep-water coral is usually composed of one polyp. It is rarely larger than an inch in diameter and sometimes as small as 1 millimeter across. These beautifully symmetrical and delicate corals, which number over 100 species in the Atlantic Ocean alone, are known as ahermatypic corals.

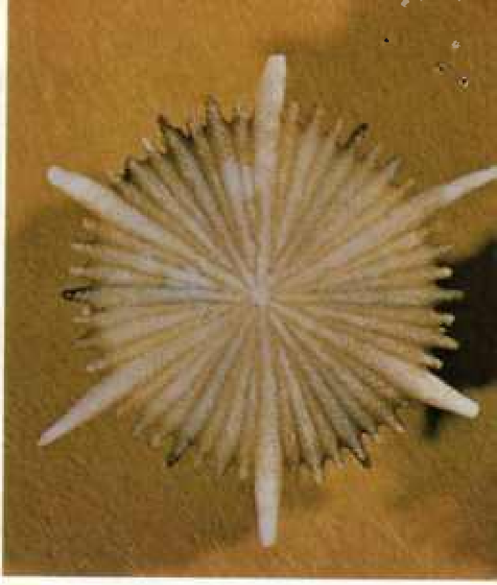
Ahermatypic corals live in deep water at the evolutionary expense of the symbiotic relationship with algae. In contrast, hermatypic corals, which always live in shallow water, have millions of tiny, unicellular algal cells, or zooxanthellae, in their tissue, giving them a brownish color when alive. The coral and algal cells live in an intimate symbiosis: the algae gain protection and nutritious waste products from the coral, while the coral gains oxygen from the algae as well as having carbon dioxide and other toxic wastes removed from its tissue. Most important, however, the coral is able to calcify faster as the result of the possession of zooxanthellae.

Obviously, zooxanthellae, which require light to photosynthesize, cannot exist in water below light penetration and, therefore, only ahermatypic

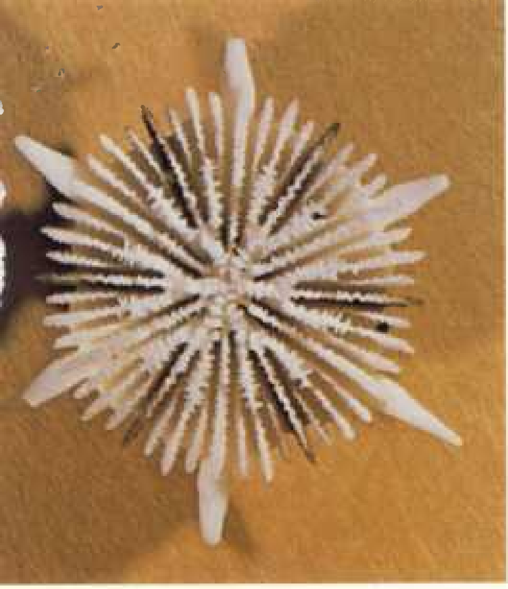
Warm, shallow waters *are popularly thought to be the habitat for corals. Yet, there are more than 100 species of corals thriving in deep, dark, cold waters in the Atlantic alone. One of these is* Javania pseudoalabastra, *which was first described by biologists as recently as 1973.*

All photographs by the author

1 inch = 2.54 centimeters.

KNOWN AS AHERMATYPIC CORALS, *these cold-water residents are usually composed of only one polyp, instead of forming a massive head with millions of polyps as do most of their warm-water counterparts. The top (left to right) ahermatypes are a delicate thin-walled* Flabellum; *a 12.5-millimeter-diameter* Deltocyathus calcar; *and a 60-millimeter-diameter specimen of* Stephanocyathus diadema, *one of the largest solitary corals known. Above is* Caryophyllia maculata *which, when alive, resembled a squat sea anemone and, at the right, is* Asterosmilia marchadi, *the outer wall of which had been carefully dissolved by a small crab to form niches.*



corals can exist at such depths. Without the aid of algal cells to help calcification, ahermatypes are, for the most part, solitary, very small, and have a slow growth rate—perhaps 1/5 that of hermatypes. The advantages gained by the loss of zooxanthellae have enabled the ahermatypes to colonize the depths of the world oceans, however, since temperature, light, and depth—limiting factors for the algae—are not limiting factors for the coral. Consequently, ahermatypic corals are found in all tropical, temperate, and polar seas (except the Arctic), thriving in temperatures as low as -1.1°C and depths of 5,800 meters.

Exceptions do occur to the generalities discussed above. For instance, some deep-water ahermatypes are colonial in growth form, but with many fewer polyps per square inch than hermatypes. Also, some ahermatypic species have colonized shallow-

-1.1°C = 30.2°F; 5,800 meters = 19,024 feet.

water environments; they live in sunlit waters but do not contain zooxanthellae.

