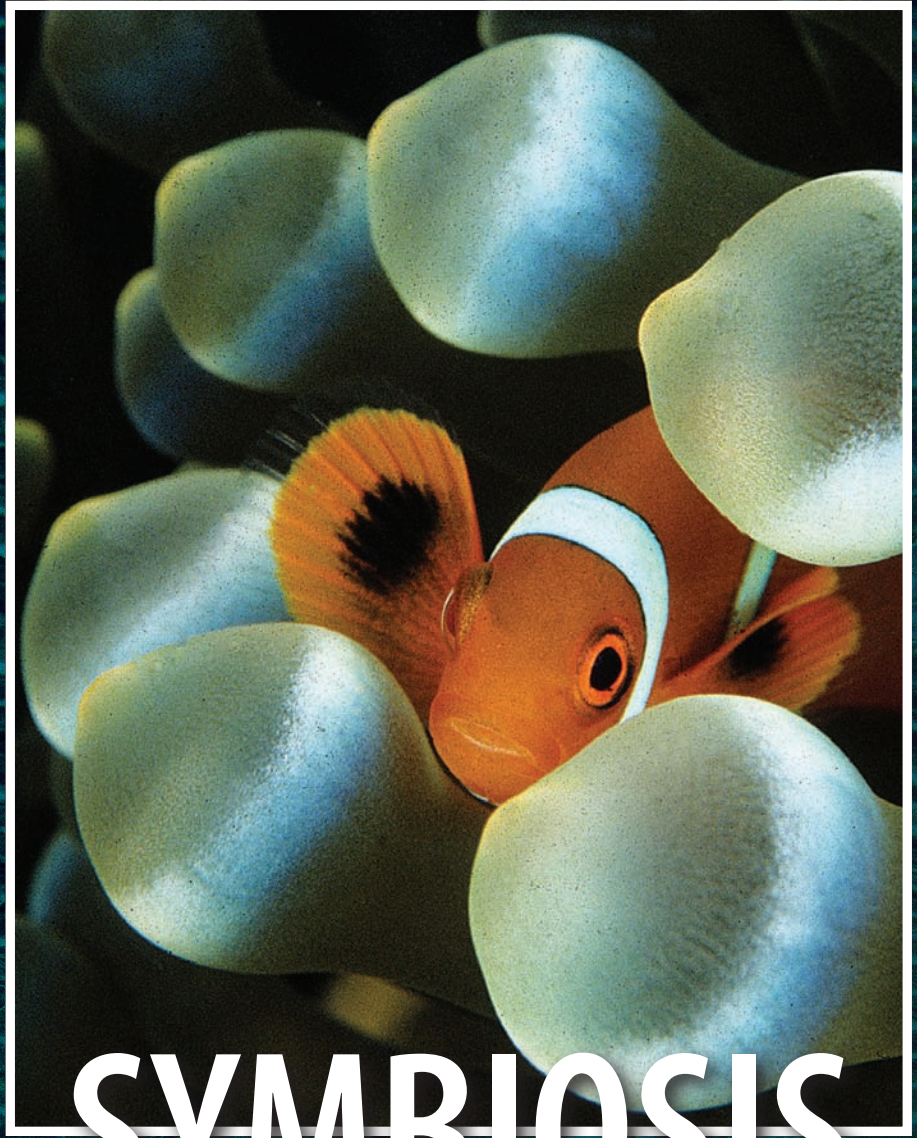




# CORAL



## SYMBIOSIS

- **Glorious Bisma Worms**
- **Heavy Metals**
- **Crown-of-Thorns Corps**



## REEF STEWARDSHIP |

ANDREW BRUCKNER, PH.D. & GEORGIA COWARD



# COTS Corps

Recreational divers vs marauding starfishes

ALL: A. BRUCKNER, PH.D.



