Diving deeper into our oceans: Underwater drones open new doors for global coral reef research

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The new and improved underwater drone with two samplers, changeable batteries, and a longer cable, makes collecting seawater samples much easier for researchers. Credit: Okinawa Institute of Science and Technology

At the Okinawa Institute of Science and Technology (OIST), scientists at the Marine Genomics Unit, in collaboration with the Japanese telecommunications company NTT Communications, have identified the genera of mesophotic corals using eDNA collected by underwater drones for the first time.

Their research has been published in the journal *Royal Society Open Science*. Now, with the help of submersible robots, large-scale eDNA monitoring of corals can be conducted without relying on direct observations during scientific scuba diving or snorkeling.

Mesophotic ("middle-light") coral ecosystems are light dependent tropical or subtropical habitats found at depths of 30 to 150 meters. They are unique because they host more native species compared to shallow-water coral ecosystems. Despite this, they are largely unexplored, and more research is needed to understand their basic biology.

Researchers studying corals access these invertebrate reef builders by snorkeling and scuba diving, but these methods have limitations, especially when identifying corals at deeper depths. Using genetic material that organisms shed from their bodies into their environment—environmental DNA or eDNA—scientists can identify types of corals and other organisms living in a particular habitat, providing a powerful tool for biodiversity assessment.

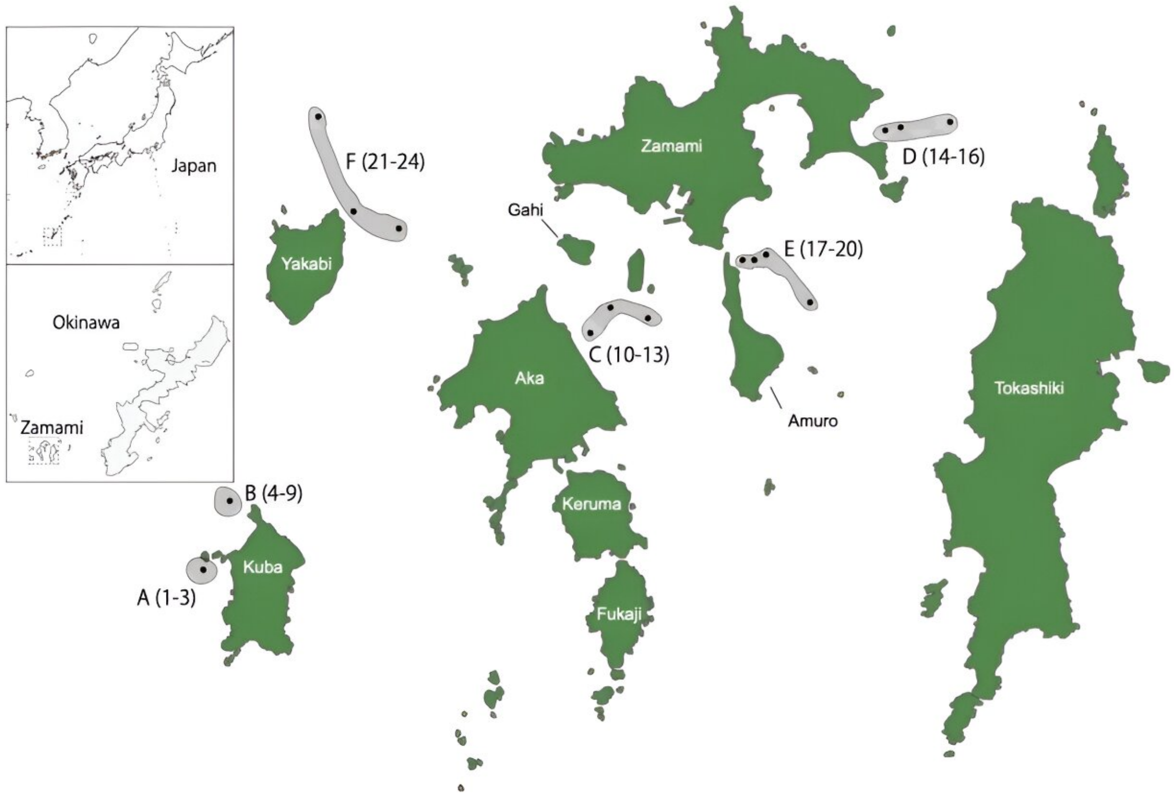
Studying the eDNA of corals offers unique advantages. First, unlike fish, corals are stationary, eliminating uncertainties about their location. Second, they constantly secrete mucus into the sea, providing plenty of coral eDNA for sampling. For this study, the researchers analyzed mitochondrial DNA, which is more abundant and of higher quality compared to nuclear DNA, improving the accuracy of their findings.

