Scientists race to create more resilient coral to survive in warming oceans

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Close up of polyps are arrayed on a coral, waving their tentacles. There can be thousands of polyps on a single coral branch. Credit: Wikipedia

In a hurricane-proof lab miles down the Florida Keys, scientists coddle tiny pieces of coral from the moment they are spawned until they are just hearty enough to be separated into specimens equipped to survive in the wild.

Then these dark-green fragments are put through misery, plunged into tanks mimicking the hotter, more acidic waters projected to one day overtake the tropical region. Many coral samples will die, but those that endure the hostile testing will be painstakingly transplanted back in the Atlantic.

For generations, marine biologists working around the 360-mile coral reef made sure their research didn't disturb the fragile kaleidoscope of marine habitat so critical to the local ecosystem and a multibillion-dollar tourist economy.

But as global warming rapidly brings the natural wonder to the brink of extermination, scientists are abandoning their hands-off approach in favor of a once-unthinkable strategy: an intervention to manipulate the natural balance of the reef.

The work is pioneering, and some say unsettling. It is generating both hope and exasperation. And it is being watched closely by entrepreneurs and technologists, who see opportunity in this effort to bring what scientists call "assisted evolution" to the wild.

On Summerland Key, an army of scientists is trying to rebuild thousands of square acres of the reef one centimeter at a time, cutting tens of thousands of coral microfragments, toughening them in the lab and replanting them in the ocean piece by piece.

At the nonprofit Coral Restoration Foundation in Key Largo, scuba divers are delicately hanging small corals on rows and rows of artificial "trees" constructed of plastic pipe in an underwater nursery, where they nourish themselves until they are ready to be replanted.

Both efforts are part of a laborious, costly international experiment that researchers say offers the only hope for warding off total devastation of

reef systems worldwide that provide the primary source of food to as many as a billion people and a home to one quarter of all marine species at some point in their lives.

"We have no choice now," said Michael Crosby, chief executive of Mote Marine Laboratory, which runs the 19,000-square-foot lab on Summerland Key. "These coral are not able to come back on their own. They are really sliding into functional extinction."

It's a familiar cliche in the Florida Keys and in the many other coastal areas where coral is on life-support: The reefs are the canary in the coal mine of climate change. This is not about projections of what might come if emissions continue unabated. The havoc is already here.

About 95 percent of the coral on the Florida Reef Tract has already died. While the damage was not exclusively caused by climate change, it is the one threat the region is largely powerless to mitigate, advancing so persistently and creating stresses on the coral so extreme that scientists are playing the role of surgeons trying to save a dying patient.

"We are not so naive to think we can restore every coral that was ever lost," said Jessica Levy, the reef restoration program manager at the Key Largo foundation. "Our goal is to keep that material out there, push it and make things as best as we can, to promote natural recovery."

She compared it to patching over a crack in a large dam. Scientists are trying to keep the coral alive long enough to buy some time for governments to solve the root problem: climate change.

"This is not going to take the place of mitigating climate change," said Christopher Page, a senior biologist at Mote. "But it will help the process along as we work to change the larger-scale things."

On a blazing hot June day, the foundation was training some of the hundreds of volunteer divers helping it create more resilient coral. The group prepared to spend many hours underwater with waterproof slates and electronic tablets, recording the condition of patches of reef.

The organization will plant about 20,000 pieces of coral this year in eight sites. But before the coral is glued to the reef, it is nurtured in the group's vast underwater nurseries. They have found that coral fragments cut into tiny pieces and hung on artificial trees grow faster early in their lives than they would in the wild.

"It has already made a difference," said Mark Eakin, coordinator of the Coral Reef Watch project at the U.S. National Oceanographic and Atmospheric Administration, the federal agency that monitors and responds to changes in climate and the ocean environment. "There are places that have not had branching corals in 30 years and now you go out and look at the bottom and say, 'Wow, this is starting to look like it used to.'"

The effort is exhausting to watch. Coral grows excruciatingly slow, often taking 200 years to fully develop. The process has been sped up considerably by science, but researchers at this point can't be certain how much of the coral they plant will be there in 100 years, when ocean conditions are projected to be significantly more challenging than they are now.

