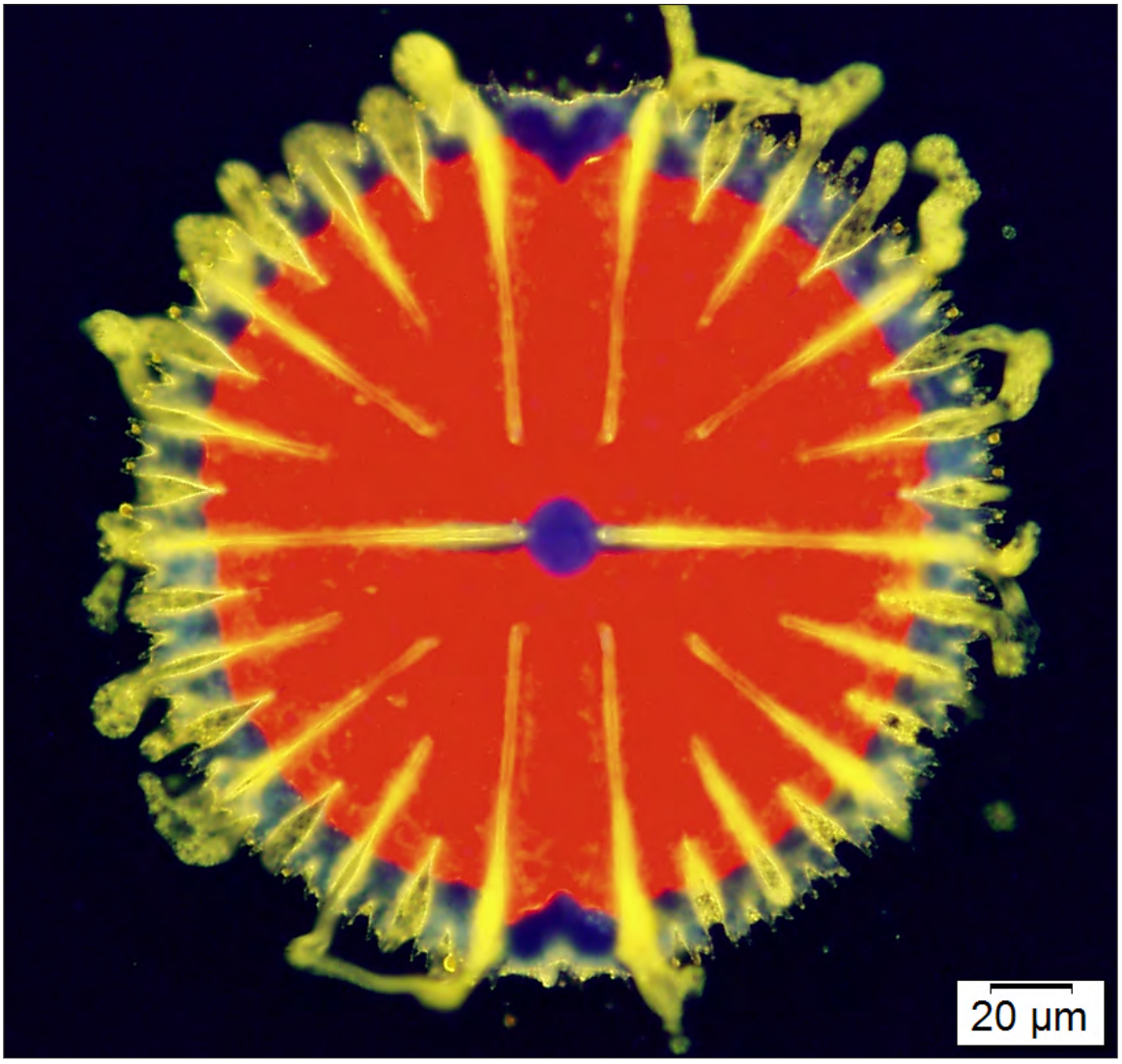
USGS
science for a changing world

Catalog of Microscopic Organisms of the Everglades Part 2—The Desmids of the Arthur R. Marshall Loxahatchee National Wildlife Refuge



Scientific Investigations Report 2019–5074

U.S. Department of the Interior
U.S. Geological Survey

Cover. *Micrasterias radiosa*. Photograph by Barry H. Rosen, U.S. Geological Survey, February 5, 2018, using an epifluorescence microscope, ultraviolet excitation.

Catalog of Microscopic Organisms of the Everglades Part 2—The Desmids of the Arthur R. Marshall Loxahatchee National Wildlife Refuge

By Barry H. Rosen, Katherine N. Stahlhut, and John D. Hall

Scientific Investigations Report 2019–5074

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2019

For more information on the USGS—the Federal source for science about the Earth, its natural and living resources, natural hazards, and the environment—visit https://www.usgs.gov or call 1–888–ASK–USGS.

For an overview of USGS information products, including maps, imagery, and publications, visit https://store.usgs.gov.

Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Although this information product, for the most part, is in the public domain, it also may contain copyrighted materials as noted in the text. Permission to reproduce copyrighted items must be secured from the copyright owner.

Suggested citation:
Rosen, B.H., Stahlhut, K.N., and Hall, J.D., 2019, Catalog of microscopic organisms of the Everglades, part 2—The desmids of the Arthur R. Marshall Loxahatchee National Wildlife Refuge: U.S. Geological Survey Scientific Investigations Report 2019–5074, 277 p., https://doi.org/10.3133/sir20195074.

ISSN 2328-031X (print)
ISSN 2328-0328 (online)

Acknowledgments

This work was supported by the U.S. Geological Survey Greater Everglades Priority Ecosystems Science program.

We thank Donatto Suratt, National Park Service, and Rebekah Gibble, U.S. Fish and Wildlife Service, for collecting samples from the Arthur R. Marshall Loxahatchee National Wildlife Refuge. We also thank Kenneth Wagner for his thorough review and the early-career guidance he and the senior author received from Hannah Croasdale.

Contents

Figures

Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4,047	square meter (m^2)
acre	0.4047	hectare (ha)
acre	0.4047	square hectometer (hm^2)
acre	0.004047	square kilometer (km^2)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
micrometer (µm)	0.00003937	inch (in.)
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
meter (m)	1.094	yard (yd)

Catalog of Microscopic Organisms of the Everglades Part 2—The Desmids of the Arthur R. Marshall Loxahatchee National Wildlife Refuge

By Barry H. Rosen,[1] Katherine N. Stahlhut,[1] and John D. Hall[2]

Abstract

The Arthur R. Marshall Loxahatchee National Wildlife Refuge (refuge), Boynton Beach, Florida, contains approximately 147,000 acres southeast of Lake Okeechobee. Water quality in the interior portion of the refuge is strongly influenced by rainfall, resulting in slightly acidic waters with low dissolved ions. Desmids, a unique, ornate group of green algae loosely associated with submerged vascular plants, were photo-documented for the first time in samples from the refuge. The canal system surrounding the refuge contains a high level of ions from agricultural runoff, and intrusion of this water into the refuge interior during high canal water levels may have altered some of the desmid population. A transect from the canal to the interior was sampled every 3 months, and the species present were photographed, identified, and catalogued. Approximately 260 unique taxa from 29 genera were encountered. The interior of the refuge had the greatest diversity of desmids; however, the areas of the refuge adjacent to the canals still contained a rich population of desmids. We postulate that the diversity of desmids indicates that the pristine portions of the refuge may be an important refugium for desmids, particularly for those species restricted to the subtropical parts of the United States. This collection of taxa, identified to species with most specimens, will allow a more detailed examination of water quality issues when co-located water quality data are collected.

Introduction

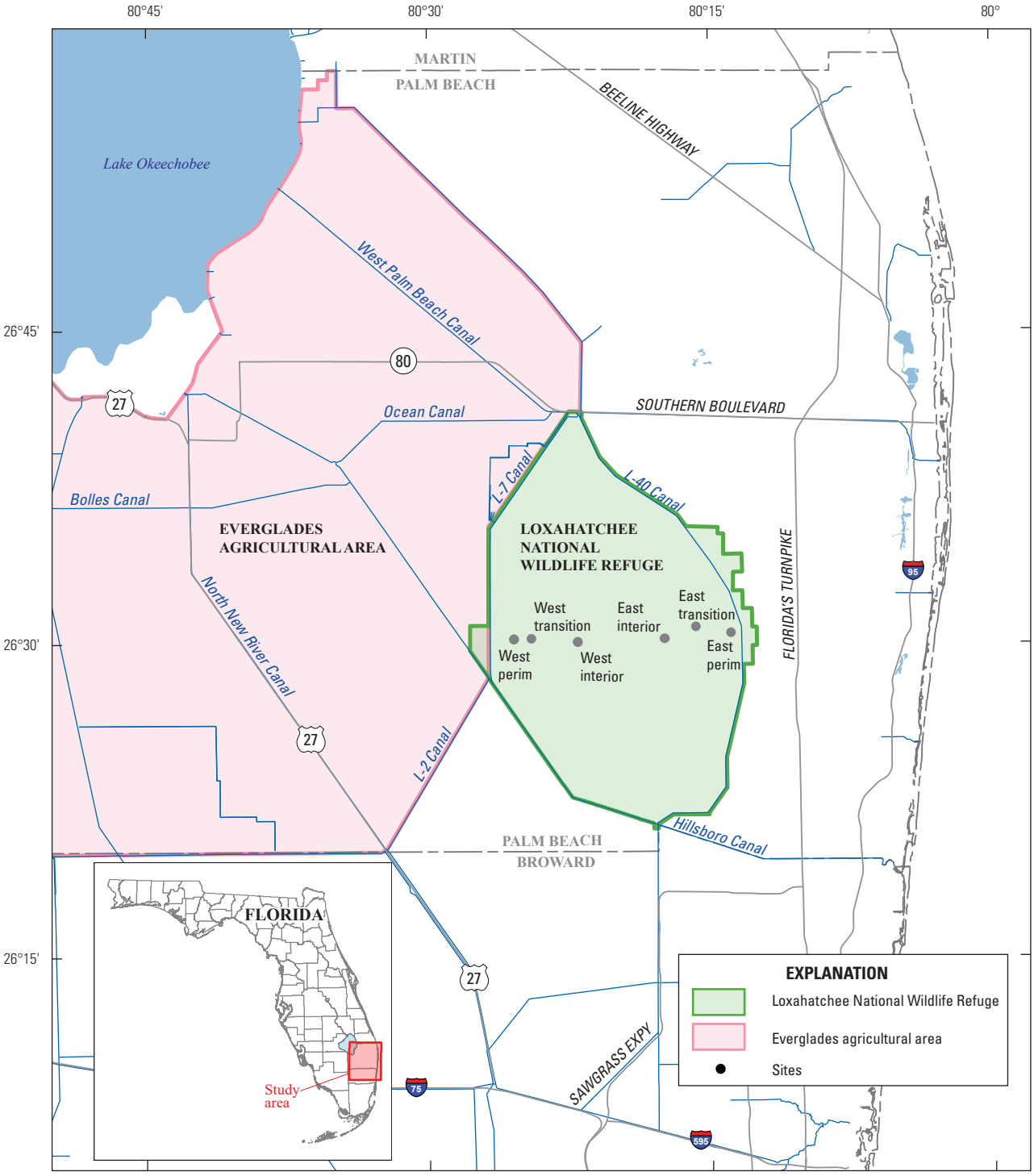
Desmids are a paraphyletic group of symmetrical green algae that belong to the class Zygnematophyceae. Desmids are made up of two groups: saccoderm desmids and placoderm desmids. Saccoderm desmids are in the order Zygnematales, with other common conjugating algae genera such as *Mougeotia, Spirogyra,* and *Zygnema.* Placoderm desmids are in the order Desmidiales and are characterized by median sutures and ornamented cell walls. This order is very species rich, with an estimated 32 genera and 1,234 species in North America (Hall and McCourt, 2015). They are most abundant in environments that have acidic, soft water, like the interior of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (refuge). In part 1 of "Catalog of microscopic organisms of the Everglades" (Rosen and Mareš, 2016), cyanobacteria in the Everglades were photographed and identified. This volume focuses on the refuge, which is rich in desmid diversity and abundance. The goal of this publication is to provide photo documentation of desmids that live in the refuge, which can also be used to help identify most desmid species throughout the Everglades.

