



# **A Student's Guide to Common Phytoplankton of Long Island Sound**



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Cover photos: Fall phytoplankton bloom with species typically found in Long Island Sound, by Dr. Paul Hargraves.

UConn student and Sea Grant intern Joey Lener takes a plankton sample for the NOAA Phytoplankton Monitoring Network, by Ken Beatrice. Below: Mixed diatoms, Olivia Mallari.



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## **A Student's Guide to Common Phytoplankton of Long Island Sound**

“Plankton,” which comes from the Greek word for “drifting” or “wandering,” is a blanket term for organisms that are carried passively along by ocean currents. Much like “living things on a farm” might include animals such as cows, pigs or goats, and plants such as corn, wheat, or alfalfa, various plants and animals floating in the ocean at a given time, such as seaweed, jellyfish, tiny crustaceans, algae, and many types of bacteria are part of the plankton either permanently or temporarily. The term plankton covers the entire soupy mix of plants, animals, and one-celled organisms floating in the ocean, not primarily propelled by their own effort. Plankton are generally divided into two categories, phytoplankton and zooplankton.

**Phytoplankton**, the focus of this publication, refers to the one-celled, plant-like branch of plankton. Most are way too small to be seen with the naked eye. They have generally been biologically classified as protists, because of their size and structure. They are most important for carrying on much of the planet's photosynthesis. Sometimes plankton can be seen when they form colonies or masses called “blooms” and the pigments inside of them turn the water green, red, or brown. Phytoplankton generate between a quarter to a half of the Earth's oxygen, and are extremely fundamental to life conditions on the planet. In a liter of Sound water, there may be hundreds of thousands or even millions of phytoplankton. Using a light microscope and a few drops, you can penetrate their tiny, tiny world to see these extraordinary organisms and learn their secrets. You probably appreciated flowers in a garden more when you learned to distinguish daffodils from roses, and so on. Likewise, the phytoplankton will become more interesting as you learn their names and distinguishing characteristics.

Many phytoplankton are capable of making small movements. The motion is minute compared to the transport by water currents, so phytoplankton are considered passively moving even though they may swim or slide a wee bit.

Referred to scientifically as “**autotrophic**,” many phytoplankton generate their own food by using the energy of sunlight to chemically convert water and carbon dioxide into simple sugar and oxygen, a process known as photosynthesis. Most are **eukaryotic**, which means that the cell has a true **nucleus** containing its genetic material, unlike viruses and bacteria. Chlorophyll and other pigments that trap sunlight for photosynthesis and give the cells their color are in cell structures called **chloroplasts**. A “**heterotroph**,” on the other hand, has to consume another complex organic compound

for food, usually a plant or animal. For example, oak trees and raspberry bushes are autotrophs; humans, fish and sharks are heterotrophs. Usually autotrophs and heterotrophs will divide into plants and animals, but like everything in nature, there is a lot of diversity and exceptions to every rule. These exceptions include a small number of phytoplankton that are both hetero- and autotrophs, consuming bacteria and detritus as nutrition in addition to self-food production. Such “combination feeders” are called **mixotrophs**, sometimes even consuming other protists.

Phytoplankton form the base of most ocean **food chains**. Larger animals graze upon them just as cows munch grass, but usually in a progression of small animals to larger ones, moving from herbivores to carnivores. One of the simplest examples occurs when krill (a crustacean-like shrimp, and a type of zooplankton) eat the phytoplankton around them in the water. The krill, which may form a large cloudy-looking mass in the ocean, then get eaten by humpback whales. This is a very simple three-step food chain, going from some of the smallest organisms on earth, microscopic phytoplankton, to krill, and ultimately to the largest mammals on the planet. In Long Island Sound, a common food chain might go from phytoplankton to copepod zooplankton, to minnows, to a large predatory fish such as striped bass, then to human consumers. Of course, a predatory seabird such as an osprey or cormorant might also snap up a fish from the water for lunch. There are many links in estuarine food interactions, so rather than a chain, the more complex concept of a **food web** is appropriate.

Phytoplankton are divided into several very different groups, of which **diatoms** and **dinoflagellates** are by far the largest. Smaller groups include euglenoids, coccolithophores, prasinophytes, **silicoflagellates**, and more.

## **Diatoms**

Diatoms are fascinating microscopic algae present in lakes and in all oceans, from the poles to the equator. Many creatures have one certain ocean area or condition in which they thrive; diatoms are unique in that they are found everywhere, even in the Arctic ice or in the desert. They are also unique in having a “bloom and bust” existence. When conditions are normal, they float about in small numbers, unseen by humans, but occasionally water conditions in temperature, light and mineral nutrients are just right, and they sometimes bloom into huge masses which can become large enough to be seen from outer space.

Diatoms have a fascinating variety of shapes and are sometimes very ornately patterned. Two general shapes are common: a rounded drum or cylindrical shape ("**centric**"), and an elongated, boat-like, cigar-shaped or feather-like ("**pennate**") shape. Centric diatoms, with radial symmetry, are more commonly found in the open water near the surface, whereas pennate diatoms are more likely to be found on shallow bottoms. There are also triangular species. They can truly be thought of as living in glass houses, because they actually incorporate silica (the same ingredient in glass, basically sand) from the ocean water into their outer shells, surrounding the cell protoplasm. The silica deposits form an outer wall similar to opal, quartz or glass, called the "**frustule**." The shape is like a lab Petri dish or a hat box, with one valve larger in diameter (the "**epivalve**") overlapping the reversed second valve (the "**hypovalve**").

Because the outer wall is so hardy, diatom fossils are very common, and have lasted hundreds of millions of years, since the Jurassic Period. Layers of masses of diatom skeletons form "diatomaceous earth." Because diatoms are so skilled at building microscopic silicon structures, they are currently being heavily studied in the field of nanotechnology in the hopes that they can be used to formulate better solar power panels.

Some diatoms attach to each other, forming colonies which also exhibit fascinating shapes; you may see something that resembles a carpenter's folding ruler, bow ties or beads, stars, and more. Some attach end to end at an angle and look like a rippling ribbon when they move through the water. It's not clear why they behave in this social fashion. One idea is that sticking together may help to protect them from predation; another is that the group synchronization may generate more effective motion using water currents.

Many centric diatoms have projecting spines, which increases their surface area in relation to the volume of water holding them up, which helps them stay buoyant. In some the spines are also silica; in others they may be hollow and made of chitin, the same material that forms the shells of crabs.

Pennate diatoms that live on rocks may have a groove on their underside, called a "**raphe**," which secretes a mucus that the cell can travel on by sliding, like a snail. This structure is unique to diatoms. Pronounce it "raff."

Diatom reproduction is remarkable. Imagine the constraints upon an organism that lives encased in glass. What happens is that the genetic material duplicates itself, then the two frustule valves (shell casing parts) simply divide and separate. After separation, each of the two parts forms a new, smaller replacement "half." ("Half" is used for simplicity, but obviously not quite half in a mathematical sense since a larger one generally overlaps the slightly smaller other.) This is

called **asexual**, or vegetative, **reproduction**. However, you can see that after this goes on for several generations, the new parts formed get smaller and smaller and smaller. When they are quite a bit smaller than the original, the diatom may suddenly switch to **sexual** reproduction, producing auxospores, large spores with male and female **gametes** which will bring them back to the larger size. Some diatoms and dinoflagellates also produce **resting spores** that sink to the bottom and allow them to wait for better conditions, like a bear hibernates in the winter. See page 16 for an illustration.

**Thought Question:** Imagine you are living in a rigid glass box. It has no nose or mouth. What problems might you have in daily life? Consider the biological characteristics that define an organism as “living.” (See page 12.)

## **Dinoflagellates**

Another major type of phytoplankton are the dinoflagellates. Most (about 90%) are marine. This name’s Greek origin means “spinning tail,” so named because these microscopic organisms have flagella—tiny tails made of protein strands. The whip-like flagella can slightly propel them in the water, rotate as they move forward, or may sometimes be used for attachment. Usually there are two dissimilar flagella, one wrapped around the body and one extending outward. Dinoflagellates differ from diatoms in many other ways. Their visible accessory pigmentation color can be red to reddish brown, whereas the diatoms are golden brown. They really blur our perception of plant versus animal because in addition to the tails, some have “**eyespot**s” that are sensitive to light. Flagella, eyespots, and chloroplasts are all **organelles**, tiny structures inside the cell that perform specific functions. Another important difference between diatoms and dinoflagellates is that many dinoflagellates frequently have an outer covering of cellulose, like plants, rather than silica. Some have thick plates that fit together, like the armor of medieval knights. The plates can slide apart or over each other. Others are unarmored. Some are naked, but never embarrassed! Usually their nuclei are larger than those of diatoms.

Some dinoflagellates are bioluminescent, meaning that they produce and emit light, or glow in the dark, like fireflies. The water can sparkle brightly like tiny holiday lights if there are enough of them.

Dinoflagellates in Long Island Sound tend to grow in numbers and peak when the weather warms after the spring diatom blooms, replacing those populations as they decline. Many dinoflagellates are found in tropical or subtropical locations such as Florida.

Most dinoflagellates are harmless in moderate or low abundance, and like diatoms they are important primary producers for food webs. However, when their populations rise to excess they can form toxic blooms known as red tides. Some emit toxins which in large quantities these can affect human health. One suggestion is that the toxins might be a defense against predation. When breathed in or consumed, toxins can cause diarrhea or affect the human nervous system, depending on which toxin it is. One of the deadliest toxins, called saxitoxin, can kill humans in nanogram quantities. That could be as few as 15-20 cells per liter of water. This sometimes happens when shellfish from a harmful algal bloom area are consumed, because animals like oysters are **filter-feeders**. They accumulate toxins during a bloom event because of the way their filter-feeding process concentrates what is in the water they take in. For this reason, shellfish beds are closed during red tide events.

## **Other Phytoplankton**

### **Silicoflagellates**

Like dinoflagellates, the tiny silicoflagellates have a flagellum, but only one rather than two. Like diatoms, they contain silica in their bodies. Their internal structure is a network of tiny silica tubes or rods.

### **Coccolithophores**

Coccolithophores are tiny organisms that have a calcium carbonate outer covering, like clams. But unlike clams, they are usually round, covered with many tiny intricate, overlapping scales. These organisms are hard to see without a powerful electron microscope, and there aren't many in Long Island Sound, so we do not cover them in this guide.

## **Requirements for Phytoplankton**

Light, temperature, salinity and nutrients are all important factors determining which phytoplankton will appear, and how many. Some are found worldwide and are very abundant, others infrequent and localized. Many are found in fresh-water as well as marine, or even have terrestrial forms as well. Harmful algal blooms have been on the rise globally in recent years, fueled by eutrophication (excess nutrients in the water) and by warming temperatures.

Both diatoms and dinoflagellates, as well as the smaller types, live in Long Island Sound; but usually one is dominant over the other. There has historically been a bloom in the late winter to early spring, with the increase beginning in February, and another, smaller bloom in late summer. The spring bloom consists largely of diatoms; when temperatures rise in summer these give way to the smaller dinoflagellates. In fall, a second peak of production occurs, mostly diatoms again. Ongoing changes in climate may alter this pattern, and already has in some areas.

Phytoplankton usually are found in the surface and upper layer of water, where there is sunlight and nutrients; most often in coastal locations because of the nutrient supply coming in from the land; when they die they sink and ultimately become part of the sediment below. There are benthic (bottom) species, too, however, which live on the surface of, or a few millimeters below, sediments beneath the waters. These may be considered plankton in the Sound, because it is shallow. Turbulence sometimes brings plankton on the bottom up to the surface.

### **Effects of Algal Blooms in Long Island Sound**

As the base of the food web, lots of algae means lots of crustaceans, mollusks, and fish! Phytoplankton support all of the larger life in the sea, so blooming algae is normally a good thing for the Sound's animals. Without them, there would be very little alive in the Sound.

