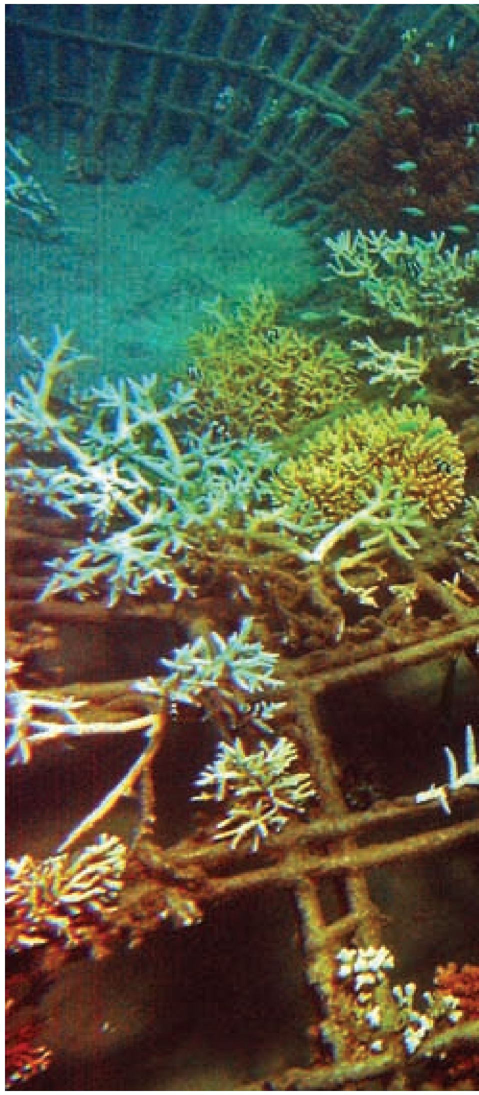
Electric Reefs



The experience is somewhere between diving on a coral reef in an aquarium and diving on a real coral reef. It is manmade and nature-enhanced; it is unusual and intriguing, thought-provoking and just plain odd.

The shapes look like tunnels, exotic hats and igloos, their shapes defined by steel rods. The architecture and pattern of the frames remind me of flower fields or lettuce gardens planted with coral instead of leafy greens.

