Caribbean coral reefs under siege from aggressive algae

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Peyssonnelid algal crusts spreading over a dead skeleton of Acropora palmata in shallow water in Great Lameshur Bay in St. John, U.S. Virgin Islands. Credit: Peter Edmunds

Human activity endangers coral health around the world. A new algal threat is taking advantage of coral's already precarious situation in the Caribbean and making it even harder for reef ecosystems to grow.

Just-published research in *Scientific Reports* details how an aggressive, golden-brown, crust-like alga is rapidly overgrowing shallow reefs, taking the place of coral that was damaged by extreme storms and exacerbating the damage caused by ocean acidification, disease, pollution, and bleaching.

For the past four years, the University of Oxford's Bryan Wilson, Carnegie's Chen-Ming Fan, and California State University Northridge's Peter Edmunds have been studying the biology and ecology of peyssonnelid algal crusts, or PAC, in the U.S. Virgin Islands, which are out-competing coral larvae for limited surface space and then growing over the existing reef architecture, greatly damaging these fragile ecosystems.

"This alga seems to be something of an ecological winner in our changing world," described lead author Wilson, noting that the various other threats to coral communities make them more susceptible to the algal crusts.

Edmunds first took note of the crusts' invasive growth in the wake of category 5 hurricanes Irma and Maria when they were rapidly taking over spaces that had been blasted clean by the storms.

Corals are marine invertebrates that build large exoskeletons from which reefs are constructed. To grow new reef structures, free-floating baby corals first have to successfully attach to a stable surface. They prefer to settle on the crusty surface created by a specific type of friendly algae that grows on the local rocks. These coralline crustose algae, or CCA, acts as guideposts for the coral larvae, producing biochemical signals along with their associated microbial community, which entice the baby coral to affix itself.

Orange peyssonnelid algal crusts spreading over a lobe of Orbicella annularis at 14-meter depth on the Tektite reef on the southern shore of St. John, U.S. Virgin Islands. Credit: Peter Edmunds

What puzzled the researchers is that both the destructive PAC and the helpful CCA grow on rocks and create a crust, but PAC exclude coral

settlement and CCA entices it. What drives this difference?

The team set out to determine how the golden-brown PAC affects Caribbean coral reefs, and found that the PAC harbors a microbial community that is distinct from the one associated with CCA, which is known to attract corals.

"These PAC crusts have biochemical and structural defenses that they deploy to deter grazing from fish and other marine creatures," explained Fan. "It is possible that these same mechanisms, which make them successful at invading the marine bio-space, also deter corals."

More research is needed to elucidate the tremendous success that the algal crusts are having in taking over Caribbean reef communities and to look for ways to mitigate the risk that they pose.

"There is a new genomic and evolutionary frontier to explore to help us understand the complexity of organismal interactions on the reef, both mutualistic and antagonistic," added Fan.

Edmunds concluded: "The coral and their ecosystem are so fragile as it is. They are under assault by environmental pollution and global warming. We have made their lives so fragile, yet they are sticking in there. And now this gets thrown into the mix. We don't know if this is the straw that breaks the camel's back, but we need to find out."

More information: Bryan Wilson et al, An unusual microbiome characterizes a spatially-aggressive crustose alga rapidly overgrowing shallow Caribbean reefs, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-76204-0

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