# CAN-124-Building a Better Coral Reef-GBR

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For a Diver Every day is Ocean Day

## *Building a Better Coral Reef*

**As reefs die off, researchers want to breed the world's hardiest corals in labs and return them to the sea to multiply. The effort raises scientific and ethical questions.**

**By DAMIEN CAVE and JUSTIN GILLISSEPT. 20, 2017**

**The New York Times**

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Cover Photo

Neal Cantin collected coral samples from Rib Reef, a section of the Great Barrier Reef off Queensland, Australia. CreditDavid Maurice Smith for The New York Times

***Building a Better Coral Reef***

As reefs die off, researchers want to breed the world'shardiest corals in labs and return them to the sea to multiply. The effort raises scientific and ethical questions.

**By DAMIEN CAVE and JUSTIN GILLIS**SEPT. 20, 2017

ON THE GREAT BARRIER REEF, off Australia — After a plunge beneath the crystal-clear water to inspect a coral reef, Neal Cantin pulled off his mask and shook his head.

"All dead," he said.

Yet even as he and his dive team of international scientists lamented the devastation that human recklessness has inflicted on the world's greatest system of reefs, they also found cause for hope.

As they spent days working through a stretch of ocean off the Australian state of Queensland, Dr. Cantin and his colleagues surfaced with sample after sample of living coral that had somehow dodged a recent die-off: hardy survivors, clinging to life in a graveyard.

"We're trying to find the super corals, the ones that survived the worst heat stress of their lives," said Dr. Cantin, a researcher with the Australian Institute of Marine Science in Townsville.

Photo

Dr. Cantin with tanks used to hold coral at the Australian Institute of Marine Science center in Cape Cleveland,

Australia. CreditDavid Maurice Smith for The New York Times

The goal is not just to study them, but to find the ones with the best genes, multiply them in tanks on land and ultimately return them to the ocean where they can continue to breed. The hope is to create tougher reefs — to accelerate evolution, essentially — and slowly build an ecosystem capable of surviving global warming and other human-caused environmental assaults.

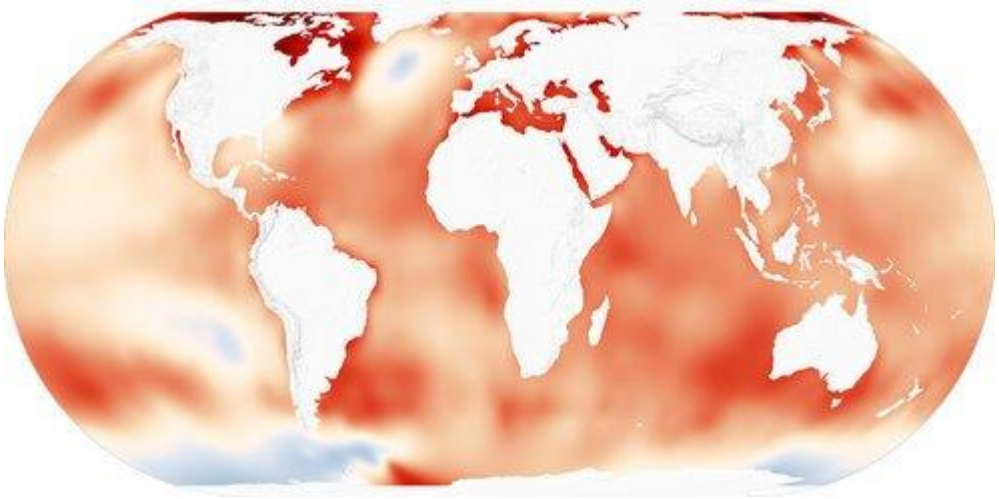
The research here is part of a worldwide push that is growing increasingly urgent. After decades of accumulating damage, followed by a huge die-off in 2015 and 2016, some scientists say they believe half the coral reefs that existed in the early 20th century are gone.

