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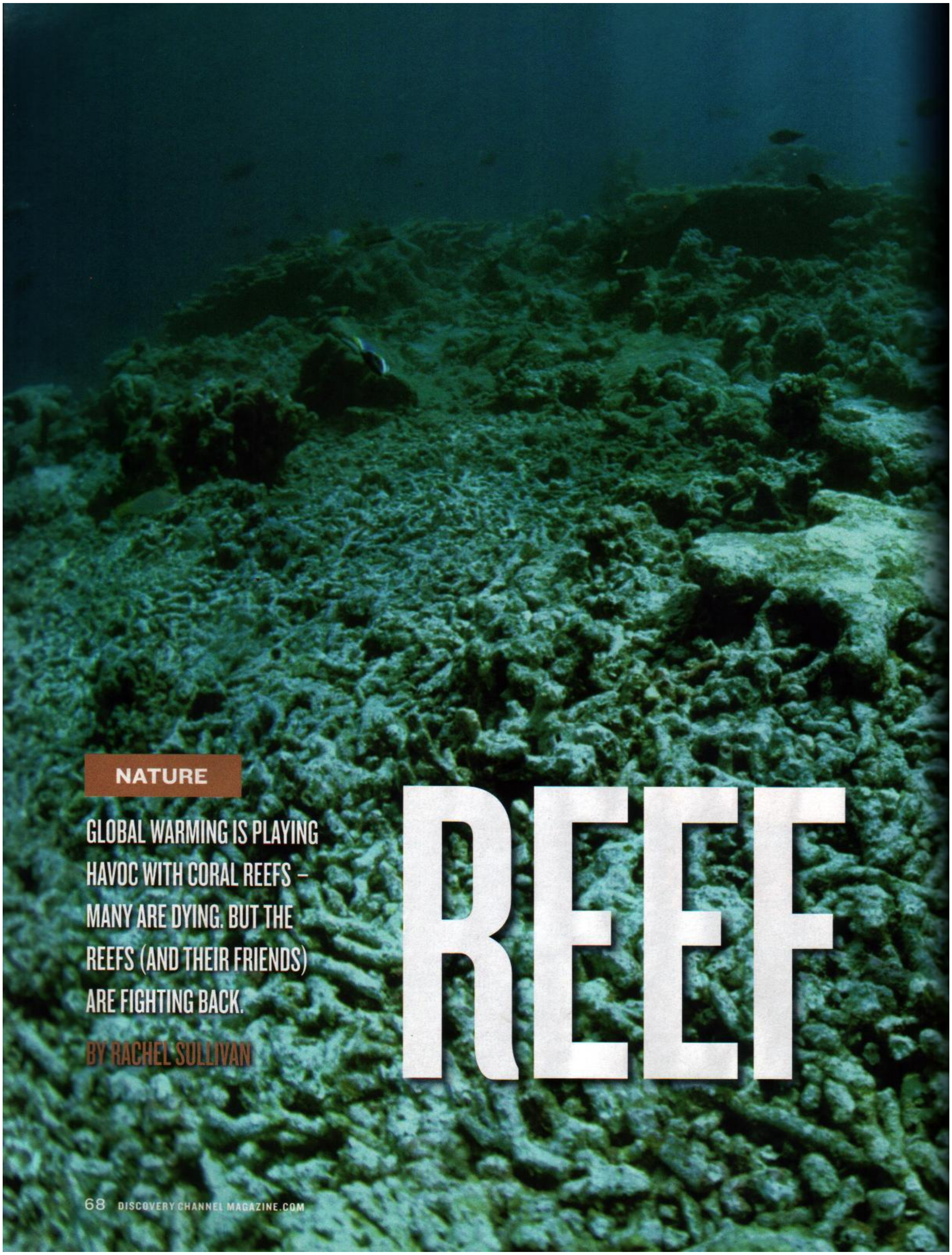
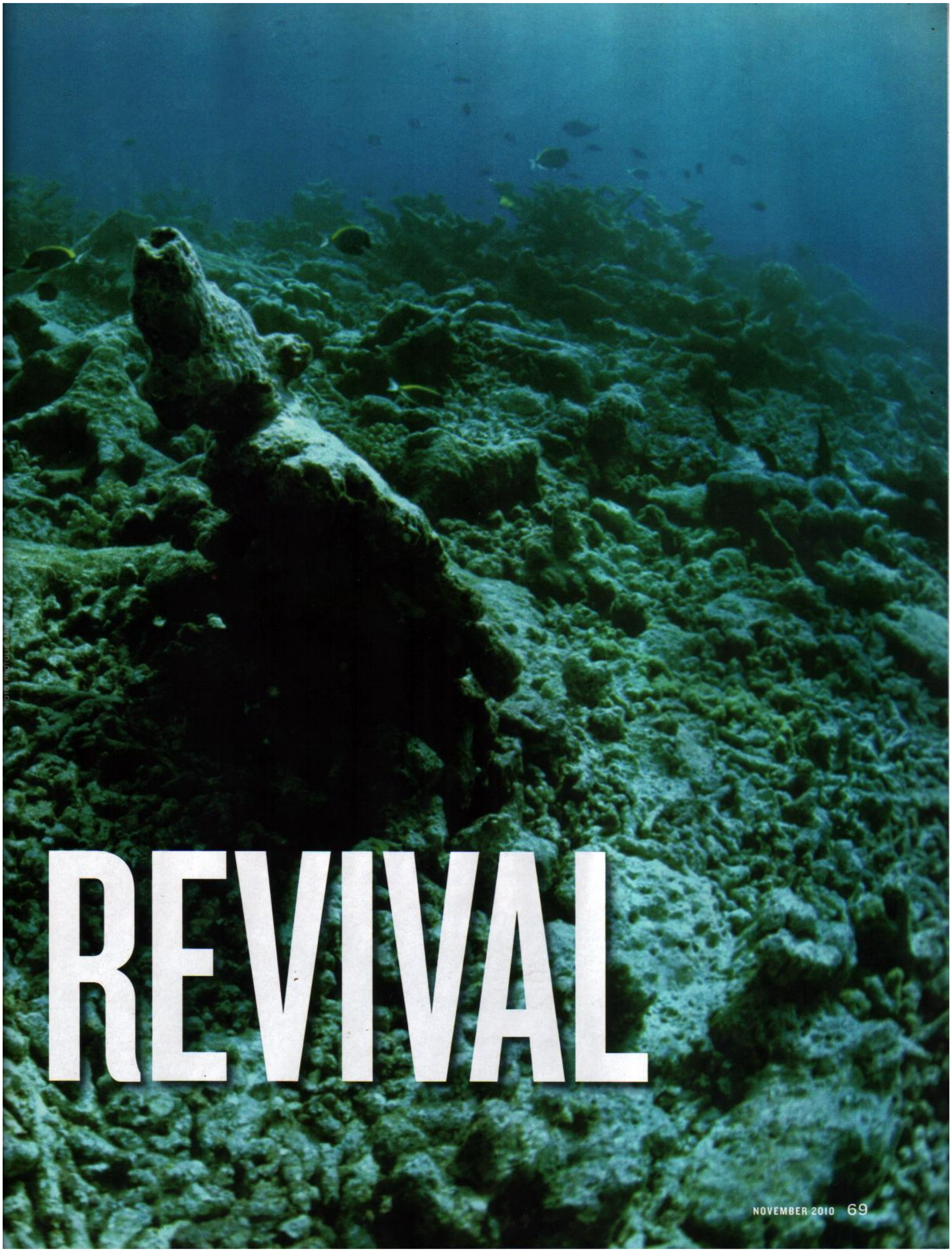


