Dyeing Corals to Track Growth

Expedition: The Ecosystem Impacts of Oil and Gas Inputs into the Gulf of Mexico (ECOGIG) Consortium


By Chuck Fisher, Penn State University and **Melissa Kurman**, Temple University, Ocean Exploration Trust team

Deep-sea corals grow very slowly, sometimes only a few millimeters in one year. In the past, it was only possible to estimate coral growth rates. Scientists would collect an entire coral colony and calculate the estimated growth rate by measuring the full size of a coral and dividing that number by the approximate age of the coral colony. The age was estimated using a **Carbon-14** dating technique on the oldest (thickest) part of the deep-sea coral colony. This calculation generates an average growth rate over the colony's whole lifespan, which can be over 1000 years old! Few studies have collected direct measurements of growth rate of a coral as it is still growing on the seafloor, making it impossible to look for growth patterns over a colony's lifespan.

That was, until scientists on board Exploration Vessel (E/V) *Nautilus'* Exploring Now: Oil Spill Impacts on Gulf of Mexico Biology (ECOGIG) cruise released a dye pack of fluorescent dye around a live octocoral (a type of deep-sea coral). This dyeing experiment was designed to give direct measurements of growth rates and show the growth patterns over time. Combined with high-resolution images of the coral colonies, this study can detect even the smallest increases in growth and estimate growth rates.

Adding Color

The fluorescent dye used to measure coral growth rates is called calcein which works by staining the octocoral's skeleton. In the lab, calcein is an orange powder but when combined with sea water, it creates a vibrant yellow-green solution. When applied, the stain is taken up by the coral polyps. The chemical is carried into the complete coral skeleton, where it can be later seen under UV light. The coral must be exposed to the dye for a minimum of six hours to ensure the coral takes up the dye.

ECOGIG

This expedition was a project of The Ecosystem Impacts of Oil and Gas Inputs into the Gulf of Mexico (ECOGIG) Consortium. This group is made up of scientists from a wide variety of disciplines that study current flow, ocean chemistry, microbial activity, deep-sea coral communities, and everything in between. ECOGIG was funded to study both the natural oil and gas seepage in the gulf and ecosystem responses and effects from the 2010 Deepwater Horizon oil spill. https://nautilus.org/cruises/2017/

A very large, and very old deep-sea coral colony imaged during this ECOGIG expedition. This *Paramuricea* colony is also home to several other animals including brittle stars, squat lobsters, hydroids, and more. *Image courtesy of Nautilus Live/OET.*

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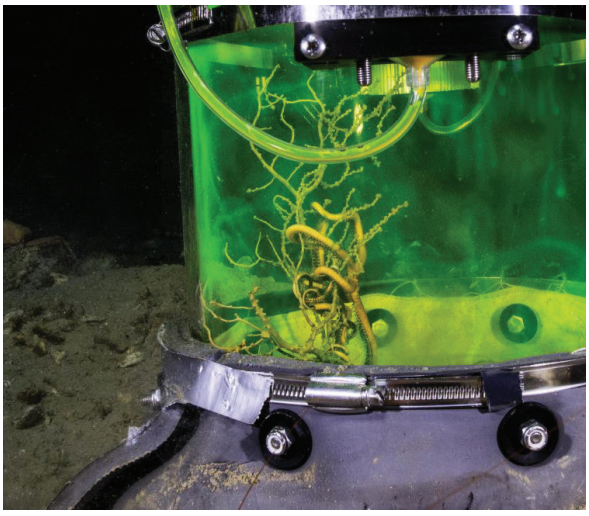
Carbon-14 is a naturally occurring, but rare isotope of carbon. It is radioactive and breaks down over time. Younger items have more carbon-14 than older ones. Scientists estimate the age of matter by measuring the amount of C-14 left in the sample and comparing that to the known rate of decay.
https://gml.noaa.gov/ccgg/isotopes/decay.html



Calcein is a fluorescent dye that stains coral skeletons which allows scientists to calculate growth rates over time. *Image courtesy of Nautilus Live/OET, ECOGIG.*

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An Engineered Solution

In order to apply the calcein to a coral in a concentrated way, scientists cover the coral with a specialized, custom-built chamber, called 'the stainer.' The stainer was first used only one month before this expedition. On this expedition, the team stained a coral called a sea fan, *Paramuricea* which is abundant throughout the gulf at about 1,000 meters (3,000 feet).