Instead of standing around watching the rest of them die, a vanguard of reef experts is determined to act.
In Florida, they are pioneering techniques that may allow the rapid re-establishment of reefs killed by heat stress. In Hawaii, they are studying the biology of corals that somehow managed to cling to life as an earlier generation of people dumped raw sewage into a magnificent bay. In the Caribbean, countries are banding together to create a genetic storage bank for corals, a backup plan if today's reefs all die.

INTERACTIVE FEATURE

**Oceans Are Absorbing Almost All of the Globe's Excess Heat**

This year is on track to be the third consecutive hottest year on record. Where does that heat go? The oceans, mostly.



**OPEN INTERACTIVE FEATURE**

"We created these problems," said Michael P. Crosby, president of the Mote Marine Laboratory & Aquarium in Sarasota, Fla., one of the institutions leading this work. "We have to get actively involved in helping the corals come back."
Photo

A section of healthy coral on the Great Barrier Reef, and an area where the coral has died.CreditLeft, Jodie Rummer/Agence France-Presse — Getty Images; right, XL Catlin Seaview Survey, via Associated Press
Yet this new push to aid the world's reefs comes with its own risks, and with many questions.

A large-scale restoration effort could be expensive, and so far, governments have put up only modest sums, despite the hit that their multibillion-dollar tourism industries could take from continued deterioration of the reefs. Private philanthropists — including Paul G. Allen, the co-founder of Microsoft — are paying for much of the early work, spending millions. But will they ultimately commit billions?

And while scientists are trying modest approaches first, the most effective strategy for saving reefs in the long run might be through genetic methods, including selective breeding or transferring heat-resistance genes into corals. That type of thing has been done for crops, but would it be ethical to do it in the wild?

"How do you decide what interventions are right and when to intervene?" said Madeleine van Oppen, a professor of marine biology at the University of Melbourne who is leading the experiments in Australia, aiming at what she calls the "assisted evolution" of coral reefs. "There's a long road ahead; that's why we're starting now."

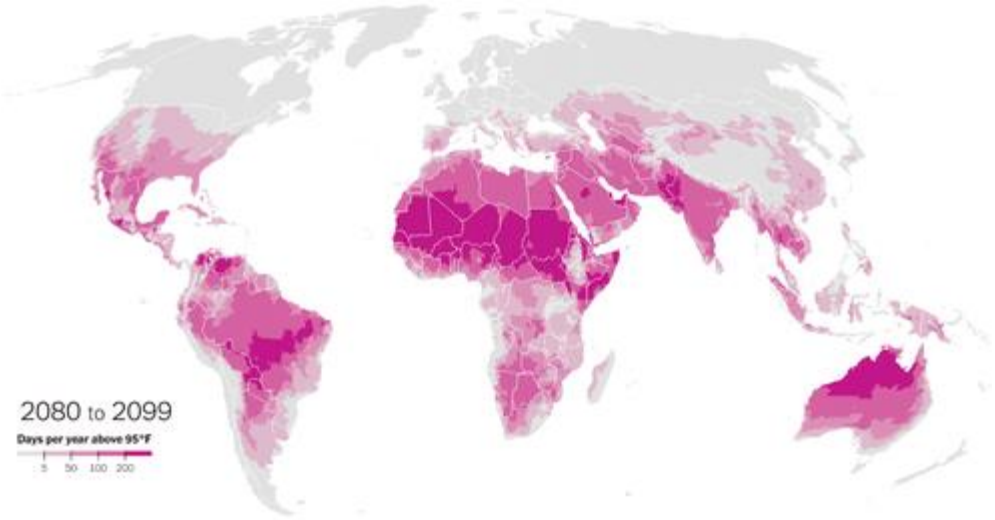
Questions like these appear to be an inescapable part of the human future, and they go beyond coral reefs.
Already, some species of fish and birds are being kept alive only because they are bred in pens or hatcheries and then returned to the wild. Forests are under stress on a rapidly warming planet, and scientists are wondering whether to manipulate their fate by planting more heat-resistant trees. Creatures are fleeing toward the poles to escape rising heat; should humanity give them a lift?

