Shore Stewards News
GUIDELINES AND RESOURCES FOR LIVING NEAR WATER | ESTABLISHED 2003

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Zooming in on Marine Microorganisms

This is a two-part series on microorganisms. The first article examines five different types of marine microorganisms and the ways in which they influence the world in which we live. In the second article we'll explore how human activity impacts marine microorganisms and learn what Shore Stewards can do.

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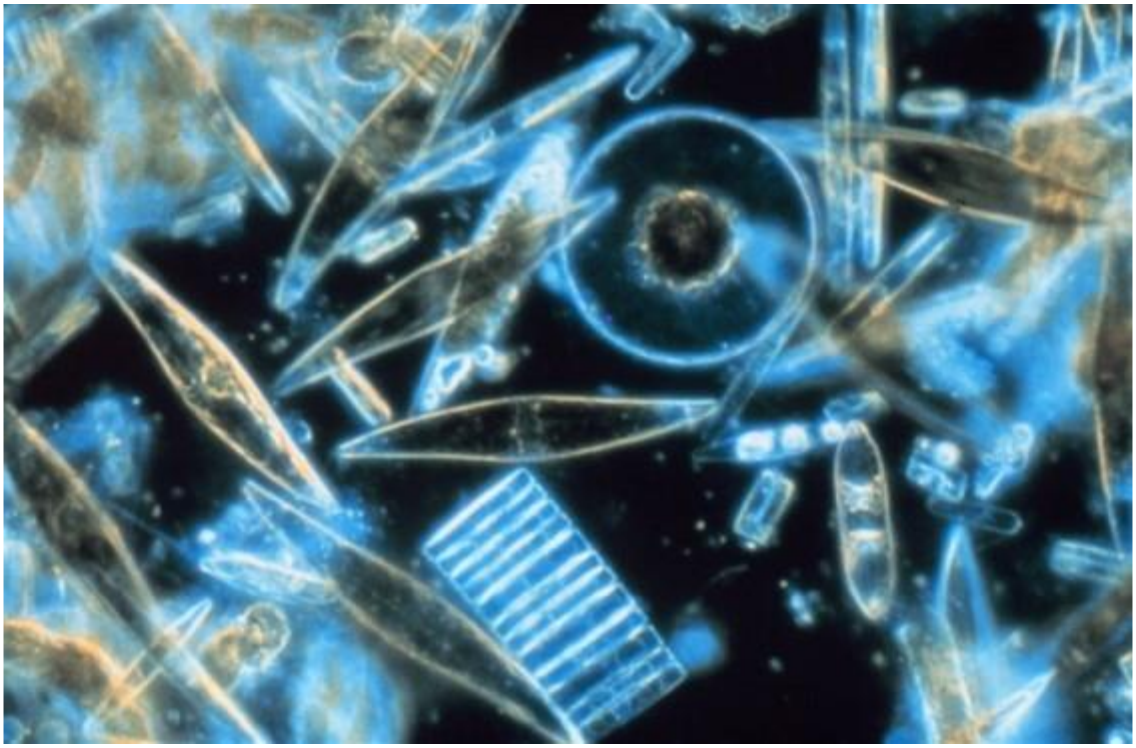

Diatoms present a gorgeous sight under the microscope with their transparent cell walls of glassy silica. They also help make life possible for the rest of us, producing 20% of the world's oxygen, more than all terrestrial rainforests combined. Image Credit: Prof. Gordon T. Taylor, Stony Brook University, NSF Polar Programs / Public Domain. NOAA Photo Library (link).

Introduction

Puget Sound is home to many beloved marine animals you might be familiar with, from orca and humpback whales to otters, salmon, and the giant Pacific octopus. Just this short list alone covers many diverse body types and lifestyles, but these animals all have one thing in common: *they're fairly large*. On the other end of the size spectrum, however, is another set of incredibly diverse organisms that are just as critical to Puget Sound and have much to tell us about the health of their marine environments.

Marine microorganisms make up the foundation of the marine food web, produce much of the oxygen we breathe, and play significant roles in the global cycles of carbon and nitrogen. Despite this, they go largely unnoticed by most humans (most of the time) and much less is known about them than many larger creatures. This first part of a two-part series will highlight five common types of marine microorganisms, describe some of their unique characteristics, and attempt to illustrate how these species, although largely invisible to the naked eye, have collectively helped shape the world as we know it. The following issue will address how human influence is impacting marine microorganisms and what this might mean for Puget Sound and our own future.

Five Prominent Types of Marine Microorganisms

Coccolithophores

If you've ever visited or seen images of the White Cliffs of Dover along the southern coast of the United Kingdom, you can begin to appreciate the influence that marine microorganisms have on the world. The white, chalky cliffs are made predominantly from the dried out "skeletons" of coccolithophores, which accumulated when the area was submerged under a shallow sea about 70 million years ago. In some places, the chalk (originally mud) accumulated up to 500 meters deep, made up of organisms each less than a millimeter across!