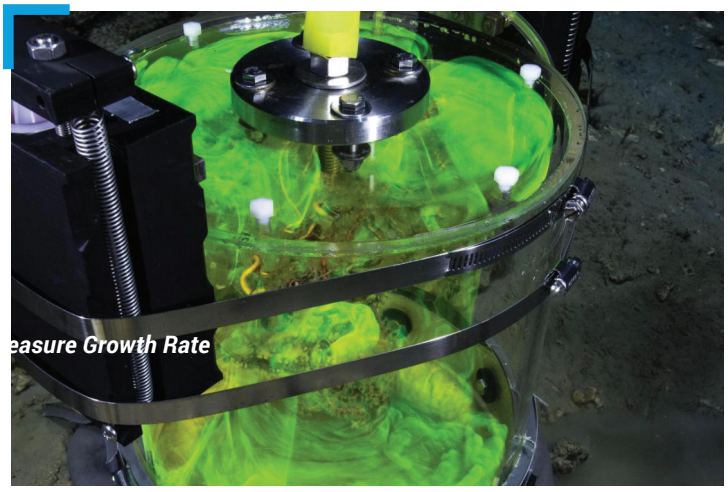
The stainer was set in place by remotely operated vehicle (ROV) *Hercules*. Before the dive, scientists prepared the stainer in the lab on E/V *Nautilus*. They filled two syringes with the dye, placed them in locked actuators (movers), and attached a small tube which allowed the stain to enter the chamber. The actuators are the black boxes on either side of the chamber. Once on the seafloor, the ROV's manipulator arms are used to pull a pin, causing the actuator to compress the syringe and release dye into the chamber. During this experiment, the stainer was left over the coral for about fourteen hours to make sure the coral took up enough of the dye.

Measuring Growth

Since this process was a new experimental design, scientists on board collected small pieces of coral during the dive to make sure that the dye was being absorbed. The team made plans to return the next year to collect the entire coral. Examining this colony will allow an accurate measurement of the coral's growth since new growth will not have any stain, but older growth will.

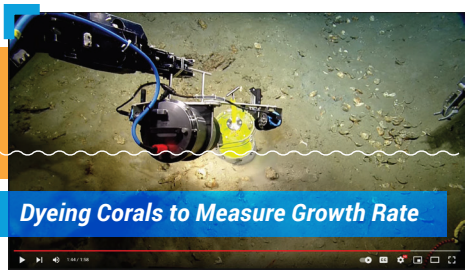
Difficulty at Sea

Conducting research in the deep sea has many challenges, which is why it is so important for a research team to be flexible and creative while on expedition. During the dive, one stainer became stuck and did not activate on the seafloor. When recovering the vehicles, it finally activated at the surface leading the team to conclude the malfunction may have been due to a pressure problem or a problem during the launch. Luckily one stainer did work as planned, and the team was able to dye a colony to begin the experiment.

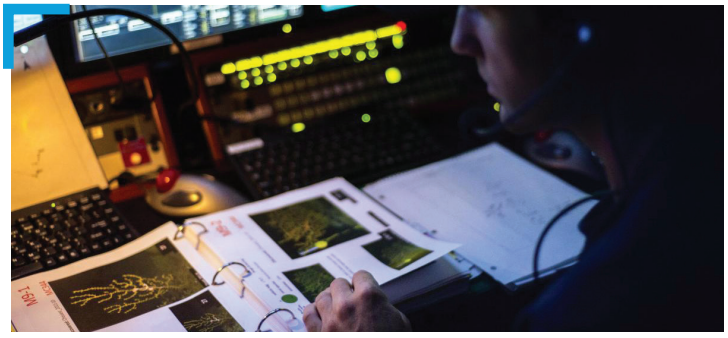


The stainer is a custom-designed chamber that is placed around the coral scientists aim to dye. The chamber is built with two syringes inside of small, black actuators. ROV pilots use the ROV's manipulator arms to move the actuators, which compresses the syringes and releases the dye into the chamber. *Image courtesy of Nautilus Live/OET.*

WATCH THE WHOLE PROCESS IN ACTION!



Video courtesy of Nautilus Live/OET, ECOGIG.



The scientists look closely over documentation and a coral image series taken from previous cruises to compare new observations and ensure they are capturing new pictures of the exact same coral year-after-year. *Image courtesy of Nautilus Live/OET.*

Original blog: https://nautiluslive.org/blog/2014/07/03/dyeing-corals-find-life
Expedition: https://nautiluslive.org/cruise/NA043
Explorer bio (Fisher): https://nautiluslive.org/people/chuck-fisher
Explorer bio (Kurman): https://nautiluslive.org/people/melissa-kurman
Deep-sea coral colony (image): https://nautiluslive.org/sites/default/files/styles/photoswipe_display/public/images/2014-07/h1337_07012014_07-16-36_0068.jpg?itok=H169RKtw
C-14 (webpage): https://gml.noaa.gov/ccgg/isotopes/decay.html
Calcein (image): https://nautiluslive.org/sites/default/files/styles/responsive_image_xl/public/images/2014-07/h1337_07012014_16-31-14_0210.jpg?itok=idEPB74E
Stainer (image): https://nautiluslive.org/sites/default/files/styles/responsive_image_xl/public/images/2014-07/h1337_07012014_02-57-20_0005.jpg?itok=mS34eOqy
Dyeing corals (video): https://www.youtube.com/watch?v=emFI-s-5VwY&t=67s
Scientists (image): https://nautiluslive.org/sites/default/files/styles/photoswipe_display/public/images/2014-06/0b1a2928.jpg?itok=HR2NrZKF

Content adapted in cooperation with the National Marine Sanctuary Foundation under federal award NA19OAR0110405 for the Deep Ocean Education Project.