The refuge is located at 26° N latitude and 80° W longitude and is part of the northern Everglades. The land to the northwest of the refuge is part of the Everglades agricultural area, and the land to the east is predominantly urban (fig. 1). The refuge was established in 1951 by the Migratory Bird Conservation Act and protects wetland wildlife such as the snail kite and wood stork (U.S. Fish and Wildlife Service, 2018).

The refuge has historically been classified as an ombrotrophic wetland, meaning that the wetland ecosystem receives water and nutrients predominantly from rainfall (Gleason and Spackman, 1974; Browder and others, 1991; Miller and McPherson, 2008). This designation was based on composition and classification of periphyton throughout the Everglades. Calcareous periphyton was found in the peripheral regions of the refuge and can also be found in parts of Big Cypress, Taylor Slough, and other regions of the southern Everglades (Swift, 1987). The waters in these locations all had high calcium concentrations and a neutral to basic pH. The interior of the refuge had non-calcareous, desmid-rich periphyton and metaphyton. The sampling locations were selected to gather periphyton and metaphyton from the acidic, low mineral content interior portion of the refuge and were generally isolated from the canals. The low mineral content and presence of non-calcareous periphyton in the interior of the refuge indicate that it has historically been ombrotrophic. Since the construction of the canals along the perimeter, stormwater discharges have threatened the ombrotrophic quality of the interior regions of the refuge (Chen and others,

[1]U.S. Geological Survey.

[2]Academy of Natural Sciences of Drexel University.



Base modified from ESRI and other Federal and State digital line data, various scales
South Florida Water Management District (SFWMD), 2018
Florida Department of Transportation Roads Characteristics inventory (RCI) dataset, 2019
TIGER/Line data from United States Census Bureau, 2018
University of Florida GeoPlan Center, 2015
Florida Department of Environmental Protection, Division of Environmental Assessment and Restoration, Watershed Monitoring Section, 2017
Universal Transverse Mercator, zone 17
North American Datum of 1983

Figure 1. Location of the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Florida, and the sampling locations for this study.

2012). Canal water intrusion and the associated inputs of dissolved ions into the refuge have the potential to affect aquatic ecosystems, particularly sensitive desmid communities that have been found in abundance in the interior portion of the refuge.

The refuge has been noted for its diverse desmid population (Swift and Nicholas, 1987), but little is known about how the population is being affected by the canal water intrusions into the refuge. A barrier to doing further research on this system is the lack of knowledge of the taxonomic composition of the desmid population in the refuge. This catalogue of desmid taxa found in the refuge will allow data to be obtained on the diversity of organisms, as well as allow future research on their response to changes in water chemistry.

Methods

Samples were collected from six locations on five dates over the course of 3 years (2016–2018) along an east to west transect shown in figure 1. Floating vegetation and associated water were collected by hand, placed in plastic containers, and kept on ice until transported to the U.S. Geological Survey (USGS) laboratory in Orlando, Florida. Live desmids were removed by gentle agitation of the vascular plant material, and many subsamples were examined from each of the 30 samples over a 3-year period.

Samples were placed on microscope slides and viewed under an Olympus BX51 light microscope with 200x, 400x, 600x, or 1,000x magnification. Photos of individual organisms were taken by using an Olympus DP74 camera. Scale bars embedded in the images were calibrated and sized by using CellSens camera software. Many of the photographs were generated by using a motorized z-stage, allowing individual images to be taken as the z-drive focused though the entire organism. These images were compressed into a single image, making an “extended focus image” that allowed for details on all focal planes to be viewed simultaneously.

Identification of the taxa present in the refuge required the use of desmid taxonomic reference literature. The “North American Flora” reference books were used and cited for all of the desmids identified in the refuge (Prescott and others, 1972, 1975, 1977, 1981, 1982, 1983). The taxonomic references provided only a line drawing of the taxa, and no image (digital or printed) was available for many of the taxa.

Results and Discussion

Analysis of samples from the refuge revealed a sizable community of desmids: 242 unique desmid taxa from 30 genera. In addition, 17 taxa could only be identified to the genus. The east interior site (fig. 1) had the highest diversity of desmids, with 174 taxa identified from this location during this study. The west perimeter site, which is near the canals, had the lowest diversity, with only 17 taxa identified. This low diversity was possibly caused by the altered hydrology and resultant plant community structure at this sampling location; the west perimeter of the refuge is dominated by *Typha*, which proliferates in enviroments with increased flow and nutrients (Newman and others, 1996). At the other five sampling locations, *Utricularia,* which is often associated with a greater presence of desmids (Schumacher, 1960), was the dominant form of aquatic vegetation.

About half of the species that are documented in this publication are common in the refuge. However, several species were rarely seen; some taxa were only in samples from one sampling location or in samples from one sampling date. While this catalogue represents most of the diversity of desmids in the refuge, some species were likely missed or are almost impossible to distinguish from others that have similar morphology.

Biodiversity and density of species in the samples were notably lower in the late summer than the during rest of the year. This could be explained by increased rain and flow though the refuge during the summer. The percentage of *Haplotaenium* desmid cells increased in all of the sampling locations during the summer. Swift and Nicholas (1987) noted that the cells of this genus (listed under the basionym *Pleurotaenium*) were the most numerous desmid cells that were found in periphyton samples in less impacted locations.

The research questions that could be addressed were limited in this preliminary study because water-chemistry data were not collected at the time of sample collection. Additional data collection and research are needed to understand the effect of water quality on the tolerance of the numerous desmid species that are found in the refuge.

This publication includes a summary of the genera found in the refuge, as well as photographs of each species.

Closterium Nitzsch ex Ralfs

Cells are typically lunate or bow-shaped, many times longer than broad, and tapered to the apices. The cell wall may be smooth or have surface features such as costae, striations, or punctae that can aid in identification. Some cells have additional thickened portions of cell wall material called girdle bands. The curvature of the cell is critical for identification. Most species have a large vacuole near the apex that has granules of barium sulfate crystals (Brooks, 1981). Pyrenoids can often be seen along the length of the cell.

Twenty-three taxa of *Closterium* were identified in refuge (figs. 2–25). They were primarily in samples from the east interior site of the refuge (fig. 1). Only two species from this genus (*Closterium kuetzingii* and *Closterium turgidum)* were found in samples from the west perimeter and the west and east transition sites.

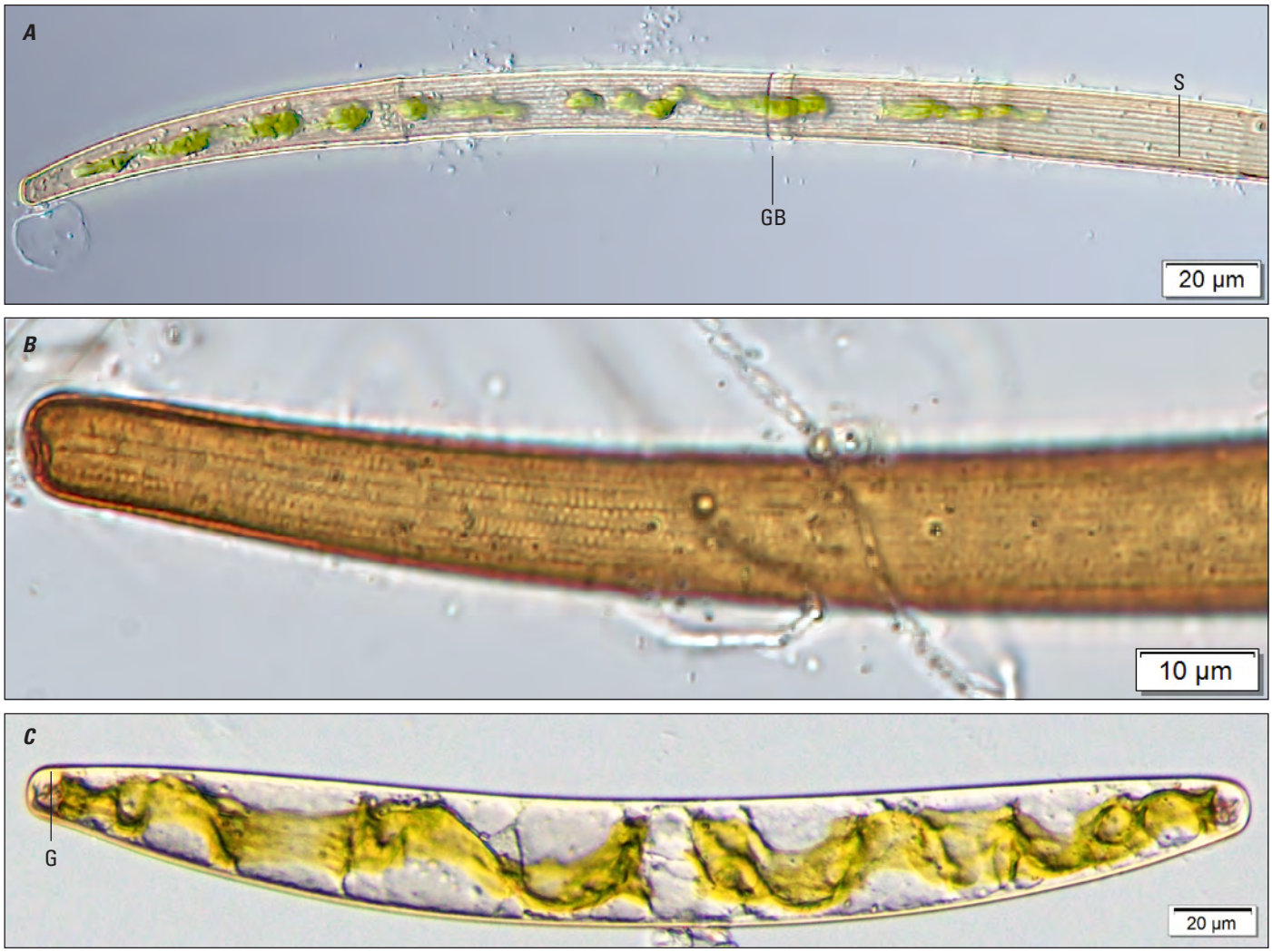


Figure 2. *A*, *Closterium juncidum* cells have girdle bands (GB) and striations (S). *B*, *Closterium lineatum* has striations made up of pores and a brown cell wall due to iron deposits. *C*, Barium sulfate granules (G) in a terminal vacuole are visible in this *Closterium baillyanum* cell. [µm, micrometer]

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium abruptum* var. *canadense* Bourelly

Figure 3. *Closterium abruptum* var. *canadense*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium acerosum* (Schrank) Ehrenberg

