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Two oceans, one country, 20 times the number of sharks

How many sharks should a coral reef have? It sounds like a simple question, but almost nowhere on Earth is there a pristine, untouched reef. So there is no yardstick against which to measure shark decline or recovery.

Researchers at UC Santa Barbara and the Smithsonian Tropical Research Institute (STRI) in Panama answered this question with fossilized shark scales that the team jokingly call “shark dandruff.” The study, featured on the cover of Science, compares ancient shark populations from Panama’s Pacific and Caribbean coasts. The paper was led by Erin Dillon (Ph.D. ’22), who began this research during her doctoral studies at UCSB. The findings reveal that the two regions once supported vastly different densities of sharks, suggesting historical shark populations on one coast should not be used as a benchmark for the other.

“Sharks are a critically important part of healthy ocean ecosystems. But they've been hammered by overfishing, shark finning and habitat destruction,” said co-author Douglas McCauley, a professor in UCSB’s Department of Ecology, Evolution and Marine Biology. “Our efforts to bring back sharks have been hampered by our inability to answer a seemingly straightforward question: How many sharks are there actually supposed to be in the sea? Erin's research finally gives us a big part of that answer.”

Sharks Shed

Sharks are covered in dermal denticles, tiny tooth-like scales that they continuously shed through life. These tough scales settle into reef sediments, where they can be preserved for millions of years. Counting the denticles in a well-dated slice of sediment can yield an estimate of how many sharks swam overhead. That’s a boon to shark ecologists and marine managers, who have long wondered how many sharks were in the ocean before humans started dramatically altering the seas.

Assaying the deposits of ancient shark scales enabled the authors to finally establish historic baselines for shark abundance. “The shark denticle approach operates a little bit like a time machine,” McCauley explained, “giving us a peek at how many

