

2003

Field Guide to Phytoplankton in the Gulf of Maine

Susan White
Maine Sea Grant

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A microscopic image of various phytoplankton species, including a large, circular, multi-segmented organism in the center, surrounded by numerous smaller, diverse cells and structures. The image is in grayscale, highlighting the intricate details of the organisms.

Field Guide to Phytoplankton

In the Gulf of Maine

Introduction

This field guide was created for the citizen volunteers who provide a first-alert system to the Maine Department of Marine Resources by watching for the presence of potentially toxic phytoplankton along Maine's coast. These volunteers are participants in the Maine Phytoplankton Monitoring Program. All who share in the wonder of life's diversity may enjoy using this guide to marine phytoplankton in the Gulf of Maine.

Phytoplankton are a critical component not only of the ocean food web, but also of the earth and its systems. These organisms have been cited as influencing ocean and atmospheric temperatures, populations of other species, and human economies at the local level.

Images in this guide are at 200 or 400 power in order to best represent what the volunteers see through their light microscopes. At this magnification, most phytoplankton are identifiable only to genus, as indicated in the text. The majority of images are of wild samples, but a few are of cultured cells and, therefore, their morphology may vary slightly from what you will find. Many of the technical words used in the text are defined in the glossary.

This guide is not intended to be comprehensive. Be aware that you may find organisms not described herein. You may even discover new species!

Acknowledgements

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Sarah Gladu, 2003

Maine Phytoplankton Monitoring Program Coordinator

University of Maine Cooperative Extension/Maine Sea Grant

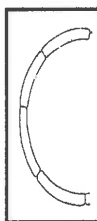
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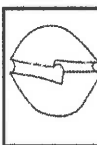
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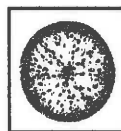
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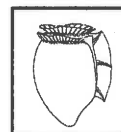
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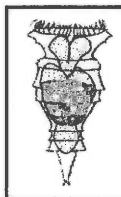
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*These cells may chain

♦These cells can produce biotoxins



Chaetoceros

Abbreviation: **CH**

Chaetoceros socialis, mass of cells in lower left of photograph

Girdle view: Cells rectangular with slightly rounded corners

Valve view: Cells elliptical to oval; surface may be flat, convex or concave

Size: 6 - 33 μm high; 6 - 53 μm diameter

Identifying characteristics: Four setae (the length varies from species to species) extend from each cell (generally one from each corner in the girdle view); cells usually in chains joined by overlapping of the setae which extend from each valve; chains can be straight, irregularly bent, or spiraled

Natural history: Diatom; often creates bloom conditions; some species form resting spores while others do not; largest genus of neritic (zone from low tide area to 100 fathoms) phytoplankton

Easy to confuse with: *Thalassiosira* (cells barrel shaped, lack the obvious setae, and not tightly linked); *Skeletonema* (cells joined by stiff silica rods)

Impacts: In bloom conditions setae can irritate fish gills and permit bacteria to enter the abrasions. The fish create a thick mucus which interferes with gill function, sickening or killing them. These events are particularly hazardous for penned fish.



Images of Cultured Cells

Melosira

Abbreviation: **ML**

Girdle view: Cells broad cylinders closely linked in straight chains by a ring of irregular spines (which may be difficult to see) at the valve apex; convex valve

Valve view: Not generally seen in this view, due to orientation of cells in chains

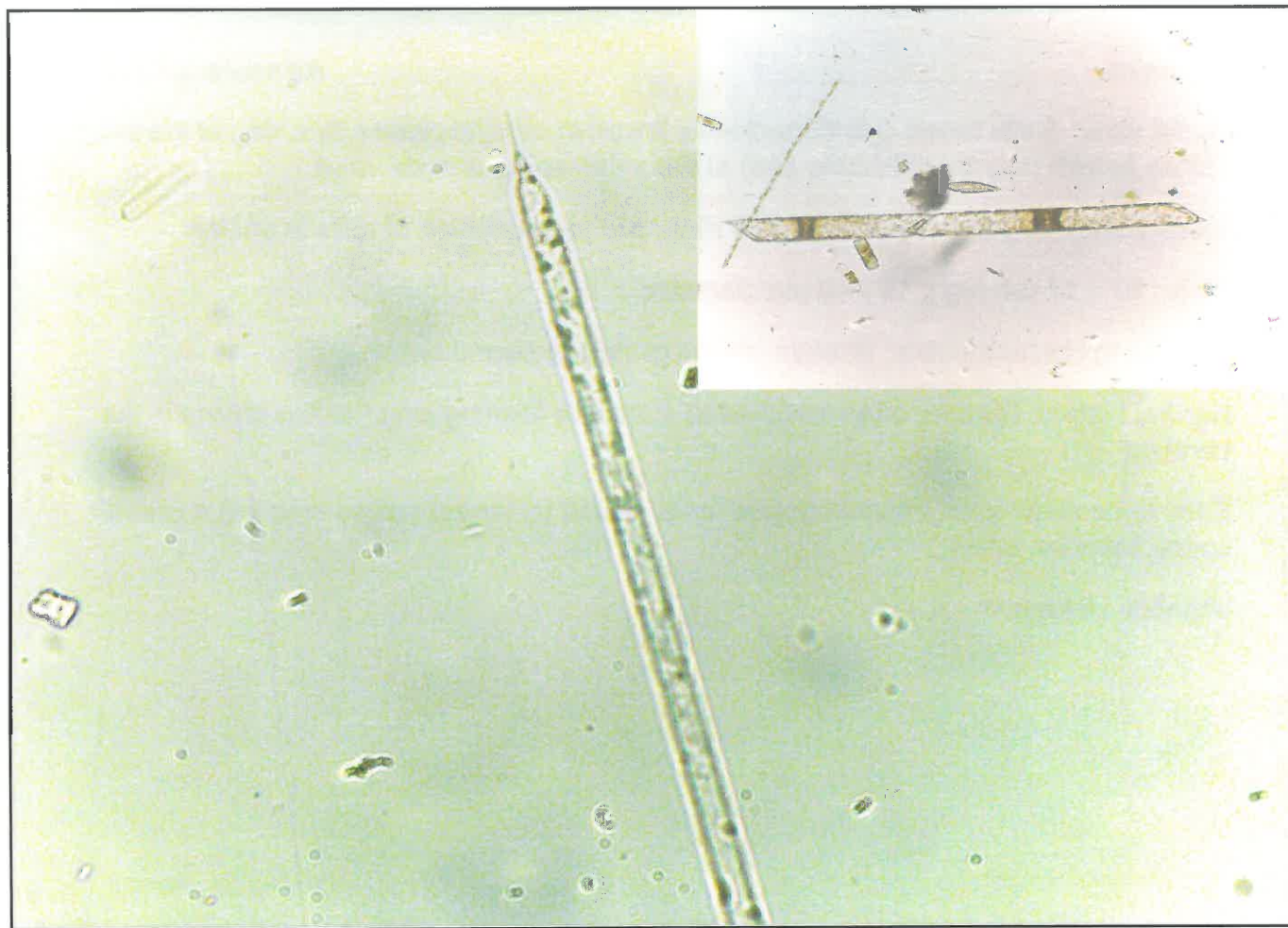
Size: 10 - 17 μm high; 10 - 40 μm diameter

Identifying characteristics: Straight chains of closely bound cells

Natural history: Diatom; often attaches to substrate forming long flexible chains in the benthos

Easy to confuse with: *Stephanopyxis* (cells bound by longer spines creating a greater space between cells)

Impacts: Unknown



Rhizosolenia

Abbreviation: **RH**

Girdle view: Cells generally cylindrical, with tapered ends and a needle-like spine; spines coarse to fine; cell height at least three times the diameter; chains straight to slightly curved, formed by spines fitting into pockets of adjacent cells

Valve view: Cells circular, oval to elliptical, or conical with a spine on the end; rarely seen in valve view due to length of cells

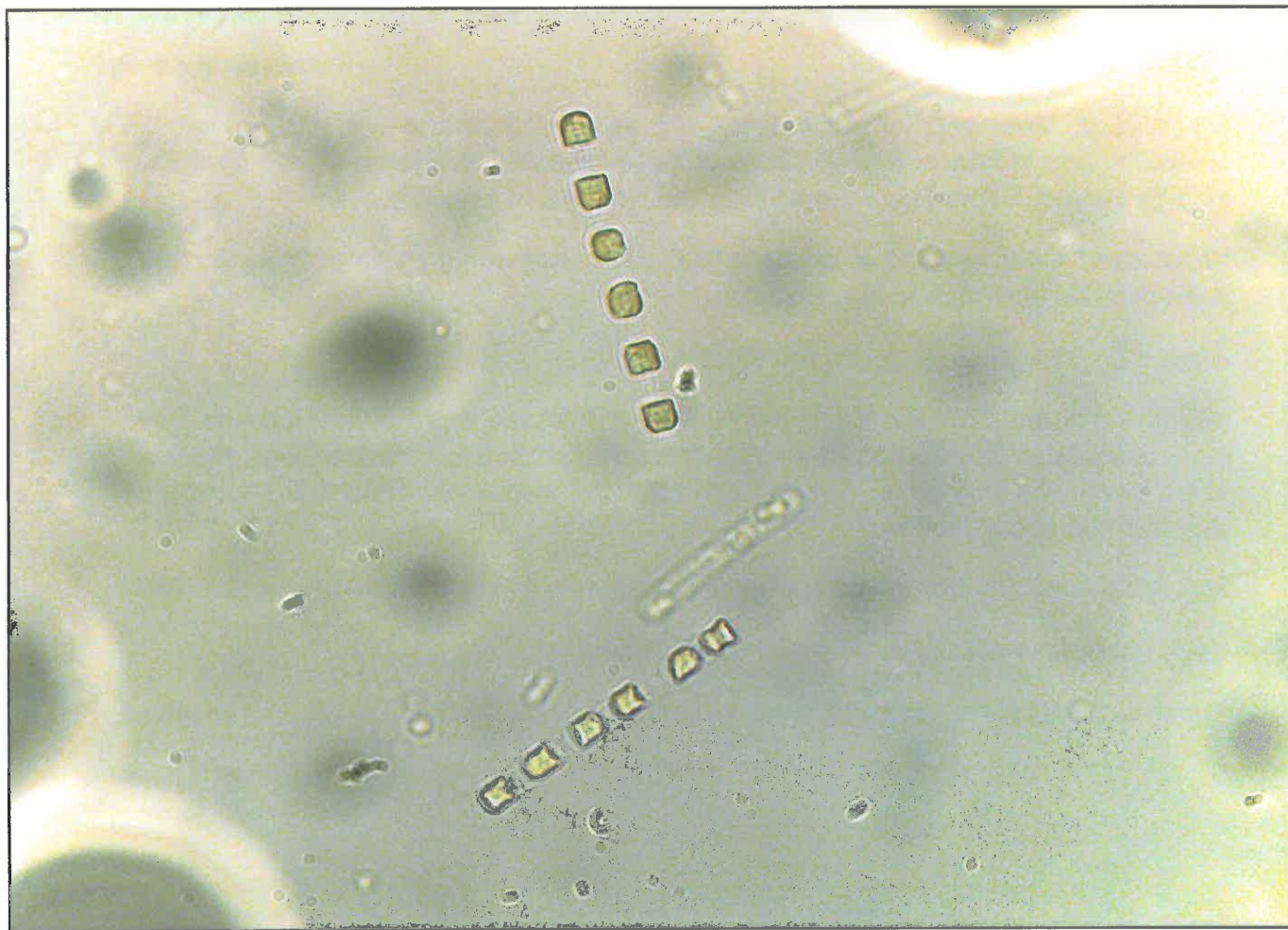
Size: 25 - 130 μm high; 5 - 30 μm diameter

Identifying characteristics: Cells shaped like a quill pen; one spine emanates from each valve face (spines can be central or located more towards one side); tapered valve face; cells may be so closely bound that the spines are difficult to see; spines delicate and easily broken

Natural history: Diatom; generally seen as chains but may be found as single cells

Easy to confuse with: *Pseudo-nitzschia* (lack spines)

Impacts: Blooms are reported to have caused salmon mortality in British Columbia.