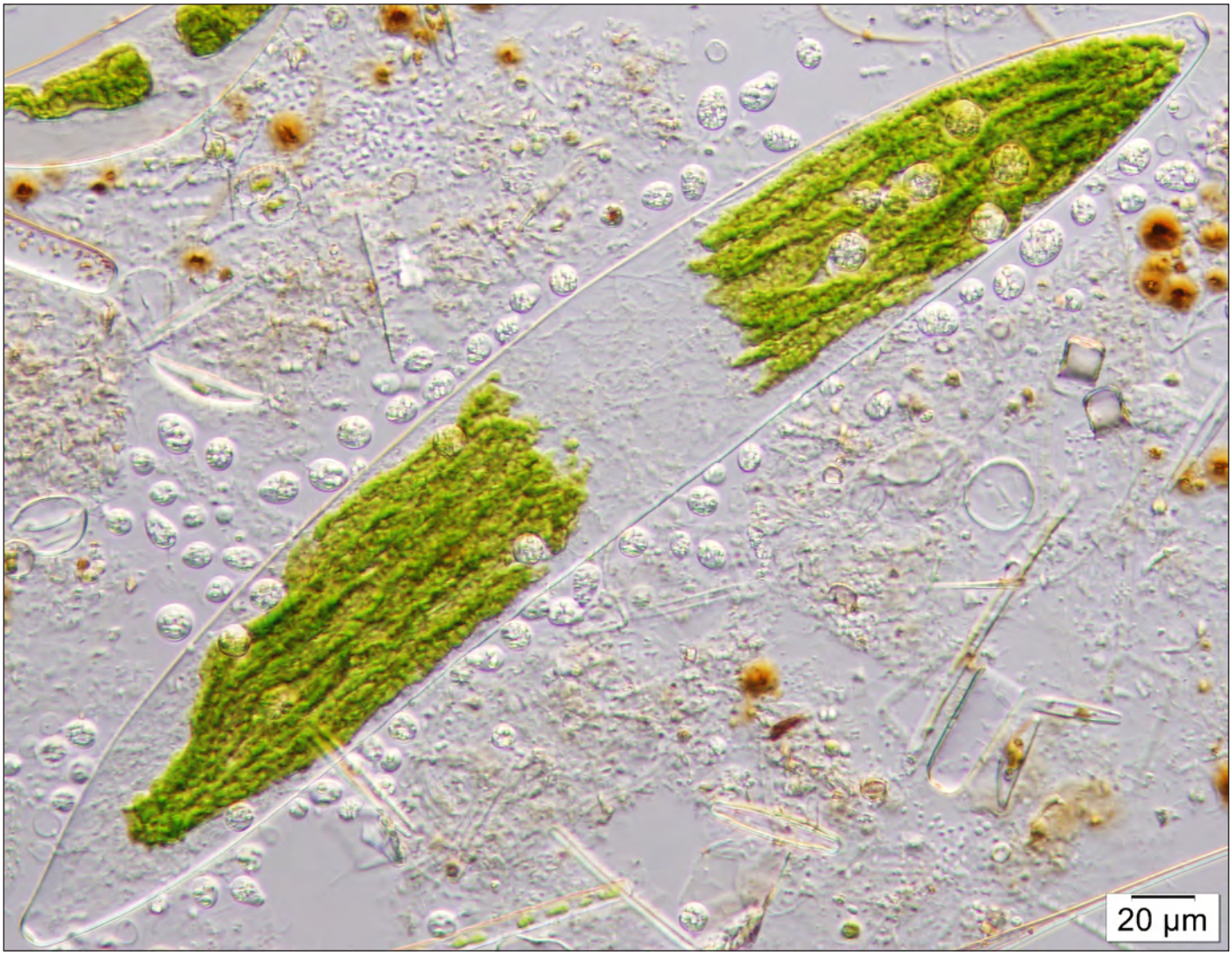


Figure 4. *Closterium acerosum.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium aciculare* T. West

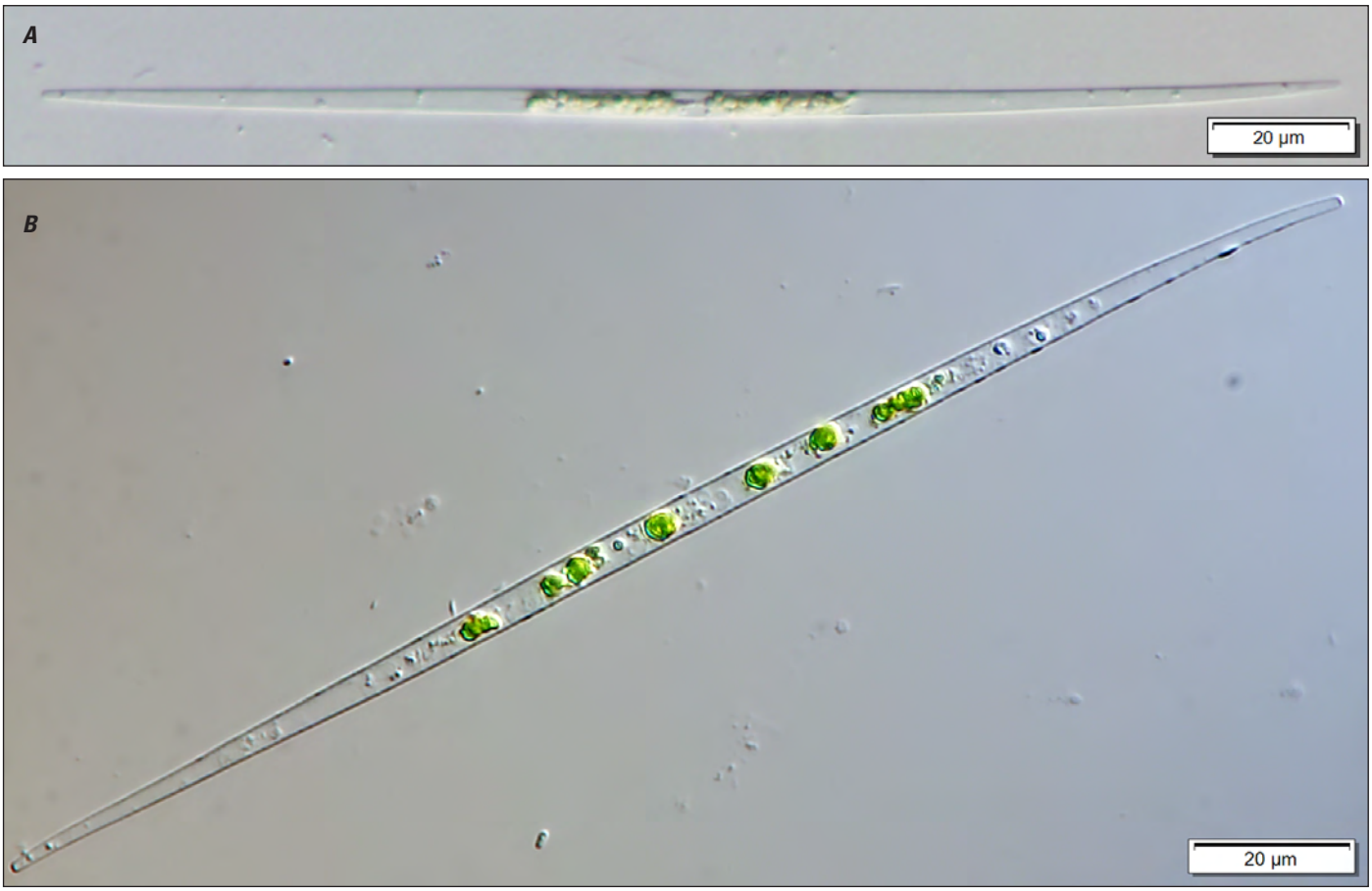


Figure 5. *Closterium aciculare*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium* cf. *angustatum* Kützing

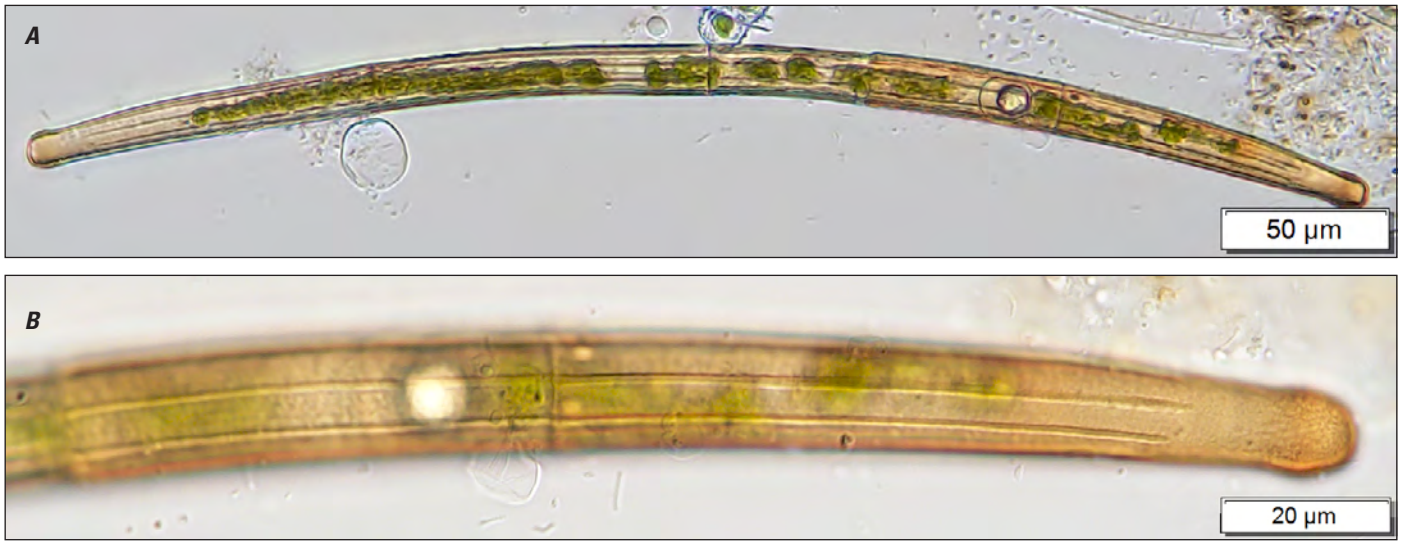


Figure 6. *Closterium* cf. *angustatum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium archerianum* Cleve ex P. Lundell

Figure 7. *Closterium archerianum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium baillyanum* (Brébisson ex Ralfs) Brébisson

