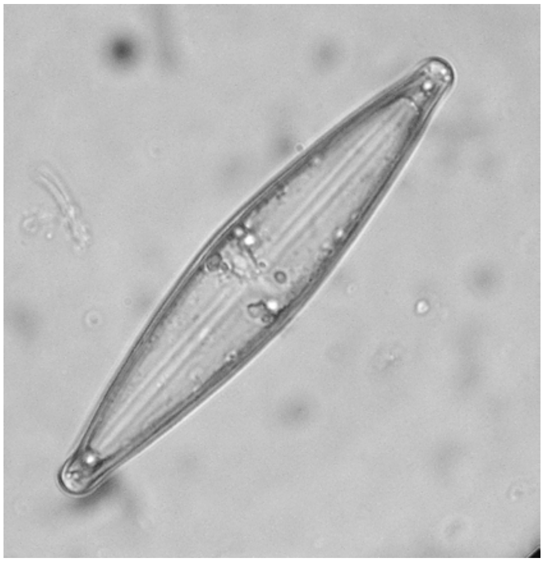
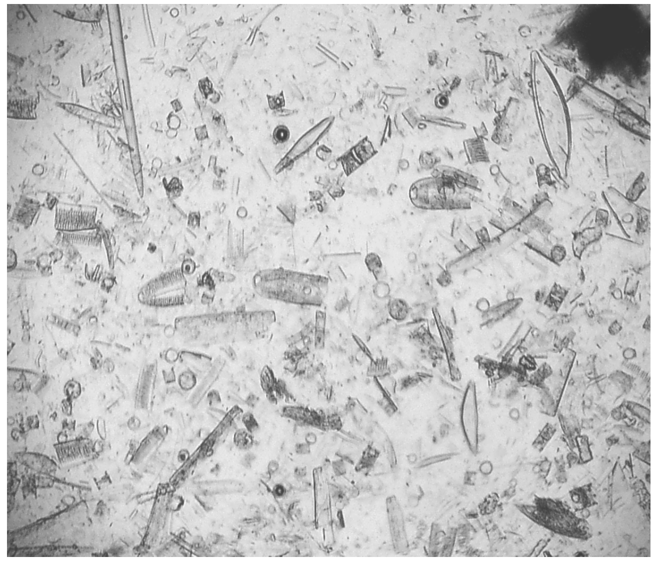




Left: A living diatom taken from Epplers Swamp, a pennate species (125 µm).
Right: Fossil diatoms, sponge spicules, and stomatocysts from the Commons Land.