Skeletonema

Abbreviation: **SK**

Girdle view: Cells small and cylindrical, joined into chains by a series of parallel silica rods connecting adjacent valves; length of rods varies and may be longer than the cells themselves

Valve view: Cells circular, flat to convex; spines emerge from valve edge

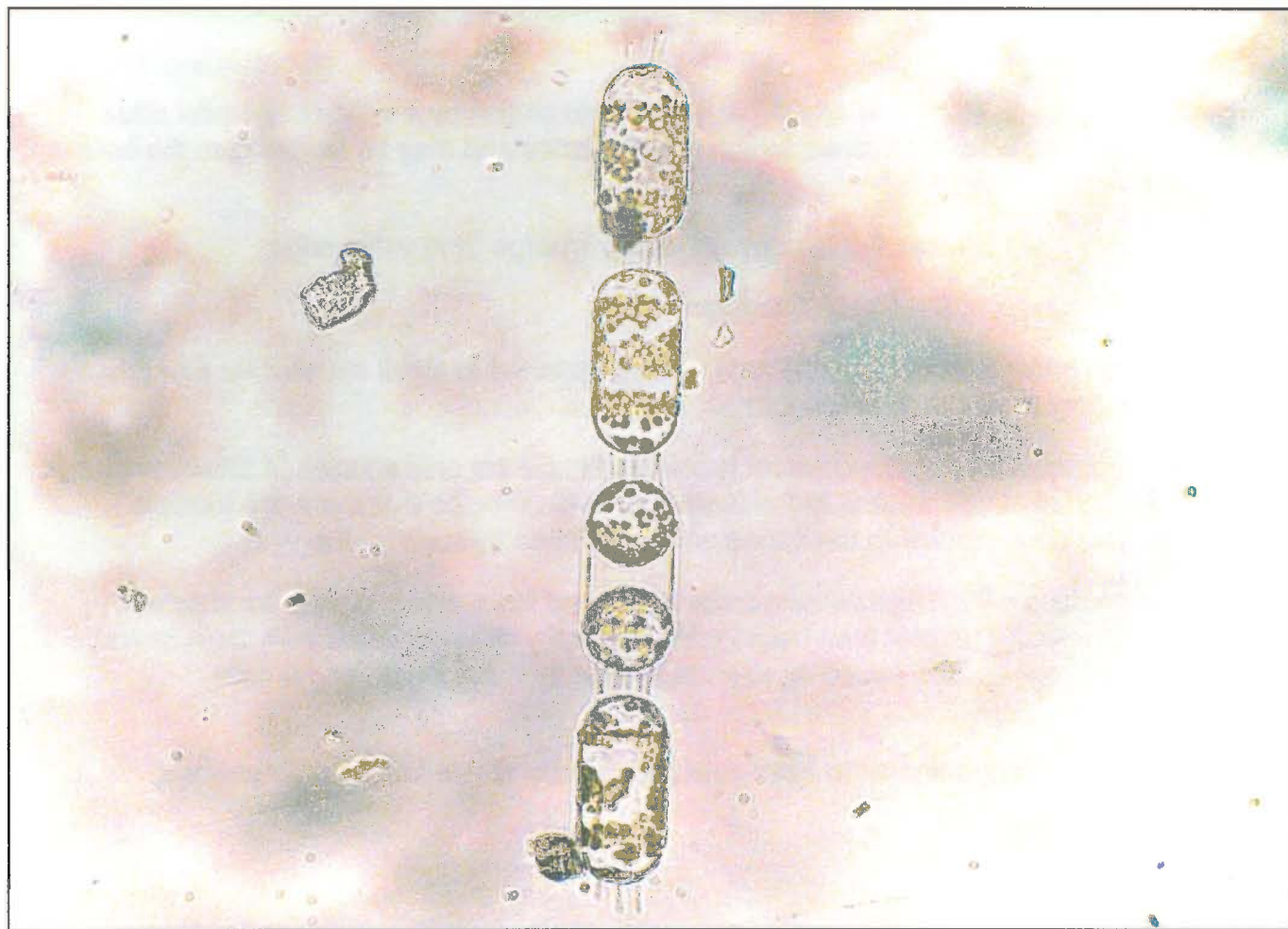
Size: 5 - 28 μm high; 5 - 13 μm diameter

Identifying characteristics: Parallel rods (tubes) attached to small cylindrical cells; tubes are commonly longer than cell length

Natural history: Diatom; *S. costatum* is believed to be the only species of *Skeletonema* found in Gulf of Maine waters, but at least one study showed that there are multiple subspecies; often blooms in the spring and is common throughout the year

Easy to confuse with: *Thalassiosira* (cells larger and have an obvious drum shape, diameter generally greater than height); *Stephanophyxis* (cells larger with stout, round, or cylindrical cell bodies joined by strands shorter than the length of the cells themselves)

Impacts: Blooms are known to have caused mortality at fish farms in Norway and Scotland.



Stephanopyxis

Abbreviation: **ST**

Girdle view: Large cylindrical cells with heavily sculptured surfaces and visible girdles; convex valve

Valve view: Cells round with convex surface

Size: 4 - 90 μm high; 20 - 60 μm diameter

Identifying characteristics: Large cells; thick cell walls; short, thick connecting silica rods; multiple chloroplasts in each cell

Natural history: Diatom; some species have resting spores; note the cell division visible in the photograph (the two round cells where one has divided)

Easy to confuse with: *Skeletonema* (smaller cells; connecting silica rods much smaller and thinner; only one chloroplast per cell)

Impacts: Unknown



Thalassiosira

Abbreviation: **TL**

Girdle view: Cells rectangular or barrel-shaped; some species octagonal in this view

Valve view: Cells round with small processes visible on the valve surface (very difficult to see), from which thin mucus threads may extend; in this view, chromatophores form a tight cluster in the center of the valve

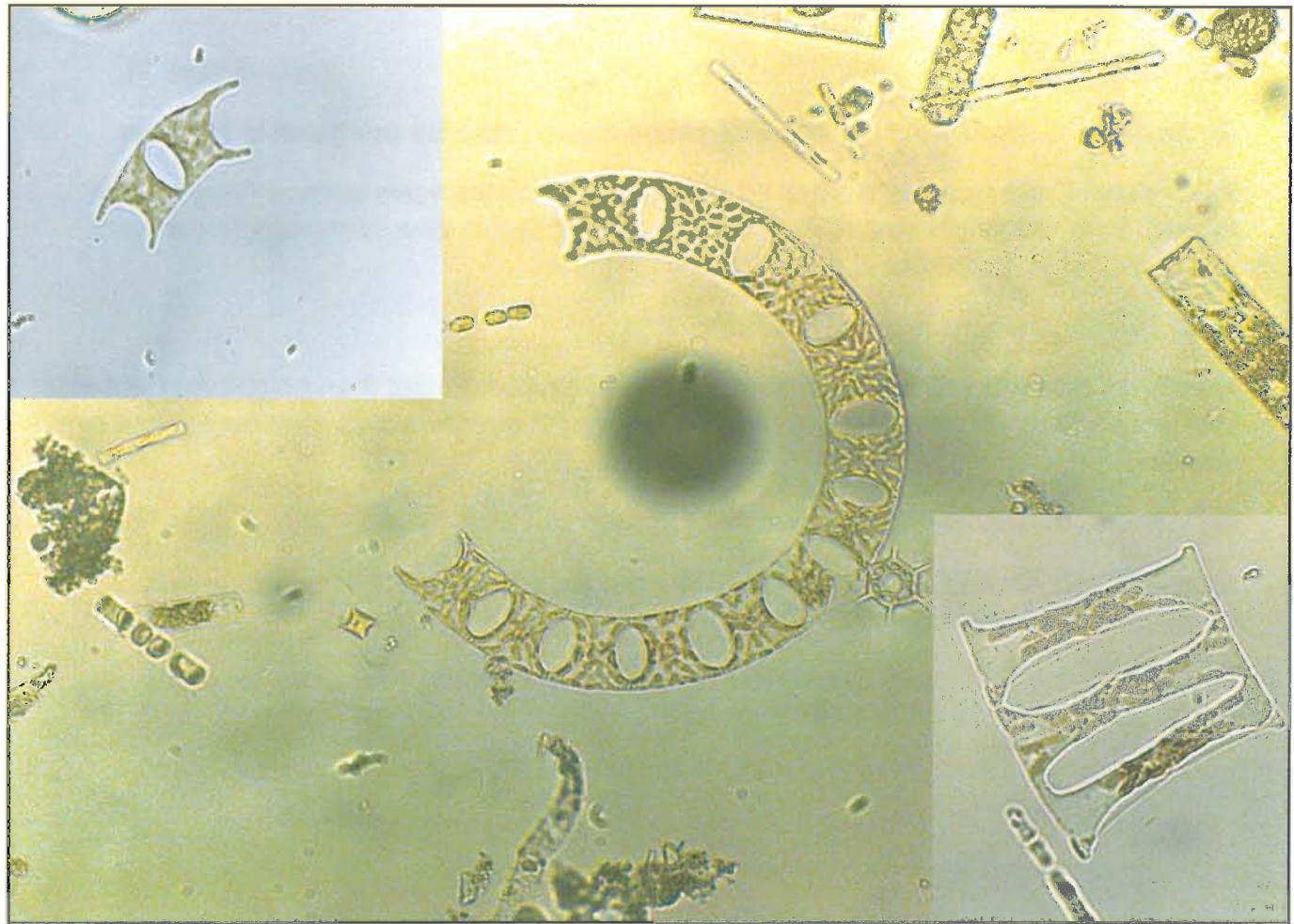
Size: 16 - 70 μm high; 3 - 6 μm diameter

Identifying characteristics: Cells drum-shaped (diameter greater than height) and joined into loose chains by gelatinous strand or pads (length and thickness of strand varies by species)

Natural history: Diatom; cells occasionally single

Easy to confuse with: *Skeletonema* (cells smaller); *Coscinodiscus* (generally cells larger and not in chains)

Impacts: Some species of *Thalassiosira* have caused mechanical damage to fish (gills), copepods, and other invertebrates.