There can be negative aspects to really large blooms when waters are not mixed by the wind, however. A large phytoplankton bloom, even though not toxic, can cause **hypoxia** (low dissolved oxygen) in Long Island Sound and other estuaries. This happens when a mass of small algae, usually spurred by excess nitrogen nutrients in the water, grows larger and eventually dies. In the decay process, the metabolism of bacteria uses up tremendous amounts of oxygen. The water is then oxygen-depleted, and animals that need oxygen to breathe must either move away, get sick, or die. The decomposition alone may cause fish and crustacean kills and a bad smell. These events usually happen in late summer when the water is warm and not well mixed with air from the atmosphere. That's why it's important to minimize use of fertilizers in the watershed area and also to try to minimize storm water runoff. Luckily, so far Long Island Sound has rarely ever experienced serious toxic dinoflagellate blooms. They are rare events. However, in 2008 to 2010 there were localized blooms of the toxic dinoflagellate *Alexandrium fundyense* on the north shore of Long Island, New York. State agencies and the volunteer NOAA Phytoplankton Monitoring Network (<http://pmn.noaa.gov>) monitor the waters for these potential harmful



algal bloom organisms by periodically sampling, identifying, and recording phytoplankton. New research is also underway to see how zooplankton affect possible blooms by eating the phytoplankton and keeping their numbers low.

## **A Word about Size**

The sizes of the phytoplankton in this guide are given in micrometers (also called microns), using this scientific symbol:  $\mu\text{m}$ . That's not a size we usually encounter in our daily lives. Just how big is a micrometer? A thousand of them ( $10^3$ ) fit in a millimeter. The head of a common sewing pin is about 2 millimeters in diameter, for comparison. A human hair is usually about 100 to 200 micrometers wide. You may not be able to measure your specimen in micrometers unless your microscope is calibrated for this, but the measurements are certainly useful for comparison purposes. We have included scale bars in our photos. The cells in the photos have been not only greatly magnified under the microscope but also enlarged on the page; the scale bars serve as an accurate measurement for the specimen depicted.

## **Collecting and Examining Phytoplankton**

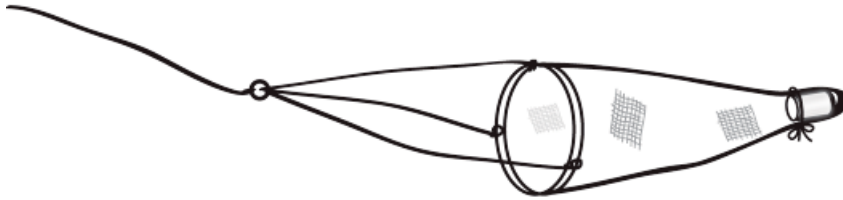
If you want to collect a phytoplankton sample from Long Island Sound, you can purchase a simple plankton net from a biological supply house online, or make your own. It should have a fine netting, say 20 micrometers. You can make one from a nylon stocking or pantyhose leg inserted into an embroidery hoop or sewed or glued around a piece of coat hanger wire. If you choose glue, use a waterproof variety. Then make 2 or 3 holes spaced around the top (not foot) end below the hoop. Insert the rope and tie securely. Large grommets can be used to make holes for a sturdy net. Securely tie lengths of rope a couple meters long into each hole. Tie the free ends together onto a plastic or metal ring. Then attach a single line, say 4-5 feet long, to the ring which you will hold as you tow it. Setting the cap aside, insert a baby food jar or plastic bottle with a tight fitting cap into the toe of the net or stocking (called a "cod-end"). Secure the bottle with a rubber band, string, or metal clamp. Now, lower your net from a dock and walk back and forth, dragging it through the water, or tow it from a small boat. Try to get it to go down about a meter—a sinker from a fishing tackle store may assist if it keeps bobbing to the surface. Do this for at least 3 minutes. Tiny plankton will collect in the bottle. Finally, haul up your net. Remove and cap the bottle. You can keep your sample for a day or two, in a cool place, but the plankton will die and the cells will decay after that unless preserved with a solution such as Lugol's.

Let the bottle settle for a while (maybe 15-20 minutes), then use a pipette or long eye dropper to sample. Place a drop on a glass slide and cover with a thin glass cover slip. You're ready to see the tiny world of phytoplankton using a simple compound light microscope. Caution: Be VERY careful not to get salt water onto your microscope. It could cause damage. Water should be only under the cover slip on the slide. Quickly wipe up any spills. Try the different magnifications available, such as 10x, 20x, 40x (higher if available), and use this guide.

### **Using this guide:**

A few new vocabulary terms in bold, explained in the text, were necessary to introduce the study of phytoplankton. Otherwise, we have tried to avoid technical jargon and stick to simple language. We tried to have our photos look like what you will observe on your own with a light microscope. Please keep in mind that the cells will look very different depending on whether you're looking at the top or bottom, or from the side. If you see a group or colony, there may be some of each.

There are hundreds of thousands of species of phytoplankton in the world, and likely thousands in the Sound, so only a small fraction can be found here, but we have selected some of the most common and most interesting examples to introduce you to this fascinating hidden world. There are larger taxonomic keys for those who want to become expert or do college level studies. We have grouped the species selected into categories of Diatoms and Dinoflagellates plus silicoflagellates and others, and arranged them alphabetically within those categories. On pages 13-14, there are shapes that you can begin with; choose the description closest to what you see and then check the entries suggested underneath. As scientists more frequently do genetic analyses, and split large groups into smaller ones, species names can change when new information is discovered. That can be frustrating or baffling to novice students, so we have also included some former names in case you encounter earlier accounts in your further exploration, even though they may not be currently used. Flip through and see if you spot your species, then see if the characteristics match. When we collect, we like to include environmental data about our samples, such as location, date, salinity, pH, water temperature, air temperature, incoming or outgoing tide. That way, the mix of species found in the samples can be compared over time and location using different conditions. You'll want to do the same when you collect your samples.



P. Van Patten

*You can buy or borrow a plankton net, or make your own. It should look something like this picture, with a means to tow it, an opening to a fine mesh net and a collection bottle at the opposite end.*

## Those Pesky Latin Names

We've heard many times that nonscientists who are interested in plants and animals don't want to learn "those pesky long Latin two-part names". Phytoplankton mostly don't have common names, and those can easily be confused since they're not "official." Several specimens here are identified only to genera rather than particular species, because it is very difficult to do without use of an electron microscope. We don't expect all of our readers to have access to that technology. We had fun investigating the origins of their names, and we bet you'll find that interesting too. If you discovered a new species yourself—and you might—how would you choose a name for it? Would you name it after yourself, or a friend, or use words that describe it? The human name that follows the genus and species is the first one to discover and report it. The year is when it was reported with a description in Latin. If there are two names, there was an earlier discovery that has been corrected in its classification.

Finally, there is a resource list at the end, which shows the sources used for authoritative identifications and species characteristics and places to find more wonderful information. As this guide is electronic, we may update it periodically as new information or new photos are available. We hope you enjoy exploring the phytoplankton.

*—Peg Van Patten, "Judy" Yaqin Li and Gary H. Wikfors*

**Answer to Thought Question:** 1. How about eating, drinking and breathing? We get sunlight, gases from the air, and water through the pores in our skin as well as through our nose and mouth. But these materials, and nutrients, don't travel through solid glass. Diatoms often have hundreds or thousands of tiny holes in their frustules (shells), like a kitchen sieve, that allow these materials to pass through faster than diffusion alone. Some of the patterns make them look very ornate, even like fancy lace. These holes allow these essential materials to reach the cell membrane, where there are uptake sites with pores. They also have many fluid-filled spaces, called vacuoles, in their cellular protoplasm. The pores often store nutritious oils. 2. How about growing bigger? As the silicious diatoms expand, a series of bands called "**girdles**" or "**girdle bands**" form at the edges of the valves so that they can slide apart.

## Search by Shapes

Our species are categorized and then arranged alphabetically, which doesn't help much when you have a live specimen but no idea where to begin. Start here by searching here and on the next page, by shape. Use your imagination, as they're certainly not perfect. Eventually you'll get used to telling apart the diatoms, dinoflagellates, and "others." Last resort is flipping through the whole guide. Remember, we couldn't include everything.

**Balls** Two balls smooshed together with rubber bands (groove) around the middle, may be twisted spirally.

Try *Cochlodinium*, page 49

**Boat or kayak**

Try *Navicula*, page 30

**Bow tie or pillow**

Try *Odontella*, page 31, 32

**Bracelet**

Try *Eucampia*, page 24; *Chaetoceros*, page 19; *Odontella*, p. 31, 32

**Bug with antennae**

Try *Pyramimonas*, page 55

**Chains**

Try *Chaetoceros*, page 19; *Eucampia*, p. 24; *Leptocylindricus*, p. 26, 27; *Lithodesmium*, p. 28; *Melosira*, p. 29; *Odontella*, p. 31, 32; *Paralia*, p. 33; *Skeletonema*, p. 36; *Striatella*, p. 37; *Thalassiosira*, p. 41,42

**Circle, capsule, cylinder**

See Rounded, next page

**Football**

Try *Navicula*, page 30, *Gyrosigma*, *Pleurosigma*, page 25;

**Heart**

Try *Prorocentrum*, page 52, 53

**Hexagon**

Try *Distephanus*, page 54

**Horned**

Try *Ceratium*, page 47, 48

**Leaf or pumpkin seed**

Try *Prorocentrum*, page 52, 53

**Letter S, elongated**

Try *Gyrosigma*, *Pleurosigma*, page 25

**Needle, slender rectangle or long cigar**

Try *Bacillaria*, page 18; *Cylindrotheca*, p. 22; *Pseudonitzschia*, p. 34; *Rhizosolenia*, p. 35

**Pear with pointy top**

Try *Peridinium*, page 51;

**Ribbon**

Try *Bacillaria*, page 17; *Rhizosolenia*, page 35

*continued on next page*

## Shapes continued

### **Rounded** - capsule, circle, cylinder, or oval

Try *Alexandrium*, page 46; *Corythron*, p. 20; *Cochlodinium*, p. 49; *Coscinodiscus*, p. 21; *Leptocylindricus*, p. 26-27; *Ebria*, p. 56; *Melosira*, p. 29; *Thalassiosira*, p. 40, 41, 42;  
- cone atop hemisphere, *Ceratium* p. 47, *Peridinium* 51

### **Skull**

Try *Ebria*, page 56;

### **Square or rectangle**, single or in chains

Try *Bacillaria*, page 18; *Chaetoceros*, page 19;  
*Leptocylindricus*, p. 26, 27; *Lithodesmium*, p. 28; *Striatella*, p. 37

### **String of beads**

Try *Thalassiosira*, p. 40, 41; *Skeletonema*, p. 37

### **Star**

Try *Asterionellopsis*, page 16; *Thalassionema*, page 38, 39;

### **Tootsie roll candy** or hot dog on a stick

Try *Ditylum*, page 23

### **Tooth or Mushroom**

Try *Akashiwo*, page 45.

### **Toothpick**, hollow and straight with tapered pointy ends

Try *Pseudonitzschia*, p. 34; *Rhizosolenia*, p. 35

### **Toothpick or square slender stick with square ends**

Try *Bacillaria*, p. 18

### **Triangle or triangle plus hemisphere**

Try *Asterionellopsis*, page 17; *Ceratium*, p. 47, 48;  
*Peridinium* 51

### **Water pitcher or vase**

Try *Dinophysis*, page 50

### **Whiskered/many long spines**

Try *Chaetoceros*, page 18; *Asterionellopsis*, page 16;  
*Ceratium*, p. 47; *Corethron*, p. 20;

### **Zig Zag** or chicken foot

Try *Thalassionema*, page 38, 39

# Diatoms

In Long Island Sound, diatoms account for most of the phytoplankton during the fall, winter, and spring. They are sometimes replaced or surpassed by dinoflagellates in the summer.