Author's photographs

Diatoms on Gabriola

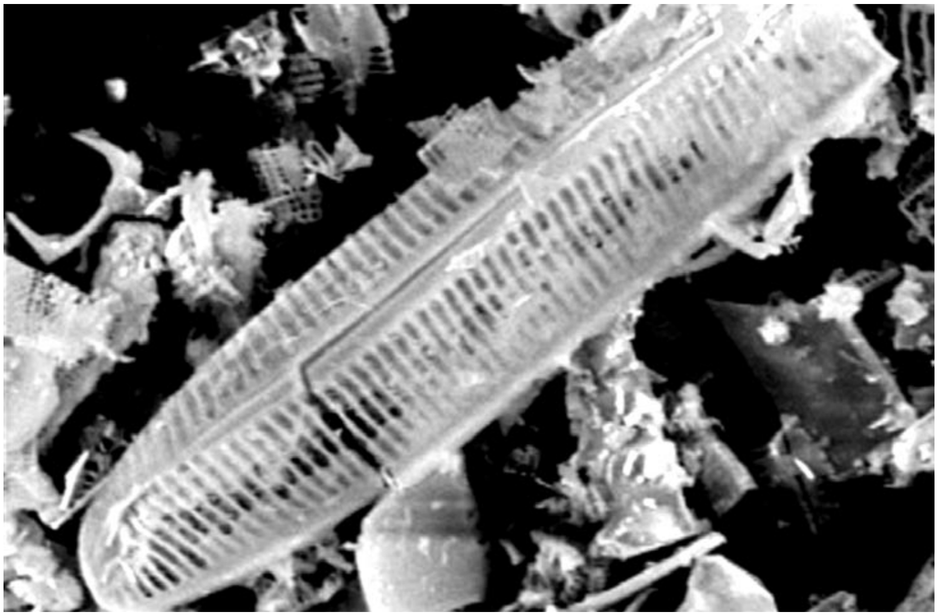
by Carol Ann Borden

Although we usually think of Gabriola as a dry habitat, lying as it does in the rainshadow of Vancouver Island, the island is home to a number of wetlands that retain at least some water throughout most of the year. Hoggan Lake and Coats Marsh are two of the more well known of these, but there are others, amongst them, those in the Descanso Valley, on the Commons Land, and in the low-lying area between Dunshire Drive and Berg Road, a depression known locally as Epplers Swamp.[1]

These are wonderfully fruitful habitats for a wide variety of plants and animals—frogs, birds, and flowering plants amongst them—but also for innumerable microscopic aquatic organisms. Some of the most abundant of the latter are single-celled algae bearing intricately patterned shells made, like glass, of silica. The algae are called *diatoms*. The photographs above show a living diatom, collected from Epplers Swamp, and fossilized diatoms, a substance known as *diatomite*, or diatomaceous earth, collected from the Commons wetland.

Like nearly all plants, diatoms make their food by photosynthesis, but in diatoms, the green pigmentation—*chlorophyll*—is obscured by additional golden-brown pigments. Chlorophyll is actually the only pigment that is able to convert carbon dioxide to organic compounds, especially sugars, using the energy from sunlight; however, the process only works using energy in the red and blue parts of the spectrum. By absorbing red and blue wavelengths much more strongly than it absorbs green wavelengths, chlorophyll makes most plants look green.

[1] This is the Dutchmans Swamp referred to in Jenni Gehlbach's article in this issue of *SHALE*. It also is known by a few as "Epps Pond".



Electron microscope picture of diatomite from Epplers Swamp. The large pennate diatom skeleton in the foreground is about 200 µm long (the thickness of two sheets of paper).

Linda Dybas

In contrast, the golden-brown accessory pigments in diatoms absorb light at blue-green (cyan) wavelengths, and they then pass that captured energy on to the chlorophyll. This arrangement enables diatoms to survive in darker, deeper, “greener” water than aquatic photosynthetic plants that lack accessory brown pigments.