Eucampia

Abbreviation: **EU**

Girdle view: Valve face concave with wide apertures (some apertures are tall); cells joined by pairs of horns; cells form short, curved, or flattened, spring-like spirals

Valve view: Valve face convex or flat in this view

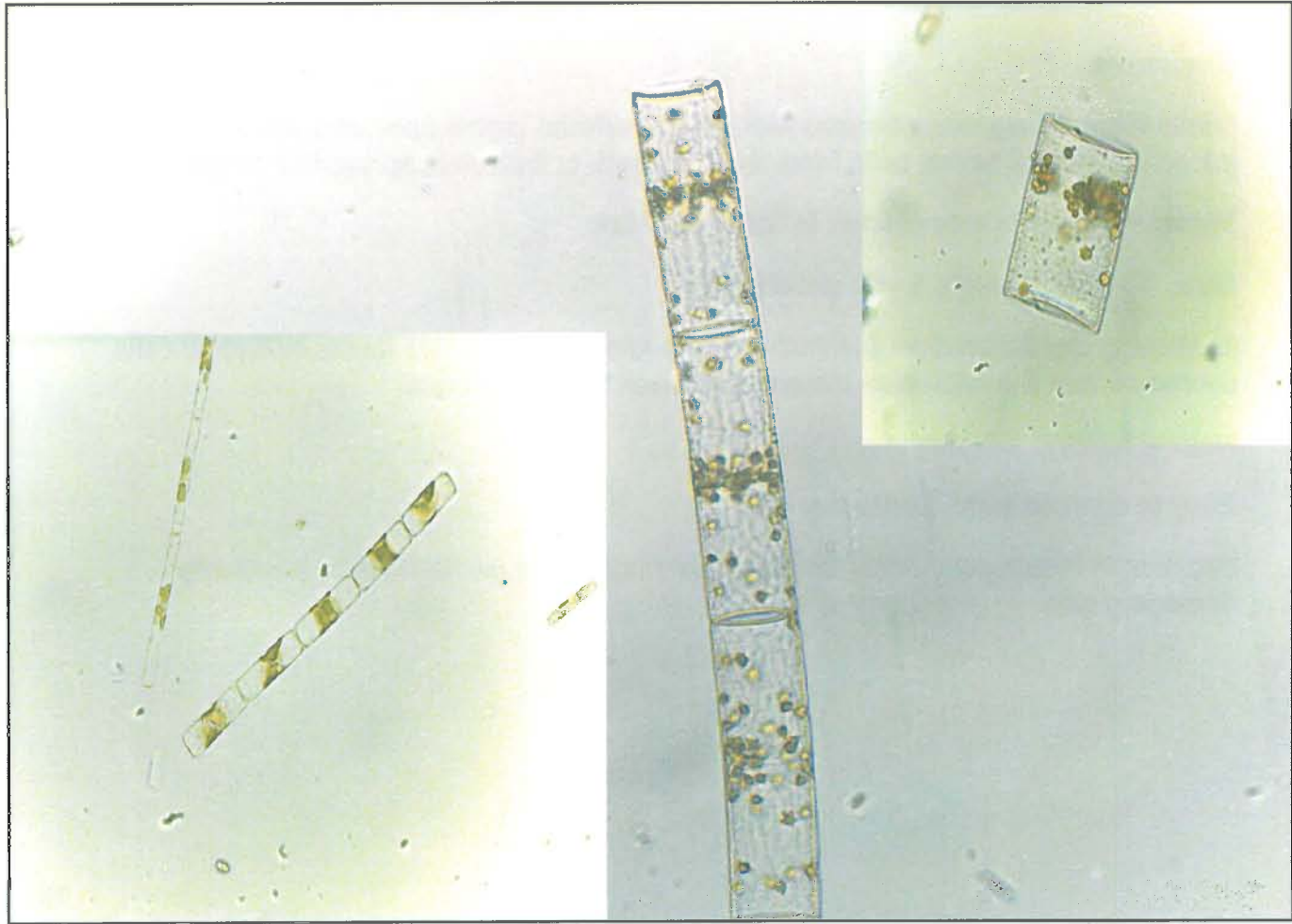
Size: 18 - 80 μm high; 6 - 63 μm diameter

Identifying characteristics: Distinctive horns and concave valve faces; individual cells curved so that the intervalve distances of each cell are unequal

Natural history: Diatom

Easy to confuse with: Distinctive

Impacts: In bloom conditions, *Eucampia* horns may cause fish kills by physically damaging gills.



Guinardia

Abbreviation: **GN**

Girdle view: Rectangular cells in close-set chains or solitary; cells straight or curved; valves straight or slightly concave; chloroplasts rounded; cells generally twice as long as their diameter; numerous intercalary bands visible

Valve view: Valve structure can be seen with a light microscope

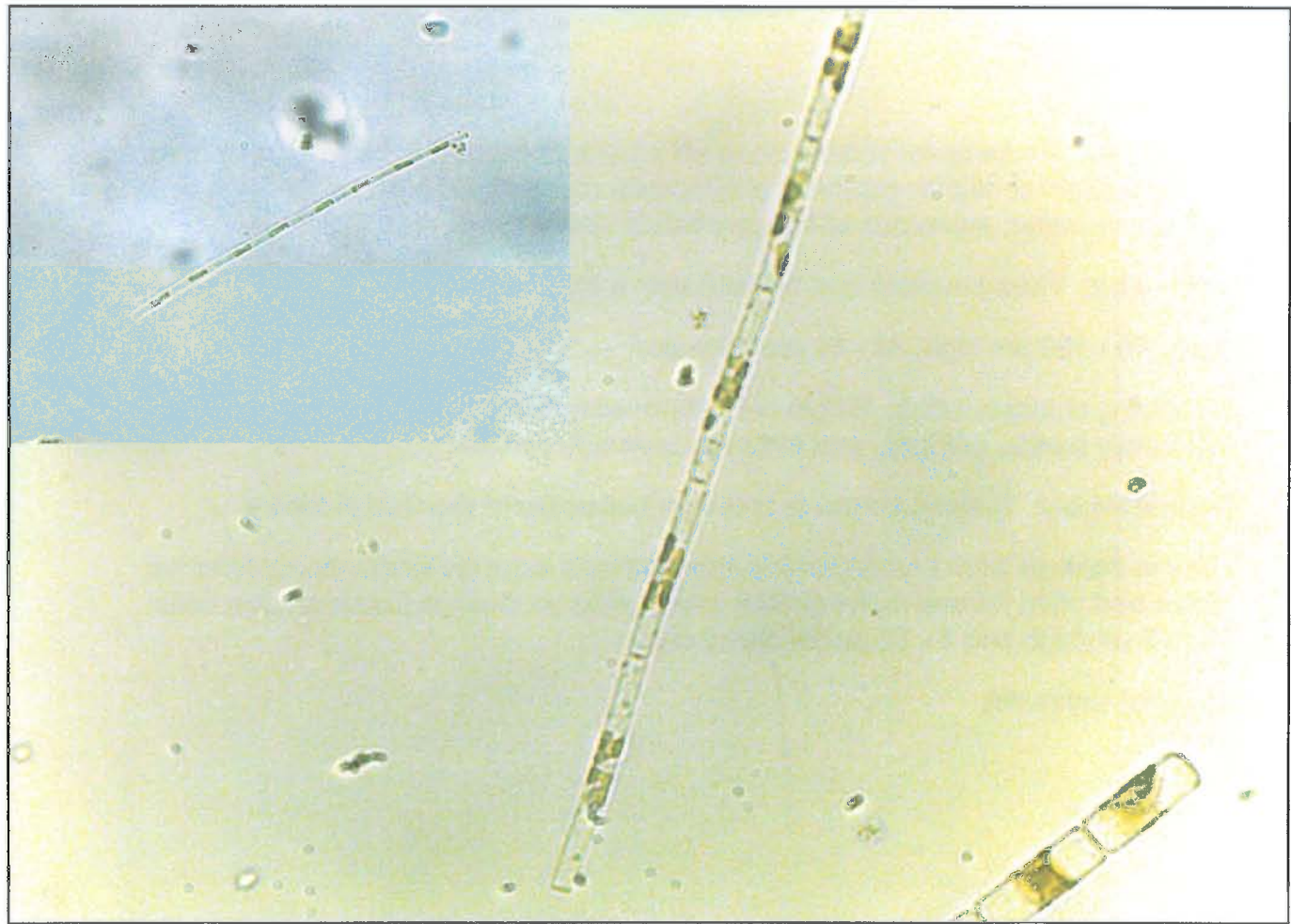
Size: 60 - 160 μm high; 30 - 80 μm diameter

Identifying characteristics: Single cells often resemble a slightly misshapen can; note intercalary bands, cell size, and plate-like chromatophores

Natural history: Diatom; known to bloom in December in the Gulf of Maine

Easy to confuse with: *Leptocylinndrus minimus* (two large chromatophores form flat plates and often adhere to the girdle); *Leptocylinndrus danicus* (much smaller cells: 30 - 75 μm high and 4 - 12 μm in diameter)

