Researchers bring 60-year-old dormant algae cells to life

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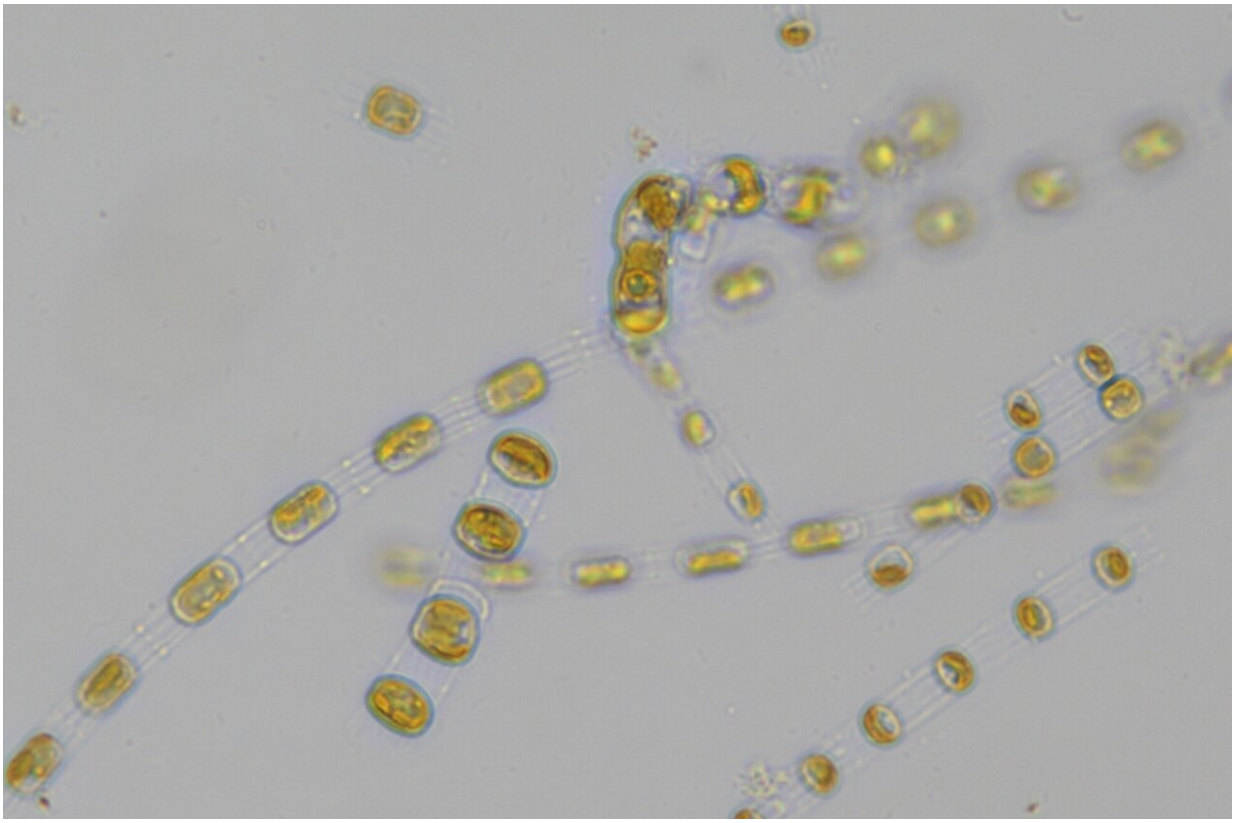


The diatom Skeletonema marinoi, which researchers at Åbo Akademi University, Finland, have managed to bring back from the 1960s, magnified 200 times. The species forms chains of cells that are connected to each other. If there is a lot of zooplankton in the water, they separate into individual cells because then they are more difficult to detect by predators. Credit: Conny Sjöqvist