Faster and easier monitoring of coral reefs

Mesophotic coral ecosystems (MCEs) in Japan have some of the highest diversity of stony corals (Scleractinia) in the world, making them particularly important for researchers, but difficult to monitor because they are often located at deeper depths. Additionally, to accurately monitor corals, scientists require both scuba diving and taxonomy skills, which can be challenging. Existing methods for monitoring MCEs therefore impose limitations on conducting thorough surveys, and new methods are needed.

In October 2022, Prof. Noriyuki Satoh, leader of the Marine Genomics Unit, was approached by Shinichiro Nagahama of NTT Communications who had read about his research on coral eDNA methods. Nagahama suggested using their underwater drones to collect samples from deeper coral reefs for eDNA analysis. Prof. Satoh then put forward the idea of using the drones to conduct extensive surveys of mesophotic corals at greater depths.

Kerama National Park in Japan, about 30 km west of Okinawa Island, boasts some of the most transparent water in the Okinawa Archipelago. Often referred to as Kerama blue, these waters provided an excellent opportunity for the researchers to test this new sampling technique. They collected seawater samples—each measuring 0.5 liters—from 1 to 2 meters above the coral reefs (between 20 and 80 meters deep).



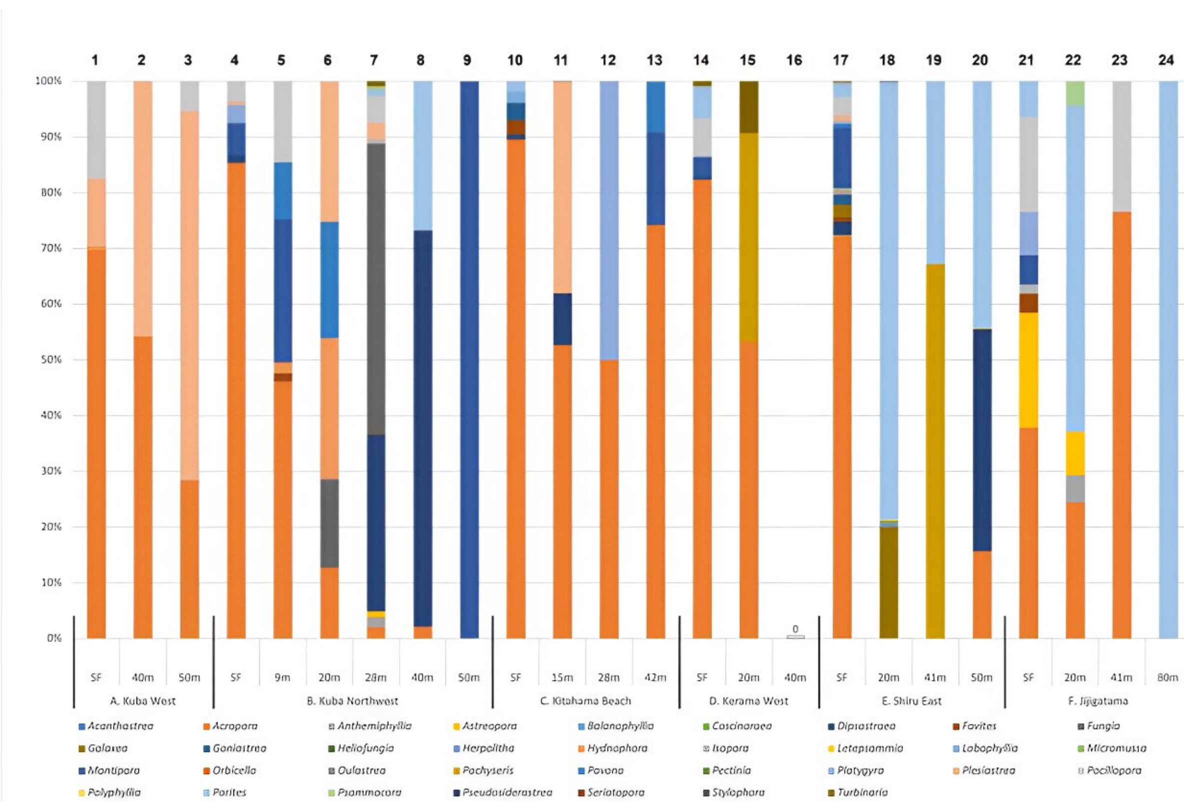
Map showing the seawater sampling sites at six monitoring locations around Zamami Island. Credit: Okinawa Institute of Science and Technology