Impacts: Unknown



Leptocylindrus

Abbreviation: **LP**

Girdle view: Narrow, rectangular cells with slightly rounded edges

Valve view: Cells elliptical or oval

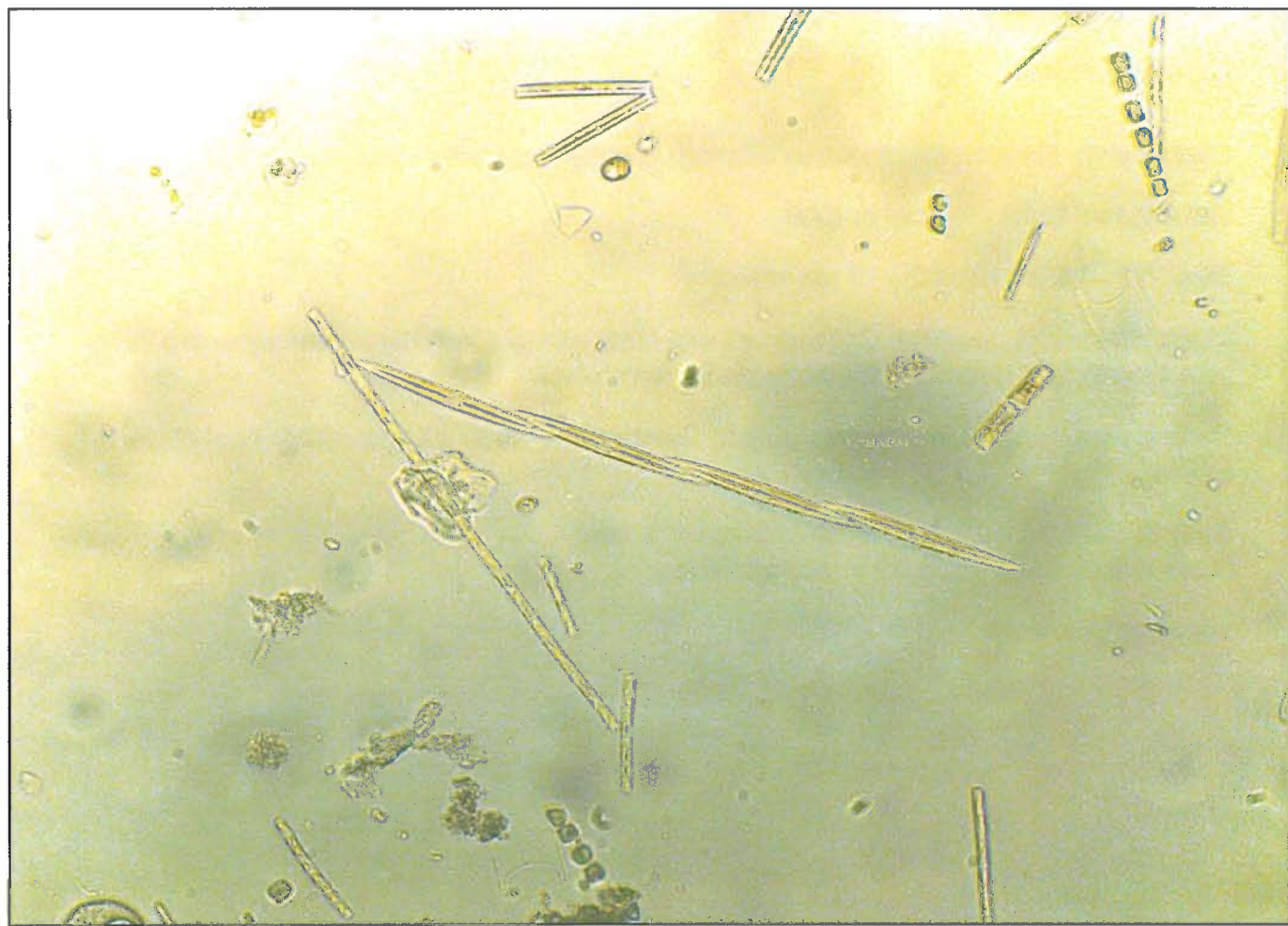
Size: 10 - 75 μm high; 3 - 12 μm diameter

Identifying characteristics: Cells joined into long, straight, narrow chains by entire valve face of adjacent cell; no projections on the valve face

Natural history: Diatom; blooms July to October and often a large component of the fall bloom

Easy to confuse with: *Guinardia* (diameter greater, cells often have slightly irregular valve faces which make them resemble a misshapen can)

Impacts: Unknown



Pseudo-nitzschia

Abbreviation: **PS**

Girdle view: Cells lance-shaped, narrowing at the ends

Valve view: Cells generally seen in this view; cells in stepped chains joined by overlap at the valve ends; chains mobile when on a firm surface such as a slide; chloroplasts generally two plates lying along the girdle; in some species, striations visible with a light microscope

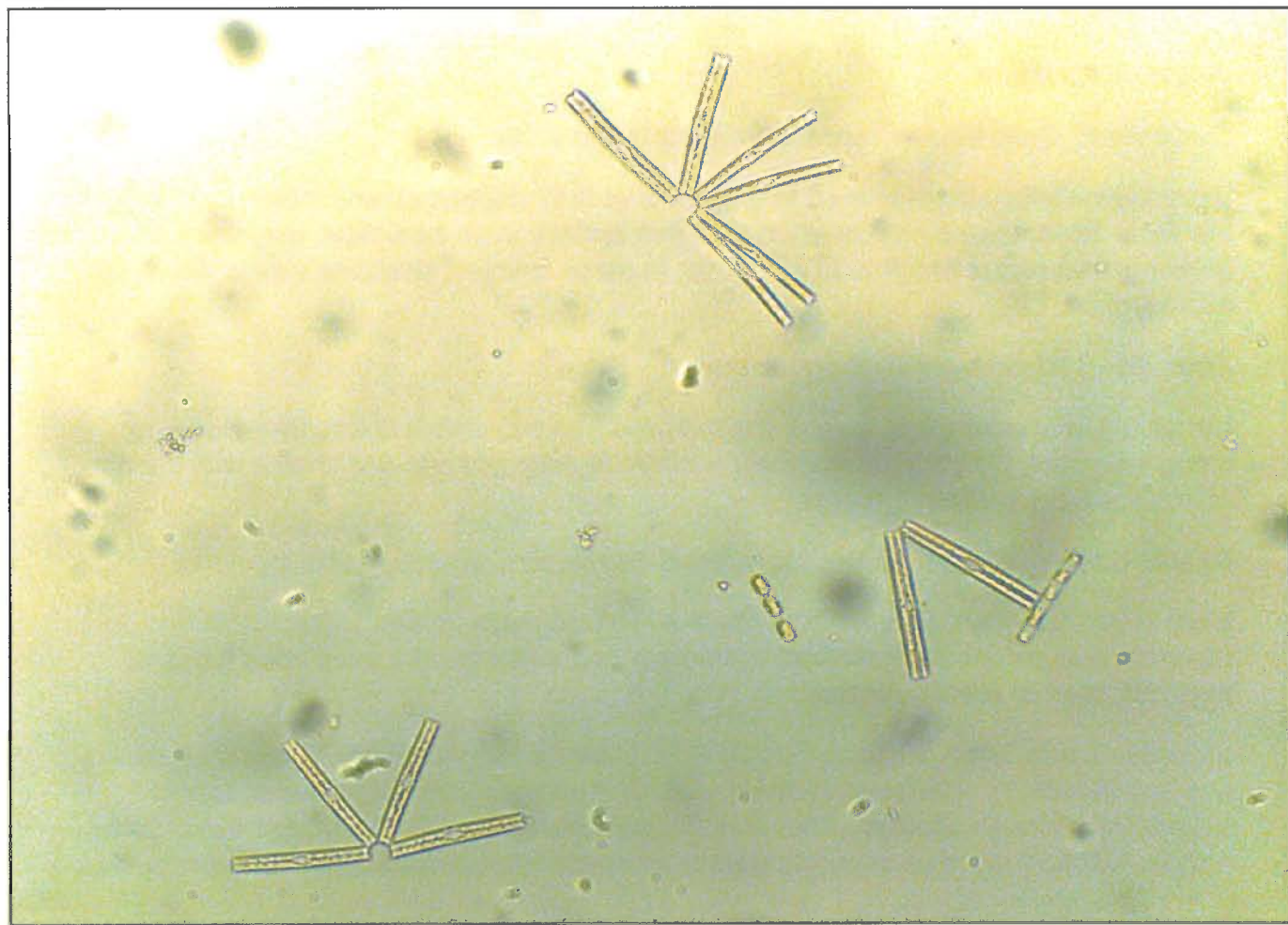
Size: 70 - 170 μm high; 2 - 8 μm diameter

Identifying characteristics: Lance-shaped cells with two visible chloroplasts located along the girdle; joined cells resemble toothpicks arranged into stiff chains with the tips of each cell overlapping the next

Natural history: Diatom; wide geographical distribution; resting spores unknown

Easy to confuse with: *Rhizosolenia* (have spines on valve faces); *Nitzschia* (considerable taxonomic questions arise here and these genera were once grouped together; refer to other sources)

Impacts: Sometimes produces domoic acid, a neurotoxin which can cause amnesiac shellfish poisoning (ASP) in mammals, including humans, and birds that consume it secondarily through shellfish. After an initial gastroenteritis with neurologic symptoms, people with ASP develop apparent permanent neurologic deficits, especially dementia.



Thalassionema

Abbreviation: **TA**

Girdle view: Cells long, narrow rectangles with slightly rounded corners

Valve view: Cells rectangular with blunt, rounded tops

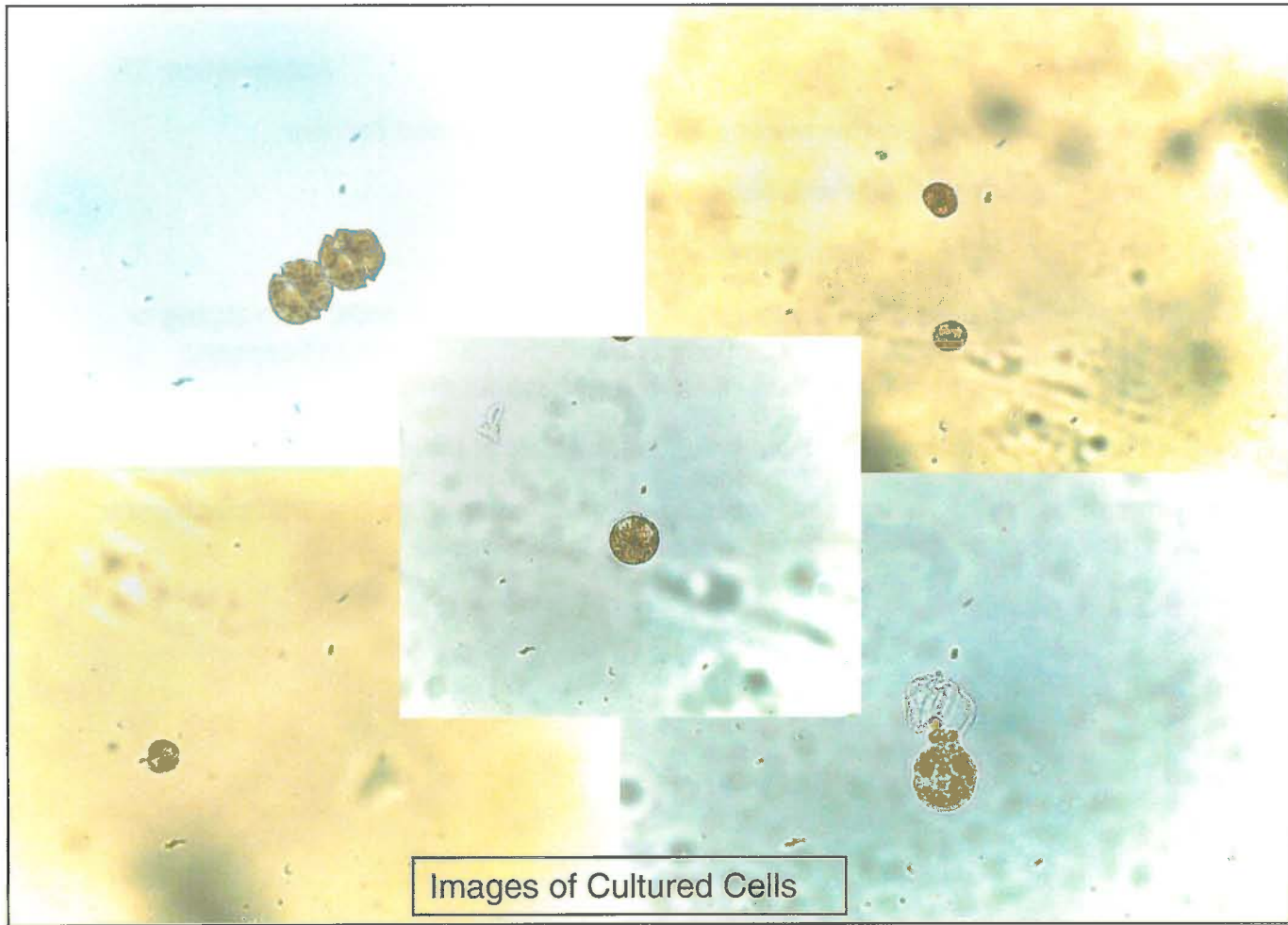
Size: 16 - 70 μm high; 3 - 6 μm diameter