Even the scientists who have plunged into this kind of work are asking themselves if it is the right thing and it if would ever be enough given the scale of climate change's predicted impact. "To think we've had to turn our science this way is kind of terrifying, but that is what we've had to do," said Ruth Gates, a coral researcher who is heading up the work in Hawaii.

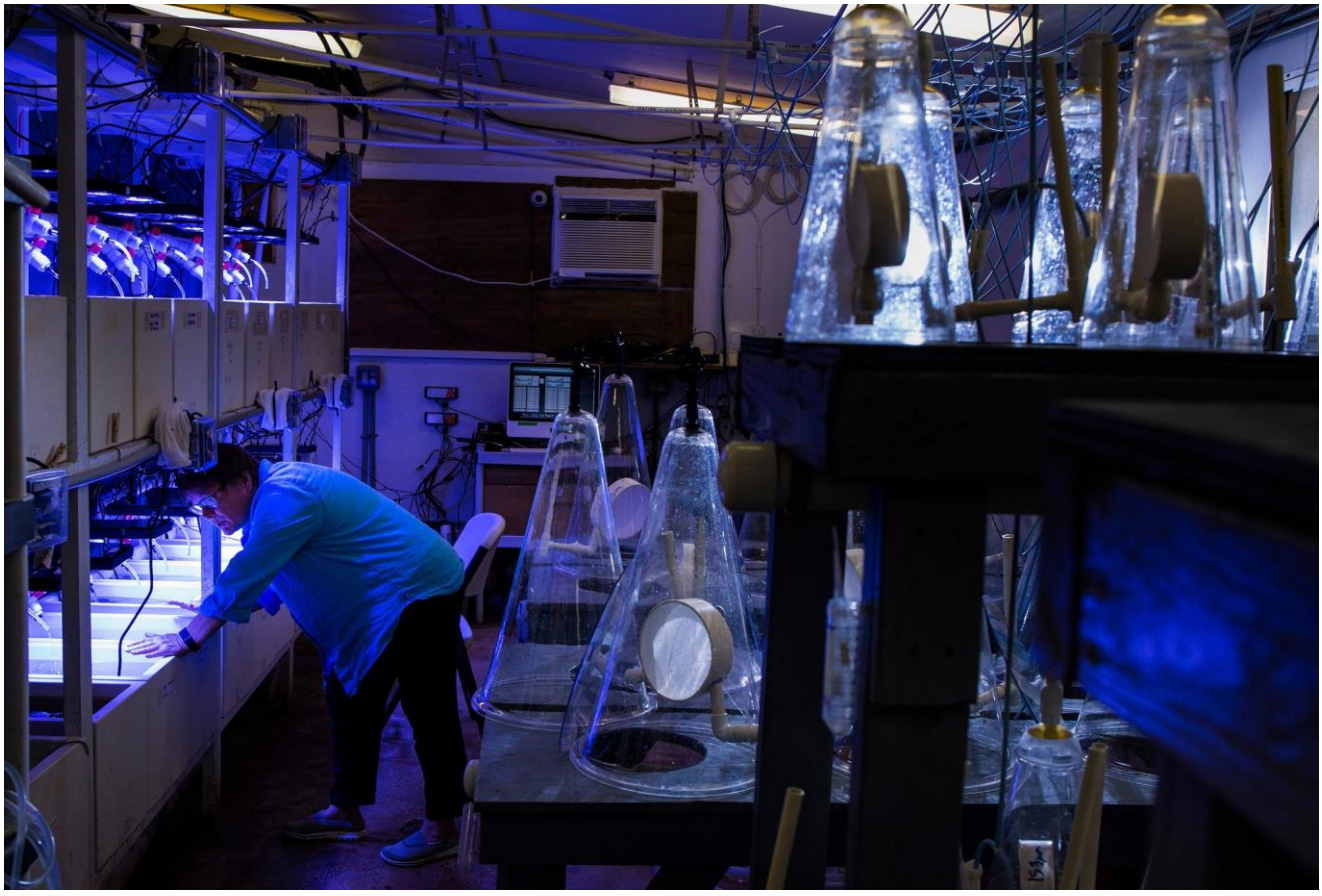
Photo

Dr. Ruth Gates with tanks of coral at the Hawaii Institute of Marine Biology.CreditLogan Mock-Bunting for The New York Times
Scientists first warned decades ago that coral reefs were particularly sensitive to heat stress and would be among the earliest victims of global warming if emissions were not brought under control.