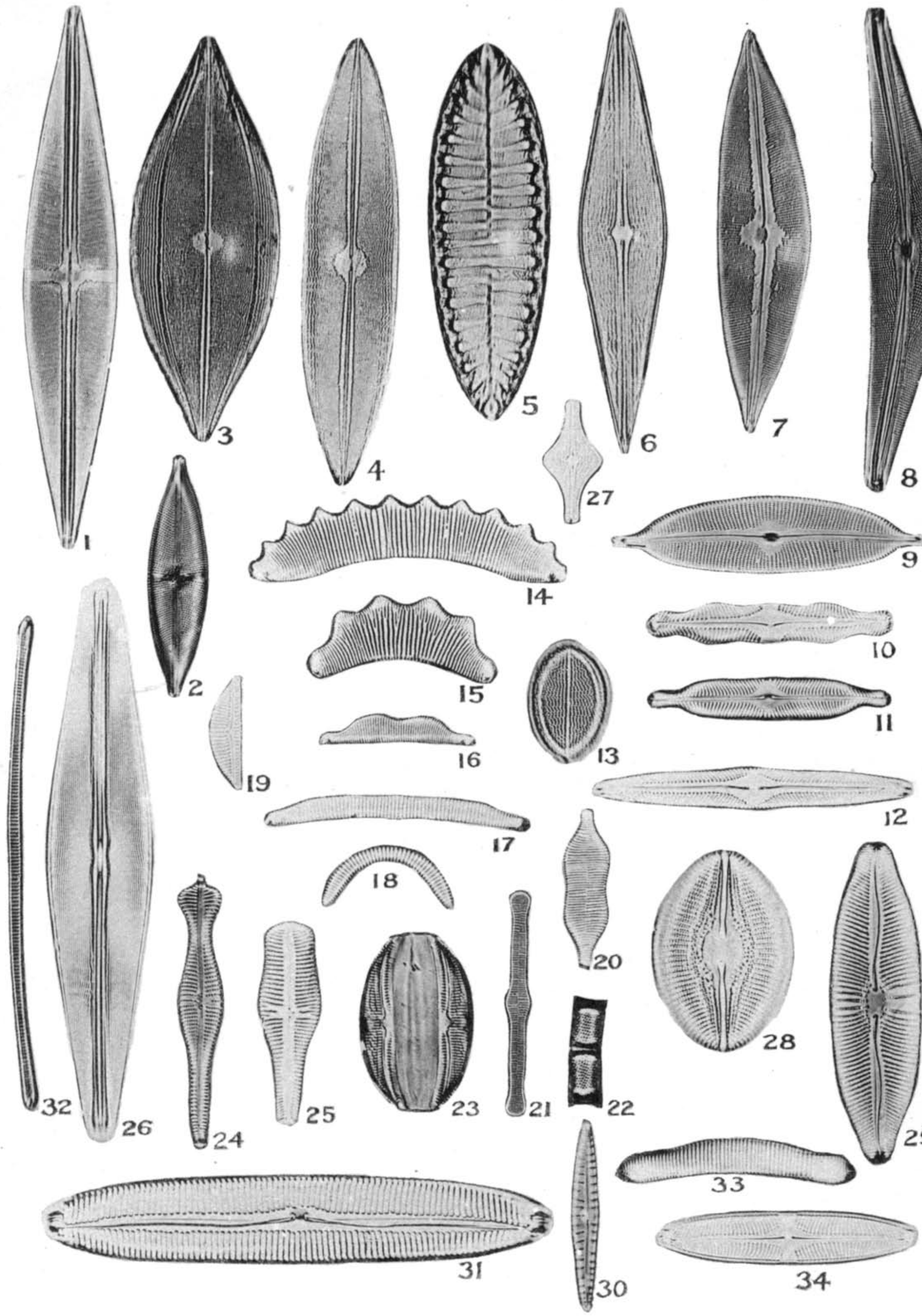
These same pigments are found in seaweeds, rockweed (*Fucus gardneri*) for example, and the even larger kelps growing subtidally offshore. Diatoms are also present on the beach, but the only ones liable to make themselves known to us without the help of plankton nets and microscopes, are those that make walking hazardous by forming slippery coatings on the sandstone.

Thousands of species of diatoms have been named and described, and it is possible that there are many more yet to be discovered. They are abundant in freshwater, brackish water, and the sea, as well as in damp niches on land. They may live on rocks and sediments, on the surface of larger aquatic plants and seaweeds, on animals, within protozoa and sponges, or suspended in the water column as plankton.

Because of their abundance, diatoms are a very important component of both marine and freshwater ecosystems, forming a vital base of the food chain. They are almost universally beneficial, or at least harmless; however, one marine species, *Pseudo-nitzschia multiseries*, produces a toxin that causes a potentially fatal illness—amnesiac shellfish poisoning (ASP). This occurs when shellfish are eaten that have been feeding on these diatoms.[2]

[2] When the shellfish consume *Pseudo-nitzschia* they are not affected by the toxin it produces, but as they take in and digest more and more of the diatom, the toxin accumulates in their flesh. When humans eat these shellfish they suffer nausea, memory loss, weakness and, in very severe cases, death. ASP is less common in western Canada than paralytic shellfish poisoning (PSP), which is caused by red tide, a different group of marine planktonic algae called *dinoflagellates*. The Canadian Food Inspection Agency monitors shellfish for toxins.

