Analysis

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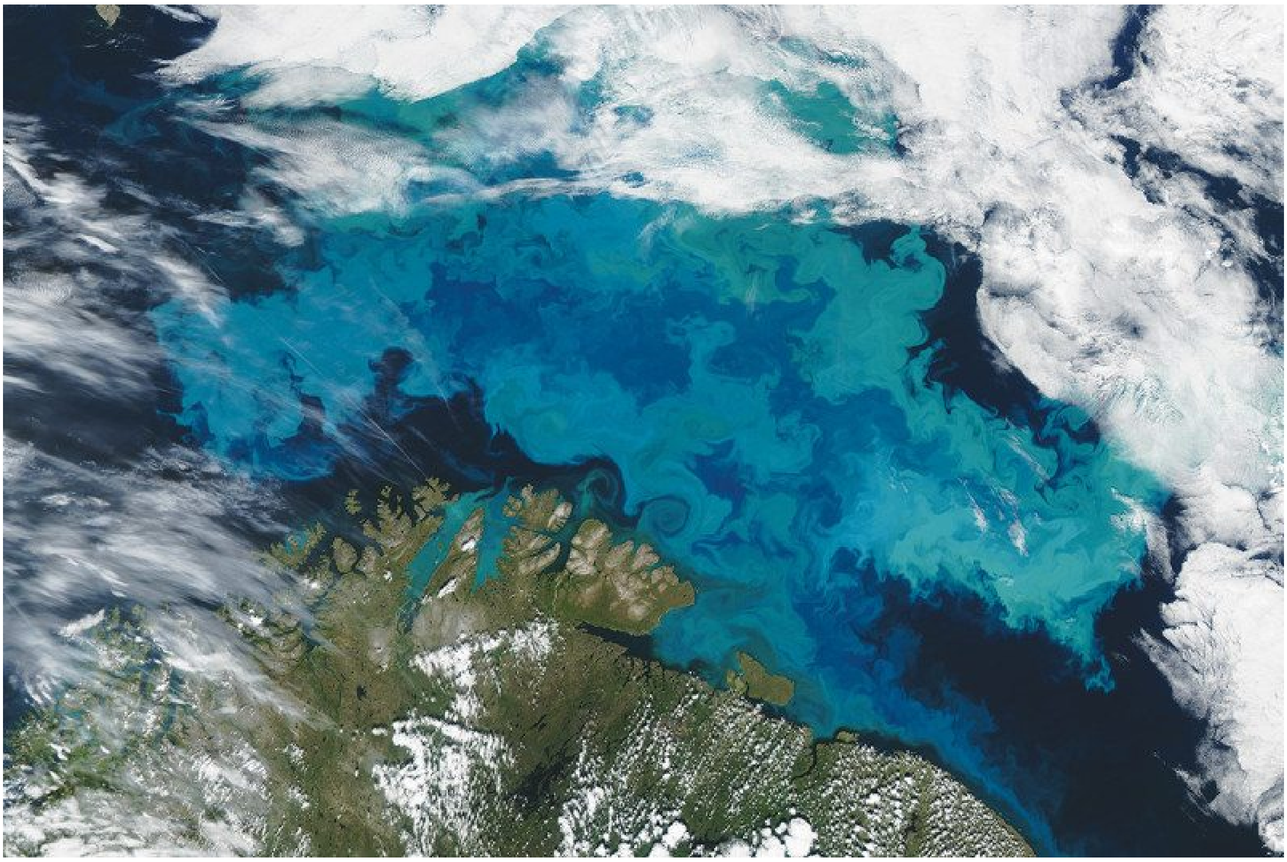
Plankton can save the ocean. But who will save the plankton?

It's not just warming oceans we need to worry about. Crucial plankton have been discovered behaving strangely, but they may point the way to better geoengineering



NASA image courtesy Jeff Schmaltz, MODIS Rapid Response Team at NASA GSFC

By Richard Schiffman

YOU needed a microscope to see it, but there it was. After an absence of 800,000 years, *Neodenticula seminae*, a native of the Pacific Ocean, had showed up unexpectedly in the North Atlantic. Marine biologists speculated that this tiny species of plankton had drifted through the Northwest Passage, which until recent summers had been blocked by a permanent wall of ice.

Melting ice is far from the only way climate change is altering the oceans. A study published last month found that dissolved oxygen levels in the water are falling. Another suggests that the plankton crucial to maintaining the balance of gases in Earth's atmosphere are in trouble.