Identifying characteristics: Cells elongated with identical valve ends; form zigzag or star-shaped chains by gelatinous cushions or bands which join the cell corners; chromatophores round or oval plates scattered throughout the cell

Natural history: Diatom; present year-round in the Gulf of Maine

Easy to confuse with: *Asterionella* (cells bone- or oar-shaped, rather than rectangular, and do not make star-shaped chains; not shown in this guide)

Impacts: Unknown



Alexandrium

Abbreviation: **AL**

Morphology: Cells spherical; girdle present, but the surface sculpturing is hard to see with a light microscope

Size: 25 - 30 μm high; 30 - 36 μm diameter

Identifying characteristics: Small round cells; girdle may be difficult to see; no points, appendages or spines; flagella not visible at low powers; moves in a smooth gliding corkscrew fashion; generally golden brown

Natural history: Dinoflagellate; several species of this genus are toxic and some are bioluminescent; *Alexandrium* is common in the Gulf of Maine and its presence does not necessarily mean that nearby shellfish are toxic (temperature, cell abundance, and species all affect toxicity levels); cells form resting cyst beds, and the location of several beds are known in the Gulf of Maine

Easy to confuse with: *Gonyaulax*, *Gymnodinium*, *Protoperidinium*, *Scrippsiella* (differentiated primarily by cell shape; see drawings on page 31)

Impacts: Some species (including *A. tamarense*, *A. fundyense*, and *A. ostenfeldii* which are found in the Gulf of Maine) produce neurotoxins that cause Paralytic Shellfish Poisoning (PSP) in humans. *Alexandrium* has also been known to kill seabirds, sardines and other fish, mussels, oysters, zooplankton, salmon, whales, and other mammals.



Gonyaulax

Abbreviation: **GS**

Morphology: Cells top-shaped with some variability; central girdle difficult to see; numerous yellow to brown chromatophores may give cell yellow, golden, or brown color

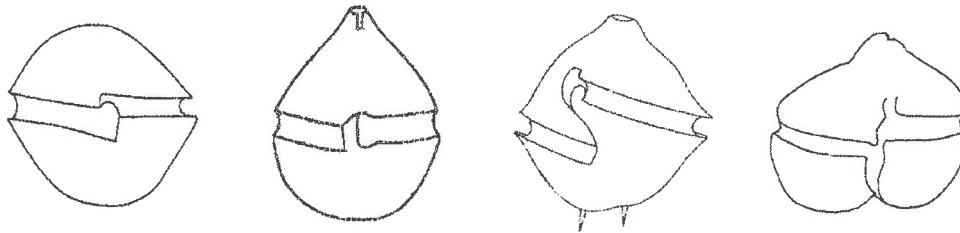
Size: 24 - 50 μm high; 25 - 50 μm diameter

Identifying characteristics: Apical horn and two antapical spines; cells solitary or occasionally in pairs; mobile

Natural history: Dinoflagellate; produces polymorphic cysts; most common August through October in the Gulf of Maine

Easy to confuse with: *Alexandrium*, *Scrippsiella*, and *Gymnodinium* (differentiated primarily by cell shape)

Impacts: Unknown



Alexandrium

Scrippsiella

Gonyaulax

Gymnodinium



Gymnodinium

Abbreviation: **GM**

Morphology: Spherical cells with the slightly conical apical end sometimes visible (depending on the orientation of the cell); generally very small cells; central girdle may be visible

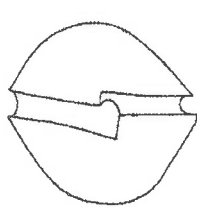
Size: 20 - 80 μm high; 10 - 50 μm diameter

Identifying characteristics: In some views, these cells will look like slightly compressed spheres, while in other views they will look spherical; mobile

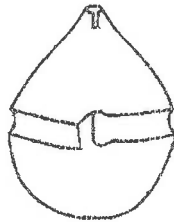
Natural history: Dinoflagellate; color can be green, yellow or brown

Easy to confuse with: *Alexandrium*, *Scrippsiella*, and *Gonyaulax* (differentiated primarily by cell shape)

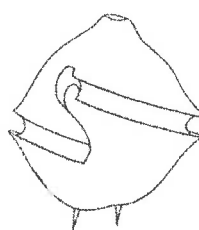
Impacts: Generally unknown. *G. Karenia (breve)* is toxic but it is not found in the Gulf of Maine.



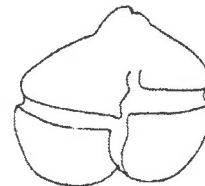
Alexandrium



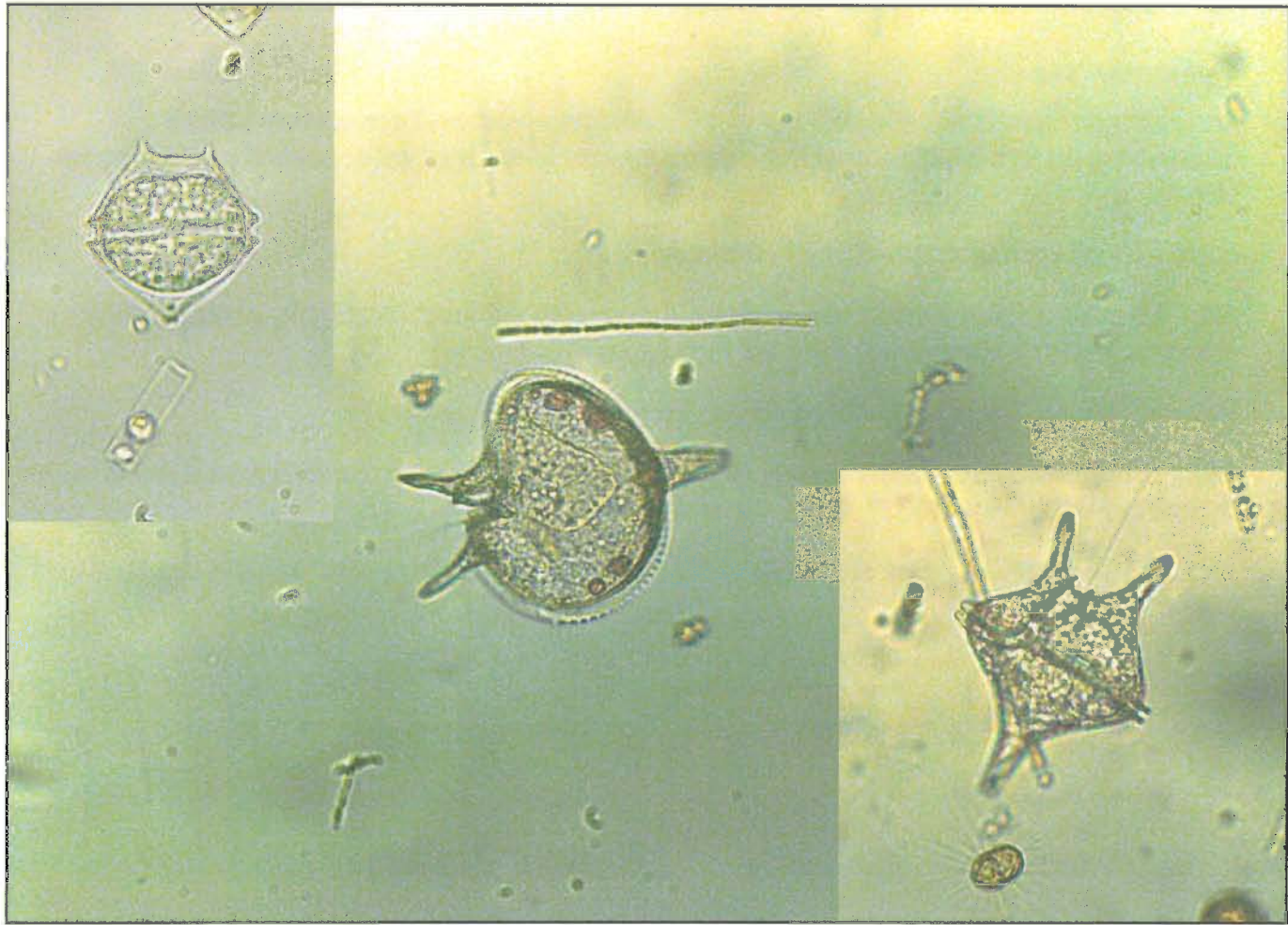
Scrippsiella



Gonyaulax



Gymnodinium



Protoperidinium

Abbreviation: **PT**

Morphology: Horns and spines species specific; each half (above and below the central girdle) is triangular shaped and most species have obvious horn(s) on each end

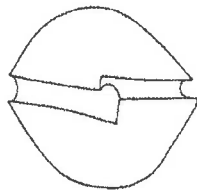
Size: 20 - 250 μm high; 20 - 150 μm diameter

Identifying characteristics: Cells top-shaped; color often pinkish or clear; surface markings may be present and varied; slow spiraling swimmers

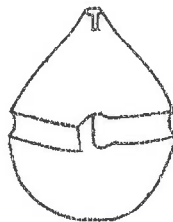
Natural history: Dinoflagellate; feeds on small diatoms and other dinoflagellates

Easy to confuse with: *Alexandrium*, *Scrippsiella*, *Gonyaulax*, and *Gymnodinium* (differentiated primarily by cell shape)