NATURE

REEF

GLOBAL WARMING IS PLAYING HAVOC WITH CORAL REEFS – MANY ARE DYING. BUT THE REEFS (AND THEIR FRIENDS) ARE FIGHTING BACK.

BY RACHEL SULLIVAN



REVIVAL

Anyone who has dived or snorkelled in the tropics in the past 20 years will have seen some major changes in the sea. Rocky ledges that once teemed with brilliantly coloured fish and elaborate coral formations replaced by submarine desert; coral rubble rolling across the murky sea floor, visible threads of algae clouding the water, and few, if any, fish. No tropical reef has been spared the impact of global warming and El Niño-related bleaching events. Around 25 percent of all reefs worldwide have already been lost and more are in big trouble.

Nowhere is this more apparent than Southeast Asia, whose 100,000 square kilometres of coral reefs (34 percent of the world's total) are home to over 600 of the 800 reef-building coral species in the world. Indonesia and the Philippines hold 77 percent of Southeast Asia's coral reefs and over 80 percent of threatened reefs.

In the late 1990s the shallow reefs around Bali and the Gili Islands of Lombok, both in Indonesia, became victims of cyanide poisoning, over-harvesting and bombing by desperate fishermen hit by the Asian economic crisis. After that, the massive 1998 worldwide coral bleaching event sealed their fate.

The reefs were stressed due to a combination of factors, like bleaching, anchoring, waves and storms, that smashed the northern part of the Gili Islands into rubble. Then pollution and the actions of humans over the last 20 years caused the beach to erode.

UNDERWATER RESCUE

But amid all this doom and gloom came a glimmer of hope in the form of Dr Tom Goreau, president of the Global Coral Reef Alliance and reef cultivator, and the late Professor Wolf Hilbertz, his research partner, marine scientist,

THE BIOROCK STRUCTURES ARE SITE-SPECIFIC, ACCOUNTING FOR TOPOGRAPHY, WAVE ENERGY AND LOCAL CONDITIONS

Kimbe Bay's reefs are home to a stunning variety of different marine animals and species. The Coral Triangle area is famous for its diversity.

WHY ARE REEFS IMPORTANT?

Like rainforests, coral reefs are highly productive ecosystems. They provide nurseries for about a quarter of the ocean's fish and support enormous biodiversity. They also help protect the coastline from destructive waves and reduce erosion, flooding and other damage to coastal communities.

Saving reefs is not just about conservation; there are social and economic issues too. More than 450 million people live within 60 kilometres of coral reefs, with most of these directly or indirectly deriving food and income from the reefs. The Great Barrier Reef in Australia alone is worth A$5 billion (approximately US$4.5 billion) each year and employs 68,000 people, while Southeast Asia's coral reef fisheries are estimated to yield US$2.4 billion every year.

Near the start of the Biorock restoration process, the structure looks more like a skeleton. Later on though, when other marine animals have moved in, the man-made reefs look like strange gardens (below left and right).

architect and inventor. Goreau has devoted his life to protecting and restoring the world's coral reefs, and with Hilbertz, developed a unique technique he calls the Biorock Process, to help restore damaged coral reefs.

"Marine Protected Areas like the Great Barrier Reef are effective [at encouraging regrowth] if they control the sources of mortality to corals. You've got prime quality habitat to begin with - but some [reefs] that are muddy, subject to strong tides or too degraded cannot make a comeback without drastic action," he asserts.

The Biorock Process grows rock from seawater: a low-voltage electrical current is applied to an underwater steel framework, causing limestone minerals to rapidly precipitate out of the seawater and onto the framework. Funded by local hotels and community fundraising projects, there are now more than 56 Biorock reefs in Indonesia at Pemuteran Bay in Bali, around the Gili Islands, in the Gili Matra Marine Protected Area, and in Tanjung in Lombok. And they are flourishing.

"Ten years ago, the once-beautiful coral garden at Bali's Pemuteran Bay was a pile of broken rubble," says Rani E. Morrow-Wuigk, co-ordinator of Pemuteran's Yayasan Karang Lestari (Protected Coral) Community Project. It had almost no fish and fewer corals due to the 1998 El Niño warming and cyanide fishing.

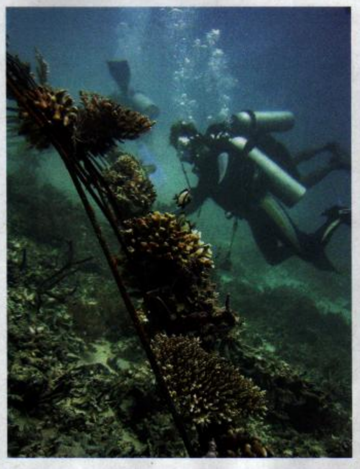
Now thanks to a bit of human ingenuity and the support of the local community, the reefs are back. "The Project is teeming with hundreds of coral species, fish and other colourful marine creatures," Morrow-Wuigk says with a smile.

The Biorock structures Goreau builds are site-specific and take into account the underlying topography, wave energy and local conditions. Then, volunteers build a framework appropriate for the site. This approach has been used in more than 20 countries. "Once the framework is covered, we seed local corals onto the structure," says Goreau. "And they grow between two and six times faster than on a normal reef."

Compared with other artificial reefs that use rubber tyres or concrete, Biorock reefs also have vastly greater rates of natural coral settlement. "And once there is coral, the fish move in overnight. The more coral there is, the more fish species are attracted," he explains. And where there are reefs, there are tourists keen to explore them, which helps reinvigorate local communities. It's a virtuous underwater cycle.

