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CLIMATE CONTROL

When it comes to regulating Earth's climate, big things really do come in small packages

by Shannon McCallum

For most of us, the words "climate change" conjure up images of rising temperatures and melting glaciers. But for Diana Varela, a biological oceanographer at the University of Victoria, what comes to mind are microscopic floating algae called phytoplankton.

Found throughout the world's oceans, phytoplankton form the basis of the marine food chain. They're eaten by small fish, which are in turn eaten by larger fish. Humans catch and eat many of these larger fish.

But the influence of phytoplankton goes far beyond our dinner plates. "Phytoplankton are tiny in size but big in impact," says Varela. "They exert a global influence on climate by removing carbon—one of the main culprits in global warming—from the atmosphere."

Like land plants, phytoplankton grow through photosynthesis by taking up dissolved nutrients and carbon dioxide, and releasing oxygen. When phytoplankton die they sink and can become buried in seafloor sediments.

This process—called the "biological pump"—traps carbon in the deep ocean and can keep it isolated from the atmosphere for thousands to millions of years.

"Understanding the cycling of nutrient elements in the ocean is a key piece in the climate puzzle," says Varela, who studies phytoplankton physiology and ecology.

She's especially interested in how phytoplankton use nitrogen, silicon and carbon—all crucial nutrients for their growth.

Two of the most important forms of nitrogen used by phytoplankton are nitrate and ammonium. In ecosystems with high nitrate uptake, such as coastal regions, there are large exports of organic matter to the ocean floor. In ammonium-based ecosystems there is very little sink of carbon to the ocean floor.

"If we can find out what form of nitrogen the phytoplankton are using," says Varela, "I can get a better measure of how much carbon is being removed from the atmosphere into deeper waters."

Varela uses growth chambers and other specialized instruments in her lab to determine how a variety of phytoplankton species acquire nitrogen and other nutrients under different environmental conditions. She also participates in oceanographic research cruises to study phytoplankton in areas such as Queen Charlotte Sound, Saanich Inlet and the Gulf of Alaska.

"The ocean is hugely undersampled," says Varela. "In general, we know that coastal regions are more biologically rich than the open ocean, but within coastal inlets and on smaller scales, not much is known. Nutrient cycles in these areas are complicated because nutrients come from numerous sources including rivers, deep ocean upwelling and pollution.

"We need to better understand the details of these smaller-scale cycles if we want to determine how much carbon is being taken out of the atmosphere by phytoplankton."

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◀ *Varela holding a beaker containing phytoplankton.*

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Ocean climate change and its effects on marine life at all depths is one of the five main research themes of the $62.4 million NEPTUNE Canada seafloor observatory project, led by the University of Victoria.

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Phytoplankton come in many shapes and sizes. The largest look like tiny specks floating in the water. Most are so small they appear as coloured water, usually brown or green. Under a microscope you'll see many beautiful and bizarre forms— such as opalescent ovals, pill-box-like chains with protruding spines, and plated "spaceships" with flickering flagella.

Phytoplankton produce about 50 per cent of the atmosphere's oxygen and take up about 25 per cent of its carbon dioxide.

Several groups of phytoplankton cause harmful algal blooms known as "red tides" which can release potent toxins that accumulate in shellfish. They can also damage the gills of fish in aquaculture operations.

Diana Varela's new phytoplankton physiology and ecology lab complements work by other climate-related research initiatives at UVic, including the climate modelling group and the Water and Climate Impacts Research Centre.

Varela's research knowledge is transferred to students in her courses on algae and fungi, marine ecology, and the oceanography section of an introductory course on Earth systems.

This article was written by Shannon McCallum, a student in the faculty of graduate studies, as a participant in the UVic SPARK program (Students Promoting Awareness of Research Knowledge).

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