GRAPHIC
**95-Degree Days: How Extreme Heat Could Spread Across the World**
Extremely hot days are expected to be much more frequent in the coming decades, potentially disrupting our everyday lives.




**OPEN GRAPHIC**



They were ignored, and humanity continued burning fossil fuels with abandon — setting up an early test of whether the scientific predictions about global warming could be believed.

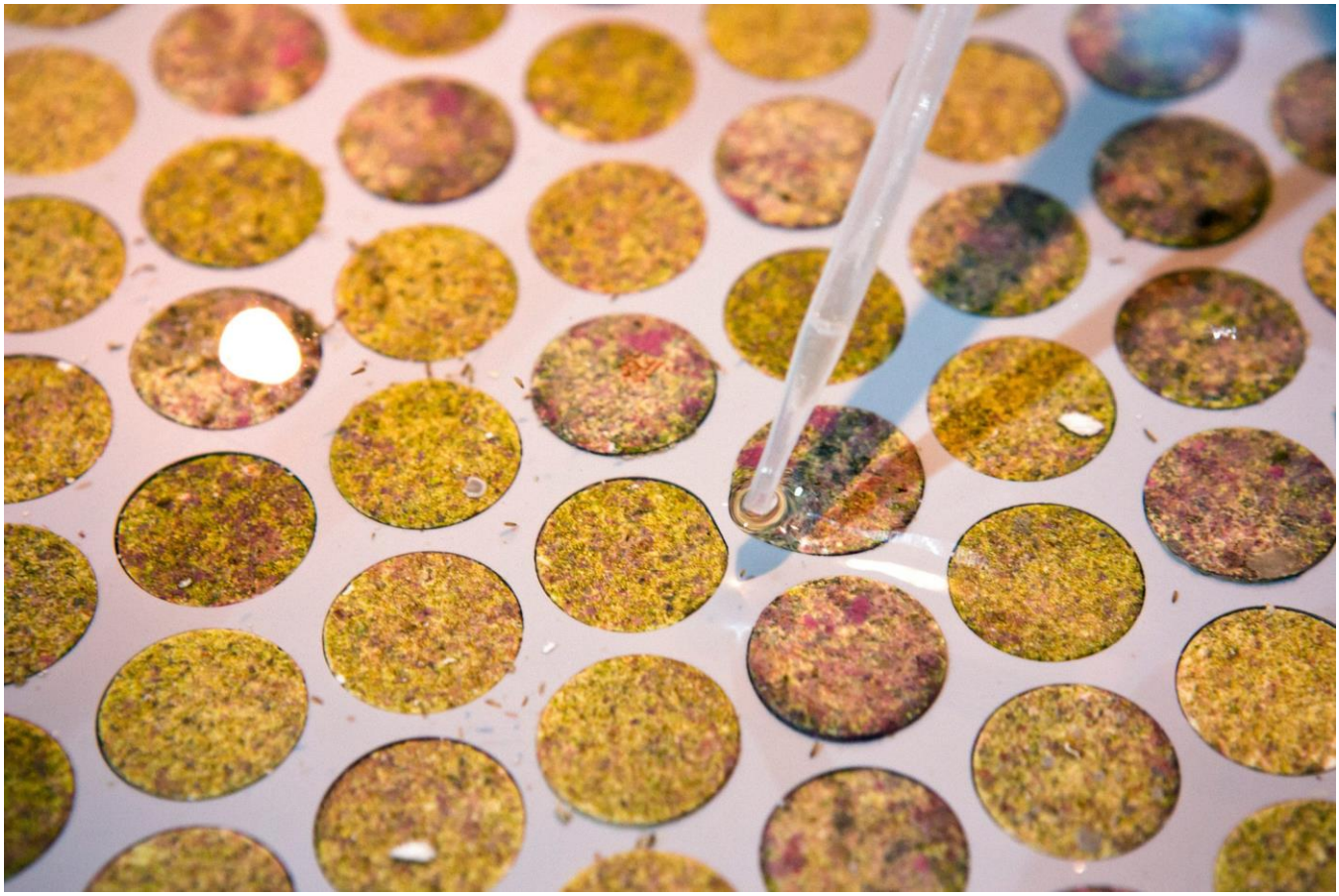
Most of the heat trapped by those emissions has gone into the oceans, which have now warmed enough that just a bit of additional heat can cause massive coral die-offs. The extra jolt arrives during El Niño weather patterns that warm large parts of the tropics.

