SCRIPPS INSTITUTION OF OCEANOGRAPHY

explorations

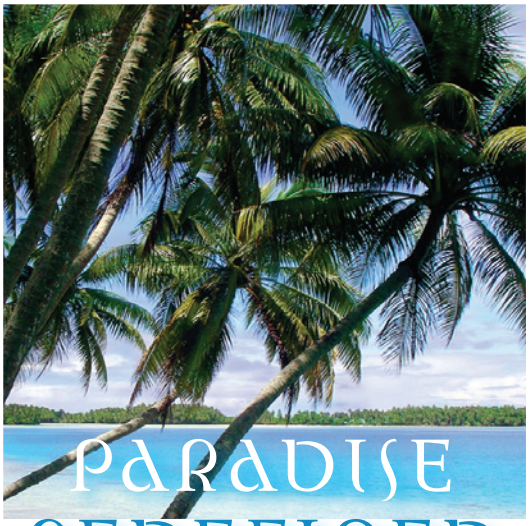
The Magazine of Ocean and Earth Sciences

JULY/AUGUST 2007

Part Two

A NEW VIEW OF PRISTINE

A JOURNEY TO A CORAL REEF CHAIN HIDDEN IN THE CENTRAL PACIFIC FORCES SCIENTISTS TO REVISIT THE DEFINITION OF A PRISTINE ENVIRONMENT



PARADISE REDEFINED

By Mario C. Aguilera

The bad news is that there is no such thing as a remote atoll anymore. While large fishes are doing better here because of fewer people fishing, corals are doing badly in some places possibly as a result of a combination of global warming and pollution from a shipwreck. The human footprint is greater than we think, and thousands of miles of sea around a coral reef does not protect it against global, invisible, yet lethal threats.

— ENRIC SALA, *JOURNAL ENTRY FROM THE LINE ISLANDS EXPEDITION, AUG. 12, 2005*

BY SEPTEMBER 5, 2005, THEY HAD DONE IT.

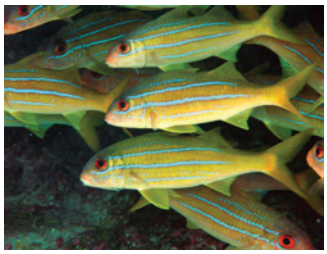
The research team led by Scripps Institution of Oceanography at UC San Diego had traveled thousands of miles across the Pacific Ocean to explore a tropical paradise. Over five weeks, the researchers conducted perhaps the most comprehensive evaluation of coral reef ecosystems to date, covering mighty predators, microscopic bacteria, and everything in between.

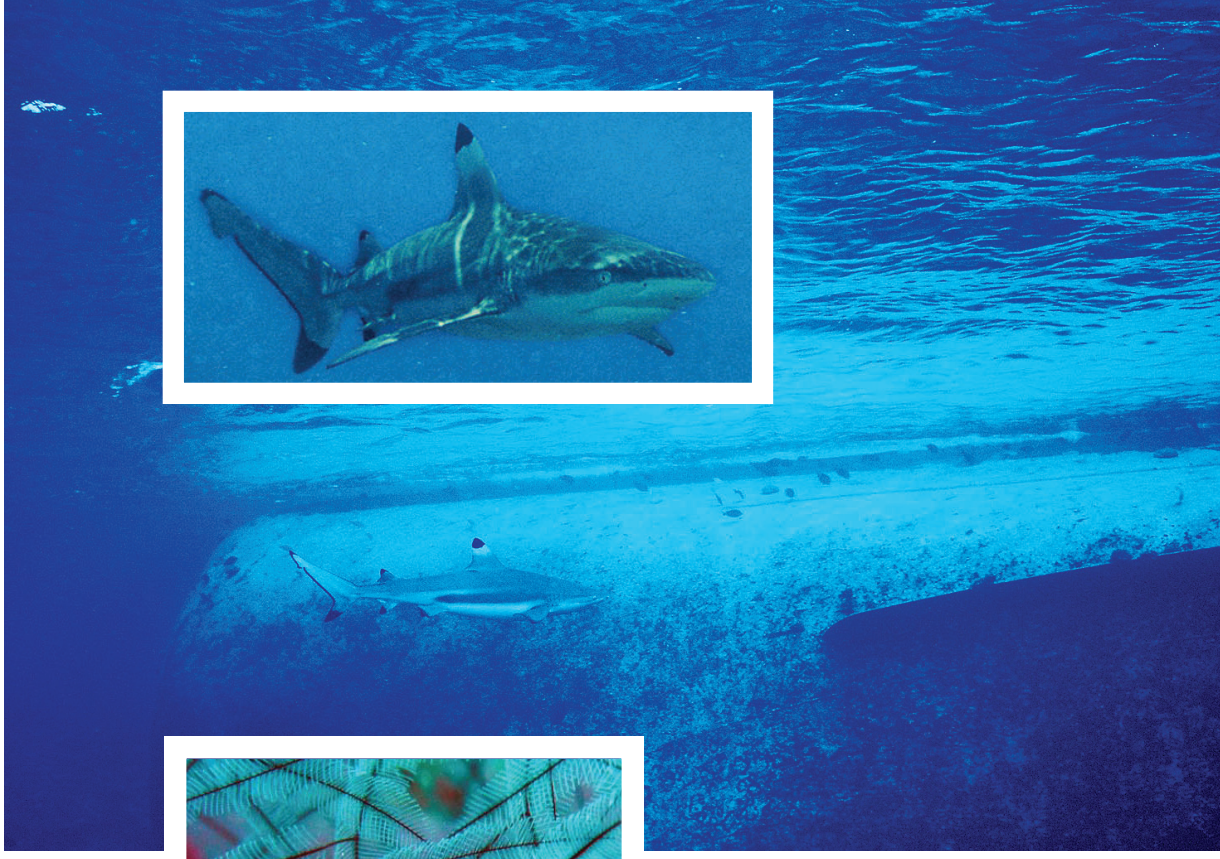
Within the Line Islands archipelago, four targeted islands each revealed a singular case study, from the heavily impacted to the virtually pristine.