The White Cliffs of Dover provide a striking example of how marine microorganisms can have profound effects on their environments. The cliffs are made of chalk that was originally the shells of microscopic coccolithophores. Image Credit: Immanuel Giel / CC-BY-SA-3.0.

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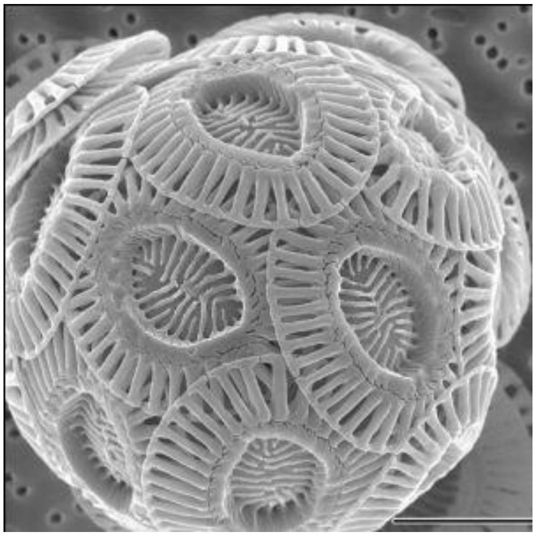
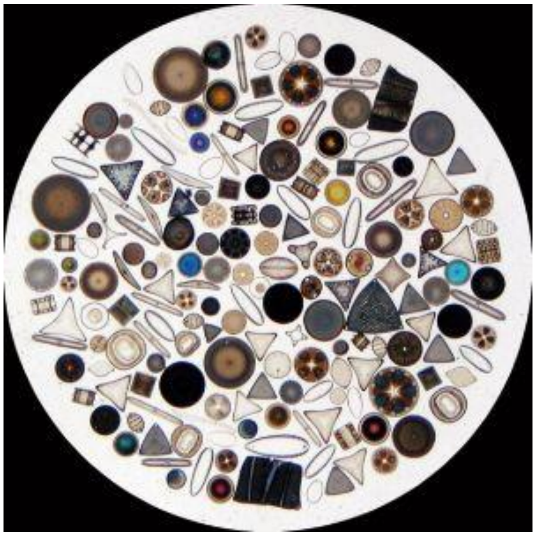


Coccolithophores build protective shells around themselves out of calcium carbonate coccoliths, which look like microscopic shields. These plates can reflect light and give coccolithophore blooms a turquoise tint in water. Image Credit: Alison R. Taylor (University of North Carolina Wilmington Microscopy Facility) / CC-BY-2.5. Wikimedia Commons (link).

Coccolithophores are a type of phytoplankton – free-floating aquatic photosynthetic organisms. Each coccolithophore is a single cell, but they build beautifully intricate protective shells around themselves out of tiny plates of calcium carbonate, called coccoliths. These coccoliths are what accumulated on the prehistoric ocean floor to make the chalk of the White Cliffs of Dover. This process is still going on around the world today to such a great degree, in fact, that sinking coccoliths account for 50% of the world's inorganic carbon pump – removing carbon from surface waters and sequestering it in deeper waters or the ocean floor. In this way, the lifecycle of coccolithophores forms one part of the global carbon cycle, which can, in turn, influence the trajectory of future climates.

Diatoms

Like coccolithophores, diatoms are also single-celled algae – photosynthetic aquatic organisms that structurally differ from plants – and make up another major subgroup of phytoplankton. Diatoms are one of the most species-rich groups of all eukaryotes (plants, animals, fungi, and protists) with an estimated 100,000 to 200,000 species. Diatoms can be identified under the microscope by their beautiful cell walls made of transparent, glassy silica. Also like coccolithophores, these shells sink to the bottom of the ocean after death. This process sometimes creates large formations of powdery "diatomaceous earth". Diatomaceous earth has a wide variety of uses, including water filtration, cleaning up toxic spills (due to its high absorbency), and as an insecticide.



Diatoms come in a variety of shapes and sizes, with an estimated 100,000 to 200,000 species. Image Credit: User:Wipeter / Wikimedia Commons / CC-BY-SA-3.0 / GFDL / Free Art License.

Back in the ocean, diatoms are prolific photosynthesizers, providing 20% of the world's oxygen each year, more than all the world's rainforests combined. As such, they are a significant component of many of Earth's climate systems. They account for 40% of marine primary production (organic matter created through photo- or chemosynthesis) due to their high growth rate and the fact that every diatom cell can photosynthesize, unlike, for example, most cells in trees. They form the foundation of the food web of many marine ecosystems.

Cyanobacteria (“Blue-Green Algae”)

Cyanobacteria – also known as “blue-green algae” – are the oldest member of this group by far. Not only that, they’re one of the oldest forms of life on Earth that we know of, with fossils nearly 3.5 billion years old! It’s believed that cyanobacteria were the first organisms to develop photosynthesis: the process through which sunlight is used to convert carbon dioxide and water into sugar and oxygen. We owe our current atmosphere to the hard work of cyanobacteria billions of years ago, who transformed it from one consisting primarily of carbon dioxide, ammonia, and methane into one with sufficient oxygen to support more complex life. In addition, cyanobacteria are also the ancestors of chloroplasts, which are the structures that perform photosynthesis within the cells of modern plants and other algae.