Ahermatypic solitary corals serve as simple models for the more complex, colonial reef corals, since each solitary coral is composed of only one unit, one mouth, whereas colonial corals are many-mouthed, or polystomous. For instance, a large solitary ahermatype, such as *Stephanocyathus diadema* (translated literally means "crown-cup diadem"), very clearly shows the radial symmetry and hexameral partitioning of the corallum, whereas a large hermatype, such as brain coral, *Diploria*, may contain millions of polyps in which the hexameral and radial symmetry is often obscured.

Most solitary corals have six thin calcareous partitioning walls, or septa, that are much larger than all the rest and subdivide the polyp into six sections. These six septa are the first ones formed in early development. A second set or cycle of six septa are next to form, one septum between each of the first-cycle septa. The third cycle that develops has 12 septa, which are formed in every space created by the first- and second-cycle septa. As the coral increases in size, each additional cycle doubles the total number of septa in the coral. Solitary corals with over 700 septa are known. In all, the symmetrical and orderly development of septa often produces a very beautiful geometric arrangement.

A Little-Known Fauna

Count Louis Pourtalès, associated with the Museum of Comparative Zoology, Harvard University, was the first oceanographer to systematically collect and study deep-water corals in the 1860s and 1870s. Since very few animals were even known to exist deeper than 200 meters in 1867, virtually every coral, indeed almost every animal dredged by Pourtalès, was new and undescribed. He personally described 59 new species of corals. The deep-water coral fauna is still not completely known despite the discovery of 22 new species last year by the author of this article.

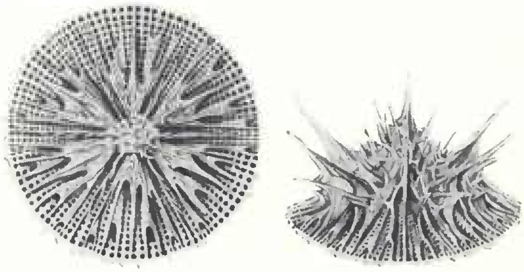
Ecology and physiology of these corals are even less well known. When collected, specimens are sometimes dragged slowly through several thousand meters of water, which changes 10° to 20°C, usually killing the animal and often stripping the flesh away. It is no wonder that aspects of reproduction, feeding, metabolism, growth rate, and age are completely unknown. It is not inconceivable that large solitary corals may be decades or even centuries old. To study the physiology of these delicate deep-water corals, it will be necessary to transfer them to a pressurized, low-temperature aquarium on board immediately after capture, or capture them in containers that maintain the great pressure and low temperature during the ascent to the surface.

In 1875, the British naturalists aboard H.M.S. *Challenger* collected a very delicate ahermatypic coral from abyssal depths (3,950 meters) off Valparaiso, Chile. Shortly after *Challenger* returned to England, H. N. Moseley, one of the naturalists who participated in the cruise, described the coral as *Leptopenus hypocoelus*, then the deep-

200 meters = 656 feet; 10° to 20°C = 50° to 68°F; 3,950 meters = 12,956 feet.

est coral ever recorded. The generic name *Leptopenus* is created from the Greek *leptos* meaning "delicate" and *penos* meaning "web," which is an appropriate name for this small coral about an inch in diameter, perforated by hundreds of holes. Specimens of this species have never been collected since. Specimens of its relative, *L. discus* ("delicately webbed disc"), have been collected three times since its original discovery by *Challenger*, however, always in depths exceeding 2,000 meters. In 1904, the American research vessel *Albatross* collected a living coral from 5,869 meters off Peru. It was named *Fungiacyathus marenzelleri* in honor of the German coral systematist Emil von Marenzeller. This species now holds the title of the deepest known species of coral.

From the Challenger Report



ONE OF THE DEEPEST *known species of coral,* Leptopenus hypocoelus *was collected by H.M.S.* Challenger *at a depth of 3,950 meters. It has never been collected again since its original discovery in 1875.*

Virgin Territories

Although most ahermatypic corals are small and solitary (some are only as large as the head of a pin), some form large, bushy colonies over a meter tall. In some areas, these colonies are so abundant that they form dense "thickets" or coral banks. These deep-water coral banks have been known from the eastern Atlantic for over 100 years, but were reported in the western Atlantic from the Gulf of Mexico for the first time in 1960. Another bank, reported here for the first time, is located just northeast of Fort Lauderdale, Florida (26°22′N, 79°35′W, at a depth of 738 to 761 meters) in the center of the Straits of Florida.

Investigation of deep-water banks promises to be just as exciting as shallow-water coral-reef biology. Besides the three to four branching ahermatypes, which form the framework of the banks, there are at least six associated solitary species and a great variety of other invertebrates, such as gorgonians, black coral, sponges, barnacles, hermit crabs, gastropods, sea stars, crinoids, brittle stars, and sea urchins. Because of the difficulty and expense of trawling at such great depths, very little is known about the community structure of a deep-water bank. It is still virgin territory—even a cataloging of species is far from complete. Undoubtedly, this community will prove to be a fascinating frontier to those scientists who are able to observe live specimens from a bathyscaphe or collect them in a pressurized tank.

1 inch = 2.54 centimeters; 2,000 meters = 6,560 feet; 5,869 meters = 19,250 feet; 1 meter = 3.28 feet.