Meticulous planning paid off with a wealth of reef data. Hundreds of dives produced a rich sampling trove and scores of images and video.

Analysis of the data began almost immediately. The researchers tediously combed through piles of information searching for clues

SCRIPPS INSTITUTION OF OCEANOGRAPHY/UC SAN DIEGO





as to what it all meant. Challenges mounted as the specialists of the various disciplines attempted to fit the scientific puzzle pieces together.

"To build one coherent story from the volumes of data is not a trivial endeavor," said Stuart Sandin, a Scripps marine ecologist and the coordinator of the Line Islands Expedition. "We just don't ever have this much data about one system to allow us to build such a clean view."

But build they did. After months of meetings, phone calls, and e-mail exchanges, a synthesis began to take shape.

Clockwise from top: *Two views of black-tip reef sharks: The bottom shark swims over the wreckage of a long-line fishing boat near the entrance to Palmyra lagoon; Scientists believe this close-up is of a hydroid, an animal that captures prey with the use of powerful stinging cells; Reef inhabitants such as steephead parrotfish (center) graze on coral and keep algae in check; "Goat fish" use whisker-like feelers called barbels to forage in sediment; Photographer Zafer Kizilkaya off Palmyra Atoll.*

THE INVERTED PYRAMID

The classically accepted picture of a marine community takes the shape of a pyramid, in which a small number of large predators sit at the top, a larger number of plant-eating fish and invertebrates lie in the middle, and a very large abundance of plants and algae form the base. A comparative examination of two of the Line Islands, however, is telling a much different story.

Off the highly fished waters of Kiritimati, or Christmas Island, the researchers observed a classic food chain pyramid. But when they arrived at the virtually pristine waters of Kingman Reef, they found the pyramid was turned on its head. They found a large number of sharks, snappers, and groupers at the top of the food chain, a much sparser population of fish in the middle, and a drastically smaller algal population at the base.

Enric Sala, a marine ecologist and adjunct professor at Scripps, was shocked when he dived there for the first time. He uses an analogy based in the African Serengeti to properly frame the experience: "It was like seeing five pounds of lion for every pound of wildebeest or zebra," said Sala, the expedition leader.

Eureka! We found it. A pristine reef where corals are alive and healthy and form a forest so thick that there is no space even for sand between them. A reef where sharks are not used to seeing humans and, instead of swimming away, they come by the dozens and swim around you during the entire dive. A reef where one's heartbeat doubles as soon as we disappear below the surface. This is Kingman Reef, the pearl of the Line Islands.

—ENRIC SALA, *JOURNAL ENTRY FROM THE LINE ISLANDS EXPEDITION, AUG. 25, 2005*

Jen Smith, who has spent the last 8 years studying Hawaiian reefs, returned from one of the dives to say, "My own personal baseline was shifted yesterday." The shifted baseline is not limited to things that we see with our eyes underwater, but also to other benefits that the ocean shares with us.

—STUART SANDIN, *JOURNAL ENTRY FROM THE LINE ISLANDS EXPEDITION, AUG. 13, 2005*

From left: *Jennifer Smith uses a squared stand to demarcate a quadrat for reef studies; Finger-like Stylophora coral sits within the rounded extensions of blue Montipora coral; Staghorn coral.*

This led to the question: What makes a food pyramid go upside down in an undisturbed environment?

Sala believes the answer is not easily derived, mainly because, as marine ecologists have come to realize in recent years, coral reef ecosystems encompass thousands and thousands of connections that make up the pyramid. Multitudes of animals, plants, and bacteria all have a role to play. Rather than a linear chain, in reality it's an intricate food web.