# Diatom Life Cycle

## Asexual Reproduction (Mitosis)

Normal vegetative cell

Vegetative cell division

Successive vegetative division

Smaller frustules

Fertile cell size

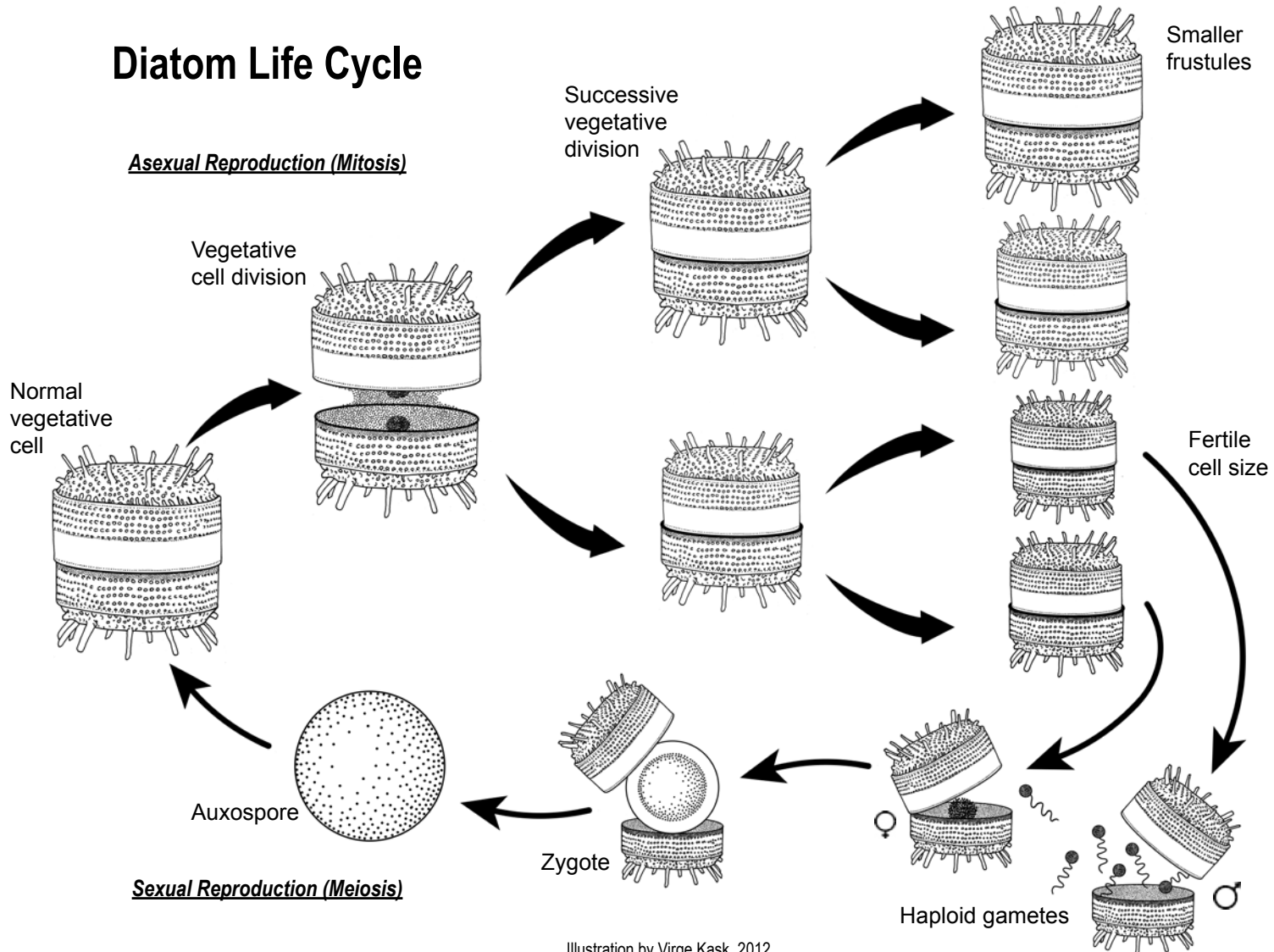
Auxospore

Zygote

Haploid gametes

## Sexual Reproduction (Meiosis)

Illustration by Virge Kask, 2012



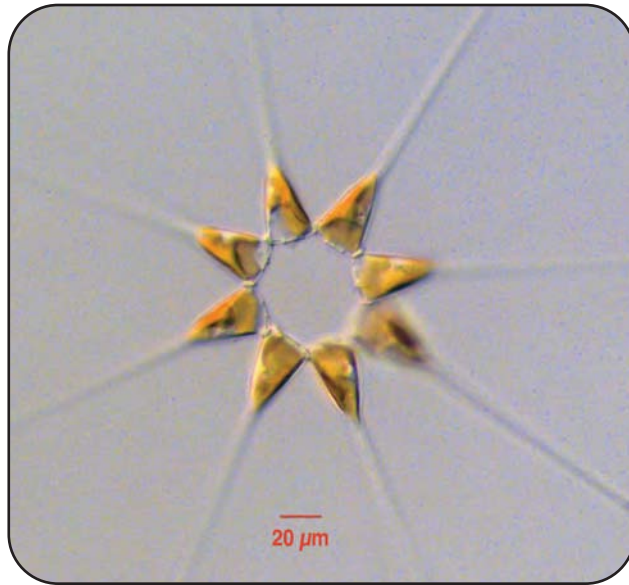


*Asterionellopsis glacialis* (Castracane)

F.E. Round 1990

Alternate names: *Asterionella japonica* Cleve 1882.

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Triangular shaped cells with a long spine sticking out from one end, often joined at the wide end to form a star-shaped colonies. This image shows eight individuals.

## Size

From wide end to end of outer spine, 30-150 μm

## When/where to Find It

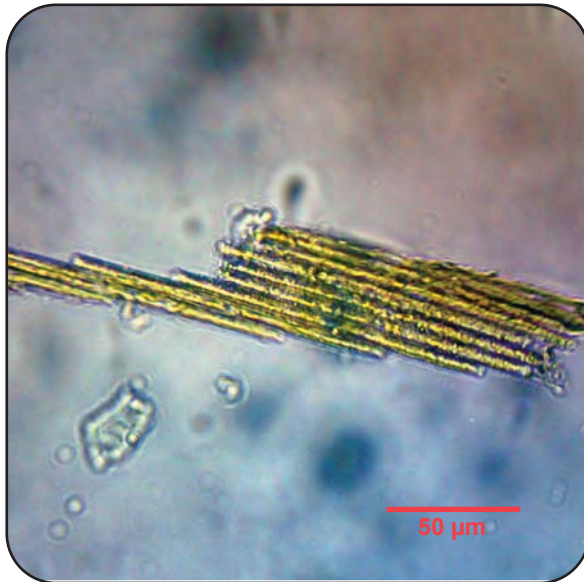
Long Island Sound, Narragansett Bay, marine waters and surf zone worldwide. Often abundant in cold to temperate waters but also found in the tropics, so a hardy species.

## Notes

The first part of its name means “little star”; the latter part means icy, frozen or glacier-like, which gives you a clue to its preferred habitat. There has been discussion as to why they group this way; no definitive answers, but one suggestion is that this typical grouping, with spines all pointed outward, could be a defense against predation.

*Bacillaria paxillifera* (O.F. Müller)  
T. Marsson 1901

Class Bacillariophyceae



O. Mallari, Waterford H.S.

## Type

Diatom

## What it Looks Like

Long slender golden cells, not pointed at the ends; rectangular. No spines. May be single or in “stepped” (overlapping one way) chains. When in stepped chain colonies, as seen here, live specimens slide along each other lengthwise, expanding and contracting the length of the chain. They may appear to move in a ripple in the water like a ribbon furling.

## Size

About 48-100 µm lengthwise; 4-6 µm wide.

## When/where to Find It

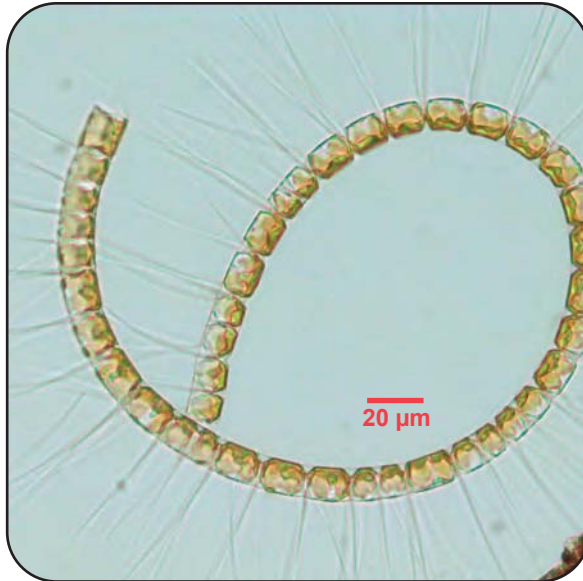
Common worldwide. Found in the early spring and fall, frequent in October. Sometimes on *Ulva* or other seaweed.

## Notes

They have a raphe structure which facilitates the gliding motion in their moving colonies. While that is the norm for a bottom dwelling species, these are often whisked up into the water column, where they move quite effectively as colonies. A pure culture from Long Island Sound has been established and is kept in the National Center for Marine Algae and Microbiota, a “living library” where both cells and DNA are made available for research experiments. Compare with *Pseudonitzschia*, page 35 and *Rhizosolenia*, page 36, which have pointed cell tips.

## *Chaetoceros* sp. Ehrenberg 1844

Class Bacillariophyceae



H. Skelton/UConn Dam Lab

### Type

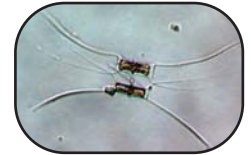
Diatom

### What it Looks Like

Usually in chains of individuals. Very long overlapping spines called “setae” are seen in pairs along the chain where the cells join, looking rather like a cat’s whiskers, and at the ends. These are hollow projections of silica. There are generally four per cell. Opposite setae touch each other at the attachment point.

### Size

About 9-80 μm length of cell excluding setae.



### When/where to Find It

Common in Long Island Sound and Narragansett Bay in spring, fall and summer. Prefers warm temperate waters; found world-wide except in polar regions.

### Notes

More than 400 species of *Chaetoceros* have been described, of which 200 or so are probably really distinct species. *Chaetoceros* can quickly become abundant when conditions are right. Its name, from Latin, means “hair horn.” like “Rhinoceros” means “nose horn.” The chains formed by colonies are often long and straight. Because it has a high concentration of lipids (fatty oil) *Chaetoceros* is being considered for use as a biofuel.

## *Corethron hystrix* Hensen 1887

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

This species has a capsule-shaped cell, with spines extending out from both rounded ends, with the appearance of cat whiskers. The spines are in sockets that articulate from the body, so can move, and may have tiny barbs. Both long and short spines may be present. Look very closely to spot them in this photo; they are clear so difficult to see. There are numerous round golden colored chloroplasts inside the cell and the nucleus is on one side.

### Size

20-150 μm long end to end; 5-20 μm across.

### When/where to Find It

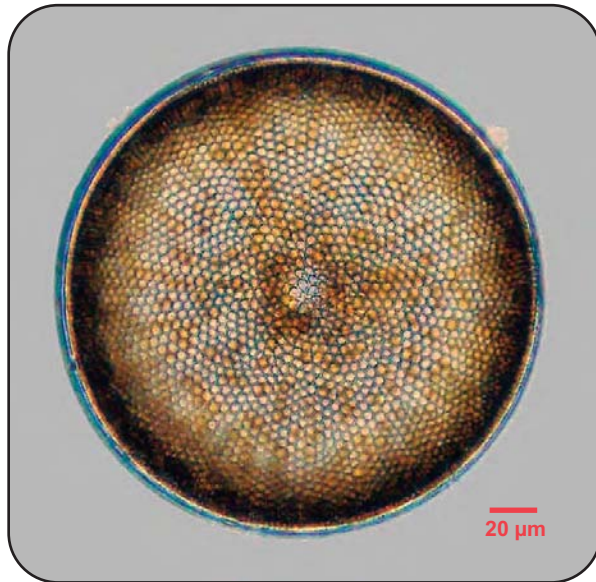
Spring and summer in North Atlantic, including Long Island Sound; also found in the English Channel, and the waters off Sweden, Spain, and Cape Verde.

### Notes

*Corethron* diatoms were collected during the famous *H.M.S. Challenger* voyage during the years 1873-76. The number of species and their distinctions have been debated. The name means spiny, in the sense of a porcupine. Another species, *Corethron criofilum*, is nearly identical but found in Arctic waters. The spines may serve to separate rather than attach the cells.