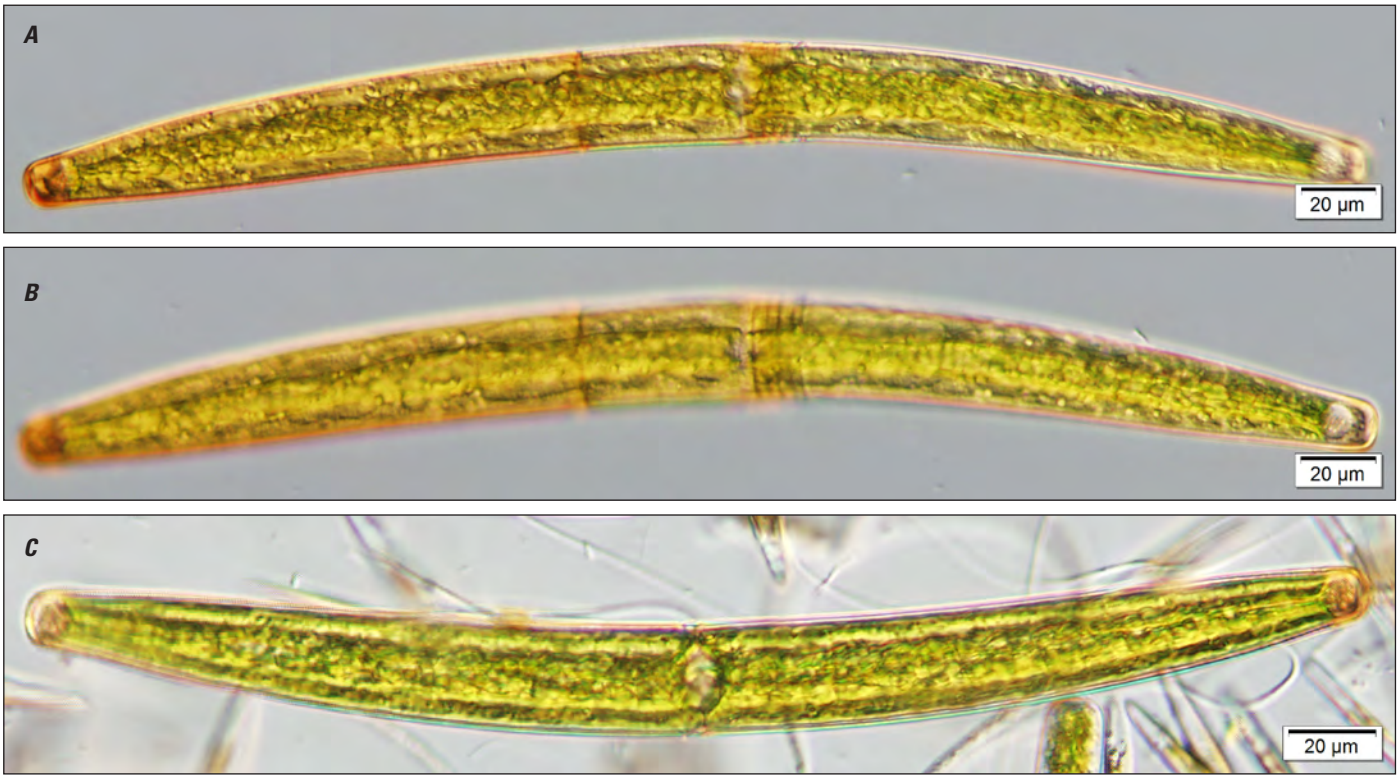


Figure 8. *Closterium baillyanum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium costatum* Corda ex Ralfs

Figure 9. *Closterium costatum.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium* cf. *cynthia* De Notaris

Figure 10. *Closterium* cf. *cynthia*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium ehrenbergii* Meneghini ex Ralfs

Figure 11. *Closterium ehrenbergii*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium juncidum* Ralfs

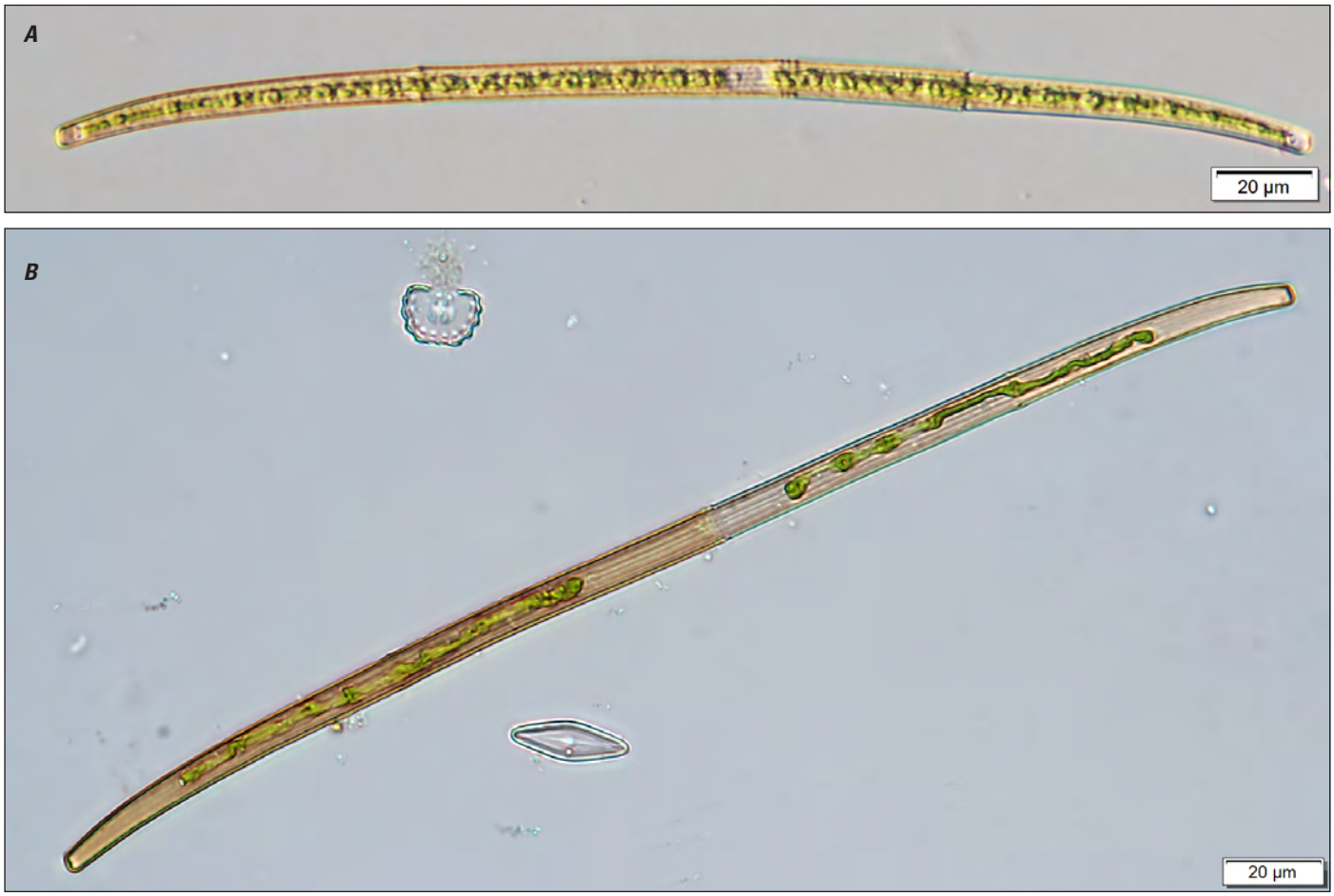


Figure 12. *Closterium juncidum.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium kuetzingii* Brébisson

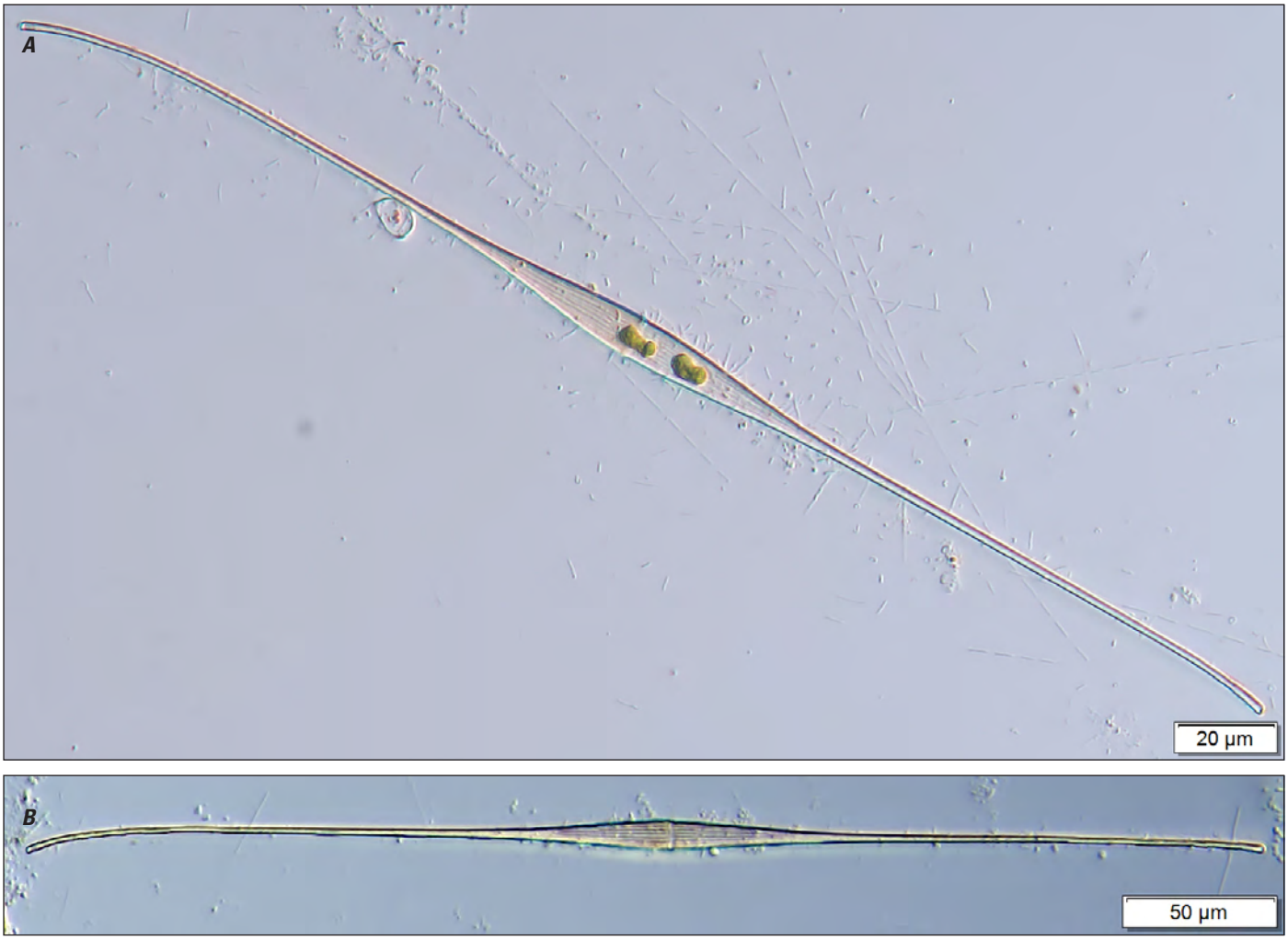


Figure 13. *Closterium kuetzingii.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium libellula* Focke ex Nordstedt

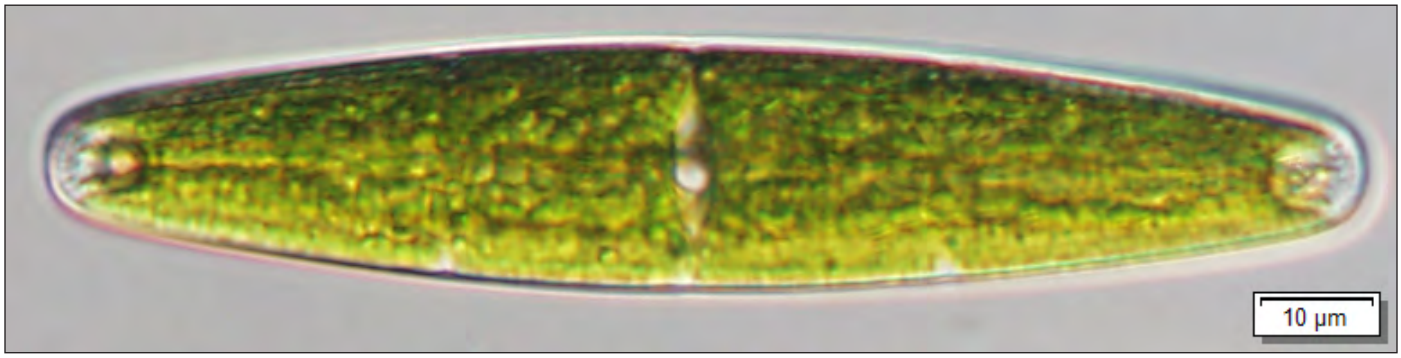


Figure 14. *Closterium libellula*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium lineatum* Ehrenberg ex Ralfs