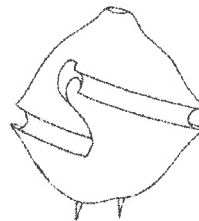
Impacts: Unknown



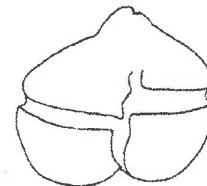
Alexandrium



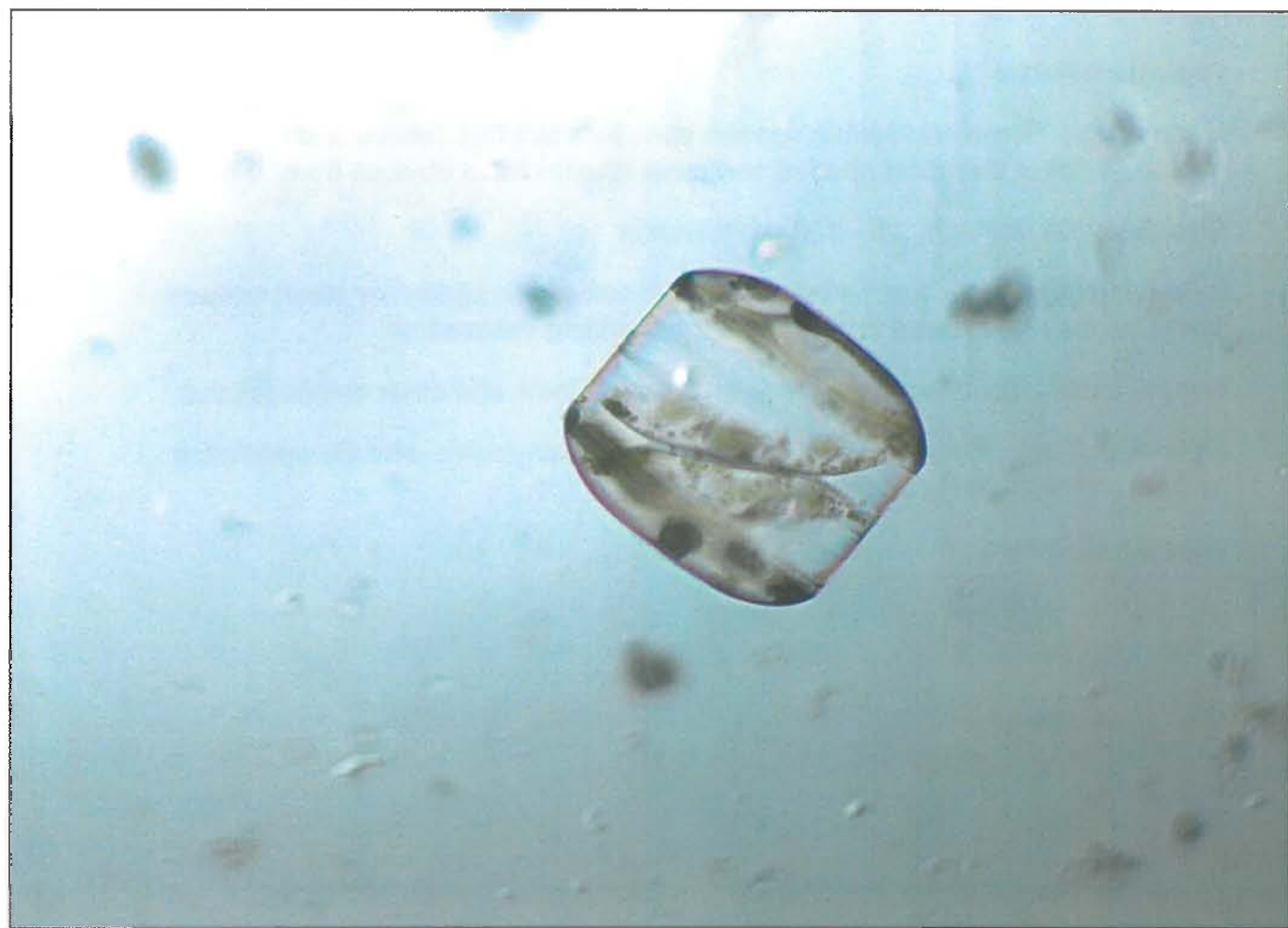
Scrippsiella



Gonyaulax



Gymnodinium



Coscinodiscus

Abbreviation: **CO**

Girdle view: Cells circular or cylindrical

Valve view: Valve sculpturing radiating from the center; small processes (difficult to see) may be visible near the valve margin; valves may be flat, convex, or concave

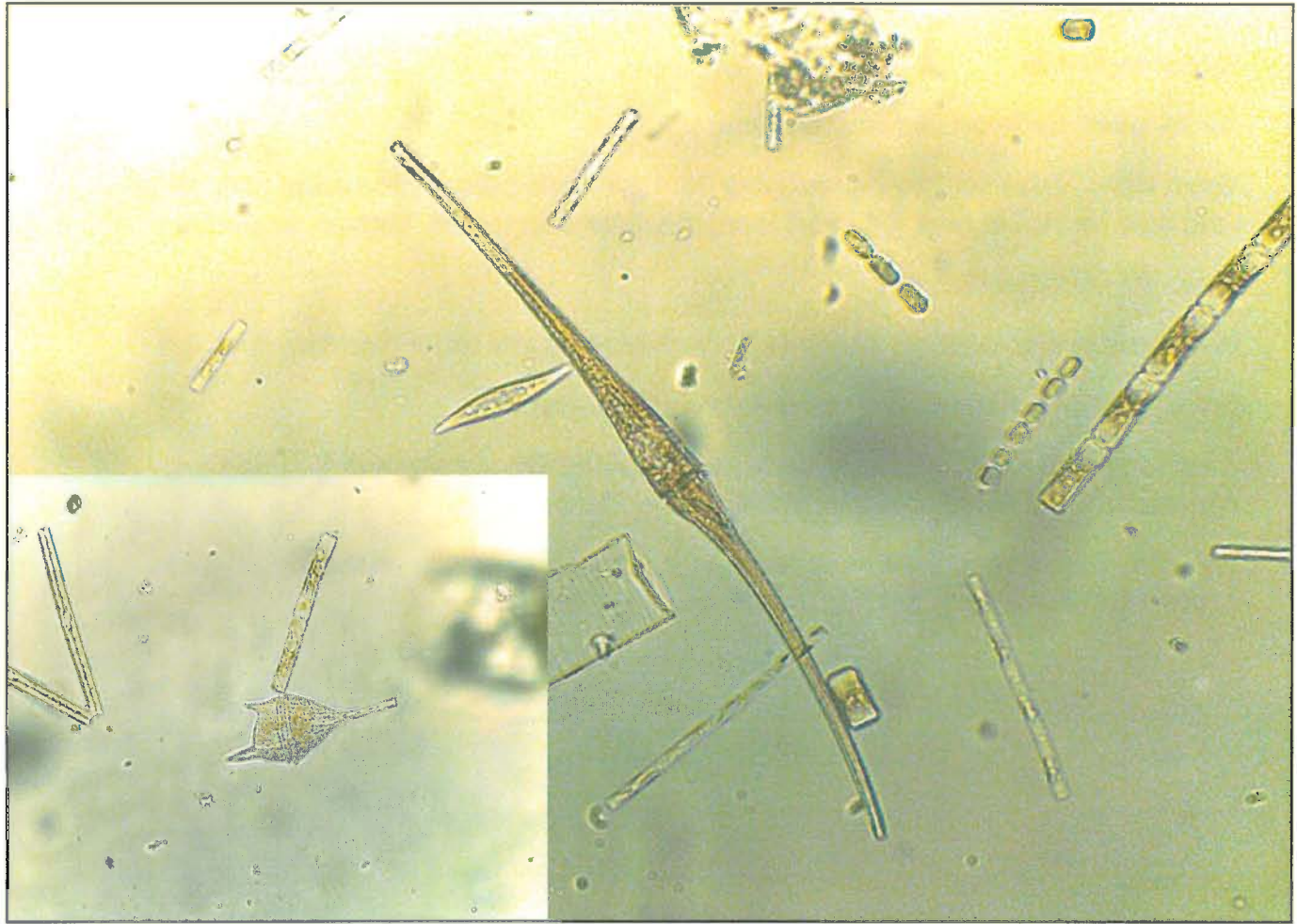
Size: 40 - 500 μm diameter

Identifying characteristics: Large cells drum-shaped and wider than they are high

Natural history: Diatom; note cell division in photograph

Easy to confuse with: *Actinopterychus* (valve divided into six alternately raised and depressed pie-shaped sections; not shown in this guide)

Impacts: Bloom conditions were reported to create an oily film on the water which caused bird mortality in the North Sea during the mid-1940s.



Ceratium

Abbreviation: **CF, CL**

Ceratium fusus, central image; *Ceratium lineatum*, inset

Morphology: Number of horns (two or three) and cell shape varies by species; girdle generally visible slightly below the middle of the cell