There is good news hiding in the bad. Some researchers think this new information points to geoengineering approaches that could solve the problem of climate-changed oceans. But we can't be sure they would work; can we risk mucking around with the world's largest ecosystem? Then again, aren't we already?

It is well known that a warmer, more acidic ocean is linked to coral and shellfish die-offs as well as the mass migration of fish. But for many years, scientists were divided on the question of how the changing climate would affect phytoplankton.

“Plankton produce nearly half the oxygen in the atmosphere, making them the lungs of the planet”

Phytoplankton (above and below) are the lungs of the planet and the base of many food chains

Steve Gschmeissner/SPL

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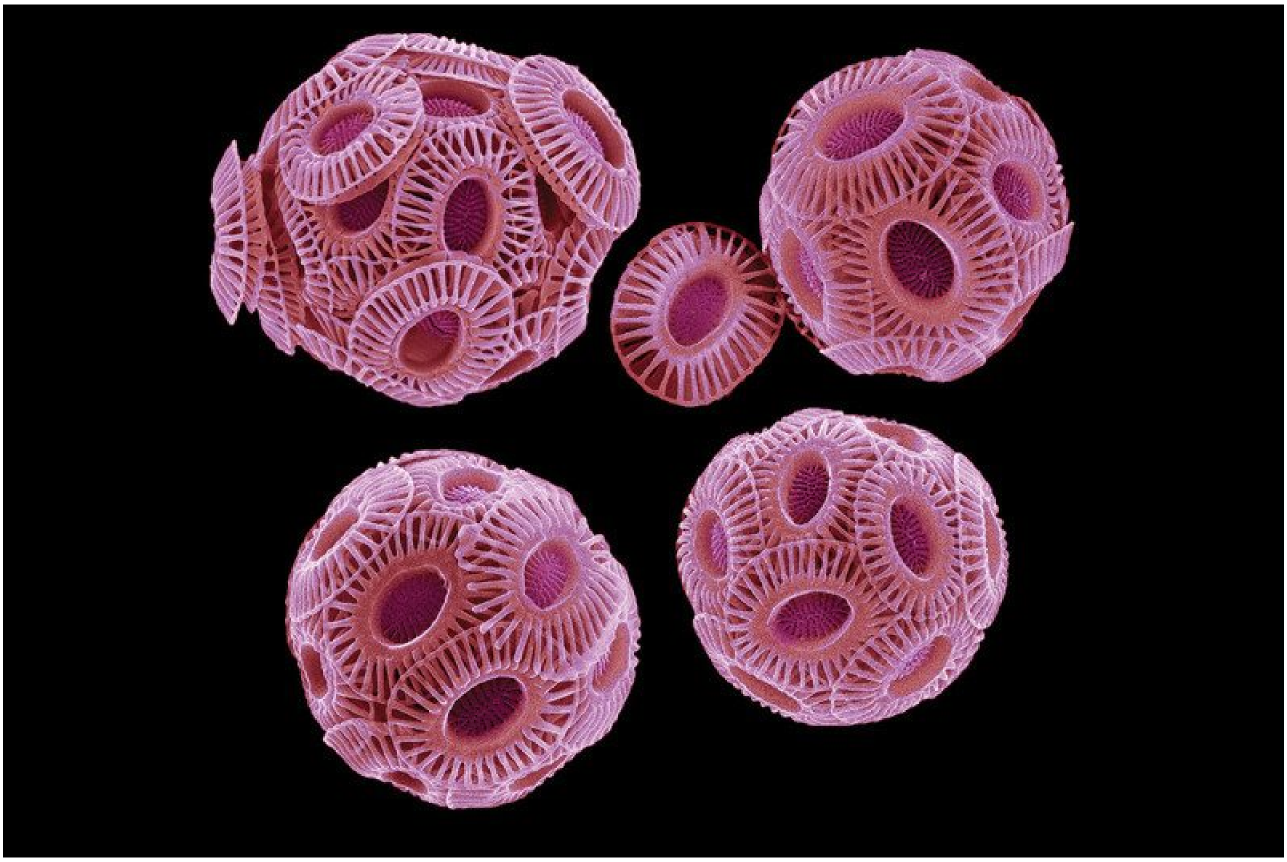


Wim Van Egmond/SPL

These plant-like marine organisms, which mainly live near the ocean's surface, are highly sensitive to environmental changes. Still, many scientists believed that rising levels of carbon dioxide in the atmosphere would stimulate their growth. In 2015, a team at Johns Hopkins University confirmed that the population of a phytoplankton known as *Coccolithophores* increased tenfold in the North Atlantic between 1965 and 2010.