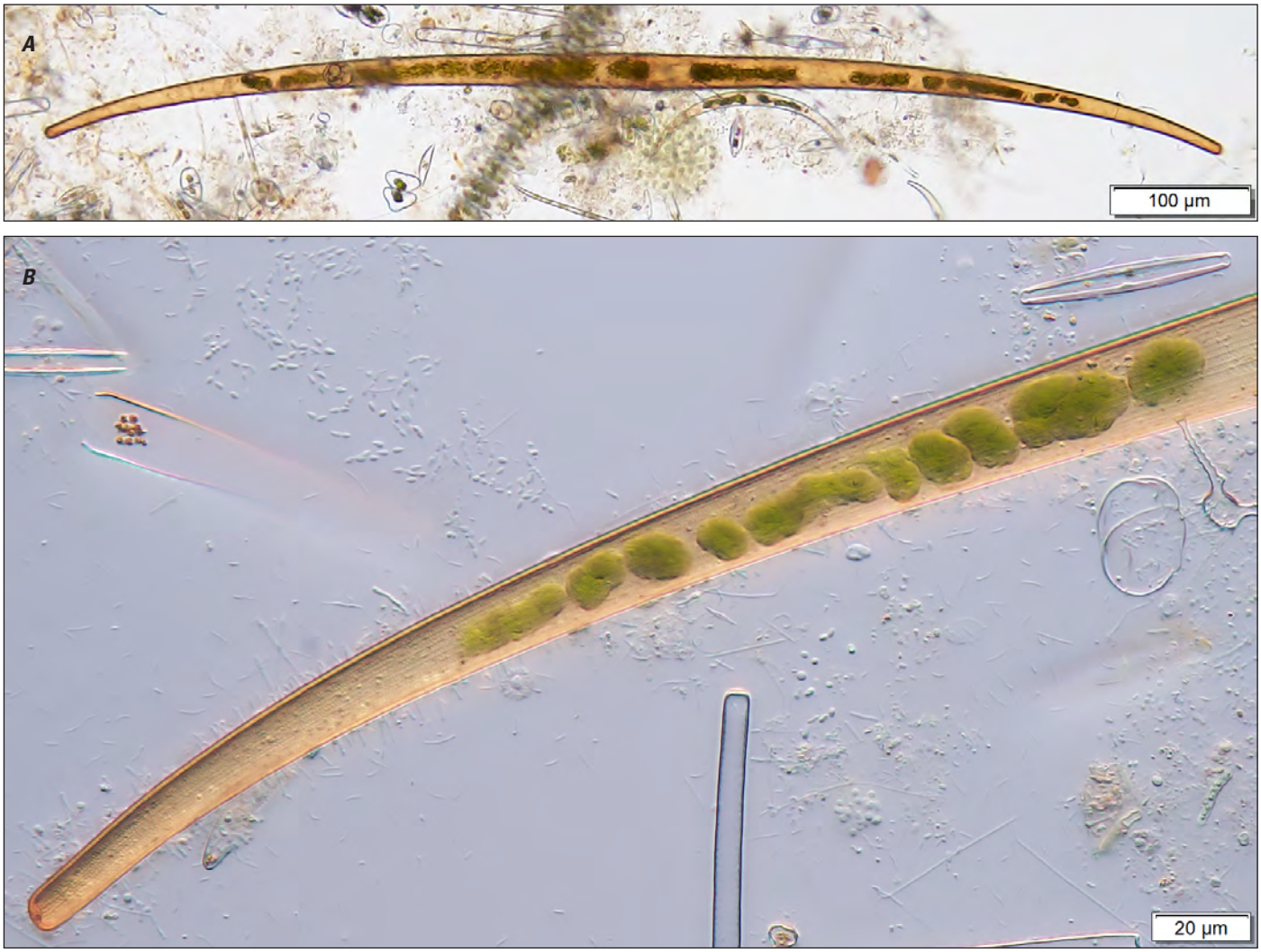


Figure 15. *Closterium lineatum.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium* cf. *littorale* Gay

Figure 16. *Closterium* cf. *littorale*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium lunula* Ehrenberg & Hemprich ex Ralfs

Figure 17. *Closterium lunula*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium moniliferum* Ehrenberg ex Ralfs

Figure 18. *Closterium moniliferum.*

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium navicula* (Brébisson) Lütkemüller

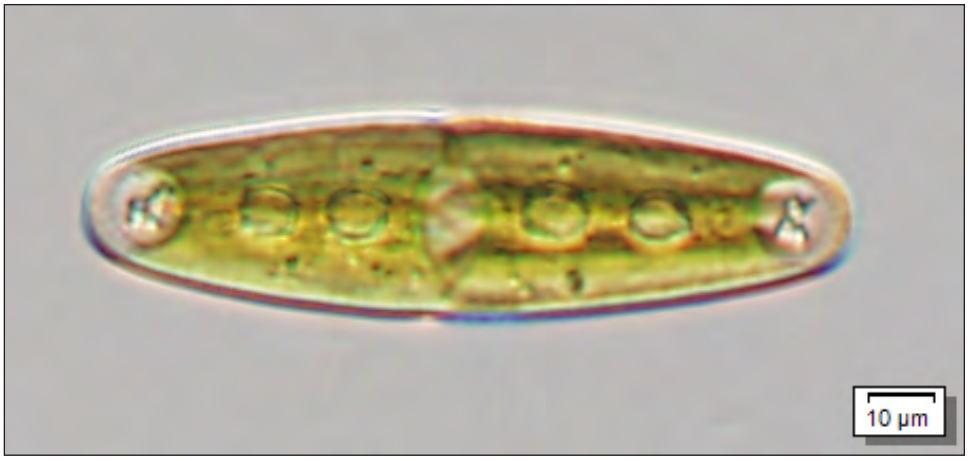


Figure 19. *Closterium navicula*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium ralfsii* var. *hybridum* Rabenhorst

Figure 20. *Closterium ralfsii* var. *hybridum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium striolatum* Ehrenberg ex Ralfs

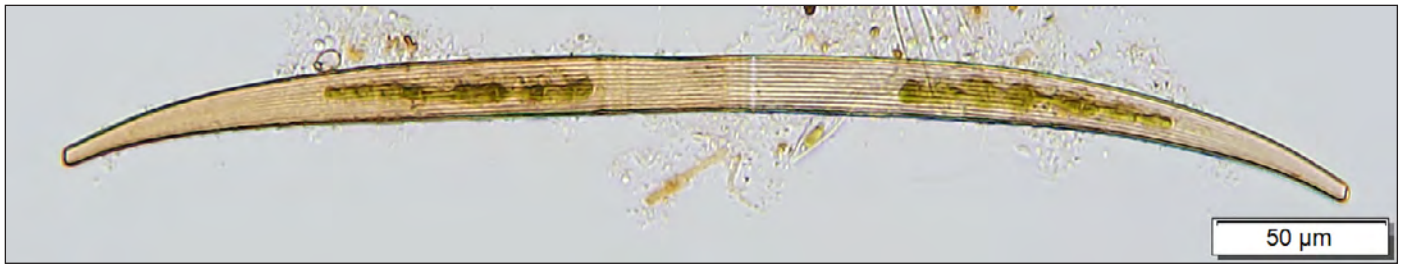


Figure 21. *Closterium striolatum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium turgidum* Ehrenberg ex Ralfs

Figure 22. *Closterium turgidum*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium ulna* Focke ex W.B. Turner

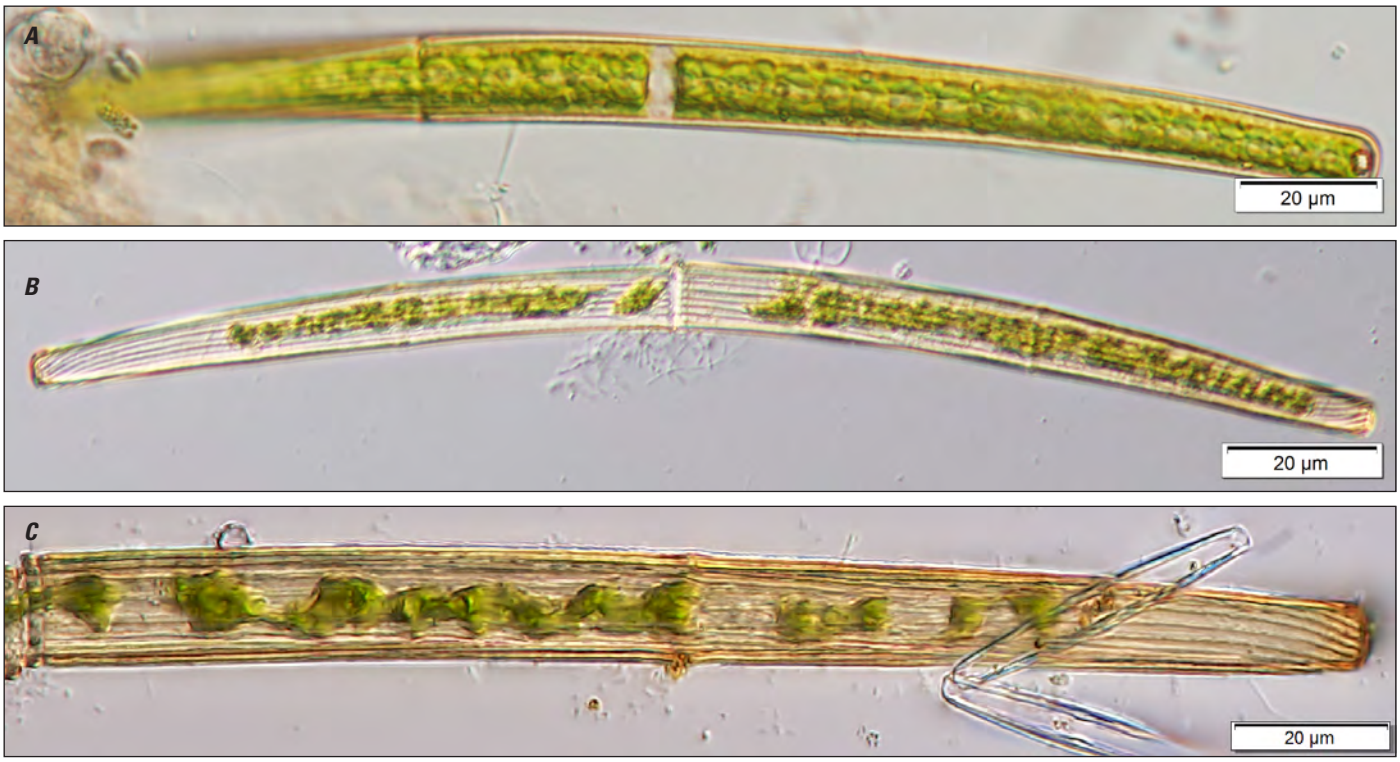


Figure 23. *Closterium ulna*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium venus* Kützing ex Ralfs

