'Janitors' of the sea: Overharvested sea cucumbers play crucial role in protecting coral

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Sea cucumbers with coral and fish in Mo'orea. Credit: Georgia Institute of Technology (Cody Clements)

Corals are foundational for ocean life. Known as the rainforests of the

sea, they create habitats for 25% of all marine organisms, despite only covering less than 1% of the ocean's area.

Coral patches the width and height of basketball arenas used to be common throughout the world's oceans. But due to numerous human-generated stresses and coral disease, which is known to be associated with ocean sediments, most of the world's coral is gone.

"It's like if all the pine trees in Georgia disappeared over a period of 30 to 40 years," said Mark Hay, Regents' Chair and the Harry and Anna Teasley Chair in Environmental Biology in the School of Biological Sciences at the Georgia Institute of Technology. "Just imagine how that affects biodiversity and ecosystems of the ocean."

In first-of-its-kind research, Hay, along with research scientist Cody Clements, discovered a crucial missing element that plays a profound role in keeping coral healthy—an animal of overlooked importance known as a sea cucumber.

Their study, undertaken in remote tropical islands in the Pacific, investigated the role that sea cucumbers play in coral health. The small, unassuming, sediment-eating organisms function like autonomous vacuum cleaners of the ocean floor. But, because they have been overharvested for decades for food and cannot reproduce effectively when in low densities, they are now rare and slow to recover following harvests. They have been gone so long that it wasn't known exactly how important they are—until now.

"We knew that removing big predators has cascading effects that commonly change how ecosystems are organized and how they function," said Hay. "What we didn't know is what would happen following removal of detritivores—or as we like to call them, the janitors of the system."

The team's research was published in the journal *Nature Communications*.

A missing component

The idea began when Hay saw an etching of a 19th-century sailing ship in a Fiji museum. The caption explained that the ship was leaving Fiji carrying many tons of dried sea cucumbers. Hay realized that the creatures he would rarely see while diving and working around reefs had likely once covered the bottom of shallow tropical oceans.

Sea cucumbers are invertebrate sea animals that come in all different sizes, colors, and shapes. They lie on and burrow under the sand all day, sucking, digesting, and excreting sediment, consuming bacteria and other organics. Hay and Clements were curious about the role sea cucumbers played when they were abundant. But it wasn't until Clements was doing unrelated field work in Mo'orea, a tropical island in French Polynesia, that an opportunity presented itself.

Clements, who has worked in coral restoration for years, has planted upwards of 10,000 corals in his career. He was planting corals in the sand just off the island shore, in an area where many sea cucumbers were present. He decided to clear out the sea cucumbers from the area because there were so many.

He noticed that the corals started to die, which seemed unusual.

"I've planted a lot of corals in my day, and my corals generally don't die," Clements said. "So I thought there must be something to this."

Experiment and findings

Hay and Clements set up patches to monitor coral health with and

without the presence of sea cucumbers. They marked the patches via GPS and went to check them daily.

For the patches without sea cucumbers, they often observed a white band developing at the base of the corals, which would work its way up and eventually kill the entire colony. It was a hallmark of sediment-associated coral diseases seen around the world.

The presence of sea cucumbers seemed to suppress coral disease. They observed that corals without sea cucumbers present were 15 times more likely to die. They did a similar experiment in Palmyra Atoll, which is part of the U.S. Minor Outlying Islands that is protected by the Nature Conservancy and the U.S. Fish and Wildlife Service. In Palmyra, the experiment had different coral species and different sea cucumbers, but they found similar results—suggesting a robust interaction.

The experiment painted an alarming portrait. Sea cucumbers seemed to be a missing component of what had been, at one point, an intact ecological system. Before humans started harvesting these sediment-cleaning organisms, they had helped protect corals from disease.

"If you remove all the scum suckers in the great fish tank of Earth, you're going to get a dirty tank eventually," Clements said. "People have paid lip service to the idea that sea cucumbers could be important for a long time, but we didn't know the scale of their importance until now."

Hay explains long-term sea cucumber removal as the lighting of an ecological fuse that has been burning for more than 100 years. With the exponential increase of human populations, the overfishing of reefs, human input of nutrients and organics, and the removal of sea cucumbers, there is now a buildup of organics and nutrients that enhance bacterial growth in the sediment. All of that is what sea cucumbers would be cleaning.

"Basically, we've been polluting our environs at the same time that we've removed all the janitors," Hay said.

