Why do plankton bloom? The answer could force rethinking of ocean's food web

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Scientist Michael Behrenfeld is leading a major study that may overturn the accepted theory about plankton blooms. Behrenfeld is a marine botanist at Oregon State University. Credit: Gail Wells

A new study at Oregon State University could overturn conventional wisdom about the role of phytoplankton in the Earth's carbon cycle, potentially changing scientists' understanding of how global warming will alter the environment for marine life.

OSU researcher Michael Behrenfeld, an expert in marine plants, is leading a $30 million NASA-funded study of a phytoplankton "hot spot" in a triangle of ocean stretching from Woods Hole, Massachusetts to the Azores and north to Greenland's southern tip.

Behrenfeld's team will gather shipboard and in-ocean data from four sea cruises over the course of the five-year study. The two spring cruises will catch the North Atlantic plankton bloom – one of the biggest on the planet – in its most southerly latitude and follow it as it progresses north with the warming weather.

Simultaneously, aircraft will fly near the ship and take measurements of tiny airborne particles called aerosols, which are linked to plankton activity and which also play a big role in the Earth's energy cycle.

Phytoplankton – which are an assortment of single-celled plants dwelling in the ocean's upper layer – are the foundation of the marine food web.

"They are tiny, but they're extremely abundant," said Behrenfeld. "If you look at the photosynthesis of all these microscopic plants on a global basis, it's the equivalent of the photosynthesis of all the plants on land."

As they capture sunlight and turn it into sugar, they become food for zooplankton (the animal variety of plankton), which are eaten in turn by other organisms, and so on up the chain.

Phytoplankton are present throughout the world's oceans and are most abundant in the high latitudes of the northern and southern hemispheres. In these cold, nutrient-rich waters, they typically undergo seasonal population explosions, or blooms.

For decades, scientists have attributed these blooms to springtime increases in sunlight and warming temperatures – much the same seasonal pattern that makes gardens bloom on land. This explanation is based on a limited number of measurements from ships in the early 20th century.

Under this traditional scenario, warmer oceans should produce bigger blooms, which should produce more food for ocean-dwelling life.

Yet satellite images suggest a different story, Behrenfeld said. Sophisticated instruments continuously monitor global plankton populations year-round by measuring shifts in light-wave frequencies that capture changes in phytoplankton abundance. Studying these images a few years ago, Behrenfeld noticed phytoplankton blooming when they shouldn't have been.

"In the middle of winter, in the worst conditions for growth, we saw that the pigment concentrations actually started to increase," he said. "That alone tells us that the old hypothesis is incorrect."

Behrenfeld proposes a different explanation: The blooms are born in early winter, when the ocean's upper waters – the so-called mixed layer – are agitated by strong winds. They also are churned by a process called thermal convection, in which the top tier of water gets cold and sinks, causing the warmer waters beneath to well up to the surface.

These physical forces cause a deepening of the mixed layer, and this, Behrenfeld believes, gives the phytoplankton room to spread out, making it easier for them to escape being eaten by zooplankton.

"You can think of phytoplankton as the grass and the zooplankton as the grazers – the cows, if you will," Behrenfeld explained. "The idea is that these strong physical processes deepen the mixing layer and dilute the phytoplankton to such low levels that the zooplankton can't effectively feed on them."

He hypothesizes that the phytoplankton take advantage of their competitive edge to out-multiply their grazers and begin a population increase that culminates in a spring bloom.

If the winter turbulence of the ocean is what triggers a plankton bloom, as Behrenfeld believes, and not spring warming, then a warming ocean should produce smaller blooms, reducing photosynthesis and potentially limiting the ocean's food supply.

The new study will provide the measurements needed to test this hypothesis and compare it to the traditional explanation.

"Our investigation will address two basic questions," Behrenfeld said. "First, what processes allow the bloom to be recreated each year? And second, how do blooms impact atmospheric aerosols and clouds? By answering these questions, we will be able to make better predictions on how marine ecosystems, including fisheries, will be affected."

Provided by Oregon State University

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