*Coscinodiscus* sp. (Ehrenberg 1839)  
Hasle & Sims 1986

Class Bacillariophyceae



NOAA PMN

## Type

Diatom

## What it Looks Like

The shape is “centric,” radially symmetrical from the center like a wheel. Thus it looks round from the top. To imagine how it would look from a side, “girdle” view, think of holding a coin on end and looking down at its edge. There are many holes in the “glass house” to let water and nutrients pass through and many round or oval chloroplasts. Found singly rather than in chains or groups; no external spines. Large in comparison to many other diatoms in this guide.

## Size

Typically about 100-300 μm diameter for many species. This one has been magnified 400 times.

## When/where to Find It

Cool to temperate waters. Very common around the world except polar regions; everywhere in Long Island Sound. Most abundant in summer and fall.

## Notes

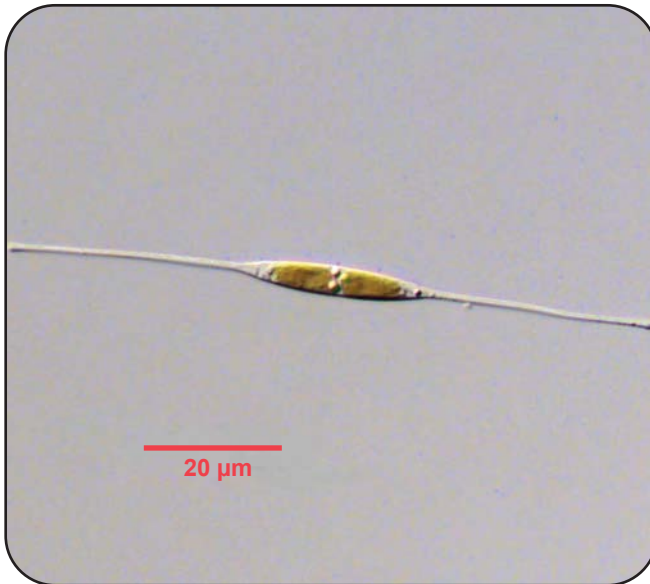
There are hundreds of species in this large genus, with varying numbers and arrangements of pores and chloroplasts. We left this example at the genus level and did not attempt to classify the specific species, as that would be beyond the range of this guide.

## *Cylindrotheca closterium* (Ehrenberg)

Lewin & Reimann & Lewin 1964

Alternate name: *Nitzschia closterium*

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

2 chloroplasts, seen in center. Cell shape is rather like a kayak or canoe seen from overhead; that is, narrow and thicker in the center with tapered opposite ends. One very long clear spine projects from each of the two tapered ends.

## Size

30-400 μm long

## When/where to Find It

Estuaries and marine saltwater, peak in spring, summer. Besides Long Island Sound, also found in the waters near Canada, Australia, Brazil, Hawaii, Spain, Korea, Singapore, New Zealand, and the United Kingdom.

## Notes

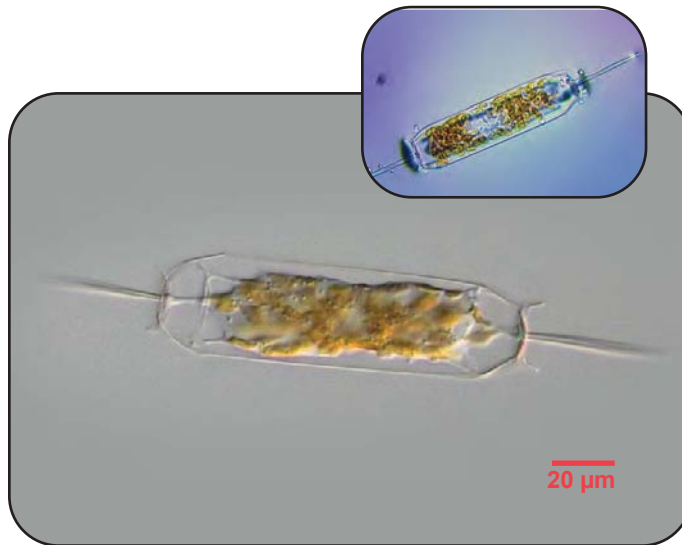
This is one of the most common species in the world. It is a pennate species, meaning it prefers bottom habitat. First identified in 1841. Although it looks a bit ungainly, it can move by secreting mucus through an underside groove called a “raphe”. It can also—rarely—be a harmful species when it is abundant.



## *Ditylum brightwellii* (West) Grunow 1885

Alternate name: *Triceratium brightwellii*

Class Bacillariophyceae



J. Li/NMFS Milford  
Inset: O. Mallari, Waterford H.S.

## Type

Diatom

## What it Looks Like

Resembles a capsule with a ring of small ridges on the two short rounded ends and a “stick” (a long thick hollow cylindrical spine) protruding from each rounded end. Shaped like a wrapped Tootsie Roll Midgee® candy, if you stuck a toothpick in both short ends. Numerous chloroplasts, golden brown color, congregated in the center of the cell. Inset shows the ring of small ridges.

## Size

25-100 μm diameter, 8-130 μm long

## When/where to Find It

Autumn is a prime time to find this species in Long Island Sound. Found in marine and estuarine waters of the western North Atlantic Ocean and beyond; reported near the United Kingdom, Brazil, Singapore, and Australia.

## Notes

This species is being studied for its population genetics and reproductive behavior, as well as its ability to bind with heavy metals such as copper. With the onset of winter and low nutrient conditions, *Ditylum brightwellii* stops its rapid fall reproduction and produces resting spores for the winter months.

## *Eucampia zodiacus* Ehrenberg 1839

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

Resembles an ornate golden bracelet, with cells linked at corners, forming curved chains that may extend to a circle, coiled in helix fashion. Links are not very visible. Inset shows another curved chain.

### Size

8-80 μm

### When/where to Find It

Find it at a variety of depths in the water column, from surface water to near bottom of the Sound. Autumn is a good time to find it. Also found worldwide; most abundant in cold waters.

### Notes

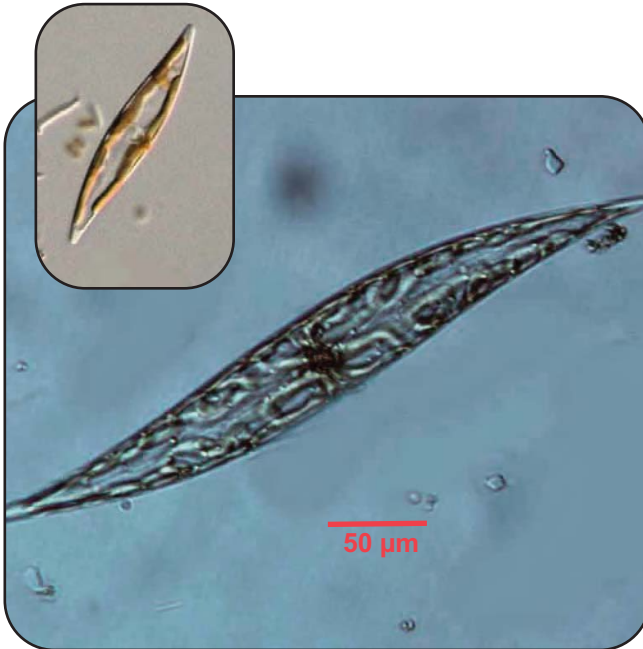
They are often found in groups of circular or curved colonies, like a collection of bracelets.



*Gyrosigma* sp. Hassall, 1845

*Pleurosigma* sp. W. Smith, 1852

Class: Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatoms

## What it Looks Like

Looks sort of like a piece of orzo pasta, but with the tapered ends pinched and skewed a bit in opposite directions, like a very elongated letter S (or backwards S, depending on which way you're looking at it.) Central area is round to oval. Some species have spoon-shaped ends.

## Size

Usually between 200-300 μm long for *Gyrosigma* and between 90-600 μm for *Pleurosigma*, depending on species; variable, but always much longer than wide.

## When/where to Find Them

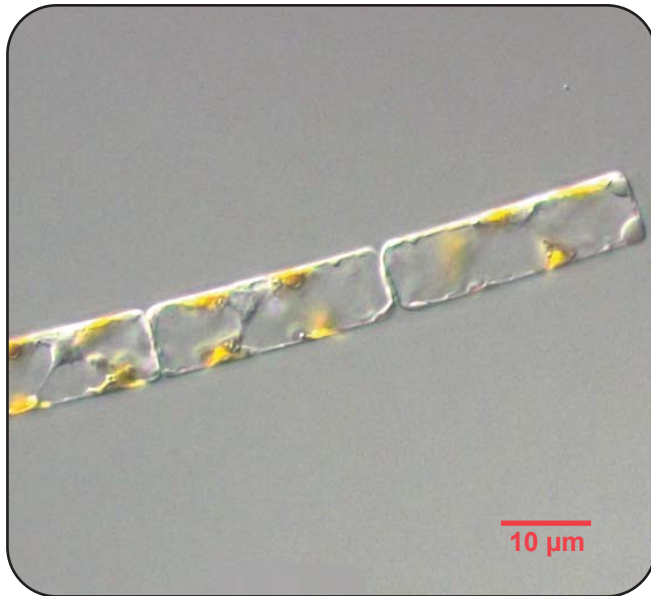
Spring or fall, brackish waters; could be anywhere in the Sound and are found worldwide.

## Notes

"Sigma" is letter S in Greek, thus an appropriate name, considering its shape. These two genera are almost impossible to tell apart without an electron microscope so we have combined them here. Both have the S shape, tapered at the ends; both have a raphe structure centered on the long axis, for motion.

## *Leptocylindrus danicus* Cleve 1889

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

Clear silica outer covering. Cylindrical, narrow cells with many golden, mustard colored chloroplasts per cell. Cells always attach end-to-end to form tight chains.

### Size

Diameter 5-16 µm; length of cells and chains varies

### When/where to Find It

Long Island Sound, Narragansett Bay, Gulf of Maine, Gulf of Mexico, waters of Croatia, Norway, Nova Scotia, Brazil, the Antarctic. Generally found in the water column, rather than attached to things.

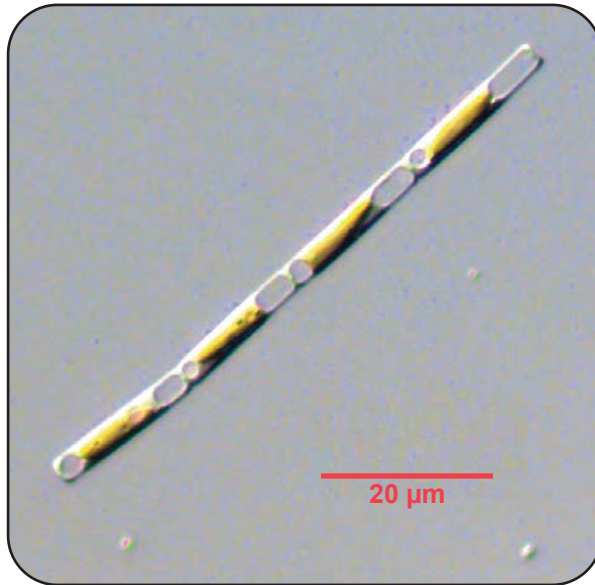
### Notes

Resting spores may form inside the cell walls. Lepto- is a Greek prefix for “slender” or “narrow”, and of course the rest means cylindrical. “danicus” indicates a Danish discovery, and indeed, the first description was from Denmark. Reproduces both sexually and asexually. It tolerates a wide range of temperatures, as you can see by the places it's found.

## *Leptocylinndrus minimus* Gran 1915

Alternate name: *Leptocylinndrus belgicus*

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

Very slender cylindrical cells with two golden brown, mustard-colored chloroplasts. Spines form a small ring on the ends. Cells may be singular or attached to form linear chains.

### Size

1.5-4.5 μm wide, 10-15 μm on longest dimension, much smaller than *L. danicus*.