Plate No. I



TYPICAL CANADIAN INDUSTRIAL DIATOMS

Photograph by:—
H. C. WHEELER, Montreal

The most conspicuous characteristic of diatoms is their siliceous shell, or *frustule*. The shells are intricate and quite remarkable for their beauty and variety, and it is well worthwhile spending a few moments doing an Internet search for "diatom images".

Like a box with its lid (a hat-box, for instance), the frustule consists of separable parts, the *epitheca* (the "lid") and the *hypotheca* (the "box"). The epitheca in turn is composed of two parts, the top or *epivalve* plus one or more rings of silica, which form the sides or *girdle*. The hypotheca is constructed the same way.

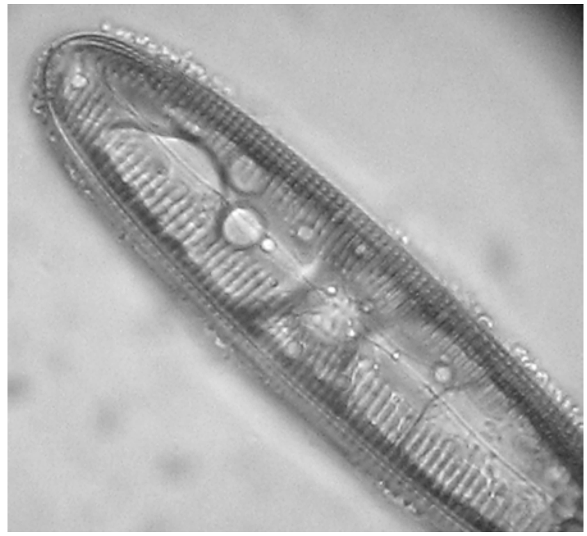
A diatom looked at from top or bottom is in *valve view*: from the side in *girdle view*. Diatoms in valve view may be roughly bilaterally symmetrical in shape with markings on the valve in two mirror-image rows (*top right*), or radially symmetrical in shape and markings (centric diatoms, *centre right*). Like a box viewed from the side, both pennate and centric diatoms in girdle view look somewhat rectangular (*bottom right*).

Some pennate diatoms bear a slit on one or both valve faces that completely penetrates the wall. This slit, the *raphe* is associated with a rapid gliding motion when the diatom is in contact with a substrate (*photograph next page*).

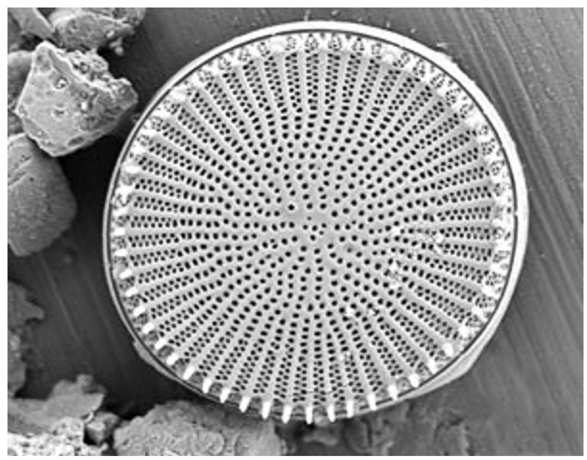
A few species have spines; some join together in rows; a few form branching gelatinous tubes with hundreds within them.

The silica walls of diatoms are penetrated by pores, which can be seen with an electron microscope, and these allow passage of gases and nutrients in and out of the cells.