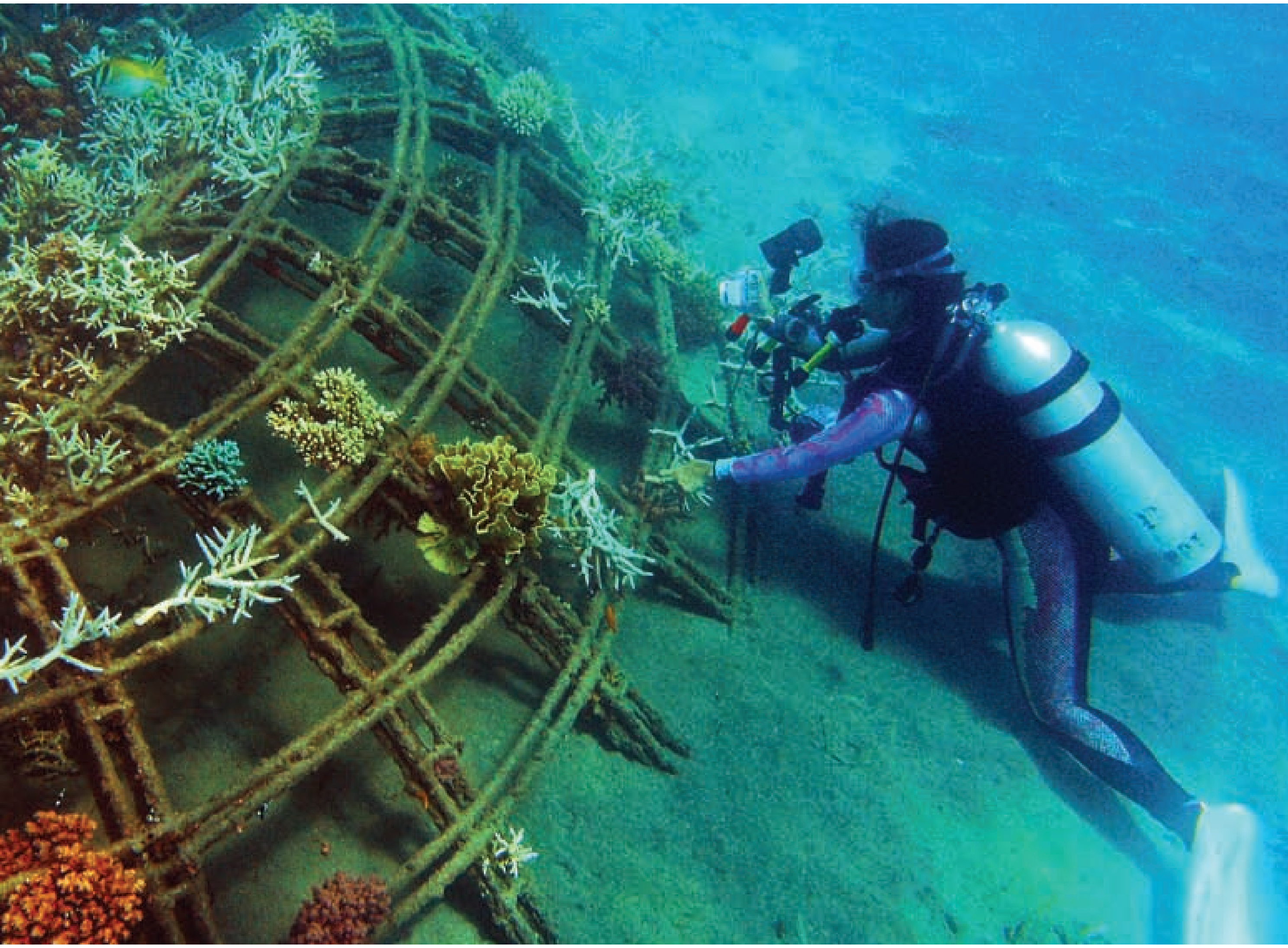
Although the coral contraptions and the coral fixtures are unusual, what is perhaps most peculiar to me is that the entire collection of structures is being energized by a small electric current.

The devastation of an El Niño

In 1998, a devastating coral bleaching caused by unusually warm waters of an El Niño hit coral reefs around the world, including the reefs of Pemuteran Bay off the coast of Bali. Within two years, the Karang Lestari Project was born. Its supporters eventually installed 22 underwater structures, creating an electric reef 750 feet (220 meters) long.

The project was the byproduct of some very creative, and equally scientific, collaboration among Professor Wolf Hilbertz, Dr. Tom Goreau, experts in electric reef technology, and several Pemuteran dive operators, area hotels and a number of local villagers. The project was considered by some to be a radical approach to reviving the coral reef. Others, who had confidence in the Doctor and the Professor, as they are known, as well as a greater understanding of the scientific "madness" behind the electrical nurturing of coral, were more supportive.

By Elizabeth Cook
Photos by Robert Yin



Soft and hard corals

A little background about corals and how they grow is in order. There are actually two broad groups of coral. While not exactly scientific, I think of soft coral as being lacey, ladylike animals that include sea fans and sea whips. These are typically the festive, colorful, decorator corals found on the reef.

The other group is the hard or stony corals that produce a limestone exoskeleton; these are the important reef-building corals. Hard corals include the sturdier corals such as brain coral, table coral, and the magnificent elkhorn and staghorn corals.

In addition to the rocklike forms that are the corals' exoskeletons, hard corals are home to colonies of soft, fleshy polyps that manufacture tiny exoskeletons that they use as protection. The resident polyps are diminutive animals, little more than stomachs with tentacles; they typically retract during the day and unfurl at night to grab tiny food particles passing by.