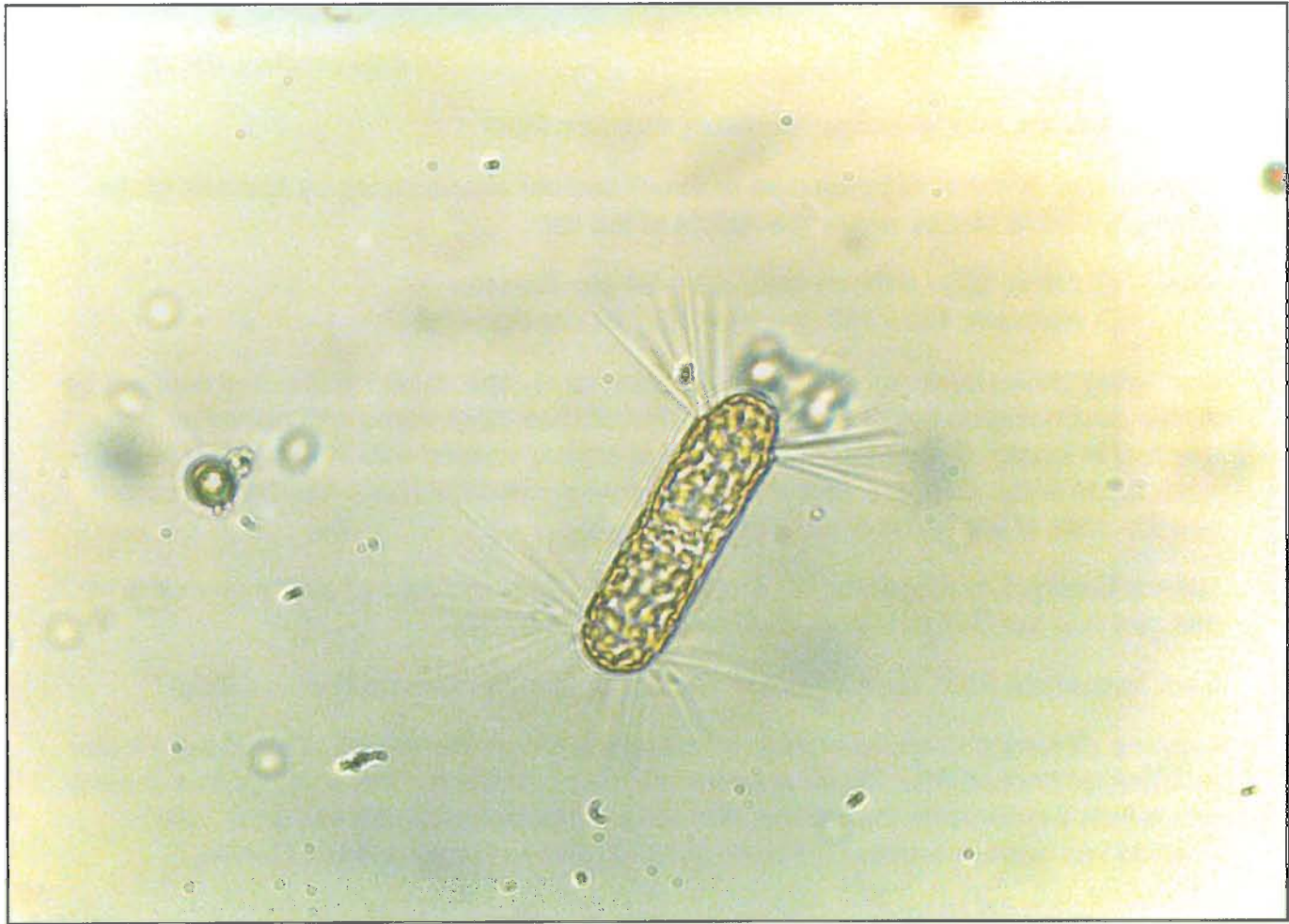
Size: *C. fusus*, 200 - 540 μm high; 23 - 34 μm diameter
C. lineatum, 100 - 130 μm high; 22 - 44 μm diameter

Identifying characteristics: *C. fusus* has three horns, one much smaller and may not be visible depending on cell orientation; *C. lineatum* has three horns with paired horns unequal in length; *C. longipes* (not shown) is anchor-shaped with three curved horns open at the ends; *C. tripos* (not shown), anchor-shaped but has a smaller cell body and the ends of the horns are closed

Natural history: Dinoflagellate; *C. longipes* is the most common of all the members of this genus in the Gulf of Maine. *C. fusus* is bioluminescent.

Easy to confuse with: Distinctive genus, though identifying to species is difficult

Impacts: The long horns can damage fish gills in bloom conditions. This is a particular problem for penned fish. There is some scientific speculation that *C. furca* (not shown) can create a neurotoxin though this has not been demonstrated in the wild. This species has been known to kill Pacific oysters (*Ostrea lurida*) and their larvae.



Corethron

Abbreviation: **CN**

Girdle view: Long, rectangular cell with distinctly convex valves; many strands extending from edges of the valve; chromatophores appearing as numerous oval plates

Valve view: Cells are round with strands emanating from the entire edge of both valve faces

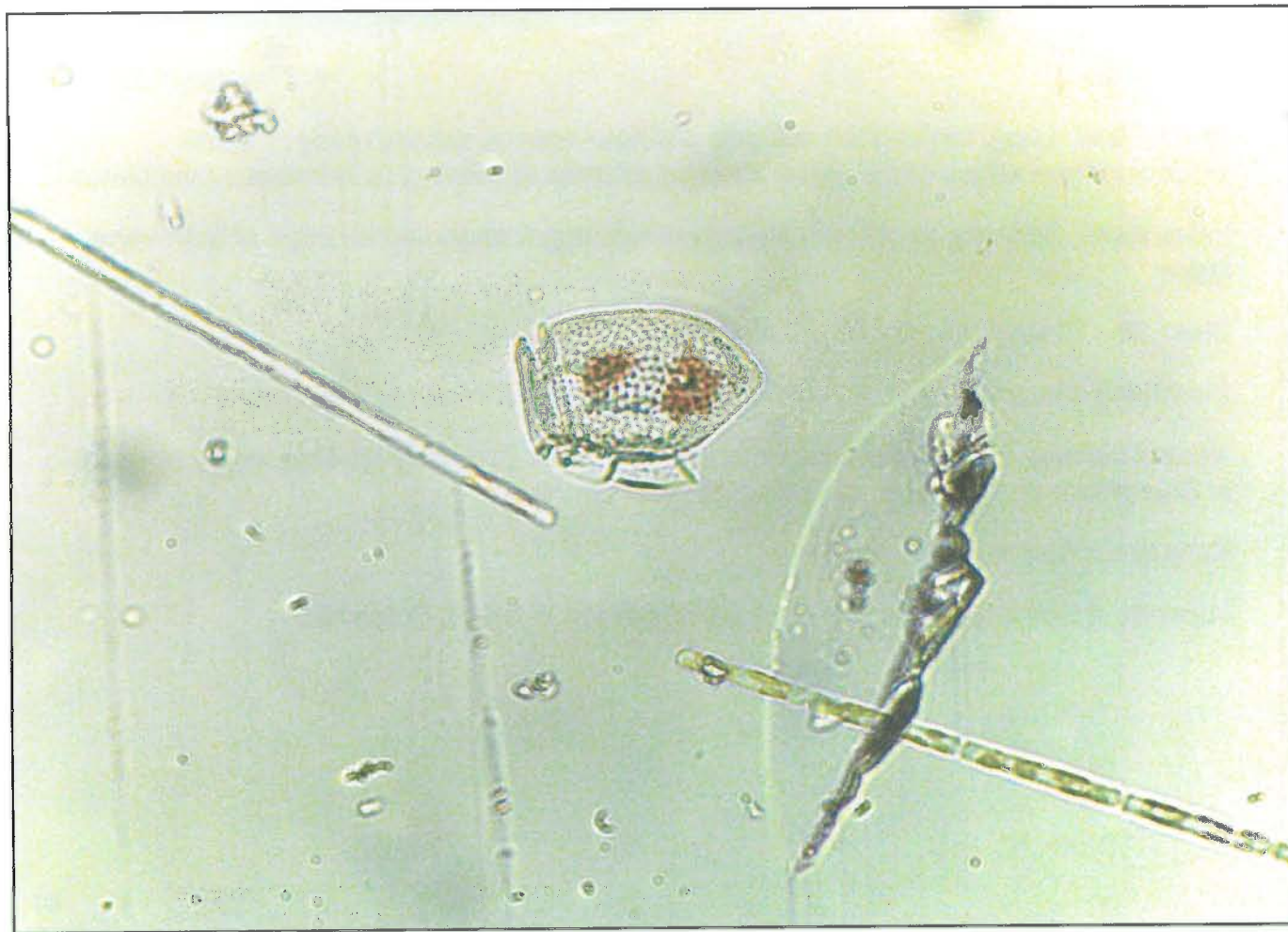
Size: 20 - 70 μm high; 8 - 70 μm diameter

Identifying characteristics: Domed valves on either end crowned with spines

Natural history: Diatom; cells occur singly, or in pairs if recently divided; most common in September and October; long strands produce mucus

Easy to confuse with: Distinctive

Impacts: Blooms have caused mortality of salmon in British Colombia.



Dinophysis

Abbreviation: **DN**

Dinophysis norvegica pictured

Morphology: Oval cell narrowing at one end, the broader end with a funnel-shaped “crown” and the wing-like appendage on one side supported by three “ribs”; valves covered in small pores; flagella not visible with a light microscope at low power

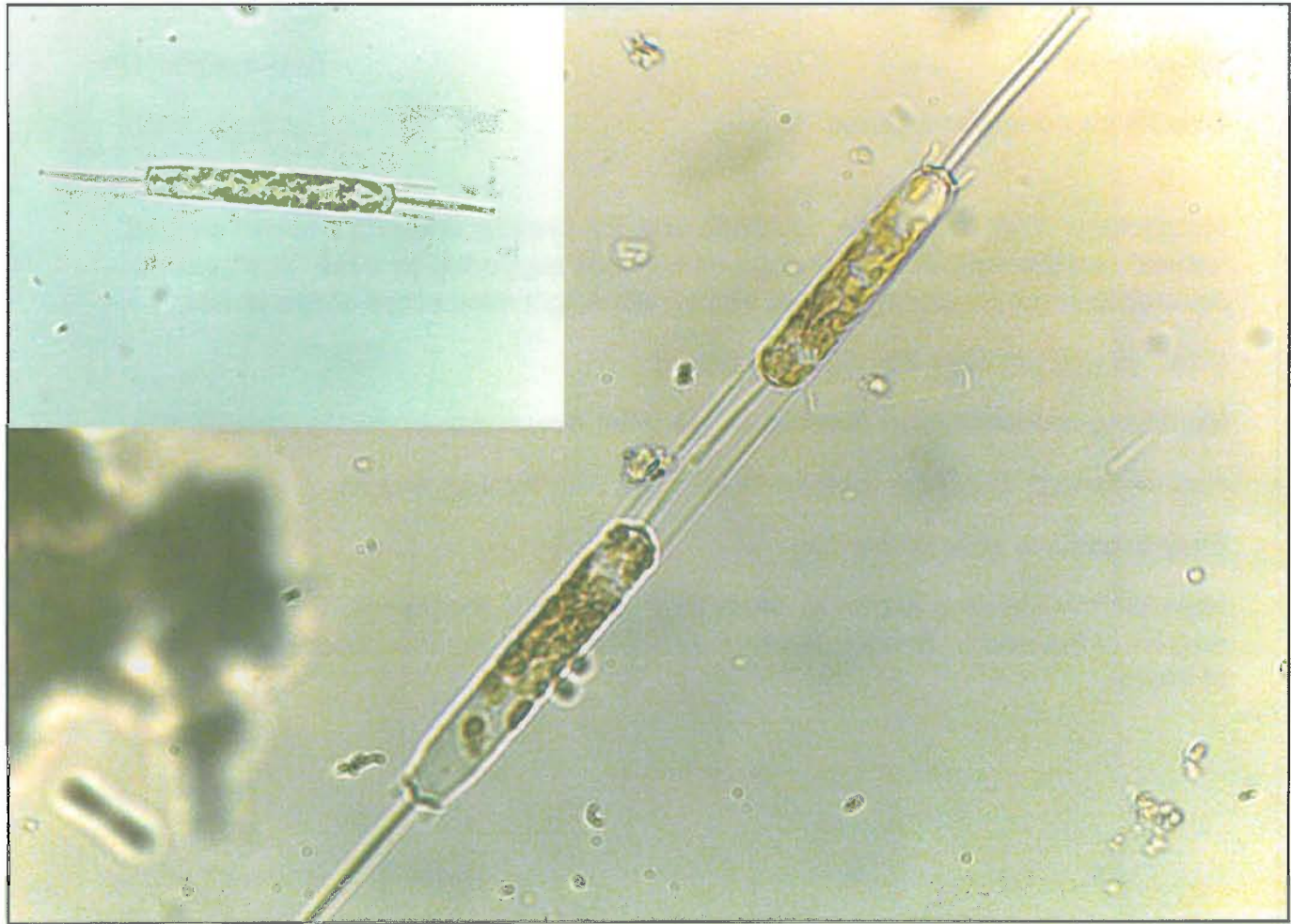
Size: 45 - 80 μm high; 26 - 50 μm diameter

Identifying characteristics: Exist as single cells; slow swimmer; highly variable size

Natural history: Dinoflagellate; tends to bloom May through August

Easy to confuse with: Distinctive

Impacts: This genus is known to cause DSP (diarrhetic shellfish poisoning) in some regions of the world. To date, *Dinophysis* has not been found to cause DSP in the Gulf of Maine.