Of course, not all species grow at the same rate, and it is here that "reef gardeners" - local divers - play a critical role. They monitor and repair the Biorock structures when necessary, collect predatory snails and crown-of-thorns starfish (*Acanthaster planci*) that eat corals, and provide information about the project, working closely with a community organisation called Pecalang Laut (people police for the ocean).

"These local people help patrol the bay to ensure there are no more fish bombings or cyanide fishing in Pemuteran Bay," says Morrow-Wuigk.



ELECTRO-LIFEFORMS

The Biorock Process uses mineral accretion technology. It involves delivering low-voltage electrical currents via cables to submerged metal structures. The electrical current causes dissolved minerals to crystallise out of the seawater onto the metal framework as limestone, providing an inviting new home for coral polyps and other aquatic animals. The structures become home to fish, crabs, sea urchins, lobsters and octopi.

Financed on a shoestring, most Biorock reefs are funded by private donors, resorts and dive shops. Expert Dr Tom Goreau, president of the Global Coral Reef Alliance, says that research is currently under way into using solar, wind, wave and tidal sources of power to produce the electrical current, with wave and tidal power prototypes being tested in the Indian Ocean. "This will make electric reefs easier to install in poor communities and developing countries, and will allow us to expand enormously," he says.

NATURE'S RECOVERY

And the good news gets better - the corals are fighting back too. The ability of corals to recover after bleaching varies between species, but it is significant that the tougher ones in some places are increasing in number.

"In the Indian Ocean, the biggest impact [of bleaching] has been in the Seychelles, but those reefs with intact fish faunas and good water quality have bounced back surprisingly quickly," says Dr Terry Hughes, director of the ARC Centre of Excellence for Coral Reef Studies at James Cook University in Townsville, Australia. "In Moorea, Tahiti, the reef has bleached five or six times, yet the coral cover has repeatedly recovered."

NO TAKE-AWAY FISH

In the Philippines, a pilot system of no-take reserves - areas where no fishing is allowed - was started off the Sumilon and Apo islands in 1974 and 1982 respectively. It was very successful at protecting local reefs; fish stocks increased significantly over a prolonged period of time, and the scheme has now been expanded to the national level with a network of over 600 protected areas. The project has seen trawlers

Reefs boast immense diversity (right), but coral bleaching is taking its toll. To better understand this phenomenon and its causes, research is now being done using live coral cuttings (above).

replaced by ecotourism operations as visitors flock to see the islands' rich marine life, including the world's biggest fish, whale sharks (*Rhincodon typus*).

And on Australia's Great Barrier Reef, which was rezoned in 2004 to increase protected, no-take areas from less than five percent to 33 percent, fish numbers inside protected green zones have more than doubled in less than five years. Outbreaks of destructive crown-of-thorns starfish have been reduced, possibly because of the increase of fish and other species that keep their numbers in check. Due to the increased number of fish inside no-take zones, the whole ecosystem is healthier and this abundance is flowing over into the areas where fishing is allowed.

"Not only are there more fish inside the exclusion zone," says Hughes, "they're bigger and fatter, meaning they produce more babies that currents disperse outside the no-take zones where fishing is still allowed." This excess bounty is making fishermen outside the no-take zones happy too.

So although there is no doubt that we need to keep up the pressure on ongoing threats including agricultural runoff, overfishing and major bleaching events due to climate change, Hughes is optimistic about the future of reefs.

"I simply don't believe they'll all be dead in 30 years," he says. Good news for divers - and fish. ■

BRING BACK THE POLYPS

Coral bleaching occurs when unusually warm water causes coral to eject zooxanthellae, the microscopic, photosynthetic algae that live in a symbiotic relationship with the coral polyp, providing most of its colour and 90 percent of its energy needs. When the water reverts to its usual temperature, healthy corals "reopen" for business and the zooxanthellae move back in.

Coral expert Dr Tom Goreau says that the theory behind Biorock is that the electrical field around the artificial reefs provides good energy reserves and helps the reef heal faster. In 1998, in the Maldives, survival rates of Biorock reef corals were up to 50 times higher than those around them, with up to 99 percent of natural reef corals dying of heatstroke. "Today, Biorock reefs are the only ones with 100 percent cover," he notes. "The corals on the Biorock bleached too, but not as much, and they have a better chance of survival."

Go on an educational – and fun – guided reef walk during low tide at Lady Elliot Island in Australia. Don't touch anything the guide hasn't okayed though; some of Earth's deadliest creatures live in the seas.