The kind of disease exacerbated by climate change is not new to the reefs. For decades, scientists have been studying die-offs, often caused by bleaching when spikes in ocean temperatures kill off large portions of reefs and transform the vibrant colors into white skeletons. Until recently, such events took place infrequently enough for the coral to restore itself and grow back. That is no longer the case.

The increase in ocean temperatures and acidification caused by global warming has resulted in a surge of mass bleaching events, leaving coral no time for recovery. Large tracts of coral are disappearing altogether. The United Nations warns that 25 of the 29 coral reefs on the UNESCO World Heritage List are at risk for devastating back-to-back bleaching events by 2040. And it warns that all 29 of the reefs, which include the reef in Florida and the Great Barrier Reef in Australia, will no longer host functioning ecosystems by the end of the century if climate change is not confronted.

Contributing to those die-offs are other diseases that coral in the past have been able to fight off on their own. Scientists are shocked by the pace at which one such disease is tearing through the coral in the Keys, moving them to experiment with medical pastes that divers are injecting into the reefs with the hope of containing the spread of the sickness.

At the Great Barrier Reef, the largest in the world, one-third of the coral was killed during an ocean temperature spike in 2016 that scientists attribute to climate change. They concluded in a study published in the journal *Nature* that the reef will never look the same again, though some portion of it could be saved if nations honor the commitments made in the Paris climate agreement, from which the Trump administration has withdrawn.

The speed at which global warming is ravaging these vital marine ecosystems leaves scientists struggling with the question of how intensely to intervene. The challenge of scaling up their efforts to the point where they can be effective at restoring areas the size of the Great Barrier Reef is daunting.

Even so, there have been encouraging breakthroughs in just the last few years. The microfragmenting effort that Page oversees has enabled Mote to step up production to a pace unimaginable until recently. Growing a

piece of reef the size of a basketball, which takes 25 to 100 years in the wild, can now be done in as few as three years.

Large volumes of corals are being placed in genetic banks underwater and in laboratories on land, so scientists can tap into various genotypes for restoration efforts, even if they become extinct in the wild.

During late summer spawning season, thousands of coral eggs that have just a 1 in 1 million chance of being fertilized in the wild are collected by the Coral Restoration Foundation and sent to the Mote lab, which guides them to reproduce. It has enabled Mote to develop thousands of new genotypes, promoting the kind of diversity that researchers say will be essential to climate resilience.

"We don't have a crystal ball," Levy said. "We don't know what the future is going to be. So we have to push diversity. ... When we are talking about a changing climate that is all about extremes, do you want to put all your eggs in one basket? What if it doesn't account for what happens?"

The large-scale rescue effort is filled with unknowns. Even the corals that thrive in lab conditions meant to simulate unbridled global warming 80 years from now, for example, could get planted in the wild and lose the traits that made them resilient in the lab. Already scientists are discussing bolstering the restoration efforts with more extreme interventions that include spraying aerosols in the clouds above them to dim the sunlight and having ships blow air bubbles into the water surrounding the reefs in an effort to block the sun's rays.

"These are all ideas that can protect those corals that you are putting so much effort into restoring," Eakin said. "They could absolutely play a role in this."

He said new technology will also be crucial to getting enough coral planted to make an impact worldwide. Eakin envisions underwater drones doing the tedious work of planting tens of thousands of pieces of coral on reefs, and robots taking over the job of cutting the microfragments that scientists now saw one by one. Already there is a robot helping tend a coral farm in Israel.

Entrepreneurs see opportunity in it all. A startup called Coral Vita is building on the work of Mote with plans for a network of coral farms catered for clients in hotel and fishing industries suffering from the degradation of the reefs. Insurance giant Swiss Re AG recently announced coral insurance policies for beachfront hotels in Mexico's Mayan Riviera protected by the Mesoamerican Reef. Under them, hotels get payouts after big storms to repair the reef, which is crucial to protecting the resorts from even more catastrophic damage in future storms and devastating beach erosion.

Scientists are encouraged to have private companies in their race to reverse the wreckage.

"We are looking at a potential complete ecosystem loss, which to my knowledge has not happened in human history," Levy said. "I don't think anyone wants to be responsible for that occurring."