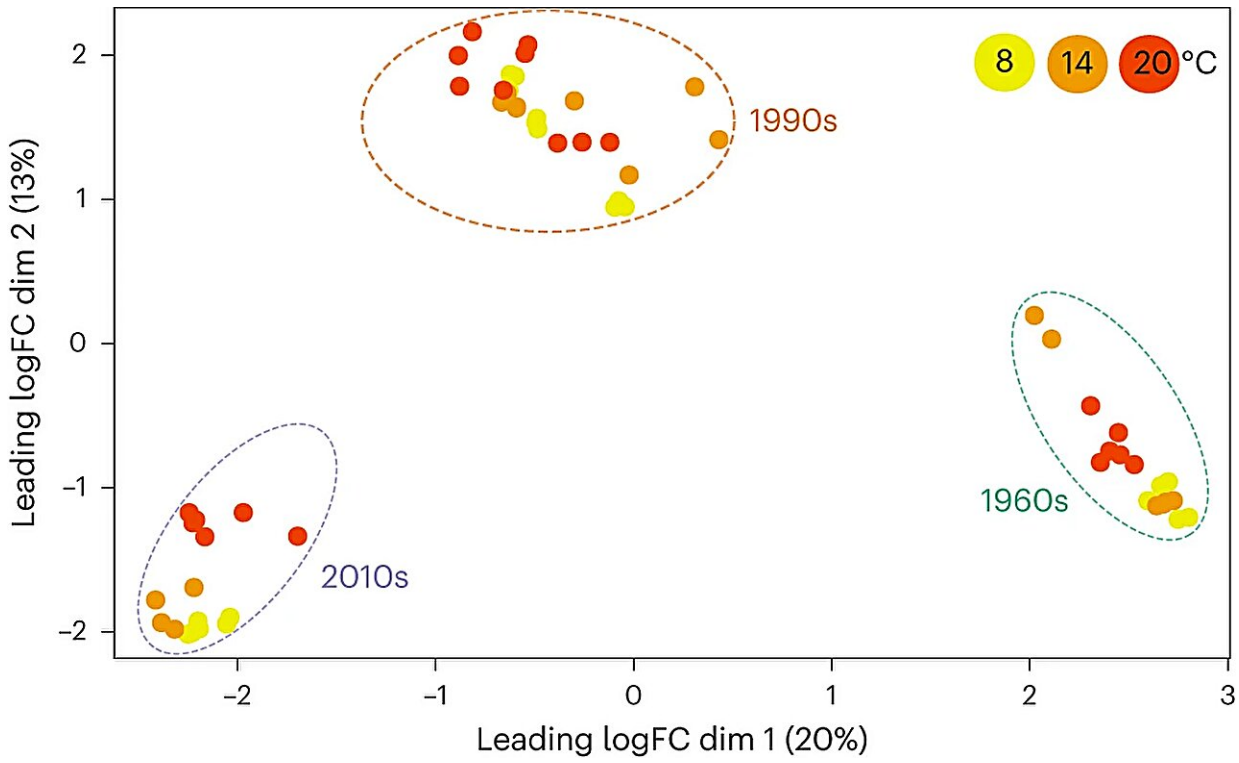
New research at Åbo Akademi University, Finland, has managed to circumvent previous challenges in finding out how microalgae adapt to global warming by studying up to 60-year-old microalgae cells from the Archipelago Sea. Some microalgae form resting cells that sink to the seabed after the blooming is over. Researchers have now managed to awaken these dormant cells from sediment cores with different chronological layers that geological methods can date.

The findings, published in *Nature Climate Change*, are unique on a global level as microalgae have not previously been shown to adapt to global warming in natural environments where complex evolutionary selection pressures govern adaptation to new conditions.

Experimental studies with the awakened cell lines have enabled scientists at Åbo Akademi University to establish that the species adapts to the documented warming of the sea. The optimum temperature for the species has risen by 0.89°C while the average temperature of the water has risen by approximately 2.5°C in the years 1960-2020.

"This awakening has enabled us to study genotypes of this species that lived in the 1960s, 1990s, and 2010s. Single-cell microalgae play a key role in the functioning of the marine ecosystem as they form the basis of the food web in marine environments," says Conny Sjöqvist, Project Researcher in Environmental and Marine Biology, Åbo Akademi University.

"They are also responsible for half of all oxygen production on earth and make the atmosphere suitable for man and much of the life that exists on the planet."



Multidimensional scaling plot displaying gene expression of the top 500 genes. Strains of *S. marinoi* from the 1960s, 1990s and 2010s in 8 °C (yellow), 14 °C (orange) and 20 °C (red). The temporal populations are highlighted by colored dashed lines. 1960s, green; 1990s, orange; 2010s, purple. Credit: *Nature Climate Change* (2024). DOI: 10.1038/s41558-024-01981-9

Researchers were also able to see a noticeable change in how today's cells react to higher temperatures compared to cells from the 1960s. For example, they change their gene expression and cell morphology to enhance nutrient uptake needed to support an increasingly intense metabolism at higher temperatures.

At the same time, genetic analyses show that cells from the 2010s did not experience high temperatures as stressful as cells from the 1960s. The gene expression of heat shock genes is displayed significantly less in

today's cells, which supports the scientists' perception of how microalgae adapt.

"Now we will move on to examine the significance of adaptation for this key species as a whole and the ecological consequences this can have for the rest of the marine ecosystem. We are particularly interested in any parallel changes that may have occurred, for example, in the fatty acid profile and nutritional values of microalgae," says Sjöqvist.

Researchers have long been studying how microalgae adapt to rising temperatures in their surroundings. Particular attention has been paid to their adaptation potential, and this has mainly been studied in the field of experimental evolution, where species are exposed to challenging environmental conditions in the laboratory.

Microalgae have been shown to have a high potential for adaptation, but at the same time, past findings have been criticized because laboratory conditions do not reflect what is realistically happening in nature.

More information: G. S. I. Hattich et al, Temperature optima of a natural diatom population increases as global warming proceeds, *Nature Climate Change* (2024). DOI: 10.1038/s41558-024-01981-9

Provided by Abo Akademi University