Other than eating, the other major job of polyps is to produce the bony exoskeletons so crucial to replenishing reefs. They do this using a calcium precipitate derived from the sea water. However, without help, polyps are very slow at building reefs and are at risk of being annihilated by major events such as an El Niño.

The secret to building a reef

The secret to polyps' reef-building success is a mutualistic relationship with the microscopic algae call zooxanthellae. The yellow-brown algae take up residence in the polyps, giving the coral color and beginning a cycle of exchange that benefits both.

The zooxanthellae use sunlight and the process of photosynthesis to convert water and carbon dioxide into oxygen and carbohydrates, in essence nutrients and air for the polyps. Polyps do best in water with limited amounts of carbon dioxide and thrive with the levels maintained by the algae. The polyps breathe the oxygen provided by the algae and expel carbon dioxide, which the algae need for the photosynthetic process, and the cycle starts all over again.

During this exchange, the conversion of calcium particles and carbon dioxide into calcium carbonate (a type of limestone) is speeded up. However, when ocean temperatures rise, the zooxanthellae are forced out of the polyps and with their absence, the coral appears "bleached." Left on their own, without the energy and nutrients provided by the algae, the polyps cannot produce fast enough to keep the reef healthy and growing. But with the help of the zooxanthellae, the polyps are able not only to build, but to rebuild after disastrous events like an El Niño.

Making coral grow even faster

So, what if we could make coral grow even faster? Would it be possible to mitigate coral reef disasters? In response to that challenge, Hilbertz and Goreau, collaborators since 1988, developed a technology originally dubbed "mineral accretion" that is now called Biorock™.

Over a period of years, on coral reefs in diverse places such as St. Maarten, Jamaica, the Indian Ocean, Japan, Panama, the Seychelles, and the Maldives, Hilbertz and Goreau set up their Biorock structures. Current for the structures is provided by two electrodes (often served by solar cells or wind-driven generators) that supply low-voltage direct current, which causes minerals in the sea water to precipitate onto the steel frames. The result is that the steel frames quickly become covered with the same limestone that is the basis for coral growth.

Once the limestone accretion establishes itself, pieces of coral harvested from coral nurseries or found broken off from wave action or blasting are then attached to the structures, where they are quickly cemented into place by the accumulating limestone. This is rapidly followed by a full complement of crabs, bivalves, sea urchins and curious fish.

It still is not clearly understood, but for some reason the transplanted corals in this project grow as much as four times faster than they ordinarily do. One hypothesis is that rather than expending energy on creating an exoskeleton, the coral polyps can concentrate on reproduction. And, according to Dr. Goreau, not only are the corals more productive, but they may be able to more easily survive stressful events. A quote attributed to Dr. Goreau indicates that he believes that during the severe coral bleaching that hit the Maldives in 1998 that less than 5 percent of the native coral survived, whereas more than 80 percent of the corals grown on the Biorock structures survived. If so, that would indeed be a compelling argument for further investigation of this technology.

What does the future hold?

Intriguing and thought-provoking, these electric reefs are being scrutinized by scientists and students alike. Although impressive, even ardent fans of the electric reef or Biorock technology agree that it needs to be thoroughly studied in controlled experiments to learn how to maximize the benefits from the technology.

In the meantime, work is under way in some countries testing Biorock systems as cost-effective, artificial breakwaters to help prevent beach erosion. These structures cement themselves to hard substrates and become natural breakwaters or wave barriers. In the Maldives, a 125-foot (38-meter) submerged Biorock breakwater has added 50 feet (15 meters) of beach over the past few years.

More recently, in 2006, on St. Maarten, where tourism is a significant source of income, this environmentally friendly technology is being used in a pilot program that may soon result in a robust house reef where snorkelers and divers can enjoy the beauty of a coral reef and learn about this unique method of gently nurturing nature.

About the Contributors

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