The first global coral die-off began in 1982, and now they seem to be happening every few years. Along the Great Barrier Reef, the El Niño-related heat wave of 2015-16 left 35 to 50 percent of the corals dead along a 650-mile stretch of the Queensland coastline, a profound blow to what was the single most impressive reef on Earth.
“It’s not too late to be aggressive and make changes to preserve the reef of the future,” Dr. Cantin said. But, he added, without a broad effort that includes tackling the emissions causing climate change, reefs could largely die within this century.

Photo

Dr. Cantin placed a Pocillopora acuta sample in a holding tank in Cape Cleveland.CreditDavid Maurice Smith for The New York Times
Photo

A researcher used a pipette to release coral larvae into trays to encourage settlement and growth.CreditDavid Maurice Smith for The New York Times



Coral reefs are among the most beautiful sights on the planet, dubbed the “rain forests of the sea” because, while occupying a tiny area, they harbor much of the variety of life in the ocean. The brightly hued corals attract equally vivid fish, as though the creatures had dressed to match their surroundings.

Coral polyps are tiny animals that act a bit like farmers, raising even tinier plants — algae — that supply them with food. The corals excrete a hard substance that builds up into a reef, giving the coral polyps and many other creatures a place to live.

The loss of coral reefs is not just an aesthetic disaster. A half-billion people depend on reef fish for food, and in some island nations, they are essentially the only source of protein. The continued destruction of reefs might well worsen global hunger. In wealthier nations, and especially in Australia, the reefs are a prime attraction in tourist economies worth billions.

Dr. Cantin is among the many marine biologists who spent the past two years watching huge stretches of Australia’s greatest natural wonder die from the heat.

A native of Canada who found his passion while diving reefs in Florida as a teenager with his father, he belonged to one of the teams that surveyed the reef, leading to a report this year that stunned the worldwith the scale of the damage.

Photo

Jose Montalvo-Proaño, left, a Ph.D. student, and Dr. Cantin on Rib Reef.CreditDavid Maurice Smith for The New York Times

And yet, on a three-day trip in July to harvest coral samples, he repeatedly found himself surprised. The Rib Reef, where he was diving, had been healthy and vibrant only a year ago. But during his return visit, large sections were dead, covered in algae that looked like soot.

The samples he collected — of the Pocillopora acuta species — were often the only healthy chunks of coral to be found among canyons of dead reefs.

Near the end of their research trip, he and two other scientists dove for nearly an hour before finding just three samples, which they removed with a hammer and chisel and placed in a metal supermarket dish rack for transport to the surface.