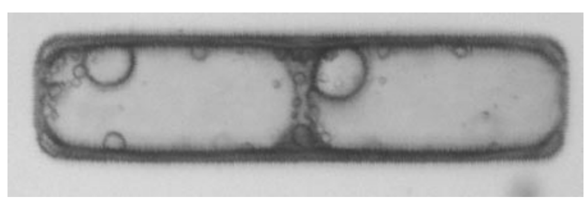
Some pennate diatoms may also have a series of long parallel ribs on their valve faces. It is the arrangement of these pores and ribs that is responsible for the



Pennate diatom from Epplers Swamp (valve view) Author's picture



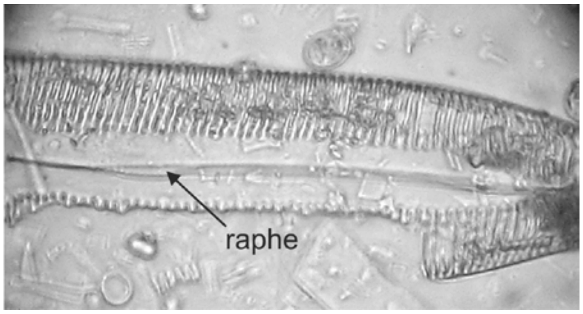
Centric diatom (valve view)
Academy of Natural Sciences Diatom Herbarium



A girdle view of a living diatom in Epplers Swamp (225 µm)

Author's picture

Previous page: V.L.Eardley-Wilmot, *Diatomite—its occurrence, preparation, and uses*, No.691, Canada Department of Mines, 1928.



The raphe is a long slit through which some diatoms secrete mucilage enabling them to glide.

Author's picture

symmetrical markings observed with the light microscope.

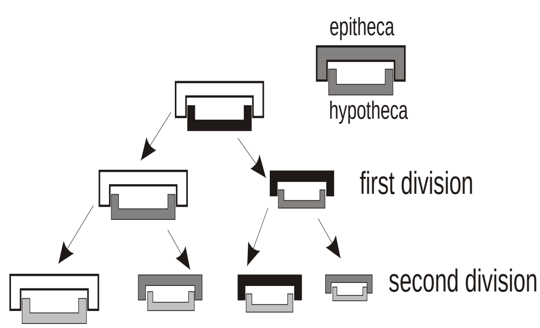
Diatoms can reproduce by simple cell division or by sexual reproduction; however, the walls of the cells pose an interesting problem for the reproduction of the diatom by cell division. As explained in the diagram on the *right*, asexual reproduction by cell division results in the average size of the diatoms diminishing with each generation to the point where they are no longer viable.[3]

In one respect, diatoms resemble mammals—and therefore us—more than they do the majority of other algae. They are diploid, that is their chromosomes (carriers of their genes) are paired, one from each parent. Only their gametes (the reproductive cells that fuse to form a fertilized egg) have a single (haploid) set of chromosomes. Centric diatoms carry the resemblance even further. They produce large eggs and smaller motile sperm that use flagella to swim.

Diatoms form spores and resting cells, not to increase their numbers, but rather to allow them to survive when conditions for growth are poor. Marine centric diatoms for the most part form spores, while freshwater pennates form resting cells. Resting cells can accumulate quantities of stored food materials, droplets of lipids for example, and are able to survive for very long periods, even for years, waiting quietly in the bottom sediments for conditions to improve. Gabriola's wetlands, like many freshwater environments, are subject to seasonally fluctuating watertables, and changes of temperature from winter to summer can be large. Resting cells and spores enable the diatoms to survive and thrive.

Diatomite

In planktonic diatoms, in both the ocean and in lakes, reproduction by cell division can produce enormous populations, year after year. When they die, their silica shells sink to the lake or sea bottom and accumulate in layered deposits known as *diatomite*, or