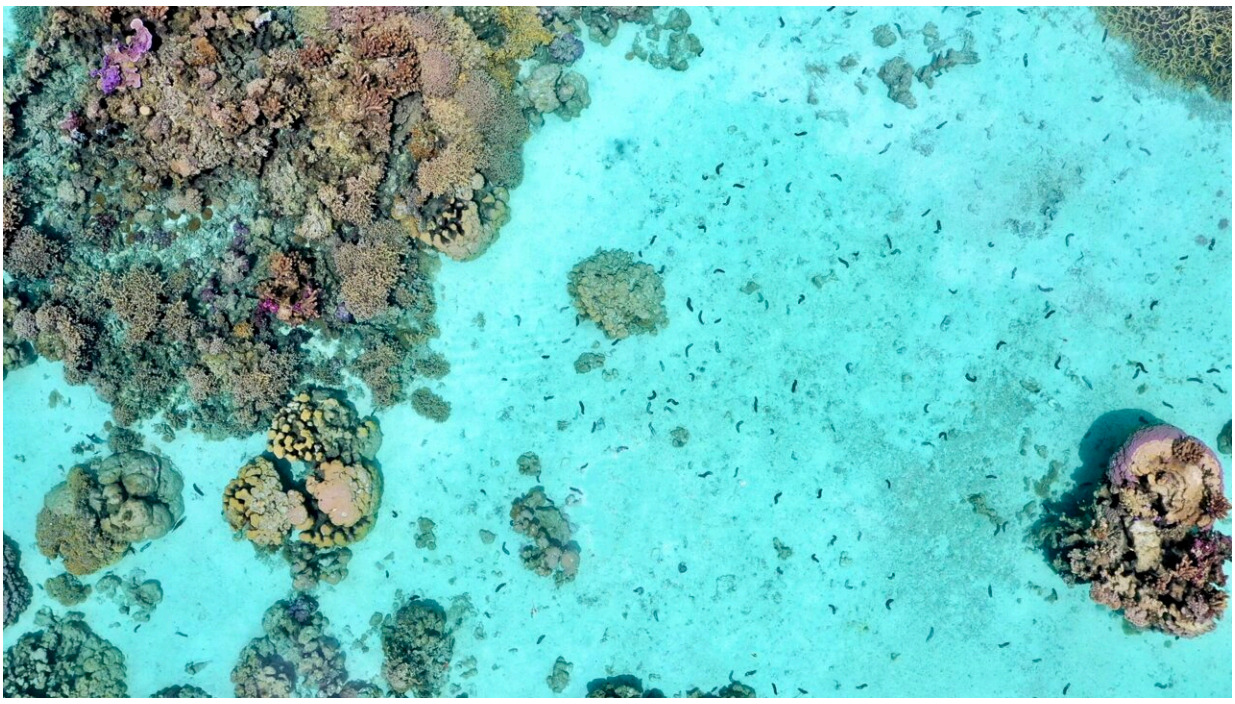
Application and resilience

Hay and Clements hope their findings will encourage communities to limit harvesting and begin to repopulate sea cucumber species. The species from their study are of little commercial or food value and could be cultured and released into the ocean. This would help to mitigate coral disease and help reefs worldwide return to health.

"Bringing these little guys back from the brink and drawing awareness to their value for ecosystems might improve the situation overall," Clements said. "It will take effort, but increasing the health of reefs would improve biodiversity and therefore the livelihoods of people in coastal communities."

Despite the many ecological fuses that humans have lit, whether knowingly or unknowingly, Hay still has hope for corals and sea cucumbers.

Drone image of sea cucumbers in Mo'orea. Credit: Cody Clements, Georgia Institute of Technology.



Sea cucumbers on the ocean floor off the coast of Mo'orea. Credit: Georgia Institute of Technology (Cody Clements)

"Organisms like sea cucumbers give us insurance for another few decades, and focusing on their importance is something to try," Hay said. "We're looking for little tweaks that can really improve the situation, while we as a society get our act in gear and do better."

He added, "If we don't cut back on pollution, if we don't cut back on overharvesting, and if we don't cut back on global warming, there isn't much hope. It's a challenge, but you can either give up and go home, or you can keep working on it."

More information: Cody S. Clements et al, Removal of detritivore sea cucumbers from reefs increases coral disease, *Nature Communications* (2024). DOI: 10.1038/s41467-024-45730-0

Provided by Georgia Institute of Technology

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