However, work by William Chivers, an ecology researcher at the University of Newcastle in Australia, confirms that not all species are thriving. Phytoplankton cannot swim, so when conditions in the water shift, they have three options: adapt, hitch a ride on ocean currents to more hospitable seas, or die out.

All three processes are currently going into overdrive. *Coccolithophores* seems to have adapted, but others are not so lucky. Many critical phytoplankton species in the North Atlantic have declined for decades, unable to survive in the warmer and more acidic seas, says Chivers.

Neodenticula seminae is far from the only climate migrant. Chivers and his team found that billions of phytoplankton now roam in a desperate search for suitable ocean habitats. Several key species have been moving poleward by up to 99 kilometres per decade in pursuit of cooler waters (see map). Others are simply dying out, including one that fisheries crucially depend on.

It's not just fisheries that will suffer: phytoplankton are the base of the ocean food web, on which everything from fish to whales to polar bears depend. They also produce nearly half of the oxygen in the atmosphere through photosynthesis – more than all of the forests on Earth combined – and oxygenate the ocean. They are the lungs of the planet.

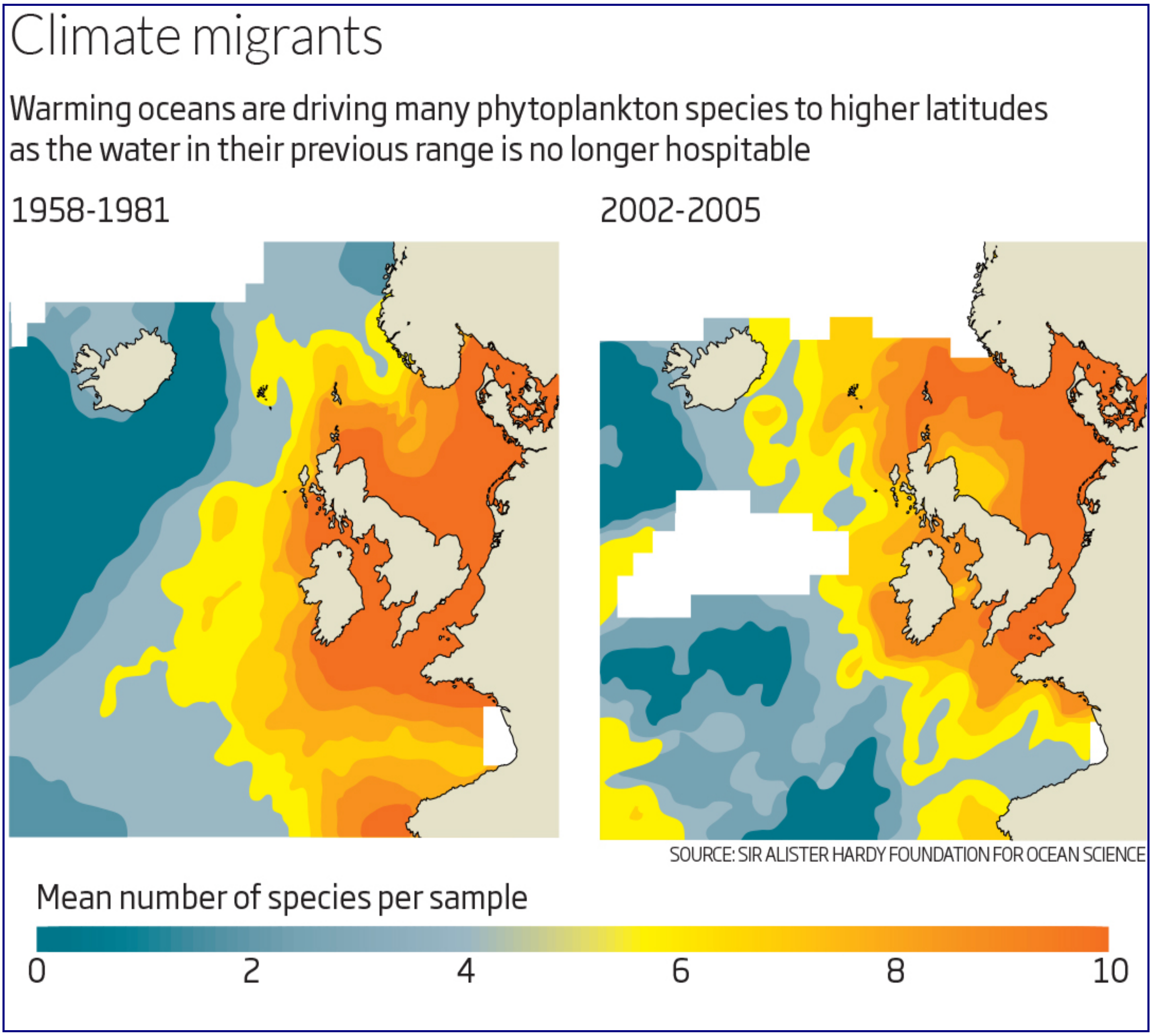
The worrying news about their losses comes hot on the heels of a study by Sunke Schmidtko and colleagues at the Geomar Helmholtz Centre for Ocean Research in Kiel, Germany. They found that oxygen levels in the ocean have dropped by 2 per cent in the past half century. This pattern shows no sign of reversing.