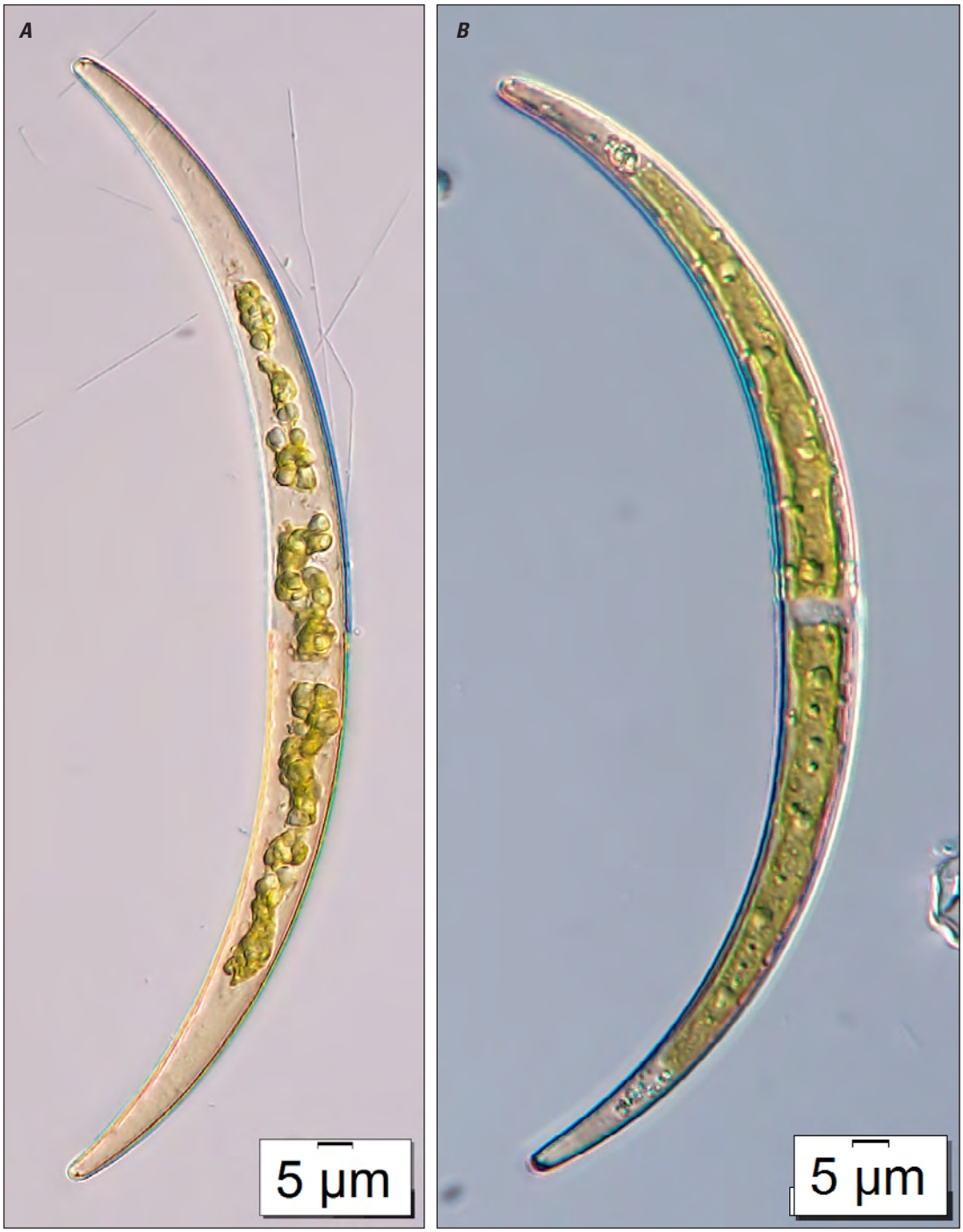


Figure 24. *Closterium venus*.

Order Desmidiales

Family Closteriaceae

Genus *Closterium*

Species *Closterium* sp.

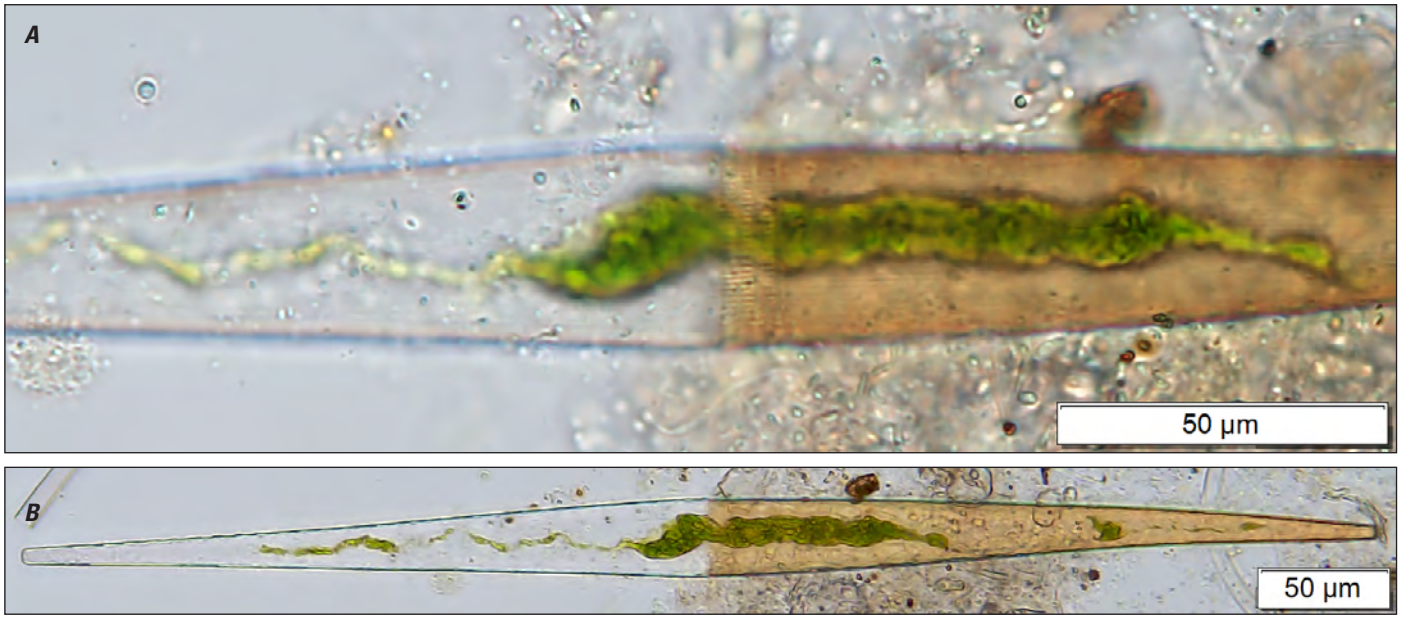


Figure 25. *Closterium* sp.

Spinoclosterium Bernard

The only species in this genus is *Spinoclosterium cuspidatum* (fig. 26). The cells of this species are shaped like many *Closterium* cells, but they have a large spine at each apex.

This species was rare in the refuge and was only found at the east interior site.

Order Desmidiales

Family Closteriaceae

Genus *Spinoclosterium*

Species *Spinoclosterium cuspidatum* (Bailey) Hirano

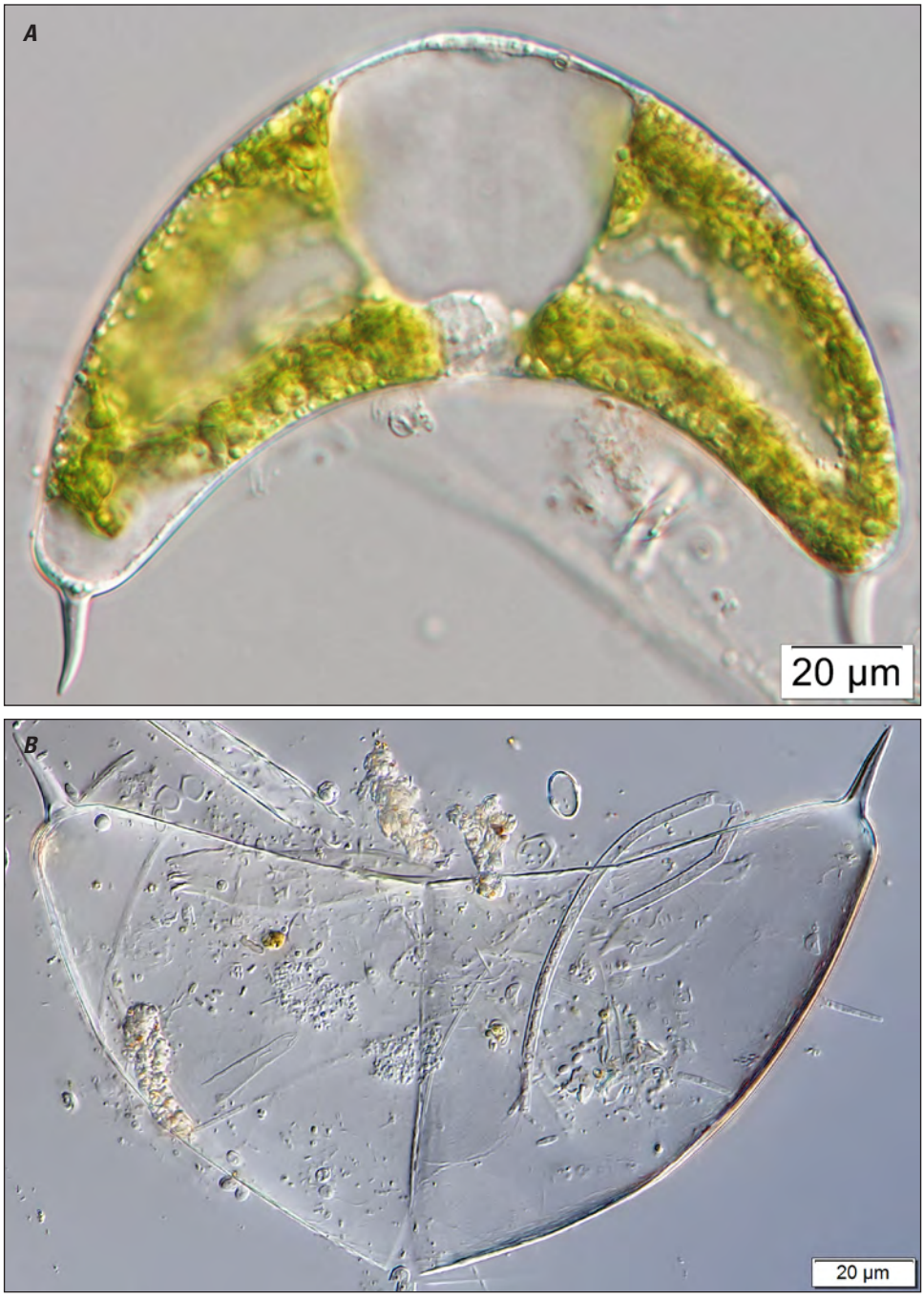


Figure 26. *Spinoclosterium cuspidatum.*

Actinotaenium (Nägeli) Teiling

Cells have a very small median constriction and elongated semicells. The cells are always radially symmetric (circular) in apical view, which can aid in distinguishing them from other genera such as *Cosmarium*. The cell wall is smooth, although pores may be visible and can often be mistaken for granules. There is a single chloroplast in each semicell, which is either stellate or asteroid with a central pyrenoid.

Two identified species and two unidentified species of *Actinotaenium* were found in the refuge (figs. 27–30). This genus was found at all sites except the west perimeter. *Actinotaenium* cells were relatively rare in all samples.