Crown-of-Thorns Starfish (aka “COTS,” *Acanthaster planci* and related species) are the most serious localized threat affecting coral reefs throughout the Indian and Pacific Oceans and the Red Sea. Outbreaks of these coral predators have increased in frequency and spatial extent over the last two decades, with recent reports coming from 48 countries. In many locations, outbreaks have persisted for a decade or more and have caused catastrophic damage to affected reefs. COTS are voracious corallivores that can destroy an reef within a few weeks. Having eaten the corals down to their skeletons, the sea stars then migrate to a neighboring reef to continue on their path of destruction.



This Crown-of-Thorns starfish has eaten a massive *Gardineroseris* colony and is now moving on to a *Porites*.

## MALDIVES OUTBREAK

The Maldives' most severe outbreak to date, and only the third in its history, began in 2014 at the western end of North Malé Atoll. Over the next two years, hundreds of thousands of COTS spread throughout the atoll and to two neighboring atolls, South Malé and Ari, and smaller outbreaks occurred in six other atolls. During the initial invasion the starfish consumed all of the table, staghorn, and digitate corals in the genus *Acropora*, which were the most abundant corals on these reefs, and also fed on many other taxa, including *Pocillopora*, *Montipora*, *Pachyseris*, *Pavona*, and *Favia*. The starfish devastated the house reefs surrounding many high-end resorts, as well as neighboring reefs.

Last year, we reported on Coral Reef CPR's efforts to control the outbreaks, in which over 10,000 starfish were removed from three heavily infested reefs in October 2015. We have continued to remove starfish from other locations, as have other dive operators and resorts. In total, more than 90,000 starfish were removed between 2014 and 2016.

From March to June 2016 the number of reported COTS outbreaks in the Maldives greatly declined, and many thought the problem would go away. During this period, water temperatures escalated, causing widespread bleaching throughout the Maldives and around the globe. By August 2016, waters had cooled and bleaching had subsided; surviving corals were regaining their normal coloration and recovery was, presumably, underway. During our post-bleaching surveys we

identified many positive signs of resilience, including bleaching refuges, corals that resisted bleaching, and high survival of juvenile corals and recruits of those species that had suffered the greatest losses. Yet, on many reefs Crown-of-Thorns Starfish reemerged and began their attacks on corals once again.

Reef conditions were not as before, and the behavior of the starfish had changed to adjust to the new circumstances. No longer were there aggregations of hundreds of starfish within a confined area, because food had become scarce. The dense living stands of *Acropora* and many other species were gone. Some reefs had lost up to 95 percent of their corals and only certain temperature-resistant species like *Porites*, *Diploastrea*, and *Gardineroseris* survived. Other reefs had small living tissue remnants of *Acropora*, along with scattered surviving fragments, coral recruits, and small juvenile colonies. There was also much more competition for the remaining food: coral-eating snails (*Drupella* spp.) had aggregated on the remaining branching corals and moved to less preferred boulder corals, and an unusually high number of coral-eating cushion stars (*Culcita* spp.) were feeding on the smaller branching corals.

Emaciated and sluggish, the starfish slowly spread throughout the reefs in search of food. They targeted all depths and habitats and invaded new reefs for the first time. COTS were seen moving across the sand and feeding on corals they had tended to avoid, including several species of *Porites* (*Porites lobata*, *P. rus*, and *P. cylindrica*) and flower corals (*Goniopora*), free-living

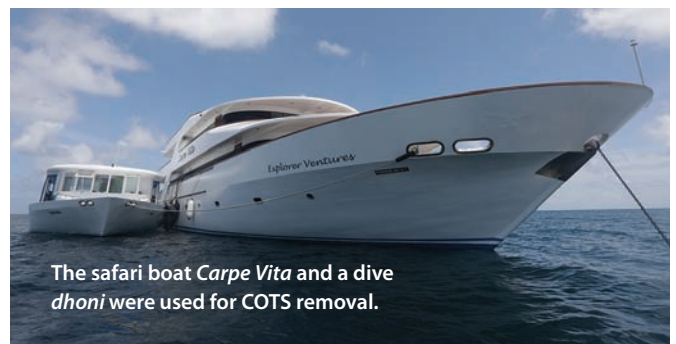
mushroom and slipper corals, and the few remaining massive, plating, and encrusting faviid corals (especially *Diploastrea*). Many of these were long-lived species that only grow a centimeter or less each year. We also observed them feeding on other types of cnidarians, such as false corals, colonial anemones, and leather corals. Most alarmingly, they were feeding on the recruits and juvenile corals in the genera *Acropora* and *Pocillopora* that had survived the bleaching event and/or had settled after the 2017 coral spawning. Given the degraded state of many Maldivian reefs following the 2016 bleaching event, we feared that continued predation pressure by these corallivores could set back recovery times by several decades.