Untenable trend

It is clear we need to save the phytoplankton. But how?

First we need to understand the trends, something scientists are still working on, says Stephanie Dutkiewicz, an oceanographer at the Massachusetts Institute of Technology who has been modelling phytoplankton groups. "Most of the models suggest that overall there will be a decrease in phytoplankton populations," she says, "but we simply won't know for sure how this will work out for another 20 to 30 years." There are just too many variables, including ocean currents and species' evolutionary capacity to adapt.

However, one trend that scientists can confidently predict is that smaller phytoplankton species, like *Coccolithophores*, will increase, while larger ones like *Neodenticula seminae* will decline. That's because as the ocean surface heats up, there will be less mixing of the warmer, less dense surface waters where phytoplankton live with the cooler, denser waters below, which contain most of the nutrients they need to survive. Big phytoplankton need higher concentrations of dissolved phosphates and nitrates, and are therefore expected to fare poorly.



That's bad news, because the larger species do most of the heavy lifting: they trap a lot of carbon, which ends up sinking to the bottom of the sea when the organisms die, and they add the lion's share of life-giving oxygen to both air and ocean. The smaller species expected to thrive in the future are not as effective at sequestering carbon. In total, phytoplankton remove about half of the CO_2 that human industries emit, making them crucial in the battle to slow climate change.

With so much at stake, scientists like Dutkiewicz say we need to quickly ramp up research into these critical organisms. But is it also time to take a fresh look at geoengineering our oceans – an idea that has been dismissed as too incautious?

Marine biologist Victor Smetacek is best known for seeding the ocean near Antarctica with 7 tonnes of finely powdered iron sulphate, an industrial waste product, in an effort to stimulate phytoplankton growth. This resulted in a large bloom of diatoms, which survived only a few weeks before dying and falling like snow to the bottom of the sea.

Smetacek has long argued that iron fertilisation of this sort could be a relatively inexpensive way to suck carbon from the atmosphere and store it in ocean sediments. But many scientists and environmentalists have baulked, saying that such experiments could have unintended consequences. Willie Wilson, who directs the Sir Alister Hardy Foundation For Ocean Science in Plymouth, UK, does not rule out iron fertilisation, but warns that a huge continuous flux of organic matter could ultimately poison the oceans and create anoxic zones hostile to life.

Instead of aiming for a dramatic bloom and die-off, what about sustaining the plankton in a more natural way? “The real problem with the oceans,” says Smetacek, “is our destruction of the megafauna, the large fish and whales, which in earlier times kept the system in balance.”

The loss of these predator species has been bad news for phytoplankton, which feed on the rich nutrients in their excrement. When they were more abundant, whales also churned the sea, bringing nutrients from the deep to the surface.

Smetacek suggests mimicking this by pumping waters from the ocean depths to the surface with a series of long pipes anchored to artificial islands. The nutrients in these deep sea waters would help rejuvenate phytoplankton populations and thus the ocean ecosystem as a whole.

Some see trouble here too, though. Stephanie Henson, an oceanographer at the University of Southampton, UK, says that cold waters coming to the surface could draw CO_2 into the ocean faster, enhancing acidification.

But not everyone is opposed. Mike Behrenfeld, a research scientist with NASA, says small-scale, short-term geoengineering experiments in the field have successfully demonstrated such approaches. Still, like Henson and many other scientists, he remains squeamish about altering ocean ecosystem in unknown ways.

“We could boost plankton populations by pumping waters from the depths of the sea to the surface”

But something needs to change. The oxygen depletion study also found that if nothing is done, oxygen in the ocean could fall by 7 per cent by the year 2100, a shift that would have a dramatic impact on life in the oceans. If that happens, oxygen-producing phytoplankton will become even more critical to maintaining marine life. “People accuse me of meddling with nature,” Smetacek says. “But not doing anything is the worst option.”

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