Reefs are dying. Scientists hope lab-bred 'super corals' can help revive them

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At a shiny new lab atop the new Frost Museum of Science, nine aquariums hold colonies of staghorn corals stressed to the edge of death.

If all goes as planned, the corals will be revived with hardier algae able to survive the planet's warming oceans and replanted during a new field trial—the first ever of its kind—to help save the ailing reef just beyond the downtown Miami museum's picture-perfect view.

The hope is that the corals will be more able to withstand devastating bleaching events now occurring globally at an unprecedented rate, and breathe just enough life into the reef to buy scientists more time to tackle more intractable problems fueled by climate change.

It's an ambitious plan, and a twist on the expanding strategy to save reefs with new breeds of what some have dubbed "super corals." But if it works here, scientists believe it could be a game changer in rebuilding reefs around the world.

"The idea is to boost their thermal tolerance before they get out-planted with the hope we're not just setting up the next set of climate-change victims," said Rivah Winter, a Frost curator and inventor-in-residence at the lab.

The challenge will be getting the corals in the wild to retain their new hardiness and grow fast enough to make a difference, said Andrew Baker, a marine biologist at the University of Miami's Rosenstiel School of Marine and Atmospheric Science who pioneered the stressing technique.

"The field is a much more complicated situation," he said.

Engineered reefs are nothing new in restoration efforts that have gained urgency with the increase in bleaching events and other coral losses. Since 1998, three global bleachings have decimated reefs, with the last in 2016 killing a third of the Great Barrier Reef. In South Florida, where a disease outbreak also has gripped the only inshore tract in the U.S., back-to-back bleachings struck in 2014 and 2015 for the first time on record.

Bleaching occurs when water temperatures rise and the algae that live inside the coral, which photosynthesize and produce food for the corals, instead produce free radicals that are toxic, Baker said. The corals spit out the algae, starve and die.

But not always, he said. Some recover and go on to thrive.

Coral scientists began identifying those species and using them to seed nurseries with a growing stockpile of more resilient corals. At UM, Baker's colleague Diego Lirman has erected several nurseries with staghorn, which were once the most dominant species on Florida's reef, providing an elaborate framework that made it among the most diverse on the planet. About 90 percent have disappeared. In the Keys, Mote Marine Lab has transplanted 22,000 corals, and in 2016 it struck a

15-year deal with the Nature Conservancy to build gene banks and begin transplanting more than a million in the Keys and the Caribbean.

But Baker worried replanting reefs with the same genotype might make them susceptible to other threats like disease. What if the algae made the difference?

"It's a very tightly evolved partnership," he said. "The corals have been with these algae for hundreds of millions of years and these algae are critical to understanding why coral reefs even exist in the first place because without these algae, corals can't survive."

In 2004, he looked at bleaching events in Panama, the Persian Gulf and the western Indian Ocean, and found that following the events, specific algae became more dominant.

"The weak link in the partnership is really the algae," he said. "When they get hit with too much heat stress, instead of producing a nice photosynthetic food ... they start producing toxins."

Baker figured out how to mimic bleaching and stress the corals just enough to get them to spew out their algae. Then, before they died, he introduced the hardier algae. Over the summer, to make the process more efficient, he plans to replicate the stressing in the field by floating the corals on rafts and exposing them to heat and light before planting them.

The project has not been without its hiccups. This fall, Baker and Lirman were preparing to stress and plant corals off Key Biscayne. Then Hurricane Irma hit. Winter was also named one of Frost's first inventors-in-residence after submitting the work for a yearlong research program, but the museum construction fell behind schedule, and the fifth-floor lab got delayed.

Miami entrepreneur Ted Caplow, a former museum board member who donated $1 million to create the lab, said the project was never part of the troubled construction budget, so it survived.

The lab will be open to museum visitors beginning March 10—part of its mission is to show science in action. But it's also intended to help put Miami on the map for innovation and showcase the kind of "accelerated adaptation" needed to address climate change, Caplow said.

"We talk about the rain forest. We talk global warming. We talk about the ozone. All of those are processes are much slower and less urgent than the loss of coral reef," he said. "If this trend continues, coral reefs are just going to be something in the history books for our children and our grandchildren."

Some newly hardened corals have already been replanted off Key Biscayne. Over the summer, when bleaching events are expected to occur, Baker, Winter and a team of reef rescuers will begin planting more between the key and Mid Beach. The corals will be monitored to see if they hold onto the algae, grow fast enough to make a difference and survive bleachings.

"We want to try to tie down both the benefits of doing this and potentially the risks," Baker said, "so that before we scale this up into something really dramatic, we can figure out how best to manage the relative cost-benefit ratio."