Evolution of ocean 'twilight zone' creatures linked to global climate change
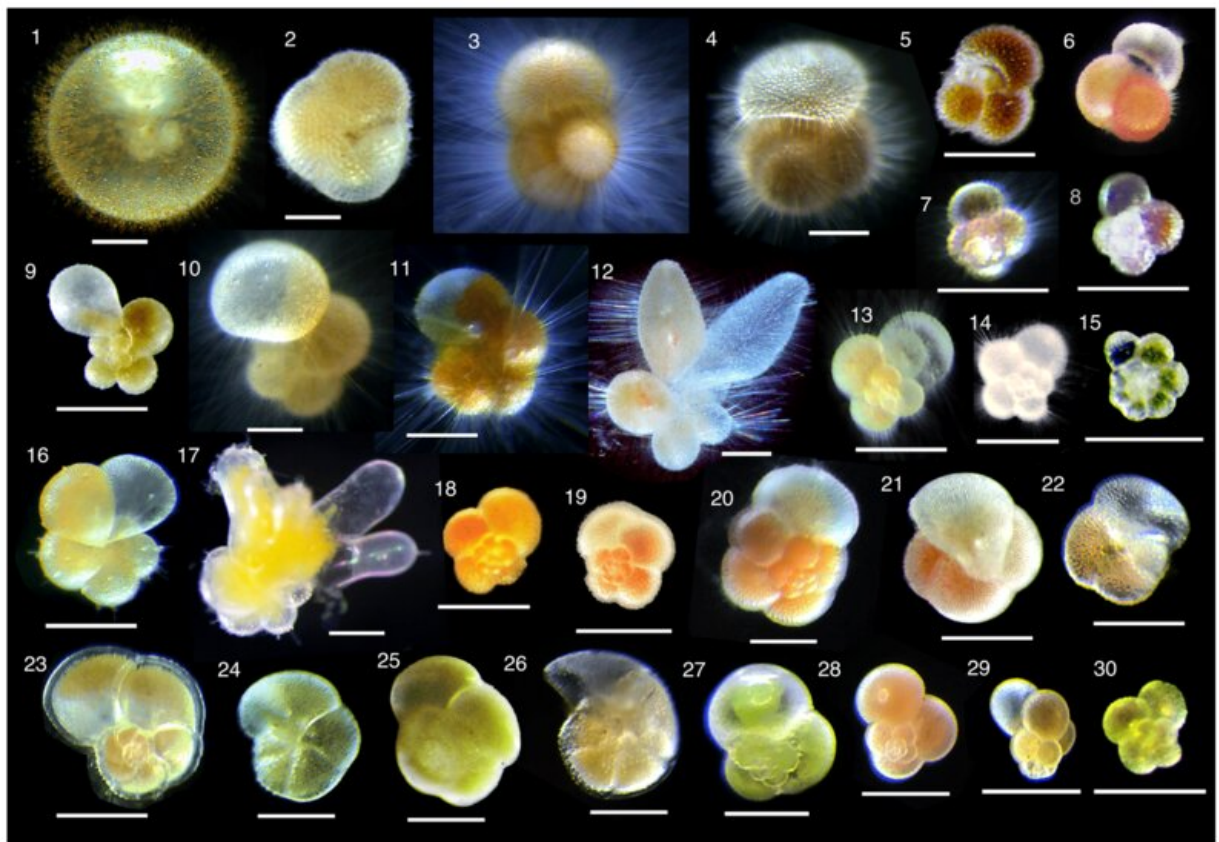
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Living planktonic foraminifera. Credit: https://www.biogeosciences.net/16/3377/2019/, doi:10.5194/bg-16-3377-2019

A team led by scientists from Cardiff University has, for the first time, been able to track the development of the largest and least understood

habitat on Earth.

The ocean's twilight zone extends from 200 to 1000 meters below the surface.

In a new study published today in *Science*, the team has shown how life there became established and diversified, driven by the cooling of the ocean over the last 15 million years. The new findings raise concerns about how the array of creatures that live at these depths may react to future heating of the oceans.

A wide range of mysterious creatures live within the twilight zone of the ocean, including plankton, jellies, krill, squid and fish. It is a true hidden treasure of biomass and biodiversity that is key to the health of our oceans. Life in the twilight zone relies on "marine snow"—organic matter that sinks down from the surface—as a source of food.

In their study, the team used tiny fossil shells obtained from mud at the bottom of the sea to track how the deep-sea creatures changed and diversified over time. "During our study, we observed evidence of species migrating from the surface to progressively deeper regions of the oceans over the 15-million-year period, which was puzzling," said paleontologist Dr. Flavia Boscolo-Galazzo, one of the two lead authors of the study.

"The temperature of the water turned out to be key to the mystery," said lead author Dr. Katherine Crichton, now at the University of Exeter, who developed a computer model simulation of the way the marine carbon cycle developed through time.

"The interior of the oceans has cooled markedly over this period. That had a refrigeration effect, meaning that the sinking marine snow is preserved longer and sinks deeper, delivering food."

"The cooling of the deep ocean gave life a boost and allowed it to thrive and diversify," said Dr. Boscolo-Galazzo. The team used drill-cores of deep-sea mud from all of the world's oceans, recovered by the International Ocean Discovery Program (IODP), to build up a history of plankton communities over millions of years.

The mud contained fossil plankton, which the team analyzed to reveal not just the depths at which the creatures lived but also how actively the marine snow was sinking around them. This fossil evidence was able to show very clearly how dependent life at depth is on seawater temperature and how it evolved through time. The team say the results raise concern about the future ocean as it heats up under the pressure of global climate change, and it is now following this up with further research.

"Many of the strangest forms of life are found in the ocean depths including comb jellies that look like alien spaceships and ugly fang-tooth fish. But they are also vital for the ocean's food webs" said project leader Professor Paul Pearson, honorary research professor at Cardiff University's School of Earth and Environmental Sciences. "Deep-living fish account for a billion tons of biomass and are a major food source for whales and dolphins and also large diving fish like tuna and swordfish."

More information: Flavia Boscolo-Galazzo et al. Temperature controls carbon cycling and biological evolution in the ocean twilight zone, *Science* (2021). DOI: 10.1126/science.abb6643

Provided by University of Exeter

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