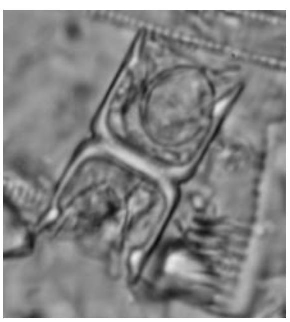


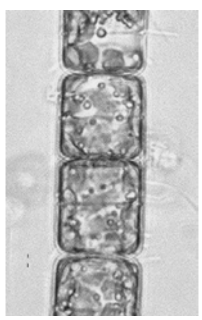
Diatoms, shown here in girdle view, most commonly reproduce by cell division, but there is a limit to the number of generations that can be produced this way. The epitheca and hypotheca of a parent become the epitheca for the two daughters, so one daughter is slightly smaller than the other. With each division, only one diatom of that generation is still the same size as the original parent—the one with no hypothecas in its lineage. Eventually, the size of most of the diatoms becomes too small for them to be viable. It requires sexual reproduction to produce offspring the size of the original parent.

[3] A few species do not have this problem. It may be that they have valves connected by more elastic girdles, and are able to expand after division.

diatomaceous earth. Because of their abundance, and the ability of their siliceous shell to resist dissolution in water, these fossil deposits may be very extensive and in some areas of the world are quarried and used for many purposes. Small amounts were mined on Gabriola just before the outbreak of World War II in 1939.

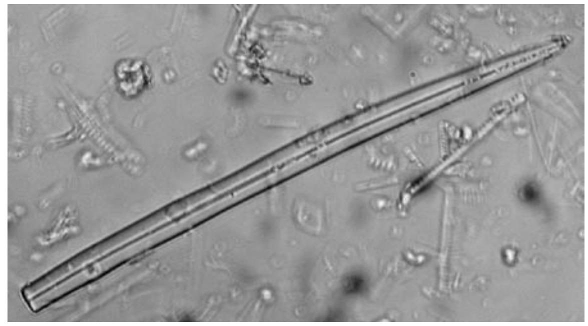
Diatomite collected on Gabriola is off-white, and soft, crumbly, and powdery to the touch. Samples from the Commons, Dogwood, and Epplers Swamp examined microscopically consist largely of pennate diatoms and fragments, intermingled with a smaller numbers of sponge spicules, and quantities of very small rounded siliceous structures that may be resting stages of other types of algae. Samples from the Commons also contained the only centric diatoms observed, a genus called *Aulacoseira* (formerly *Melosira*).

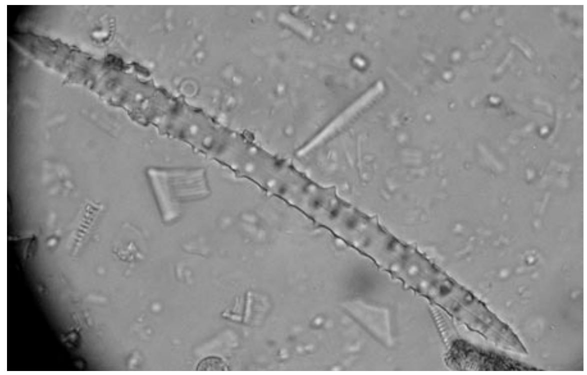




Top: Fossil *Eunotia* sp. (55 µm)
Below: Fossil centric diatom *Aulacoseira* sp. (15 µm), girdle view. This species forms chains of cells when alive, picture *right*.

Author's pictures





Fossil spicules (180 µm) of freshwater sponges made of silica found in diatomite on Gabriola. These are of interest to paleobotanists because the species can give valuable clues as to the type of environment that existed when they were alive.

Author's pictures

Aulacoseira spp. form chains of cells (picture *bottom near left*) but show up in diatomite as fragments of these chains in girdle view (picture *bottom far left*).

Freshwater sponges

Samples of diatomite from Dogwood Crescent show numerous pennate species mixed with sponge spicules—elongated needles of silica (shown *above*). These once formed elements of the skeletons of freshwater sponges. Most of the thousands of species of sponges are marine, but these are from the few freshwater species. Fossil freshwater spicules can give clues as to the environmental history of wetlands. ◊

Thanks to Dr. Linda Dybas for taking electron microscope pictures for the article.