### When/where to Find It

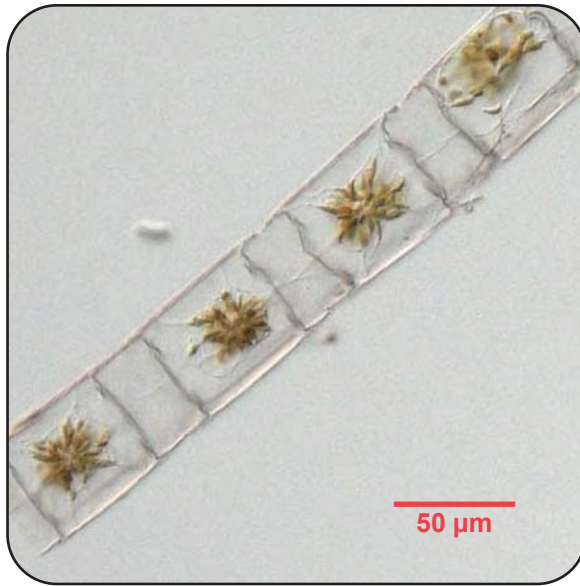
Very widespread; cool temperate waters. In Long Island Sound, it is most abundant in the spring. Also seen in Narragansett Bay, Gulf of Maine, United Kingdom, Croatia, Norway, Nova Scotia, Brazil, the Antarctic.

### Notes

“Minimus” of course means “minimal”, or “little”. Despite its diminutive size, this is a harmful species when abundant. Blooms have harmed fish, both wild and aquacultured, in other places but we don’t normally get that many in the Sound. This species was first described from European waters. When conditions are very unfavorable, it forms resting spores inside the cell walls—but it happens rarely.

*Lithodesmium undulatum* Ehrenberg  
1839

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Viewed from this angle, cells appear roughly rectangular with extensions at corners, clear, with large spaces between the connections. Viewed from the side, this diatom would appear triangular, with a spine coming out from the center.

## Size

37-93 µm

## When/where to Find It

Besides Long Island Sound, this marine species has been reported in Spain, the Canary Islands, Brazil, and other parts of the world. Found in a survey of the Bay of Fundy, Canada, in 1995 as a “new” species.

## Notes

This name begins with “Litho,” from the Greek word for stone and “des-” for binding; probably because the genus was found preserved in ancient fossils, thanks to its strong covering. The undulatum part is from a Latin word for undulating, or wavy, referring to the wavy appearance of the cell edges.

*Melosira nummuloides* C.A. Agardh 1824

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

This species has rounded cells surrounded by a clear “collar” closely surrounding the cells. There are numerous round chloroplasts, so very colorful. The cells unite into chains by means of mucilage pads that they secrete.

## Size

10-40 µm valve diameter; 10-14 µm valve height

## When/where to Find It

Prefers briny warm coastal waters, so seen in summer and late spring. Also found in coastal Florida waters.

## Notes

“Melo-” means “honey” in Latin, and that’s a good description of the chloroplast color. “Num-” has the same root as “number”; sometimes the chains pile up in great numbers of cells. The species tends to be benthic (bottom-settling) or attached to something else by means of the mucilage, rather than in surface waters. There is a similar Arctic species too, *Melosira arctica*.

## *Navicula* sp.

J.B.M. Bory de St.-Vincent 1822

Class Bacillariophyceae



Top: O. Mallari, Waterford H.S.

Bottom: NOAA Phytoplankton Monitoring Network

## Type

Diatom

## What it Looks Like

The clue that this pennate specimen belongs to the genus *Navicula* is the boat shape; some with rounded ends. There may be a round or elongated central nodule. It is bilaterally symmetrical; that is, one side is the mirror image of the other. They have two chloroplasts and a straight raphe.

## Size

Typically 50-130 μm lengthwise, end to end; width about 5-20 μm.

## When/where to Find It

Anywhere in the Sound and worldwide. They are so common that you may find one whenever you sample.

## Notes

*Navicula* has been the largest diatom genus, with thousands of species, most of which are benthic (bottom-living). They glide via a straight raphe which you might be able to see with the light microscope. Its name comes from Latin for “small boat.” Associating its boat shape with the word “navigation” may help you to remember the name since the first 4 letters are the same. Because the giant genus became unwieldy, it is now being broken into several new genera. Check <http://algaebase.org> for new ones.

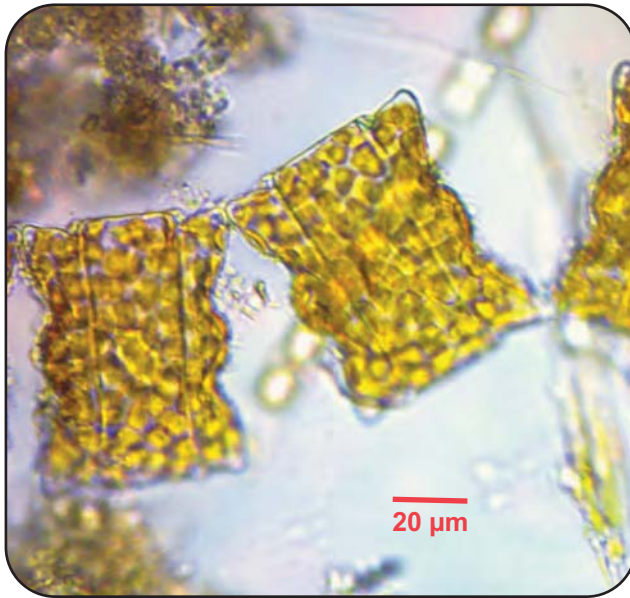


## *Odontella aurita* (Lyngbye)

C. A. Agardh 1832

Alternate name= *Biddulphia aurita* 1838

Class Bacillariophyceae



O. Mallari, Waterford H.S.

## Type

Diatom

## What it Looks Like

Curved valves, which viewed from above look square or rectangular, but with a small horn extension on each “corner,” kind of like a bowtie. Numerous yellow-brown chloroplasts. Forms long chains. They are thicker in the center, so viewed from the side, the shape would be football-like.

## Size

10-97 µm end-to-end on longer axis, as viewed here.

## When/where to Find It

Prefers cold surface waters, but found at greater depths in temperate waters. It begins to grow rapidly in early spring, when the water is between 1-3°C. A very cosmopolitan species, widely found in cold coastal waters and estuaries including Long Island Sound.

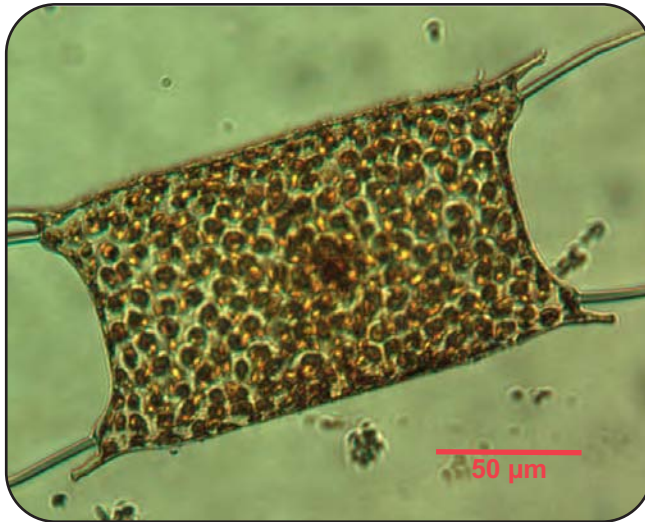
## Notes

There has been a great controversy over whether this species should be classified in the genus *Odontella* or *Biddulphia*; both names are used as synonyms. *Odontella* means “little teeth;” *aurita* means “long ears.” Like many other diatoms, this species contains Omega-3 fatty acids, so is a healthy diet for animals that consume it. In France, this species is approved for use as human food.

*Odontella sinensis* (Greville) Grunow  
1884

Alternate name: *Biddulphia sinensis*

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

From valve ("top") view, looks rectangular but with the four corners pulled out. Spines both short and long extend from these corners.

## Size

90-260 μm lengthwise end to end

## When/where to Find It

Besides Long Island Sound and Narragansett Bay, it has been reported in the Netherlands, Canary Islands, Brazil. Look in winter or spring.

## Notes

Lots of genetic studies have been done on this species. It is believed that *Odontella* evolved from the red algae. Like *Odontella aurita*, it has fatty acids and antioxidant properties, and so is being studied for use in biotechnology. It was first identified in the China Sea and Hong Kong in the 1880s. By 1905, it had spread to Europe and then all over the world, so it is an invasive species. Ballast water has been suggested as the likely method of transport. We don't know when it reached Long Island Sound, and we don't know of any ill effects from it.



## *Paralia sulcata* (Ehrenberg) Cleve 1873

Alternate names: *Gaillonella sulcata*  
*Melosira sulcata*

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Cell walls have a thick clear silica casing surrounding the oval center. Cells are wider than long, as seen here. They form chains in which the cells lock together with tiny ridges and grooves. Many chloroplasts.

## Size

20–45  $\mu\text{m}$  long; 40–65  $\mu\text{m}$  wide. Cells are wider than long.

## When/where to Find It

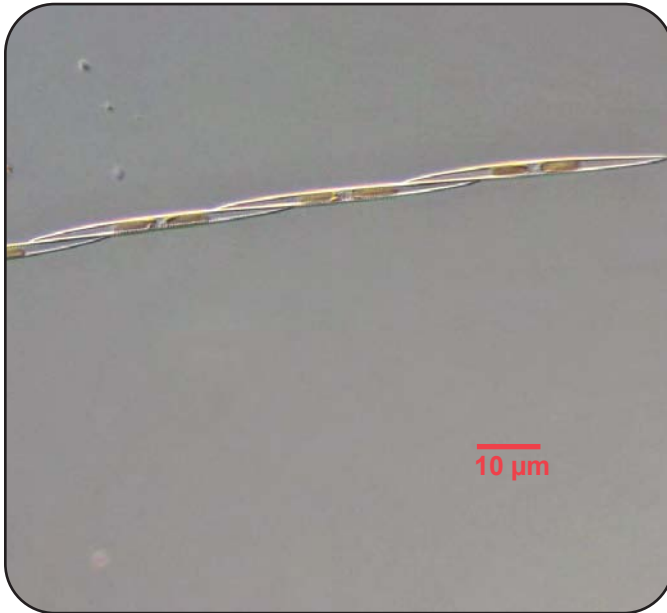
Very common in temperate and tropical estuarine waters, in both littoral and sublittoral zones. Reported in Long Island Sound, Narragansett Bay, Europe, Nova Scotia, North Sea, Great Britain, Romania, Brazil, and Japan.

## Notes

Prefers well-mixed, nutrient-rich highly saline water. These conditions result in large populations of small-sized cells. Research suggests that in contrast, if the water is stratified with low salinity and low nutrients, there may be fewer *P. sulcata* cells, but more cells greater than 20  $\mu\text{m}$ . Taxonomists, the people who identify and name species, believe that what we call *P. sulcata* now may actually be three separate species, so watch for future name changes.

*Pseudo-nitzschia* sp. H.Peragallo 1900

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Very long and slender cylinder, travels in chains of individuals that overlap at one end, as seen here.

## Size

About 30-160 µm long;

## When/where to Find It

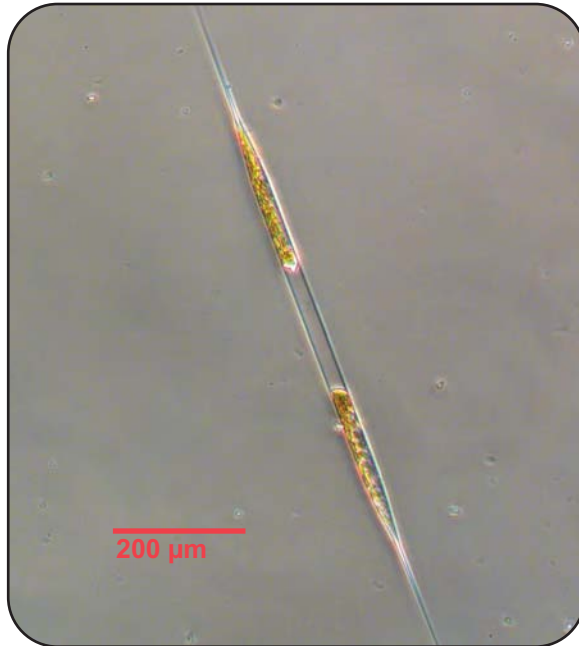
Almost any estuarine environment, including Long Island Sound.