Order Desmidiales

Family Desmidiaceae

Genus *Actinotaenium*

Species *Actinotaenium adelochondrum* (Elfving) Teiling

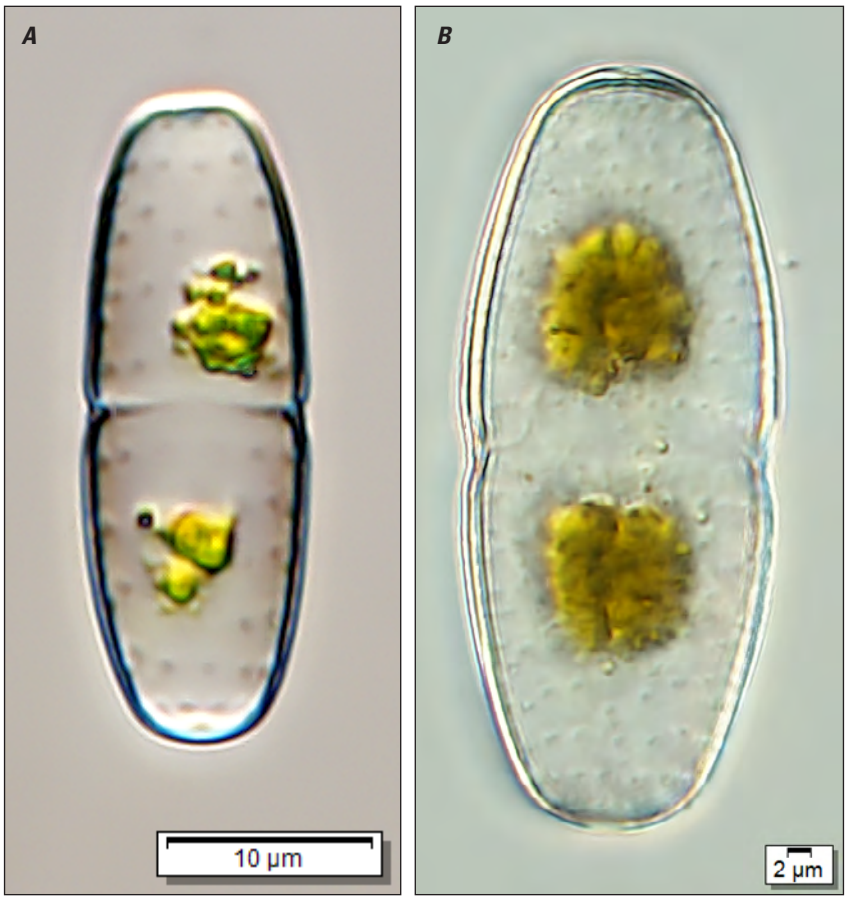


Figure 27. *Actinotaenium adelochondrum.*

Order Desmidiales

Family Desmidiaceae

Genus *Actinotaenium*

Species *Actinotaenium diplosporum* (P. Lundell) Teiling

Figure 28. *Actinotaenium diplosporum.*

Order Desmidiales

Family Desmidiaceae

Genus *Actinotaenium*

Species *Actinotaenium* sp.

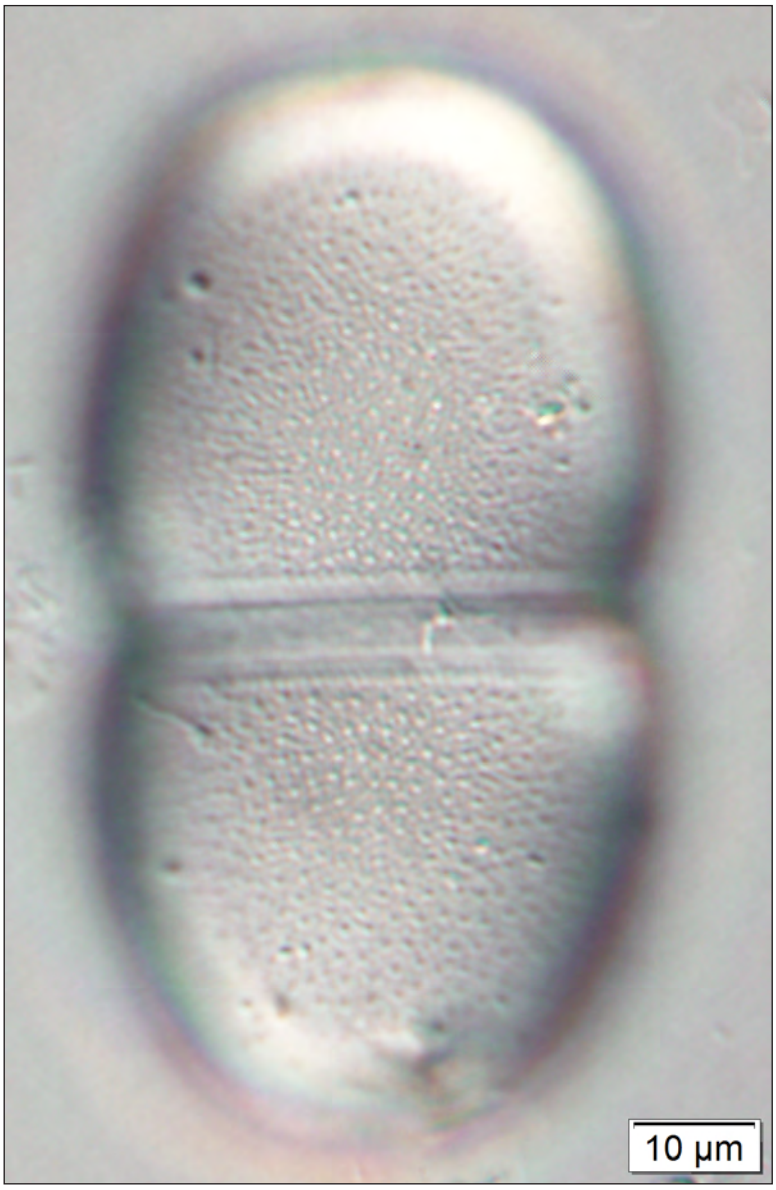


Figure 29. *Actinotaenium* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Actinotaenium*

Species *Actinotaenium* sp.

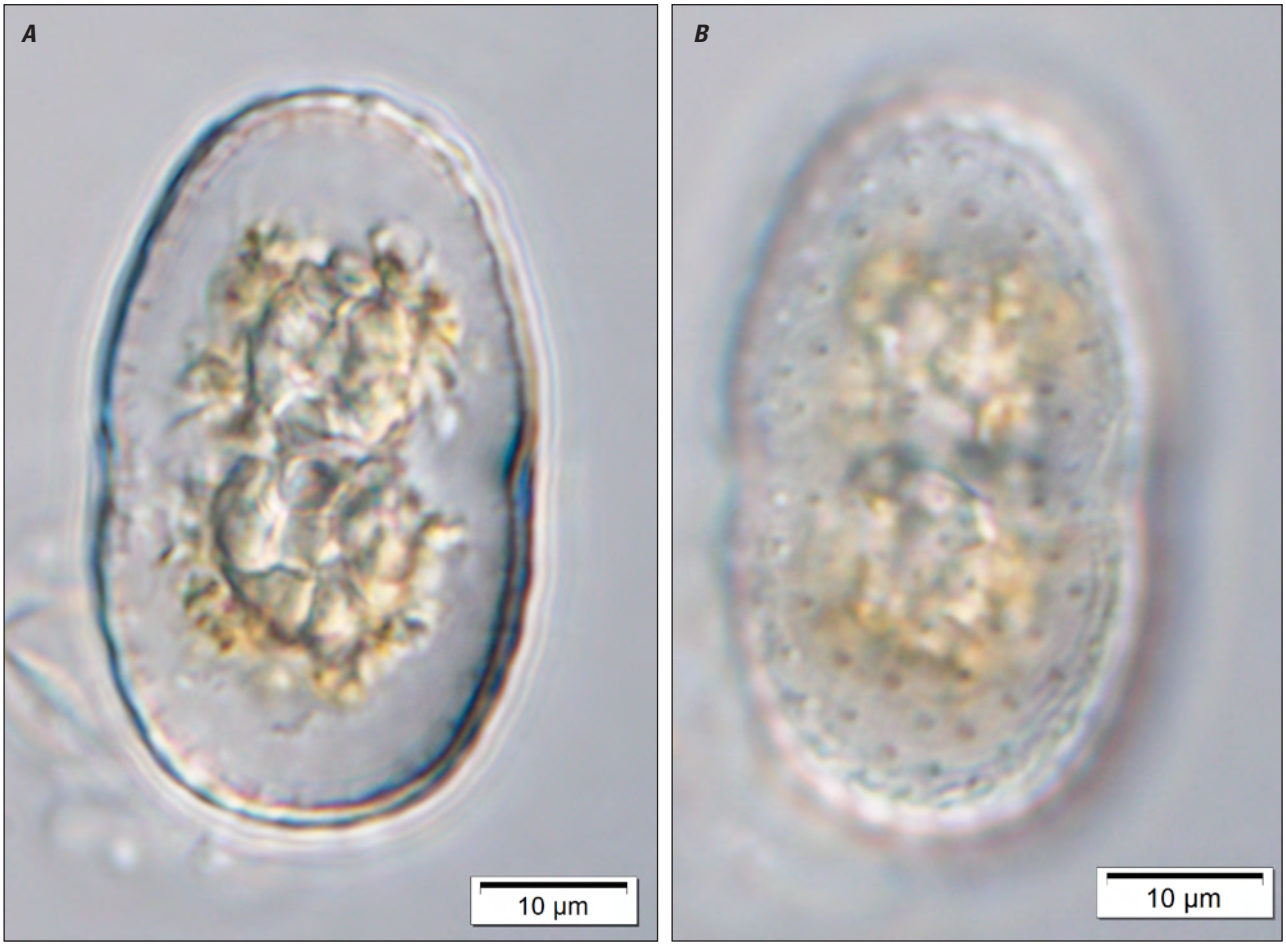


Figure 30. *Actinotaenium* sp.

Bambusina Kützing

Cells are barrel shaped and form filaments. They are swollen in the midregion, near the suture of the cell. The cell wall is mostly smooth, although rows of pores can sometimes be seen near the apex. The chloroplast is stellate and axial.

Only one species, *Bambusina borreri*, was found in the refuge (fig. 31). It was found at all sites except the west perimeter.