One explanation for the inverted pyramid focuses on the importance of sharks in coral reef ecosystems, a function still poorly understood by scientists.

"The coral reef food web is not static," said Sala. "It's like a house made out of matches, but the matches are continuously changing places. Then we have the threats of pollution, global warming, and overfishing. I believe sharks are the very foundation for the stability of the house."

The food web phenomena ignited deeper questions within the Line Islands research group.

REDEFINING PRISTINE

If sharks and other predators are more prevalent in an unspoiled environment, perhaps this is the way things should be, rather than the much more common coral ecosystems characterized by few predators and abundant algae.

This evoked the idea of "shifting baselines," the concept devised by fisheries biologist Daniel Pauly and popularized in large part by Scripps Professor Jeremy Jackson, also a Line Islands Expedition participant, that argues that environments appear "normal" to us as we first know them. In a personal sense, a baseline could be a childhood memory of a favorite park or playground that is "shifted" when that place is degraded or "shifted" over time.

Jackson's research shows that many well-grounded scientific ideas in marine ecology should be reevaluated because the baseline in which they were developed may have already been disturbed.

Indeed, Sala says that more than 90 percent of marine biological studies, and 99.9 percent of studies on coral reefs, were conducted in conditions in which the environment was already seriously impaired.

"There has been a shifting baseline in ecology because every ecosystem has lost its predators," said Sandin. "It's no

Researcher David Obura takes counts of coral, including the young staghorn coral immediately in front of him. A giant clam sits in the foreground.

longer accepted that that's the way things should work."

In 2003, Palmyra Atoll was initially selected as the sole study site for the project because it had been regarded as a model destination for studying unspoiled coral reefs. With swaying palm trees and idyllic sunsets, it would be hard to argue otherwise at the surface.

Yet underwater the researchers found a different scene. Thousands of U.S. soldiers were stationed at Palmyra during World War II because of the atoll's strategic location. Even though the soldiers only stayed five years, they left a mark on the coral communities still visible today.

The scientists were able to document areas of Palmyra that are clearly degraded and other areas that have rebounded since the war with the emergence of new coral growth "recruits."

This evidence is giving them unique opportunities to study how much pollution and overfishing a coral system can withstand and what it takes to recover.

In the future, such analyses will be vital for decision makers around the world grappling with the best ways to implement marine reserves, locations set aside for rehabilitation from human impacts.

"Learning about Palmyra and Kingman brings us back to square one," said Sala. "This will be important for science and for conservation. It will help us determine the minimum area that we need to protect if we really want to protect the entire ecosystem."

REVISITING A VANISHING WORLD

The 2005 expedition also revealed to the researchers that one visit wasn't enough. Following the expedition, the scientists immediately decided that sharks would be a focal point of any future Line Islands research as part of an effort to understand more about the predators' role in coral reef ecosystems.

Another team of scientists returned in 2006 to focus on Palmyra and Kiritimati. They conducted experiments and collected samples to further pursue questions related to the growth rates of algae and fish and the associated dynamics of the coral food web.

In August 2007 they will return to Kingman for a comprehensive examination of the entire island in the hopes of learning more about the ecological processes involved in this extraordinary showcase of the undisturbed.

Another major expedition is in the planning stages for 2009, this time targeting the southern chain in the Line Islands archipelago. The researchers will start in Tahiti and steam north through the southern islands, covering 2,000 miles through destinations virtually untouched directly by humans.

"These are islands that people have no information about," said Sandin. "Essentially this is getting into the unknown."

With knowledge acquired from the initial Line Islands Expedition and its subsequent voyages, Sandin and Sala hope "the unknown" becomes "the known," and in the process provides an understanding of the ecological past of coral reefs to help guide their fate in the future.

We learned that it is impossible to have islands completely excluded from human influence. We accepted that the coral reefs of the future will be different than those of the past, except for maybe a few places such as Kingman reef. Our next challenge is to decide what we are going to be happy with, to identify a place along the gradient of human disturbance where both we and reefs will thrive.

—ENRIC SALA, *FINAL ENTRY FROM THE LINE ISLANDS EXPEDITION, SEPT. 5, 2005*

To view Line Islands Expedition multimedia presentations, see:

scripps.ucsd.edu/lineislands
explorations.ucsd.edu/Feature/Paradise_pt1/
explorations.ucsd.edu/Feature/Paradise_pt2/

FOR MORE INFORMATION PLEASE CONTACT
SCRIPPS COMMUNICATIONS OFFICE
Scripps Institution of Oceanography
UC San Diego
9500 Gilman Drive, 0210
La Jolla, California 92093-0210 USA
Phone: 858-534-3624
e-mail: scrippsnews@ucsd.edu
web: scripps.ucsd.edu

07-2007