“This is probably a three-year-old coral,” he said back on the boat, admiring a pinkish sample with a handful of healthy branches that made it look like a fist-size shrub. “We want to take the whole adult coral, collect its babies and then grow the larvae into adult coral.”

Professor van Oppen, a senior scientist who oversees Dr. Cantin's research, said that part of what makes the Australian experiment stand out is the "sea simulator" at the Townsville marine institute. It is a complex high technology laboratory where corals live in tanks with water temperatures that can be calibrated to a tenth of a degree and simulate seasonal patterns of warming events. Lighting systems replicate the moon cycles that corals use to time their spawning.

Future generations of corals, the offspring of the those Dr. Cantin harvested, will be tested for resilience in this artificial environment, with warmer and more acidic water that mimics what scientists are predicting for the years 2050 and 2100.

Photo

Young Pocillopora acuta, bred from samples collected on the Great Barrier Reef, in Cape Cleveland.CreditDavid Maurice Smith for The New York Times

The strongest corals will then become parents again, with some crossbreeding of the same species from different sections of the reef and also crossbreeding of different species to create genetic hybrids.

“If the speed of natural adaptation was fast enough to keep up with climate change, we wouldn’t see the scale of loss we’re seeing,” Professor van Oppen said. “There’s an urgent need to come up with ways to slow it down.”

Professor van Oppen is collaborating with Dr. Gates, who heads the Hawaii Institute of Marine Biology on a small island in Kaneohe Bay, off Oahu. Their joint project is partially funded by the family foundation of Mr. Allen, the billionaire philanthropist.

On a recent day at the lab, a manager, Jen Davidson, meticulously examined coral colonies growing in indoor tanks under artificial lights.

Starting with hardy coral polyps that survived past environmental assaults in Kaneohe Bay, the Gates lab is trying to make them even hardier, crossbreeding the corals and testing offspring in water treated to mimic the hotter, more acidic conditions likely to prevail in a future ocean.

Under normal conditions the animals grow and build their reefs only slowly, one of the factors that is stymying the effort to save them. “We can do all this work here, but can we scale it up enough to make an impact?” Ms. Davidson asked.

Researchers in Florida may be closest to answering that question. At the Mote laboratory in Sarasota, a researcher named David Vaughan has perfected a technique in which coral samples are broken into tiny fragments; the polyps grow much faster than normal as they attempt to re-establish a colony.

“It used to take us six years to produce 600 corals,” Dr. Vaughan said in an interview. “Now we can produce 600 corals in an afternoon, and be ready in a few months to plant them.”

