Newly discovered gene may give 'sea pickles' their glow

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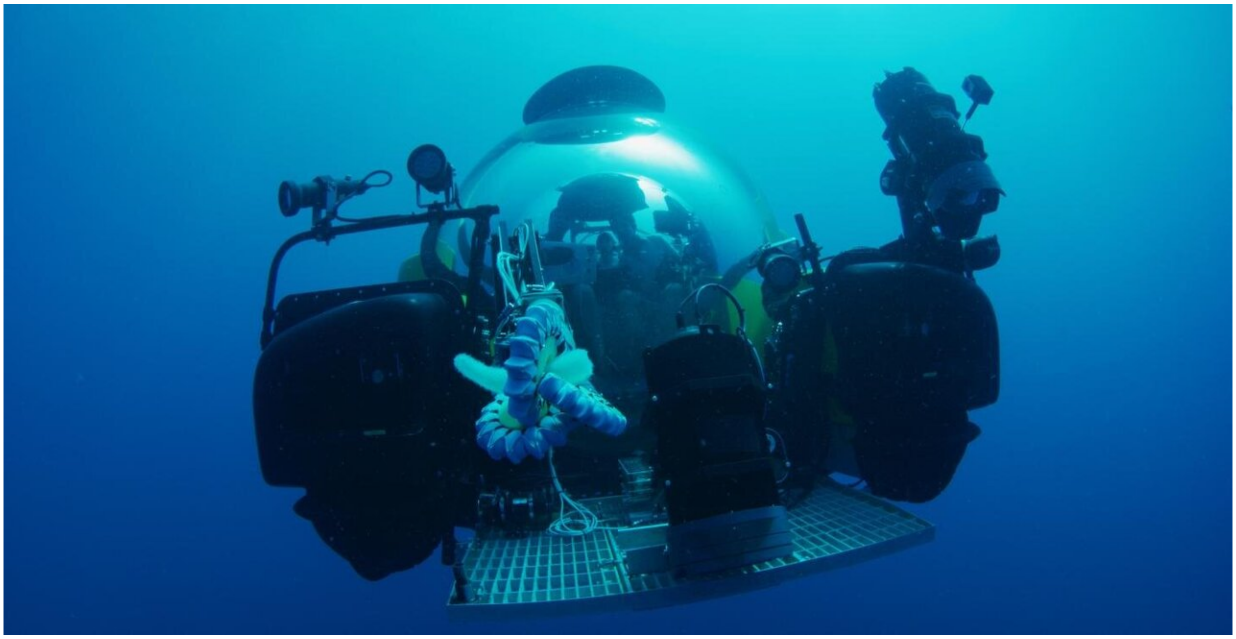
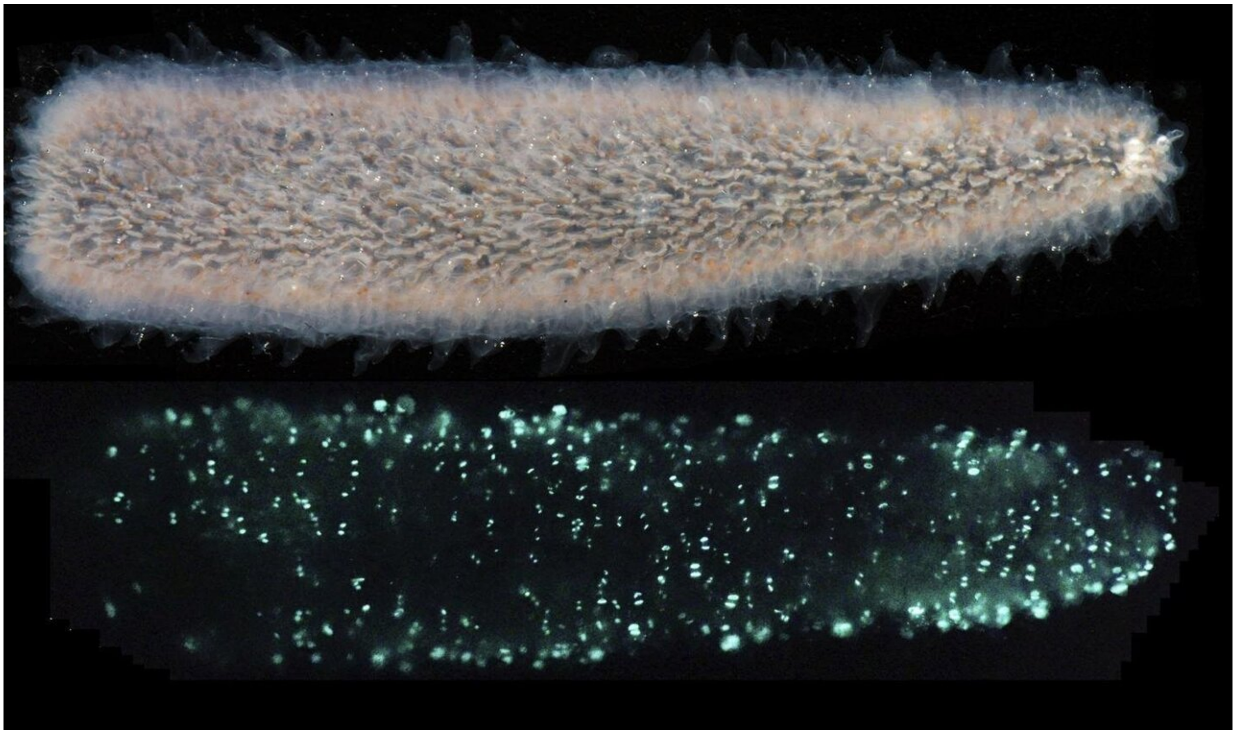