Ditylum

Abbreviation: **DM**

Girdle view: Cells rectangular with convex valves; one long spine extending from the center of each valve and surrounded by a whorl of smaller spines

Valve view: Cells in valve view generally triangular, but rarely seen in this view because of cell length

Size: 80 - 130 μm high; 14 - 45 μm diameter

Identifying characteristics: Straight rectangular cells with a long spine radiating from the center of each valve; cells may be solitary or in short chains bound by the overlapping of central spines

Natural history: Diatom; only *D. brightwellii* occurs in the Gulf of Maine; one of only two *Ditylum* species forming resting spores (Note that the cells in the image are recently divided, evidenced by the fact that they are in a chain.)

Easy to confuse with: *Rhizosolenia* (pencil-shaped and the central spine relatively shorter compared to the overall size of the cells)

Impacts: Unknown



Gyrosigma

Abbreviation: **GY**

Girdle view: Cells rectangular with rounded corners, the cell center slightly constricted; chromataphores adhering to each valve face and tapering to the ends of the cell

Valve view: Cells are long, tapering at the ends; striations are perpendicular (see left-hand drawing below); striations may be coarse or fine, and difficult to see

Size: 110 - 175 μm high; 12 - 35 μm diameter

Identifying characteristics: Canoe-shaped with slight curvature at the ends in opposite directions, giving the cell a slight "s" shape; mobile when in contact with a substrate, such as a slide surface

Natural history: Diatom; cells occur singly; blooms spring (March) and fall (September - October) generally; very common

Easy to confuse with: *Pleurosigma* (valve striations at oblique angles, right-hand drawing below; otherwise this genus very similar in appearance)

Impacts: Unknown

Gyrosigma



Pleurosigma

Image of Cultured Cells



Prorocentrum

Abbreviation: **PM,PL**

P. micans, central image; *P. lima*, inset

Morphology:

P. micans - Cell leaf-shaped with a short spine (stylus) at the blunt end, the opposite end tapering to a point; the surface covered with small pores

P. lima - Oval cell with v-shaped groove at the narrow end

Size: *P. micans*, 35 - 70 μm high; 22 - 30 μm diameter

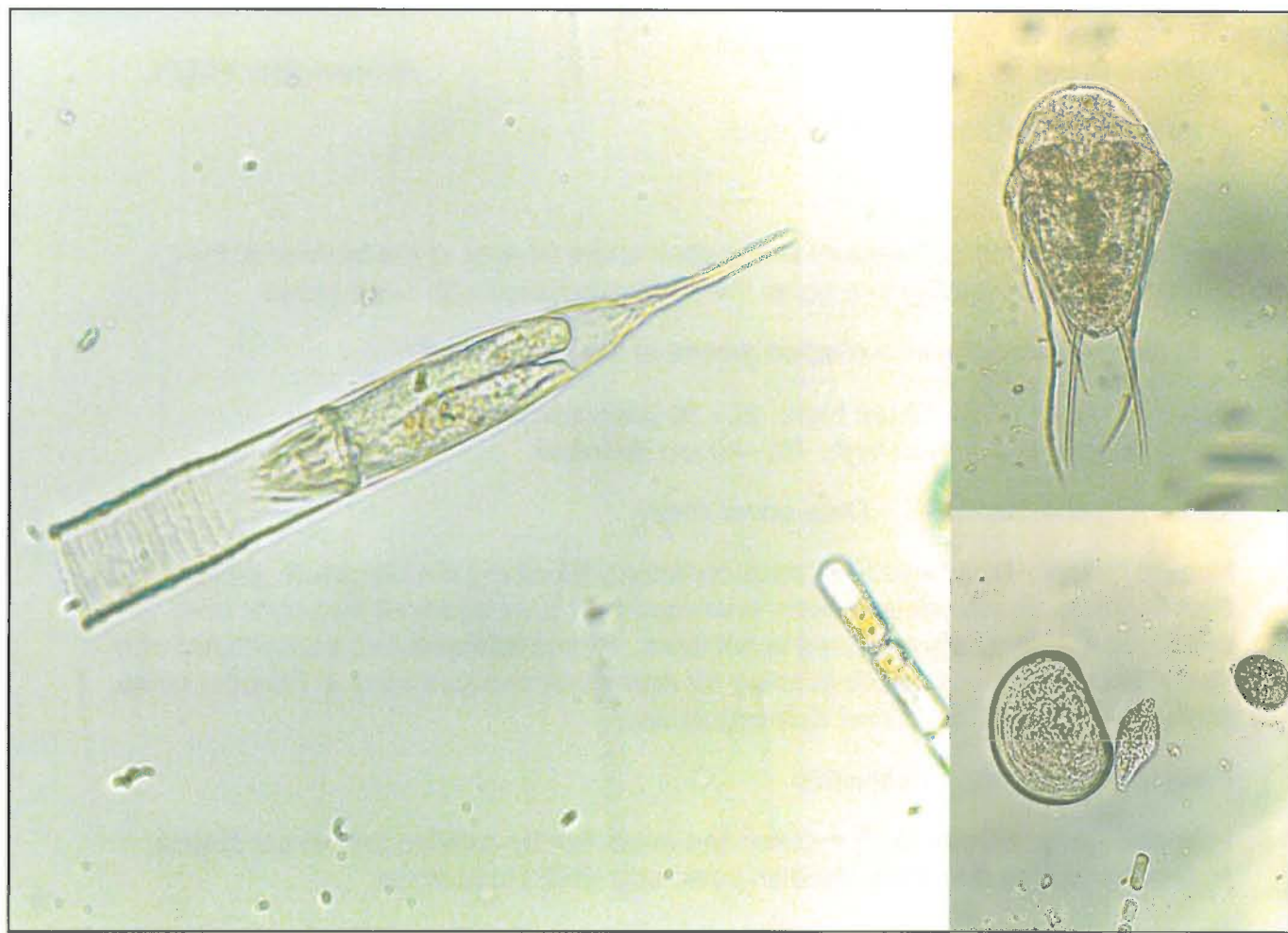
P. lima, 31 - 47 μm high; 22 - 40 μm diameter

Identifying characteristics: Cells occur singly

Natural history: Dinoflagellate; most commonly blooming dinoflagellate genus in the Gulf of Maine. *P. micans* is present year-round. *P. lima* is benthic/epiphytic and, therefore, not generally captured in net tows. *P. lima* is known to be associated with "fluffy" filamentous seaweeds growing on *Ascophyllum nodosum* and *Fucus* species, such as *Pilayella littoralis* and *Ectocarpus* spp.

Easy to confuse with: Distinctive

Impacts: Large blooms of *P. micans* can affect fish by causing anoxic conditions. *P. lima* can cause diarrhetic shellfish poisoning (DSP) in humans.



Zooplankton

Left: **Tintinnid**

Abbreviation: **TN**

Identifying characteristics: Shaped like an eye-dropper with a very fine tip; if not moving, you may be viewing the empty lorica (covering) without the organism inside; some species ornament the lorica with sand grains and small organisms; large

Natural history: Free-living, single-celled, ciliates (organisms that use cilia, or tiny "hairs," to move and feed) that graze on plankton; cover themselves with loricae (stiff encasements of seawater minerals or tiny pieces of sediment)

Impacts: Scientists have estimated that tintinnids may consume as much as 90 % of the planktonic bacteria and algae in certain environments.

Easy to confuse with: Broken *Rhizosolenia*

Top right: **Harpacticoid Copepod**

Abbreviation: **CD**

Bottom right: **Bivalve larvae**

Abbreviation: **BL**

Note: At straight hinge stage, shown in photo, difficult to determine species

Glossary

Apical - the tip of the epitheca (the upper section of a dinoflagellate cell)

Antapical - the tip(s) of the hypotheca (the lower section of a dinoflagellate cell)

Chromatophore - a specialized structure containing chlorophyll or other pigments; starch, protein, and pigments are stored in these structures

Cyst - a protective covering made by some phytoplankton to protect them from harsh conditions

Diatom - group of phytoplankton with cell walls of silica. The cell walls (frustules) are composed of two slightly unequal halves, the valves, which may be ornamented with a variety of structures. The band on the side of the valve is the girdle.

Dinoflagellate - a phytoplankton group named for their two flagella which allow them to be mobile. Some organisms are covered with plates of cellulose. Cells may be autotrophic (chloroplasts convert sunlight to energy) or heterotrophic (absorbing other phytoplankton and bacteria for energy).

Flagella - hair-like appendage of some phytoplankton used for locomotion

Girdle view - the view visible when the viewer is looking at the side of a diatom

Intercalary bands - rings of silica between the valves of diatoms

Micron (μm) - unit of linear measure, one millionth of a meter or one thousandth of a millimeter

Process - an appendage or projecting part of an organism

Seta (plural, **setae**) - a bristle or bristlelike part or organ

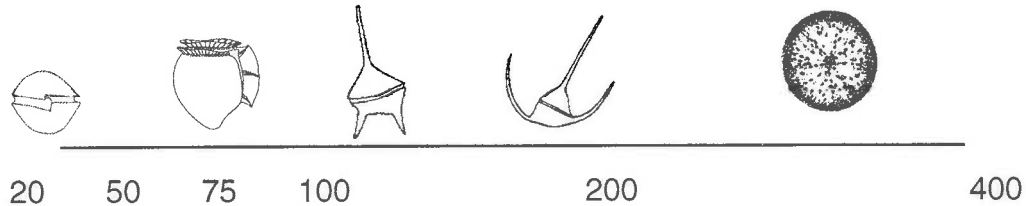
Stylus - tooth-like projection

Valve view - the view visible when the viewer is looking at the top or bottom of a diatom

Size Chart

Relative Size Scale (in microns, μm)

Alexandrium, Dinophysis, Ceratium lineatum and C. longipes, Cocinodiscus



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