The sampling sites were chosen across 24 locations within six different areas around the picturesque Zamami Island. The next step involved subjecting these samples to coral metabarcoding analyses, which uses Scleractinian-specific genetic markers to identify the different genera of corals present in each sample.

From the eDNA analysis results, the researchers successfully identified corals at the genus level. The presence and absence of certain genera of stony corals shown by this method indicated that reefs around the Kerama Islands exhibited different compositions of stony corals depending on location and depth. For example, the genus Acropora had the highest ratios at 11 sites, indicating that these corals are common at Zamami Island reefs.

The researchers also found that the proportion of Acropora eDNA was higher at shallow reefs and upper ridges of slopes, while the proportion of the genus Porites increased at mesophotic sites. Regarding depth, Acropora was readily detected at shallow reefs (≤15 meters), while other genera were more frequently found at deeper reefs (>20 meters).

To study corals using eDNA metabarcoding methods, further sequencing of mitochondrial genomes of stony corals is needed, and this study suggests that it may be possible to more efficiently monitor mesophotic corals at the generic level using eDNA collected by underwater drones.



Bar graph showing the distribution and approximate proportions of scleractinian corals at each monitoring site at the Kerama Islands. Names of Scleractinian coral genera are shown in different colors at the bottom. Numbers 1-24 indicate eDNA sampling sites with approximate depths in meters. SF refers to surface seawater. Credit: Okinawa Institute of Science and Technology

Corals produce a protective mucus layer that shields their tissues from the surrounding seawater. Within this mucus layer, certain substances actively combat harmful bacteria, preventing potential coral diseases. Credit: H. Yamashiro

Collaborative innovation ahead

NTT Communications has developed a new version of the original drone used for this study. In response to a request from Prof. Satoh, an additional sampler was added so that two samples can be collected during a single dive. Additionally, the cable length between the controller and drone was extended from 150 meters to 300 meters and the battery is now changeable, so researchers can continue their survey work for an entire day.

Prof. Satoh is now working with two mesophotic coral specialists at the University of the Ryukyus, Dr. Frederick Singer and Dr. Saki Harii, to further test this method at study sites near Sesoko Island, using the new and improved drones. He hopes to revolutionize the way coral surveys are conducted. Currently, surveys are limited to very restricted spots, but with the help of these advanced underwater drones, scientists can extend their research from the shallowest regions to depths of 60 meters and beyond.

"My ideal survey would include the entire spectrum of the coral reef, from the shallow waters to the mesophotic zones, and even the sandy depths. These machines provide an excellent method for conducting broader eDNA monitoring studies," he said.

More information: Koki Nishitsuji et al, Possible monitoring of mesophotic scleractinian corals using an underwater mini-ROV to sample coral eDNA, *Royal Society Open Science* (2024). DOI: 10.1098/rsos.221586

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