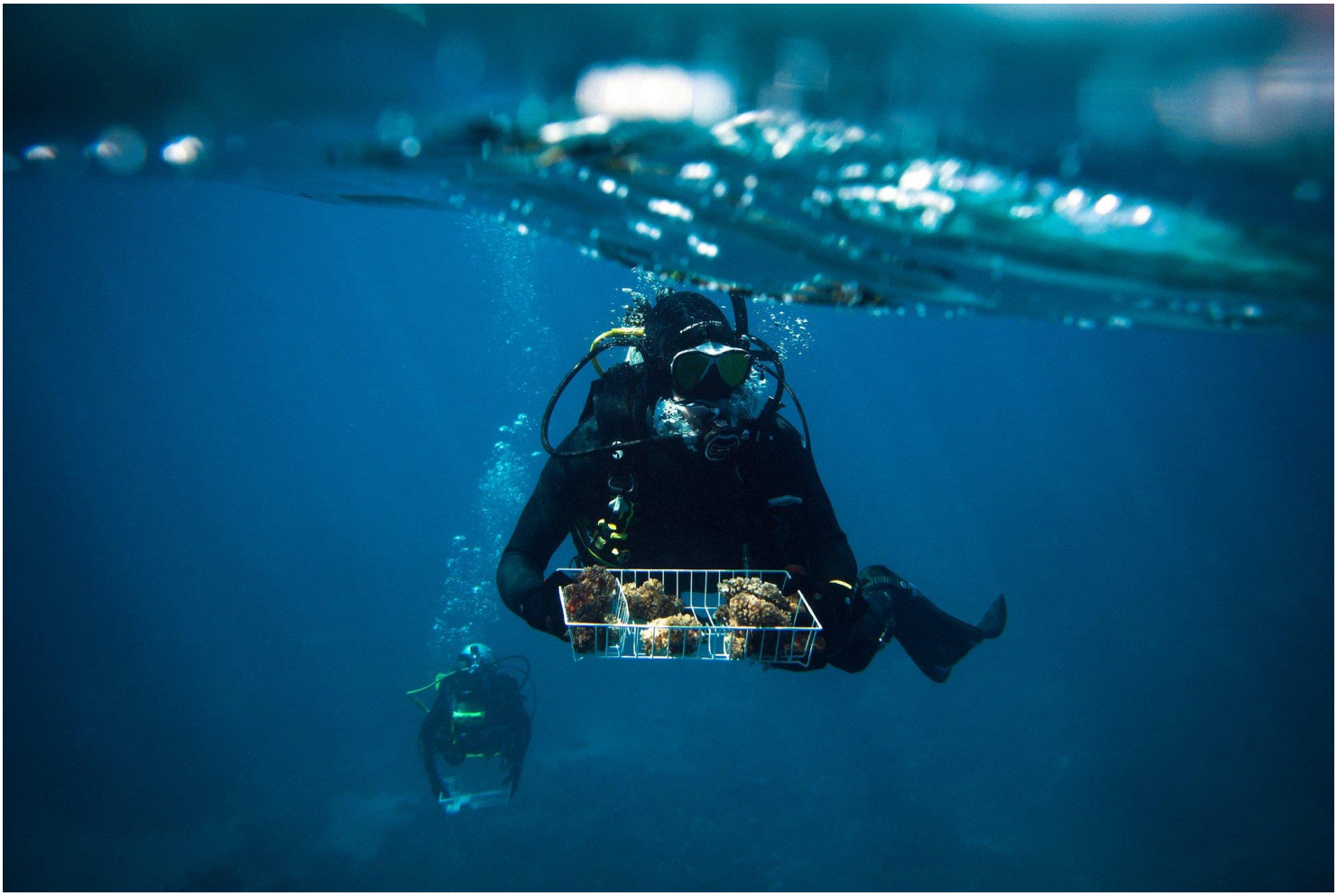
Florida’s reefs have been badly damaged over the years, not just by climate change but by more direct human assaults, like overfishing that disturbs the ecological balance. Yet the Mote lab and other centers have already replanted thousands of small coral colonies.

Continue reading the main story

Photo

Mr. Montalvo-Proaño with coral samples from Rib Reef. CreditDavid Maurice Smith for The New York Times

A center in Key Largo, the Coral Restoration Foundation, has had particular success in bringing back two species, elkhorn and staghorn corals, that had been devastated in Florida waters. The state legislature has begun to appropriate small sums as Florida’s scientists dream of reef restoration on a huge scale.



Though the risks remain unclear, the day may come when many of the reefs off Florida and Australia will be ones created by scientific intervention — a human effort, in other words, to repair the damage humans have done.
"We've shown that there is hope in all of this," said Kayla Ripple, manager of the science program at the Coral Restoration Foundation. "People shouldn't just throw their hands in the air and say there's nothing we can do."

***Correction: September 20, 2017***
*Because of an editing error, a photo caption with a previous version of this article gave the wrong name for the research center headed by Dr. Ruth Gates. It is the Hawaii Institute of Marine Biology, not the Hawaii Institute of Marine Science.*

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A version of this article appears in print on September 30, 2017, on Page A6 of the New York edition with the headline: Building a Reef Tough Enough To Survive a More Perilous Sea. Order Reprints| Today's Paper|Subscribe

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