CORAL | THE REEF & MARINE AQUARIUM MAGAZINE

CORAL

BREEDING Milestones

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COVER CREDITS: Ornate wrasse, top, and Hoeven's wrasse —two recently captive-bred *Halicheores* species. Frank Baensch Background: *Montipora* sp. coral under blue light. Daniel Knop

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FEATURE ARTICLES

AQUARIUM PORTRAIT

DEPARTMENTS

 ANDREW BRUCKNER and GEORGIA COWARD

Survivors of the 2016 Bleaching Event in the Maldives

Entering the water at the end of July was both shocking and surprising. The water temperature had steadily cooled from 89.6°F (32°C) on May 6 to 83.3–84.2°F (28.5–29°C) by July 30, which was almost normal for this time of year. The monsoon had kicked in, bringing with it strong currents, waves, and a great increase in nutrients. Gone were the doldrum-like conditions and gin-clear water we had seen in April; instead we faced a drop in visibility from over 328 feet (100 m) to just 33–98 feet (10–30 m). While rough conditions and low visibility present challenges for underwater photographers, this changeover marked the end of the stressful 2016 El Niño, high temperatures, and damaging ultraviolet radiation and the return of the mantas, whale sharks, and other plankton-feeding animals.

Focusing on the sea floor, our research divers witnessed the devastation caused by the bleaching event. The shallow reef terrace, formerly dominated by large table Acroporids, thickets of staghorn coral, large aggregations of cauliflower coral, and dozens of boulder, plating, and foliaceous coral species, was now a graveyard of coral skeletons carpeted in thick turf algae. Over 95 percent of the fast-growing corals had died. Many of the boulder corals and plating corals were still bleached, while others had lost portions of their tissue but were still hanging on. Coral death extended to depths of 98 feet (30 m) and beyond. Many of the deeper corals resisted bleaching until early May, and were now stark white and beginning to die.

As we continued the assessments of our permanent sites, other alarming signs became apparent. On some reefs there was a re-emergence of Crown of Thorns Starfish. In April, these voracious coral predators had moved off the reef in search of cooler water and were extreme-

A Spotted Eagle Ray swims over a bleached reef in the Maldives.

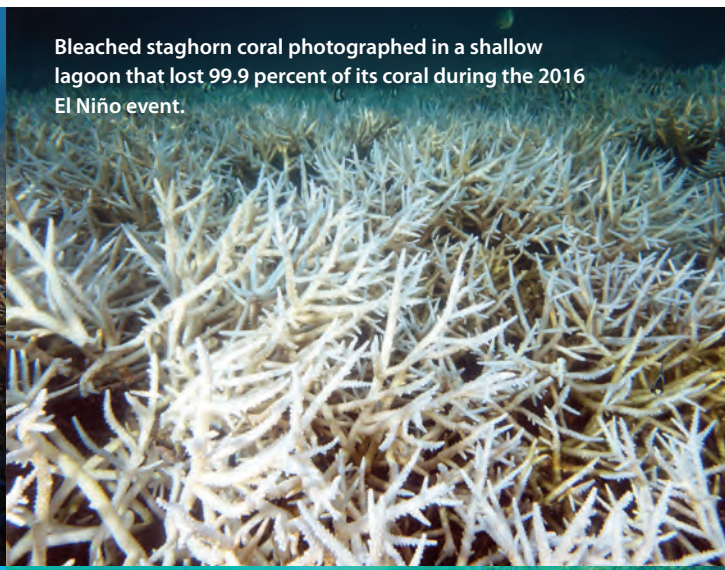
ly rare on all the reefs we dived, but now they were back. Most of their preferred food sources (*Acropora*) had died during the bleaching event, so they had begun feeding on other corals. This included many of the longer-lived species, such as *Porites*, which could take decades to recover. On South Malé Atoll, there was also a dramatic increase in the number of corallivorous (coral-eating) snails. The gastropod *Drupella* was aggregating on the few remaining branching and table corals, especially *Acropora*, because their food source was now very limited. We were removing up to 250 snails from single corals!

These findings are extremely disturbing. Both of these animals are feeding on the corals that resisted the bleaching and that are likely to be the strongest and best able to tolerate high water temperatures. Furthermore, there has been a notable increase in coral disease, especially black band disease and white syndrome, both of which were very rare prior to April 2016. Are these bleached corals more susceptible to disease? These theories seem to fit in the Maldives.

However, there were still signs of hope. We found several reefs where most corals had survived. These were located in channels and submerged reefs known locally as "thilas," where there is much more water movement. These bleaching refuges had high numbers of boulder corals, as well as the more fragile branching and plating Acroporids. Coral mortality was also reduced on outer reefs that are exposed to high wave action. These areas had still lost most of their branching and table corals, but they were dominated by boulder corals, especially *Porites*. These massive corals are much slower-growing and tend to be

The beginnings of the bleaching.

The sequence of coral bleaching in a shallow lagoonal environment over one month (clockwise).