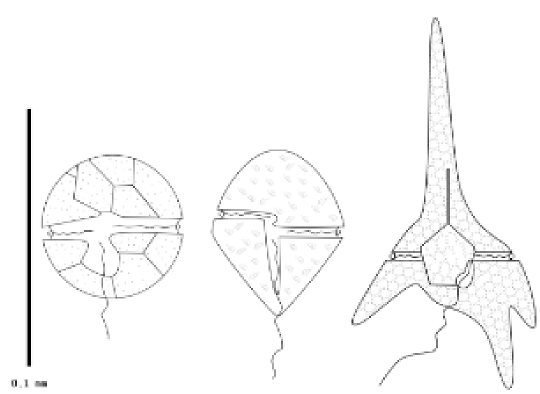
Certain types of microbes, including cyanobacteria, can form domed structures called stromatolites. Their fossilized remains show how the structures are built gradually in concentric layers, and they have provided evidence for some of the earliest life on Earth. Image Credit: James St. John / CC-BY-2.0. Wikimedia Commons (link).

Free-living cyanobacteria are still widespread in today's oceans. In a few places though, they form rocky domed structures called stromatolites in shallow water. Mats of cyanobacteria can trap sediments from the water, which gradually solidify into successive layers as the bacteria move further up to stay in the sun. Modern stromatolites are only found at a few unique sites and typically only grow about a foot or two in diameter, but in the distant past they were more common and could grow up to the size of a house. The durability of stromatolites in the fossil record has provided evidence of what may be some of the earliest life on Earth.

Dinoflagellates

Dinoflagellaetes are considered plankton but are actually able to swim on their own thanks to two whip-like appendages called flagella. Many dinoflagellates photosynthesize, but about half of the species eat other creatures (usually other plankton), with many "mixotrophic" species capable of doing both. Dinoflagellates are well-known for their bioluminescence, with certain species responsible for spectacular nighttime light displays when concentrations are high and the water is churned by boats, waves, or strong currents. It's hypothesized that flashing brightly can help dinoflagellates survive by startling predators, such as small zooplankton – plankton that cannot photosynthesize – or by attracting even larger predators that consume those feeding on the dinoflagellates.

Dinoflagellates are considered plankton, but are capable of motion on their own thanks to their whip-like flagella. Image Credit: User:Shazz / Wikimedia Commons / CC-BY-SA-



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One subgroup of dinoflagellates, known as zooxanthellae, perform a critical role in many coral reefs. The zooxanthellae live within the coral structures, performing photosynthesis and supplying the living coral with oxygen and nutrients. In return, the coral provide the zooxanthellae with a safe and stable environment and the compounds needed to perform photosynthesis. This type of mutually beneficial relationship is known as mutualism, and this particular relationship has been key to the productivity of corals around the world.

Foraminifera (“Forams”)

Foraminifera, or “forams” for short, are another group of marine microorganisms. Forams are also single-celled, but they create intricate shells, called “tests”, around themselves, either out of calcium carbonate or by cementing together other particles such as sand grains. Forams consume other microscopic organisms for food rather than photosynthesizing, but some can “farm” algae within their tests as a food source. Foraminifera come in many diverse species, including floating planktonic ones and bottom-dwelling benthic ones. The relative abundance of different species, along with the condition of their tests, can indicate the environmental conditions in which they lived. This, combined with the fact that forams exist in the fossil record since roughly 500 million years ago, makes them excellent tools for dating rock layers and investigating past climates, and their fossils can even aid in oil exploration by shedding light on the conditions in which the rock units around them were formed.

Microfossils like those pictured here, including radiolaria (small clear spheres) and foraminifera (small white shells and larger white and brown shells), can help in identifying rock layers, studying past and current environmental conditions, and even in oil exploration. Image Credit: Hannes Grobe 20:52, 12 November 2006 (UTC), Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany / CC-BY-SA-3.0 / CC-BY-2.5 / GFDL. Wikimedia Commons (link).

Fun Fact: Believe it or not, jellyfish are considered large zooplankton. They rely primarily on ocean currents to carry them through the water.

A New Challenge for Marine Microorganisms

These are only some of the immense variety of marine microorganisms, which also include microscopic crustaceans, green algae, and the beautifully intricate radiolarians. If you would like to learn about more types of fascinating marine microbes, a great place to start is this article hosted by the Smithsonian Institution.

Marine microorganisms form a critical part of Puget Sound's ecosystem. Marine microbes have been producing oxygen, helping regulate cycles of chemicals and nutrients, and providing the foundation of the food web for millions of years, but now they're facing a relatively new challenge: humans!

We'll delve into how human activity impacts marine microorganisms and learn what Shore Stewards can do, in the second part of our two-part series, coming soon.

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