## Notes

This diatom is unusual because some species produce domoic acid, a toxin that affects the nervous system. In excess, it can contaminate shellfish with a poison that gives human consumers amnesia. Ordinarily, it is an important food source to grazing zooplankton. Nutrient enrichment in the water can trigger massive blooms that become a problem when consumed by animals higher on the food chain, if the *Pseudonitzschia* are in a life stage when they emit domoic acid. Mussels, sea lions, and other animals have been poisoned in bloom conditions in other locations. This has not yet been a problem in Long Island Sound. Cell shape resembles *Rhizosolenia*, but *Pseudonitzschia* is much smaller. Also resembles *Bacillaria* in its movement.

## *Rhizosolenia setigera* Brightwell 1958

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

Very long, straight and slender cylinder or tube, tapering at both ends to a point, looking like a pencil sharpened at both ends in this view. Clear color with many small golden chloroplasts. There are often stacked girdle band segments. The length to width ratio may be as high as 20:1.

### Size

4-25 µm diameter; spines 30-50 µm; may be 100-725 µm long not including the spine. Spine length varies.

### When/where to Find It

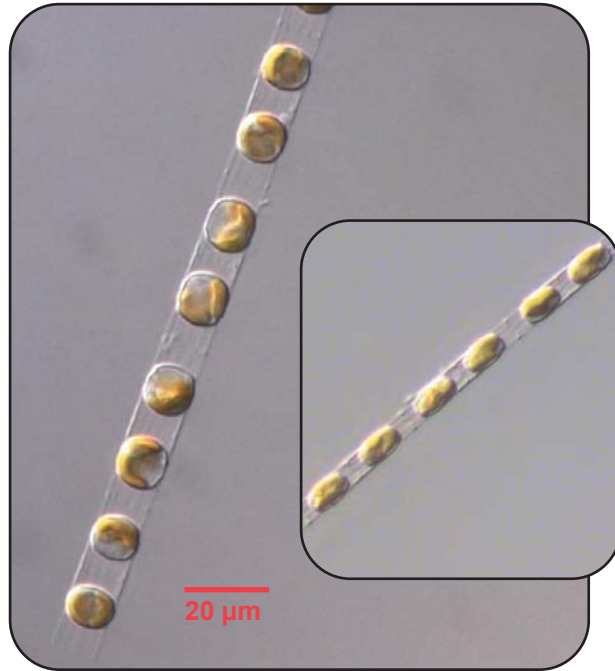
Found in Long Island Sound and marine waters worldwide; tolerates a very wide range of salinities and temperatures.

### Notes

These rather long, skinny diatoms cluster together by overlapping one end against the next individual. It's very common for large colonies to move together, overlapping ends against one another so that they look like a rippling ribbon. How and why? Perhaps we'll know the answers someday. In a bloom situation with individuals, they may look like someone dropped a box of crystal toothpicks rather than the ribbon. Compare with *Pseudonitzschia*.

## *Skeletonema* sp. Greville 1865

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Oval to squarish shaped yellow-brown cells in a chain with multiple connecting filaments in between, and long spaces between cells. The inset shows a different cell shape, to give you an idea of the variations possible.

## Size

2-21 μm width of individual cell

## When/where to Find It

Most abundant in the spring and to a lesser extent in the fall, but present year round. Found everywhere in Long Island Sound. Also worldwide except for polar regions.

## Notes

Sometimes predators slurp up the whole chain like a strand of spaghetti. Ever since the 1950s, *Skeletonema costatum* was considered to be the most abundant diatom in Long Island Sound. However, recent studies show that a large complex of *Skeletonema* diatoms reported as *costatum* species over the years were actually several separate species. In any case, we have here *Skeletonema*, a common primary producer that is a critical component of the Sound's food web.

## *Striatella unipunctata* (Lyngbye)

C.A. Agardh

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

From this side, or girdle view, square or rectangle shaped cells with numerous bands with delicate, narrow walls. There will be about 6-10 bands in a 10 µm measurement. It may look like the corner tips have been broken off of the “square.” Cells form chains or “ribbons.” From the valve view, it is shaped like a bay leaf, or a lance head; that is, thicker in the center and roundly tapered at both ends.

### Size

35-130 µm lengthwise; 6-20 µm wide

### When/where to Find It

Boreal to temperate marine species; found in Long Island Sound, Narragansett Bay, Nova Scotia and other parts of the North Atlantic; European, South American, and Australian waters. January is a time when it may be abundant. It's found both at the surface and at the bottom.

### Notes

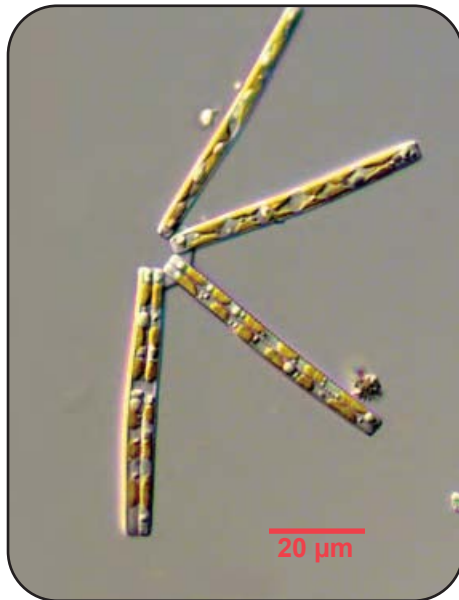
This species is often found on rocks or on seaweeds such as sea lettuce and *Ceramium*. It prefers salinities above 10 ppt. Some researchers think it is a good indicator of highly eutrophic waters—that means it will bloom where there is excessive nitrogen in the water.

## *Thalassionema frauenfeldii*

(Grunow) Hallegraeff 1986

Alternate name: *Thalassiothrix frauenfeldii*

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Zig-zag like a carpenter's folding ruler, or joined radially from one end, like a star; golden brown pigment.

## Size

54-200 µm on axis

## Where/when to Find It

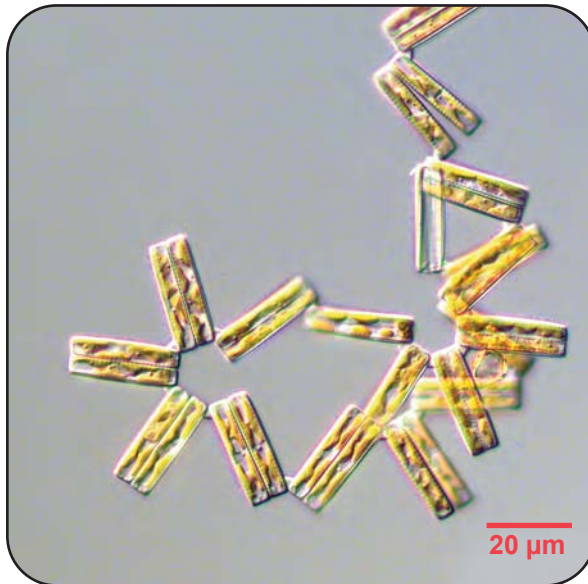
Marine, warm to temperate waters. Found in Long Island Sound in late spring and early summer. Also seen in Narragansett Bay, Brazil, and the Adriatic Sea.

## Notes

In 1986, this species was reclassified by transfer from the genus *Thalassiothrix* to *Thalassionema*. The two are very similar and belong to the same family. Both have long needle-shaped straight cells. Differences in the small depressions (pores) along the edges and whether or not there are spines on the margins are used to tell which is which. These tiny details are best seen with a scanning electron microscope. You may find it cited as either name.

*Thalassionema nitzschioides* (Grunow)  
Van Heurck 1862

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Rectangular in side (“girdle”) view; needle- or lance-shaped linear cells in valve view. The cells may typically stack and/or join at one end in a radial fan arrangement as seen here, which may remind you of a chicken’s foot, or a folding carpenter’s ruler, if opposite ends and sides attach.

## Size

10-100 μm along the long axis

## When to Find It

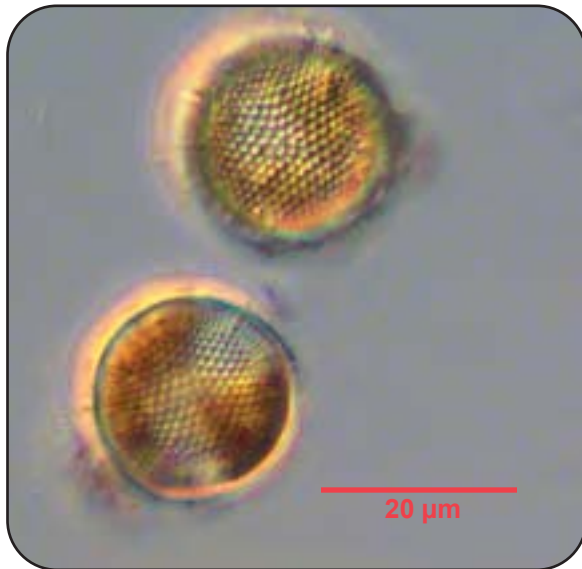
Prefers warmer waters. Found around the world except in polar regions; everywhere in Long Island Sound.

## Notes

Older names (no longer accepted): *Synedra nitzschioides* Grunow; *Thalassiothrix nitzschioides* (Grunow) Grunow in Van Heurck 1862. The prefix “Thalassio-” means “sea”.

## *Thalassiosira* sp. Cleve, 1873

Class Bacillariophyceae



J. Li/NMFS Milford

### Type

Diatom

### What it Looks Like

Circular viewed from “top” or “bottom”; actually shaped like a drum or hat box. Specimens can vary in size just as there are very large and very small people.

### Size

Depends on species, typically about 20 µm diameter

### Where/when to Find It

Just about everywhere

### Notes

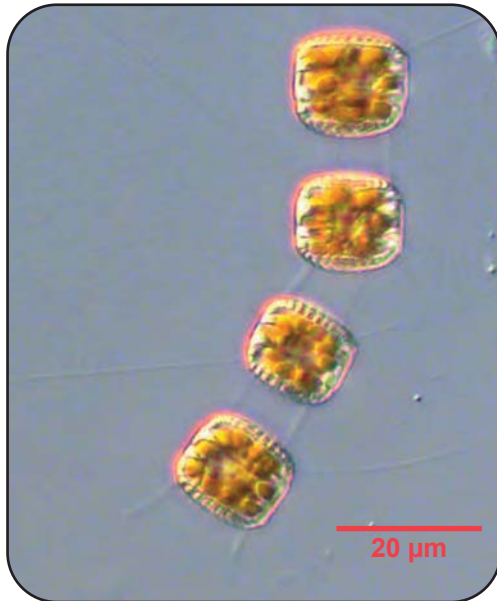
We could not identify this specimen to species level, since we have only the top valve view and not the side (girdle) view, but it is clearly in the genus *Thalassiosira*. Compare this specimen with *T. pseudonana*. It is much larger in size. General characteristics of *Thalassiosira* include chains that can be held together by chitin threads or cells embedded in mucilage, small spines, radial symmetry, and lots of small holes in the valves. Chitin is the same substance that forms lobster and crab shells.



## *Thalassiosira auguste-lineata*

(A.Schmidt) G.Fryxell & Hasle 1977

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Cells have rounded corners; although it is hard to make out here, there are hairs coming out from each corner. The key to the species identification is the ring of multiple connecting threads between cells. A similar species, *T. nordenskiöldii*, has only a single connector between cells in the chain.

## Size

14-78 μm diameter

## Where to Find It

Cool waters of the Sound; northern locations such as the waters of New England, Nova Scotia, the Labrador Sea, United Kingdom and Germany.

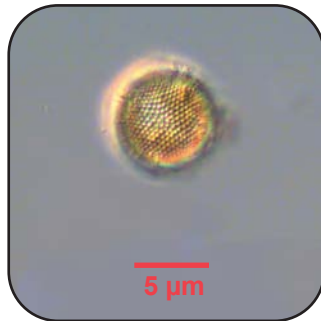
## Notes

Research sampling both historical and recent shows that *Thalassiosira* and *Skeletonema* are the two most abundant phytoplankton genera in the Sound, considering all seasons.