Members of the research team off the coast of Brazil collecting a Pyrosoma atlanticum specimen with a special soft robotic arm outfitted on a submersible Credit: OceanX

A new study describes a bioluminescent gene that could be the reason that so-called 'sea pickles,' or pyrosomes, an underwater free-floating colony of thousands of tiny animals, reverberate in blue-green light. If confirmed, the finding would be the first bioluminescent gene identified from a chordate—the group that includes all vertebrates as well as a couple types of invertebrates: sea squirts (including pyrosomes) and lancelets. The research is published today in the journal *Scientific Reports*.

"We know that throughout the tree of life, there are many hundreds of organisms that can produce light and that they do it for a variety of reasons," said co-author Michael Tessler, an assistant professor at St. Francis College who conducted the research while he was a postdoctoral researcher at the American Museum of Natural History. "Our work suggests that there is a common gene shared among at least some animals that, with a few small changes, could be responsible for this bioluminescence. A baseline gene like this could help explain how many of these very different organisms, like a brittle star and the sea pickle, ended up with the same ability to glow."

The idea for this study arose in 2017 when co-author David Gruber, a Museum research associate and a Presidential Professor at Baruch College, was off the coast of Brazil testing a new collecting tool outfitted to a submersible: squishy robotic hands meant to gently grab delicate sea creatures. The expedition team, which included Museum Curator John Sparks and was funded by the Dalio Family Foundation and OceanX, collected a selection of sausage-sized pyrosomes (*Pyrosoma atlanticum*).



Pyrosoma atlanticum under white light (top) and producing bioluminescence following mechanical stimulation Credit: © D. Gruber

These gelatinous colonies are made of hundreds of tiny animals called zooids—each with a heart and a brain—that work together to move, eat, and breathe. The name pyrosome, which in Greek translates as 'fire-body,' is derived from their unique bioluminescent displays, which, unlike many bioluminescent animals, can be triggered by light. While pyrosomes attracted the attention of naturalists in the 17th and 18th centuries, many of the most basic facts about their bioluminescence remain elusive.

"Understanding the biochemical pathway for pyrosome bioluminescence is of particular interest because as a chordate, these animals are much more closely related to vertebrates—and to us as humans—than many of the more traditional bioluminescent creatures that might come to mind, things like jellyfish or fireflies," Gruber said.

Like other bioluminescent organisms, pyrosomes rely on a chemical reaction between a substrate (luciferin) and a gene (luciferase) to produce light. The researchers found that mixing a common type of luciferin, called coelenterazine, with *Pyrosoma atlanticum* resulted in bioluminescence. To further investigate the inner workings of this reaction, they sequenced the RNA of the pyrosomes collected in Brazil as well as from additional specimens found in a large bloom off of Vancouver Island in Canada.

The researchers discovered a gene that matches a luciferase often used in biotechnology that is found in sea pansies, a relative of jellyfish, anemones, and corals. They confirmed that the newly discovered pyrosome gene does, indeed, produce light by expressing it in a bacterial colony and adding coelenterazine.

"Being a part of this study felt like being a part of a century-old mystery novel as to how the pyrosome glows in the dark," said Jean Gaffney, a co-author and assistant professor at Baruch College. "I have never worked with a species that was seemingly so alien, but as a chordate is strikingly similar to us."

A similar gene was recently predicted from a bioluminescent brittle star, indicating that these types of luciferases may have evolved convergently from a baseline gene.

"This study advances the debate about pyrosome bioluminescence," Tessler said. "We provide justification for the idea that this animal produces its own light and it might be able to do so because of a pattern of evolution that as repeated throughout the animal tree of life."

More information: Michael Tessler et al, A putative chordate luciferase from a cosmopolitan tunicate indicates convergent bioluminescence evolution across phyla, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-73446-w

Provided by American Museum of Natural History