### “RESCUE A REEF”

In 2017, Coral Reef CPR began implementing a new program, “Rescue a Reef,” in partnership with the safari boat operator Carpe Diem Maldives Fleet. We wanted to take advantage of a select and continuously growing group of people: the 25 million SCUBA divers who have been trained and certified by the Professional Association of Dive Instructors (PADI) since 1967. We wanted to work with recreational divers who were seeking a new experience and were eager to contribute to the conservation of coral reefs. Our pilot COTS removal effort in May 2017 involved 17 recreational divers from nine countries, who

worked alongside Coral Reef CPR scientists and six of Carpe Diem’s Maldivian dive guides, targeting reefs in North and South Malé. After a safety briefing and short training workshop, the team worked together to remove 900 COTS from eight different reefs in two atolls.

The second “Rescue a Reef” expedition was undertaken in September 2017, again with 17 recreational divers and staff members from Coral Reef CPR and Carpe Diem. During the week-long effort we identified one heavily infested reef off South Malé and two off Ari Atoll, collecting nearly 1,500 COTS in total. A second team immediately followed this group, working to remove the remainder of the starfish from these reefs. Together, we estimated that the total number of starfish removed from these reefs would save an estimated 20 million square



The safari boat *Carpe Vita* and a dive *dhoni* were used for COTS removal.



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Variation in coloration of different age classes of starfish in the Maldives. The animal on the left is 1 inch (3 cm) long, the one in the center is 6 inches (15 cm), and the one on the right is 12 inches (30 cm).



Sending a bag of COTS to the surface using a surface marker buoy (SMB).



The team of volunteers with Coral Reef CPR scientists and Carpe Diem staff.

feet (1.9 million m<sup>2</sup>) of reef habitat, based on the measured rate of consumption of 6 m<sup>2</sup> of coral per starfish each year over their 15- to 17-year lifespan.

### DIVE FOR CHANGE

Tackling global stressors, particularly climate change, is a difficult prospect and will only be successful once governments take drastic measures to reduce the burning of fossil fuels. However, we believe that we can successfully work at a local level to mitigate localized stressors, such as COTS outbreaks. This will provide us with more time for the resolution of global issues and allow corals the opportunity to adapt to changing conditions. These COTS removal expeditions have shown us that recreational divers are the perfect group to work with, and that diving with a purpose appears on many divers' wish lists. Our "Rescue a Reef" expeditions have received incredibly positive responses from the divers involved; many of them have claimed these trips were "their best diving experience to date" and booked repeat trips. We are providing recreational divers with a chance to give back and protect the marine environments that they dive on every year. Having our Coral Reef CPR scientists on board also offers an oppor-



*Pocillopora* colonies often host symbiotic *Trapezia* crabs. The crabs defend the coral against COTS and other predators.

tunity for all marine-related questions to be answered and for critically important messages to be passed on. Ultimately, these divers leave with a new perspective on coral reef ecosystems and an understanding of their importance and the threats they face.

### JOIN THE COTS CORPS

Carpe Diem Maldives Fleet and Coral Reef CPR are excited to announce the first three "Rescue a Reef" expeditions scheduled for 2018: *Carpe Novo* May 26-June 2, *Carpe Vita* July 15-22, and *Carpe Diem* September 8-15. You can find out more about these trips through [coralreefcpr.org](http://coralreefcpr.org) or [carpediemmaldives.com](http://carpediemmaldives.com).



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