*Thalassiosira pseudonana* Hasle & Heimdal 1970

Alternate name: *Cyclotella nana* Guillard

Class Bacillariophyceae



J. Li/NMFS Milford

## Type

Diatom

## What it Looks Like

Circular viewed from “top” or “bottom”; cylindrical from side or “girdle view.” There is always variation in the size range—just as there are extraordinarily large and small people.

## Size

typically 4-5 µm diameter

## Where to Find It

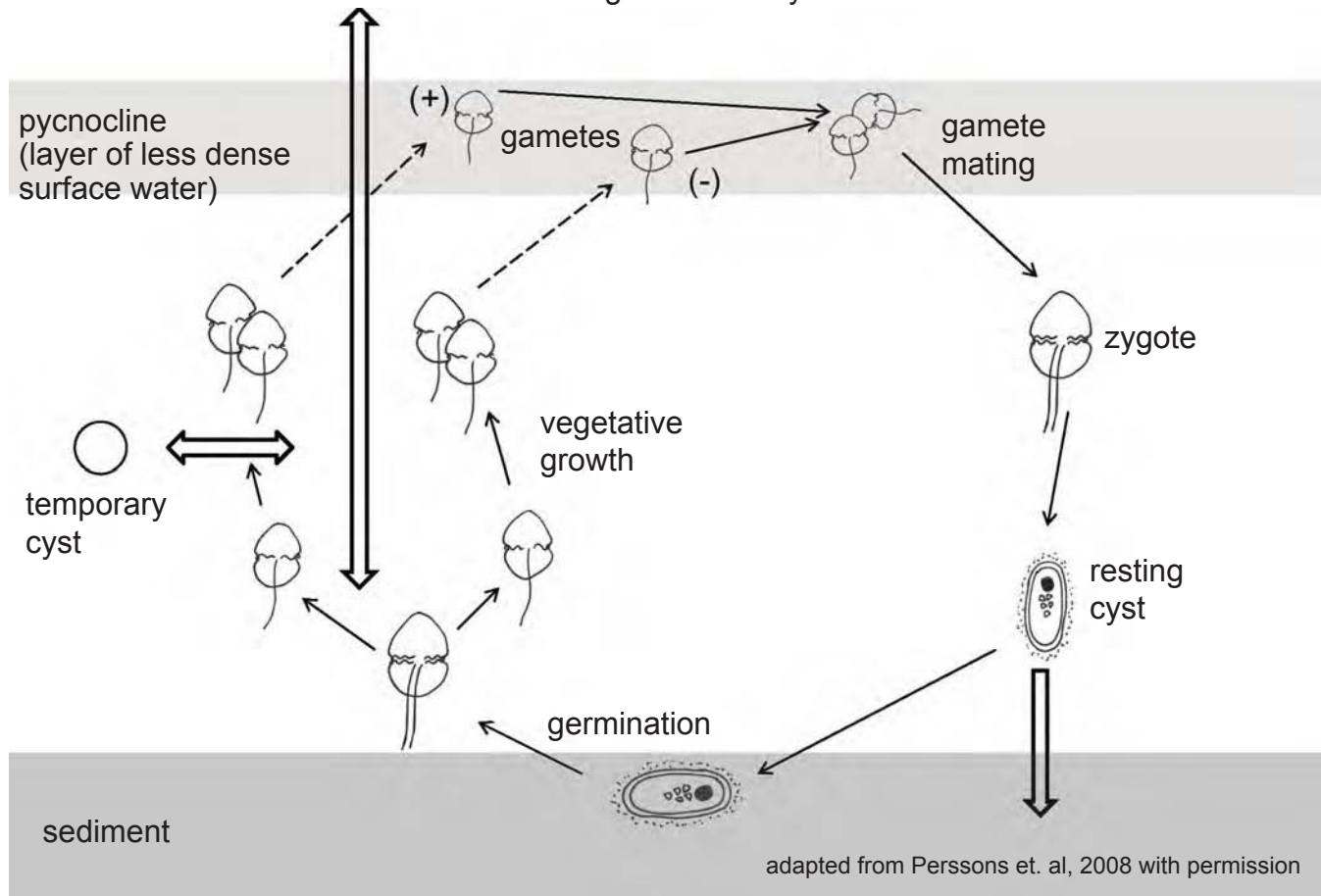
Found in both marine and freshwater; Long Island Sound and Northwest Atlantic, Gulf of Mexico, Alaskan coast, Belgium, Finland, Germany, UK, and Spain

## Notes

This species was the first diatom to have its complete genome sequenced, and serves as a model diatom for genetic and evolution studies. The clone was originally collected in Moriches Bay, Long Island. The species was originally described from a tidally-influenced river in Germany in 1957. It may have potential to mitigate effects of climate change because of its biological role in pumping carbon in the ocean.

# Dinoflagellates, Silicoflagellates, and other Flagellated Phytoplankton

## Dinoflagellate Life Cycle

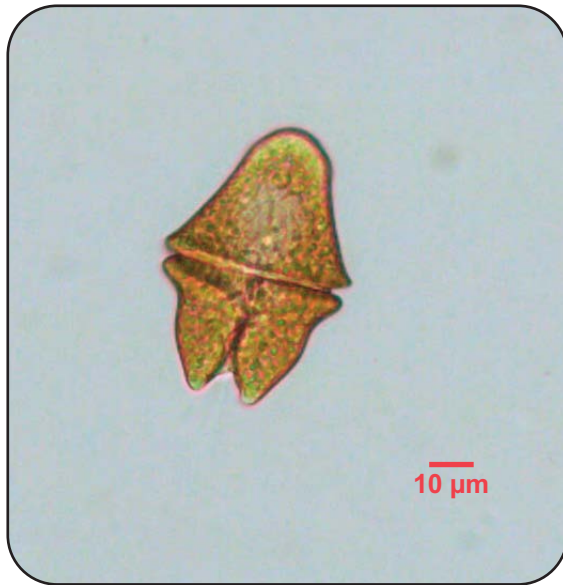


*Akashiwo sanguinea* (K.Hirasaka)

G. Hansen & Ø.Moestrup 2000

Alternate (older) name: *Gymnodinium sanguineum*.

Class: Dinophyceae



H. Skelton/UConn, Dam Lab

## Type

Dinoflagellate

## What it Looks Like

Reddish gold to brick color, not armored with cellulose plates. Looks like a golden human tooth. Cone shaped on one end; two lobes on the other—the rounded end shape has been described as a “Smurf cap” or mushroom cap. Has a deep groove around the middle and two flagella (“tails”), too faint to see here.

## Size

40-80 μm long

## When/where to Find It

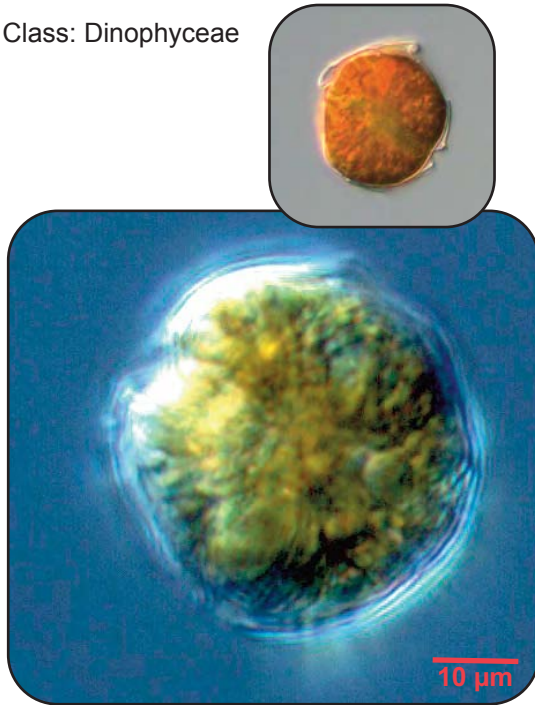
Warm estuary and coastal marine waters in the late summer to early fall. Besides LIS, it's been reported in the Pacific and South America. It really gets around the world.

## Notes

Once thought to be harmful, no toxin has been found in this species. In other locations, it is often found mixed with other toxic dinoflagellates in harmful algal blooms called “red tides” when it proliferates, usually in late summer to early fall. Red tides occur in New England but have not happened in Long Island Sound except for a few small local incidents. Sanguineum comes from Latin for “blood-red” and refers to its ruddy color from its red accessory pigments.

*Alexandrium fundyense* Balech  
1985

Class: Dinophyceae



Top: G. Wikfors, NMFS Milford  
Bottom: S. Lin/UConn

## Type

Dinoflagellate

## What it Looks Like

It's rounded like a ball but with a groove that is displaced on one half; rounded or slightly angled on one end. No horns or spines. The outer "house" is cellulose and structured as small plates that fit together like puzzle pieces. Two flagella are present, but they may be difficult or impossible to see with a light microscope. One flagella or "tail" fits in the groove around the middle and the other extends outward. Big photo is a live cell; inset clearly shows red pigment and morphology.

## Size

27-50  $\mu\text{m}$ ; it's about as wide as it is long.

## When/where to find It

Summer.

Found from the Bay of Fundy to Long Island Sound.

## Notes

This species, in excess, can cause red tides, a type of harmful algal bloom. It contains a toxin that poisons fish and shellfish, and can make humans sick with paralytic shellfish poisoning. In summer 2005, a massive bloom of this species occurred in New England from Maine to Martha's Vineyard, Mass. It closed fisheries along the coast, but stopped short of Long Island Sound. In recent years, red tide blooms composed mainly of this species reached the north shore of Long Island. Scientists are studying the ability of zooplankton grazers to control them.

*Ceratium furca* (Ehrenberg)

Claparède & Lachmann 1859

Alternate name: *Neoceratium furca*

Class: Dinophyceae



NOAA PMN

## Type

Dinoflagellate

## What it Looks Like

Robust central body that tapers to a long pointed horn on top. There is a groove around the middle, and two horns like “legs” on the bottom. One horn of the two “legs” is usually shorter than the other. Brownish-yellow color.

## Size

70-200 µm long, 30-50 µm wide

## When/where to Find It

Warm estuaries, July to September in Long Island Sound. Not frequent. Also elsewhere in the Atlantic Ocean.

## Notes

*C. furca* has been implicated in red tide blooms in Japan and elsewhere. It is sometimes seen in samples collected from Long Island Sound, but has not caused any massive bloom problems. It is photosynthetic but also capable of ingesting protozoans, so a heterotroph. Whether *Ceratium* will increase in abundance in Long Island Sound with warmer temperatures of longer duration remains to be seen. The horns are extensions of the body and may be hollow or partly solid in some places.

Similar species: *Ceratium lineatum*.



## *Ceratium tripos* (O.F. Müller)

Nitzsch 1817

Class: Dinophyceae



MyFWC

## Type

Dinoflagellate

## What it Looks Like

The marine species have a hard coating of five plates, like armor. The body has a nearly triangular shape with a long, straight narrow spine at one angle, and two opposite spines curving downward like a water buffalo's horns in the same direction at the other two angles. There are two flagella.

## Size

Rather large in comparison to other dinoflagellates; 100-200 μm long including long spine and 70-90 μm wide.

## When/where to find It

Summer, tolerates wide temperature and salinity variation; coast and ocean; worldwide

## Notes

While relatively harmless and a source of nutrition to larger organisms, this species can cause red tide if found in great abundance. It is a mixotroph, obtaining its food through both photosynthesis and consuming detritus and bacteria. Some species of the genus are bioluminescent, glowing with a soft blue light. A similar species, *Ceratium longipes*, has even longer "horns." Differences have been noted between freshwater *Ceratium* and marine, so the marine *Ceratium* species may be renamed *Neoceratium* in the future.

*Cochlodinium polykrikoides* Margalef  
1961

Class: Dinophyceae



J. Li/NMFS Milford

## Type

Dinoflagellate

## What it Looks Like

Not armored, spiral shaped body with yellow-green to brownish chloroplasts.

## Size

30-40 μm long, 20-30 μm wide

## When/where to Find It

Warm surface waters worldwide, July to September in Long Island Sound; concentrations decline after that.