Bleached staghorn coral photographed in a shallow lagoon that lost 99.9 percent of its coral during the 2016 El Niño event.

Dead and dying Acroporids with damselfishes that rely upon them for food.

A dead stand of *Acropora* colonies being overgrown by algae.

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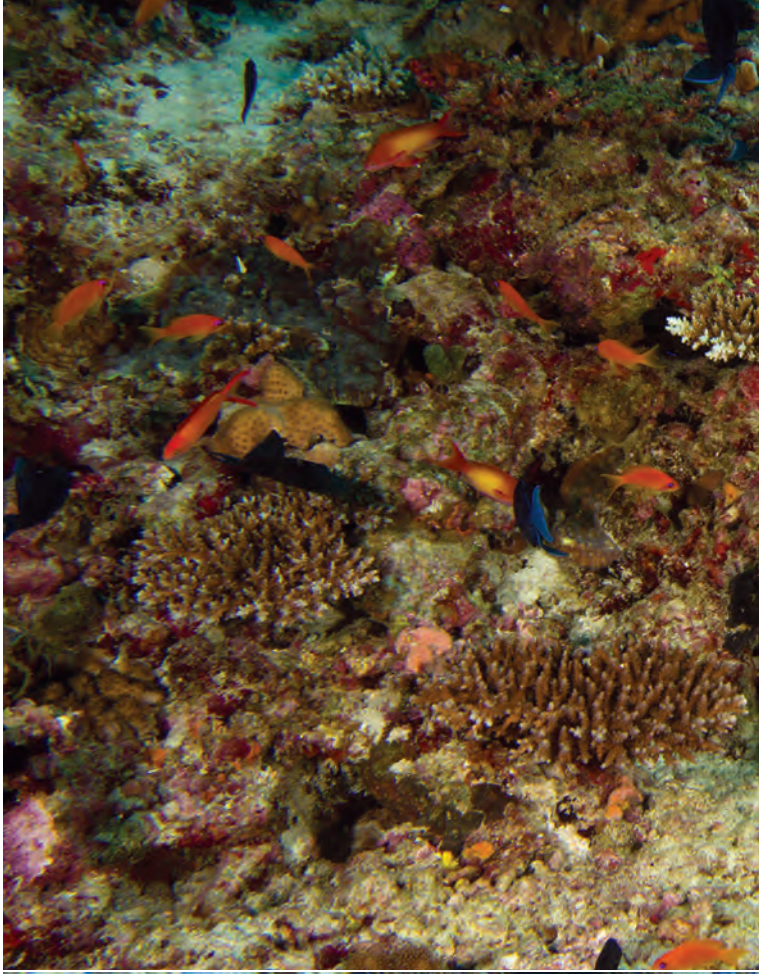

Table Acroporid fragments that survived the bleaching event.

long-lived; on some reefs it is common to see colonies that are 500–1,000 years old. Although many of these had lost some tissue, very few had died, and we had begun to see tissue recovery.

We also found much higher survivorship of corals on reef slopes. In many cases, the steep part of the slope was littered with hundreds of broken branches. These were fragments that had been detached from larger colonies on the top of the reef and carried down the slope. Their high survivorship is a mystery, as they would have been stressed as they tumbled down the reef slope, but many had already reattached to the reef and showed signs of new growth. Most unexpectedly, we also identified very high numbers of coral recruits and juveniles that had survived. On many reefs, 90–95 percent of the larger adult corals had died during the bleaching event, but the corals that were the size of a baseball or smaller had survived and regained their normal coloration.

One of the most intriguing discoveries was made in a lagoonal reef that was only about 6.5 feet (2 m) deep, but formerly had some of the largest thickets of Staghorn

Below, left: The peak of coral bleaching in May on a reef in South Malé Atoll. Below, right: Surviving *Acropora* corals guarded by a "farming" damselfish.

Coral we had seen to date. These corals, all of a single species, were nearly dead at the end of April, and the few survivors had died by July. We searched each of the coral stands for survivors, but more than 99.9 percent of the corals had died and were now covered in long strands of cyanobacteria and turf algae. Just as we were ready to give up, we found a large patch that still had numerous living branches of coral. These branches were located within territories of herbivorous damselfishes. Damselfishes farm algae, creating dense stands of turf algae on the reef that they carefully maintain and defend from other herbivores and intruders. Often, these fishes will kill living corals to open up space for algal settlement. Remarkably, we saw the only surviving branches of this species of *Acropora* within the damselfish territories. The branches extended upward from the dense turf algae. They were fully pigmented and had healthy growing tips.

With this knowledge under our belts, and as the reefs begin to rebound, Coral Reef CPR has initiated the next phase of the Holistic Approach to Reef Protection (HARP) program—the establishment of coral nurseries. Shifting away from the traditional approach used in the Maldives to grow corals, we are targeting the "super corals" that survived the bleaching event, as they are more resistant to higher temperatures and more likely to survive future El Niño events. Read more about our coral nurseries in the next issue.