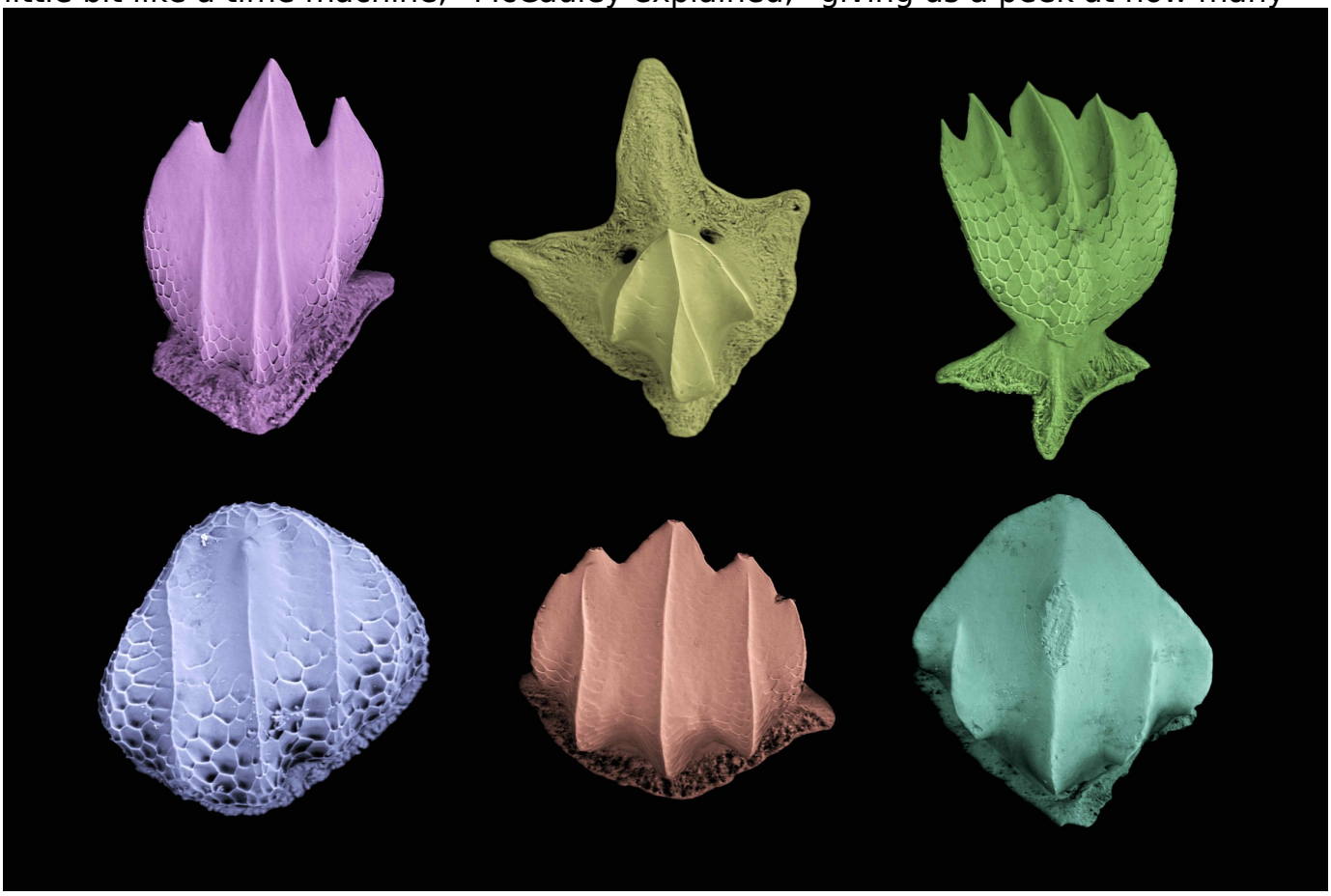

Photo Credit
Erin Dillon, Aaron O’Dea, and Jorge Ceballos

The shape of a dermal denticle is related to its primary function and can be used to identify the kind of shark it came from.

The team applied this approach on both sides of the Isthmus of Panama, comparing sediments laid down between 7,000 and 3,000 years ago — long before intensive fishing — with sediments from the past century. The researchers collected 3,497 denticles from 157 samples.

The data took more than a decade to build, providing insights along the way. “This project began 12 years ago with a wild idea to search for shark scales in reef sediments,” said Dillon, now a postdoctoral researcher at STRI. “Finding the first denticle was exhilarating.”

The team had to work out what information the denticles could provide, how to collect them from reef sediments and how to interpret a fossil assemblage. “Panama represented the perfect place for applying the approach, because it let us compare shark baselines across two very different oceans separated by a single strip of land,” Dillon explained.

Hints of the results came early in the study. “In Bocas del Toro, on the Caribbean coast of Panama, we were finding around 50 shark denticles in 10 kilograms (22 pounds) of reef sediment,” said Aaron O'Dea, STRI staff scientist and co-corresponding author. “When we took our first, much smaller sample, from a Pacific reef, we were shocked to find 200 denticles in just one kilogram (2.2 pounds).”

A tale of two coastlines

This difference continued to hold as the authors began modeling the data to account for variation in dating and effort. Before humans began heavily fishing, reefs in the Gulf of Panama on the Pacific coast supported roughly 20 times more sharks than their counterparts in the Caribbean. Yet the two regions are only about 100 kilometers away and share many of the same shark species.

The two coasts have diverged further in the intervening centuries. Caribbean denticle accumulation fell by about 75%, while Pacific rates today are statistically unchanged from their prehistoric baseline. The upshot is that reefs on Panama's Pacific coast now yield about 100 times more denticles than those on its Caribbean

coast.

Scientists generally sensed that the Caribbean's sharks had been hit hard. "But a 75% drop in abundance is a lot," McCauley said. "That was a sobering result."

What makes this particularly puzzling is that the Pacific coast has been fished much more heavily. More than 98% of Panama's fishing happens there.

"When we think about the oceanographic context of our samples, this pattern makes sense," Dillon said. "The Gulf of Panama is a highly productive environment fueled by seasonal upwelling, which brings deep nutrients to the surface and provides enough food to support large predator populations.

"The Caribbean, on the other hand, is more nutrient-poor," Dillon continued. The result is the glassy water from postcards of Caribbean coral reefs, where energy and nutrients are locked up in biomass, rather than available in the water column. The result is lower shark abundances that are more vulnerable to fishing."

There's the rub

These differences have practical consequences: Conservation targets set from the wrong baseline can be way off.

Resource managers routinely estimate how many sharks a reef ought to have by looking at the healthiest reef they can find nearby. In Panama, using the Pacific as a reference for the Caribbean, or assuming the two coasts have suffered comparable impacts, would set a conservation target off by an order of magnitude, or more. Ocean productivity, the authors argue, deserves as much weight as fishing history when recovery goals are set.

The findings are not, however, a clean bill of health for Pacific sharks. "Our samples from the last 100 years may not be telling the whole story," said O'Dea. "Targeted shark fishing in the Gulf of Panama ramped up in the 1980s, so recent declines could be diluted when averaged across a century."

Work by STRI staff scientist Héctor Guzmán shows that shark populations in Pacific Panama are under pressure from intensified fishing today. It could be enough to

overpower the region’s historical resilience.

Climate change also looms over the future of the Pacific sharks. Last year the group reported that the upwelling that pumps cold, nutrient-rich water into the Gulf failed for the first time on record.

“Putting this together, sharks along Panama's Pacific coast have a high capacity to recover, but overfishing combined with changing ocean conditions may be pushing them into a state not seen for millennia,” O'Dea said.

This story was adapted for The Current from a release by The Smithsonian Tropical Research Institute.

Tags
Ocean and Beaches

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