## Notes

This is another harmful red tide species that has caused fish kills in Japan. While blooms have not been reported in the Sound so far, there was a late summer bloom in a cove in Narragansett Bay, Rhode Island in 1980. It was described as “large dark red patches.” In September to October, the bloom disappeared. Research at Stony Brook University, NY suggests that the presence of grazers may prompt chain formation, perhaps as a defense against predation. Interestingly, vitamin B also kept the predators away.

*Dinophysis acuminata* Claparède &  
Lachmann 1859

Class: Dinophyceae



G. Wikfors, NMFS Milford

## Type

Dinoflagellate

## What it Looks Like

Gently curving oval sides; resembles a little water pitcher with a handle and a frilly rim or “collar” on the top. The surface has many tiny pores. Although it looks like a vase with candy or a lovely little bag of jewels here, it’s no treasure. See notes below.

## Size

Length 40-50 μm, width 20-35 μm

## When to Find It

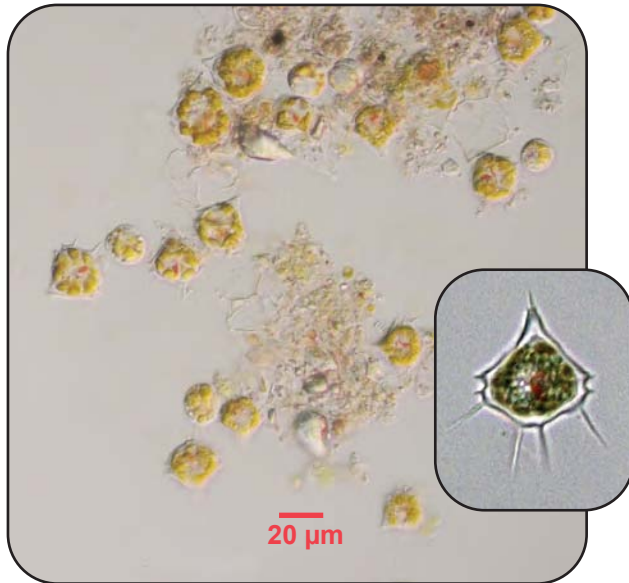
Summer

## Notes

Although it looks pretty, this species can be a problem. Species of *Dinophysis* may produce okadaic acid and related toxins. These toxins are concentrated by filter-feeding bivalves (shellfish) and can cause diarrhetic shellfish poisoning (DSP) in humans. This species is a major concern in Europe and Japan, and several occurrences of *Dinophysis* have been reported for the East Coast of the U.S.A. Good news is that it has not caused problems in Long Island Sound to date.

## *Peridinium quinquecorne* Abé 1927

Class: Dinophyceae



### Type

Dinoflagellate

### What it Looks Like

This species is surrounded by a thick wall of 35 scale-like plates. One end is pointed and the other rounded, shaped sort of like a pear with a pointy top and spines. A cone shape atop a half sphere would also describe it. There are 4 stiff spines. Often in loose groups.

### Size

25-30 µm long; 20-25 wide. There is some variation.

### When/where to Find It

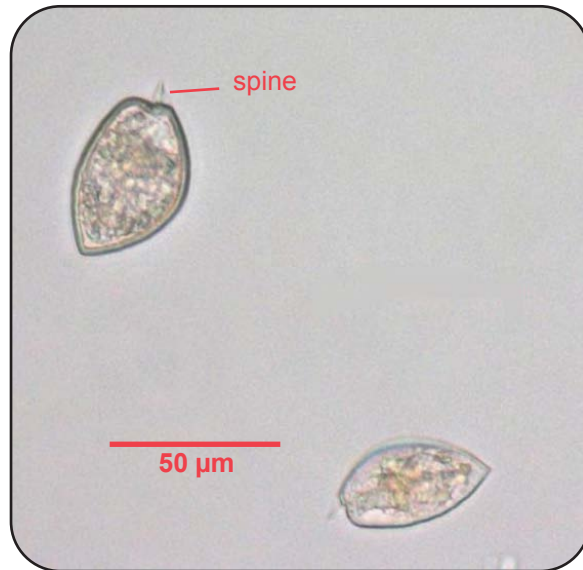
Found mostly in the summer in Long Island Sound, prefers brackish to low salinity water and warm temperatures. Also found in the waters off of the Caribbean Islands, Brazil, Japan, and Mexico.

### Notes

This species contains a round diatom endosymbiont (an organism that lives inside another but does not harm it). In excess, it can cause red tide, a harmful algal bloom; there was one in the Gulf of California in 2003. Scientists measured 4 million cells per liter of water! It has a hook-shaped eyespot that can be seen with a really powerful microscope.

## *Prorocentrum micans* Ehrenberg 1833

Class: Dinophyceae



G. Wikfors/NMFS Millford

## Type

Dinoflagellate

## What it Looks Like

They are shaped like a small leaf, or a heart; curved outward and broadest in the middle, but pointed at just one end. The opposite end has a small spine, resembling the stem of a leaf, about 10  $\mu\text{m}$  long. One side of the body may be more curved than the other. Flattened if viewed from the side.

## Size

35-60  $\mu\text{m}$  long; 15-50  $\mu\text{m}$  wide.

## When/where to Find It

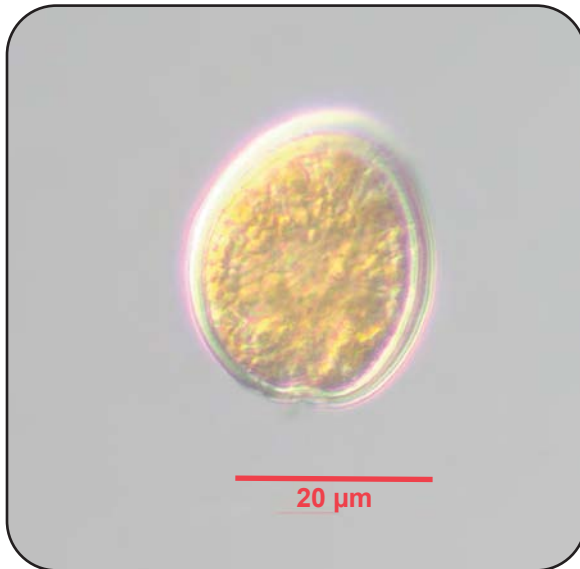
Common. Tolerates high salinity and a wide range of temperatures from cool to tropical. Found in estuaries including Long Island Sound and ocean environments all over the world, even in salty lagoons. Peak abundance is in summer.

## Notes

This species is capable of forming blooms but is usually found in small numbers, harmless, and not toxic. A massive bloom could cause oxygen depletion by means of the bacteria that decompose the algae when it dies. However, that would be a rare event and has not happened in Long Island Sound. Some other species of this genus *are* toxic.

*Prorocentrum minimum* (Pavillard)  
Schiller 1933

Class: Dinophyceae



J. Li/NMFS Milford

## Type

Dinoflagellate

## What it Looks Like

This little species has quite a few variations on shape. It may be shaped like a pumpkin seed, a heart, teardrop, oval, or an egg—or even a rounded triangle. There should be a very small spine projecting from one end, though that is not visible in this photo and frequently is not visible.

## Size

14-22 μm long

## When/where to Find It

Mostly lives in temperate estuaries such as Long Island Sound, and is found worldwide. In summer, it may become dominant in the western Sound.

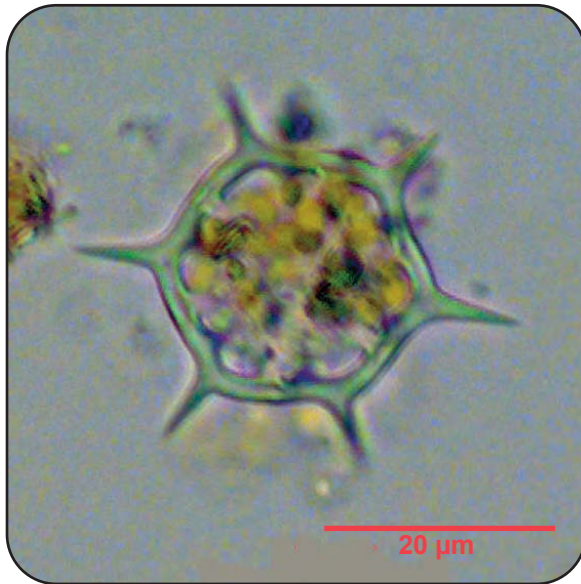
## Notes

Its small size is reflected in its species name, minimum. It is usually seen as single cells in a mix of phytoplankton. However, despite its small size, it can form toxic blooms when a bloom occurs and has caused both fish kills and shellfish poisoning. Populations increase after diatoms decline in the summer.

*Distephanus speculum* (Ehrenberg)

Haeckel 1887

Class Dictyochophyceae



J. Li/NMFS Milford

## Type

Silicoflagellate

## What it Looks Like

Six-sided opal-like silica skeleton, with spines projecting from each corner. There may also be projections that go inward, which may join to form a ring. Faint pseudopodia may project from the tops of the spines. Only one flagellum.

## Size

About 18-20 μm diameter without spines

## When/where to Find It

Anywhere in the Sound

## Notes

The name is Latin for “mirror”. It may cause harmful algal blooms that cause fish kills when they decompose, which have been linked to anoxia (lack of oxygen), but there have been no such events in Long Island Sound.



## *Pyramimonas* sp. Butcher 1959

Class Prasinophyceae



J. Li/NMFS Milford

### Type

Prasinophyte

### What it Looks Like

Very tiny green or yellow-green alga. It has a single cup-shaped chloroplast. Shape is broad at one end and pointed at the other, like a pyramid, but sides are rounded. It usually has four flagella and a single eyespot, but specimens with 8 or 16 flagella and two eyespots have been reported.

### Size

about 4–18 μm

### When/where to Find It

Besides the Sound, this species is found in other coastal Atlantic locations, the Arctic, Pacific Ocean, and Mediterranean Sea.

### Notes

This is an example of prasinophytes, really tiny green algae. The green is from chlorophyll. They are usually found near the surface where there is ample light. Their cell structure is very simple and they are thought to be the smallest group of cells with true nuclei. Two flagella are quite visible in this photo. They could be mistaken for antennae if one didn't know better. Species are distinguished on the basis of various types of scales, but these cannot be seen with a light microscope.



## *Ebria tripartita* (Schumann)

Lemmermann 1899

Class Ebriophyceae\*



J. Li/NMFS Milford

## Type

Protozoan\* (\*it's difficult to place and so has been classified as a silicoflagellate, dinoflagellate, and even a radiolarian, before being placed in its own unique class.)

## What it Looks Like

It is very round in shape; it was once considered a dinoflagellate and indeed has two unequal “tails” (invisible here). It’s “naked” on the outside, but has a thick 3-part skeleton inside, composed of silica rods. It has a large nucleus. It’s a loner—usually found singly rather than in groups or chains.

## Size

25–40 μm

## Where/when to Find It

Besides the Sound, it’s found in many places worldwide, such as the Baltic Sea. It prefers temperatures anywhere from freezing to very warm, (23C) and salinity between 18 ppt and 38. While widespread, it’s not found frequently.

## Notes

“Ebria” means “drunken” in Spanish, and describes the erratic, wobbly way they move about in the water. This tiny species is phagrophic, a fancy term that means it can surround and consume other very small species or particles as food. It is known to feed voraciously on whole chains of diatoms such as *Skeletonema*.

## Resources for Further Investigation

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- Tomas, C.R. (ed.) 1993. *Marine Phytoplankton a guide to Naked Flagellates and Coccolithophorids*. Academic Press, Inc. San Diego, Calif. 263 pp.

**Our web sites:** The Long Island Sound Study <http://longislandsoundstudy.net>  
Connecticut Sea Grant <http://seagrant.uconn.edu>  
New York Sea Grant: <http://www.seagrant.sunysb.edu>  
National Marine Fisheries Service Milford Laboratory: <http://www.mi.nmfs.gov/>

**Volunteer to Monitor Phytoplankton:** NOAA, the National Oceanic and Atmospheric Administration, has a citizen volunteer phytoplankton monitoring program. With the training that the program provides, you could volunteer to collect and identify phytoplankton, and submit your data to their national database. To find out more, see <http://pmn.noaa.gov>.

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