Order Desmidiales

Family Desmidiaceae

Genus *Bambusina*

Species *Bambusina borreri* (Ralfs) Cleve

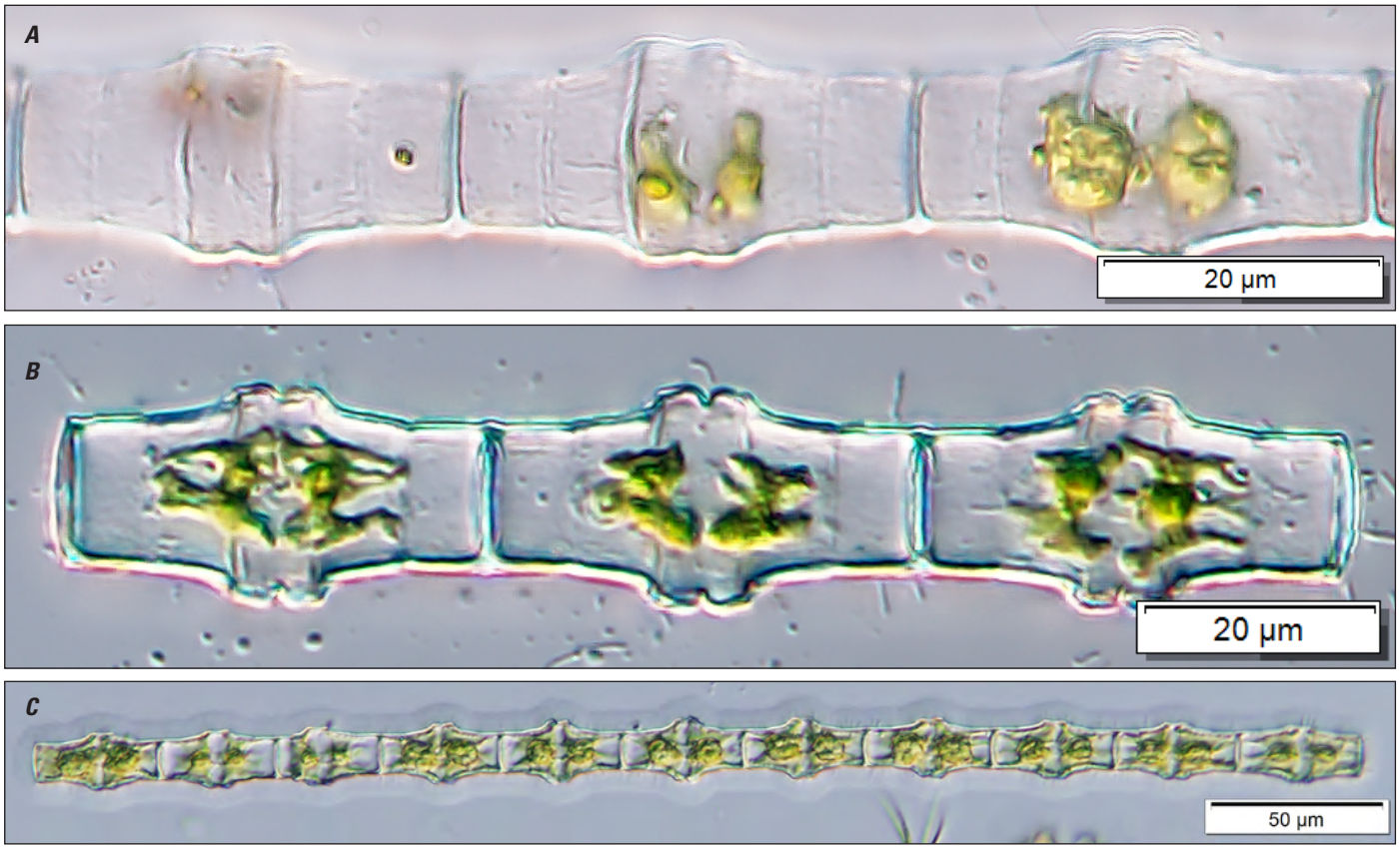


Figure 31. *Bambusina borreri.*

Cosmarium Corda ex Ralfs

Cells are variable in shape but are compressed in apical view. The cell walls are often ornamented with granules, papillae, scrobiculations, and pores (fig. 32). This ornamentation and the shape (outline) of the cell and chloroplasts are often used to identify the species of cell.

Cosmarium was the most common genus in the refuge, with 66 taxa identified (figs. 32–98). This genus was found at all sites sampled. Some taxa, such as *Cosmarium ovale* var. *subglabrum* and *Cosmarium moniliforme* var. *indentatum*, were only found at the east interior site. Others, such as *Cosmarium pyramidatum* and *Cosmarium inaequalinotatum*, were more common and found at every site, including the west perimeter.

Figure 32. *A*, *Cosmarium papilliferum* has papillae (P) and scrobiculations (S). *B*, *Cosmarium phaseolus* has a small protuberance in the midregion of the cell. *C*, *Cosmarium nymannianum* has a single large middle pore, surrounded by scattered, smaller pores. *D*, *Cosmarium isthmochondrum* is ornamented with granules.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium amoenum* Brébisson ex Ralfs

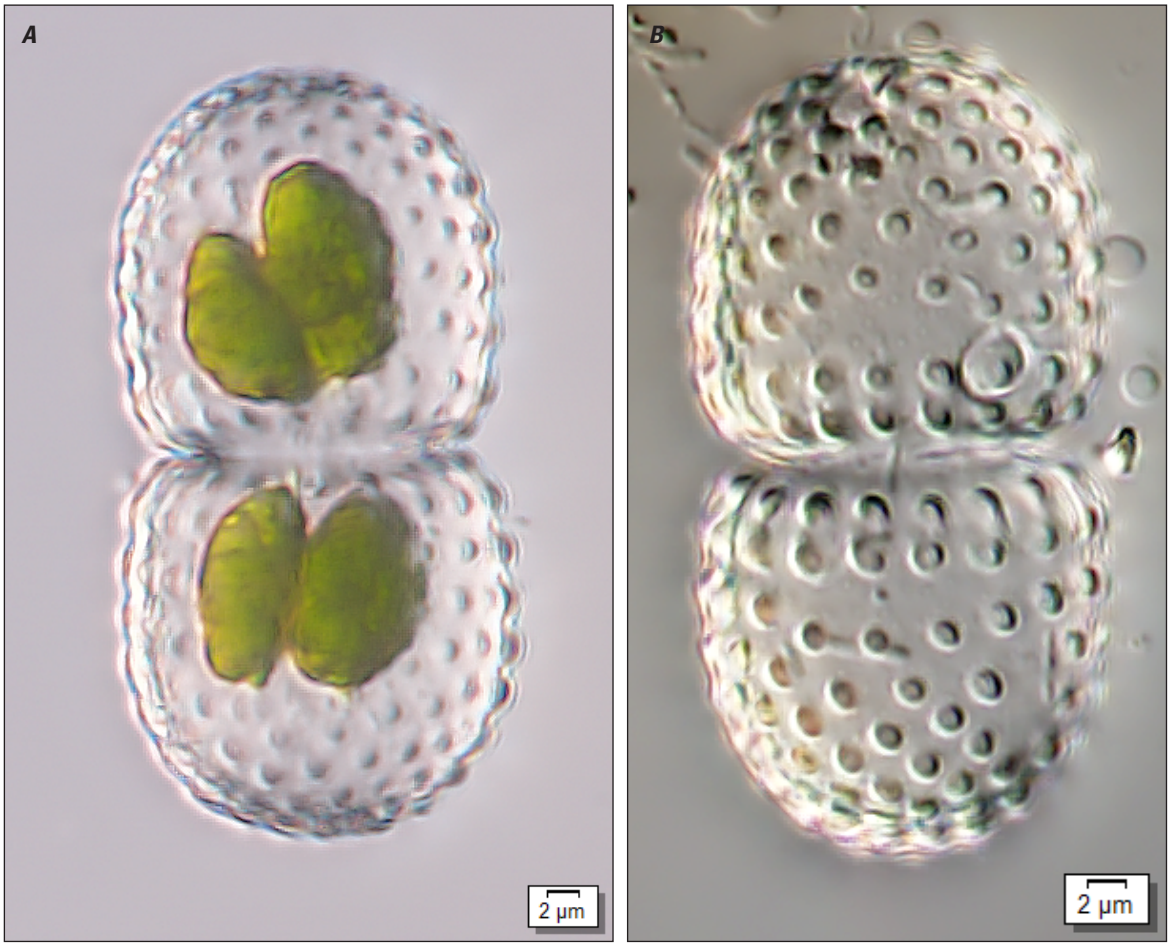


Figure 33. *Cosmarium amoenum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium amoenum* var. *constrictum* Scott & Grönblad

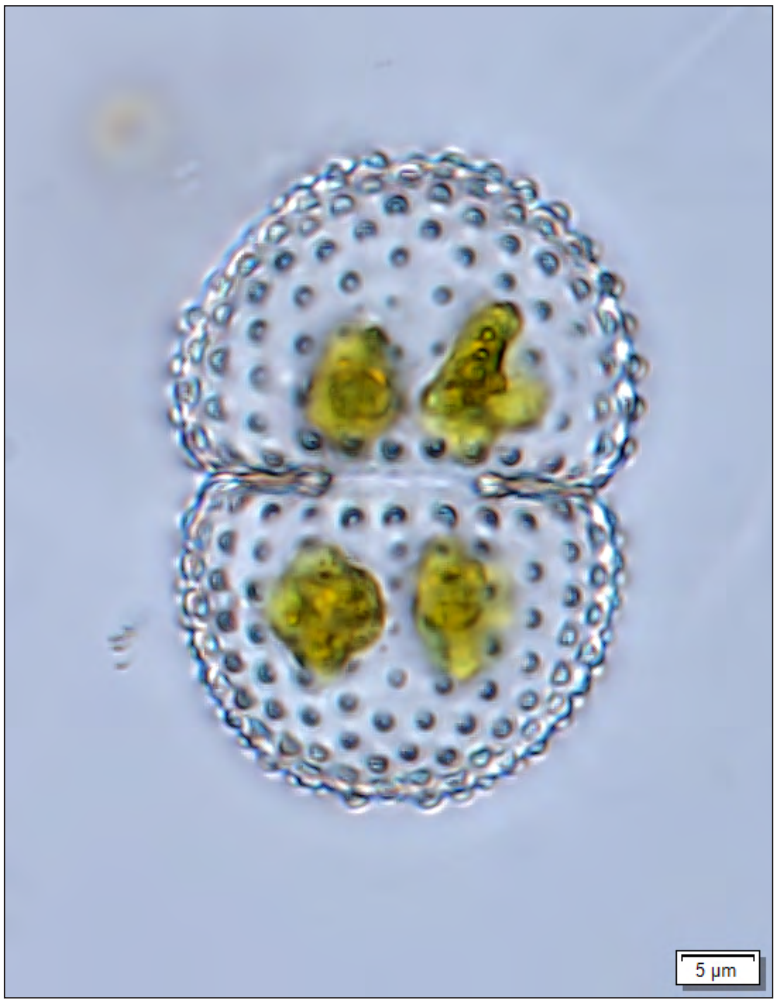


Figure 34. *Cosmarium amoenum* var. *constrictum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium angulosum* Brébisson

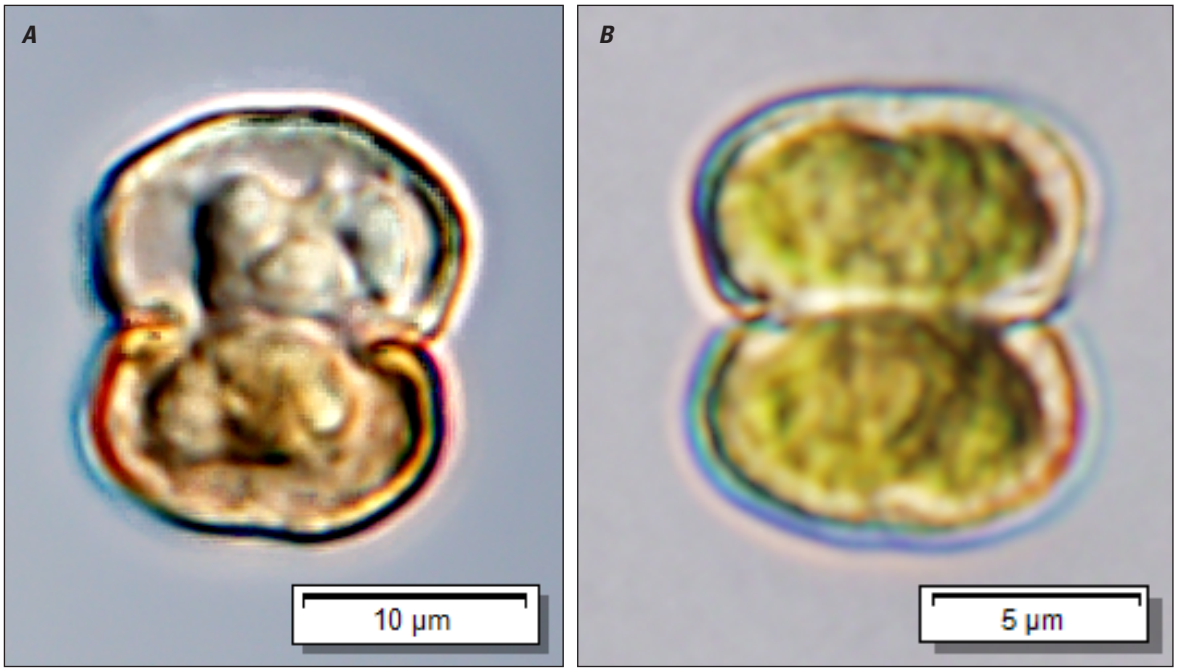


Figure 35. *Cosmarium angulosum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium bimamillatum* var. *evolutum* C.E. Bicudo

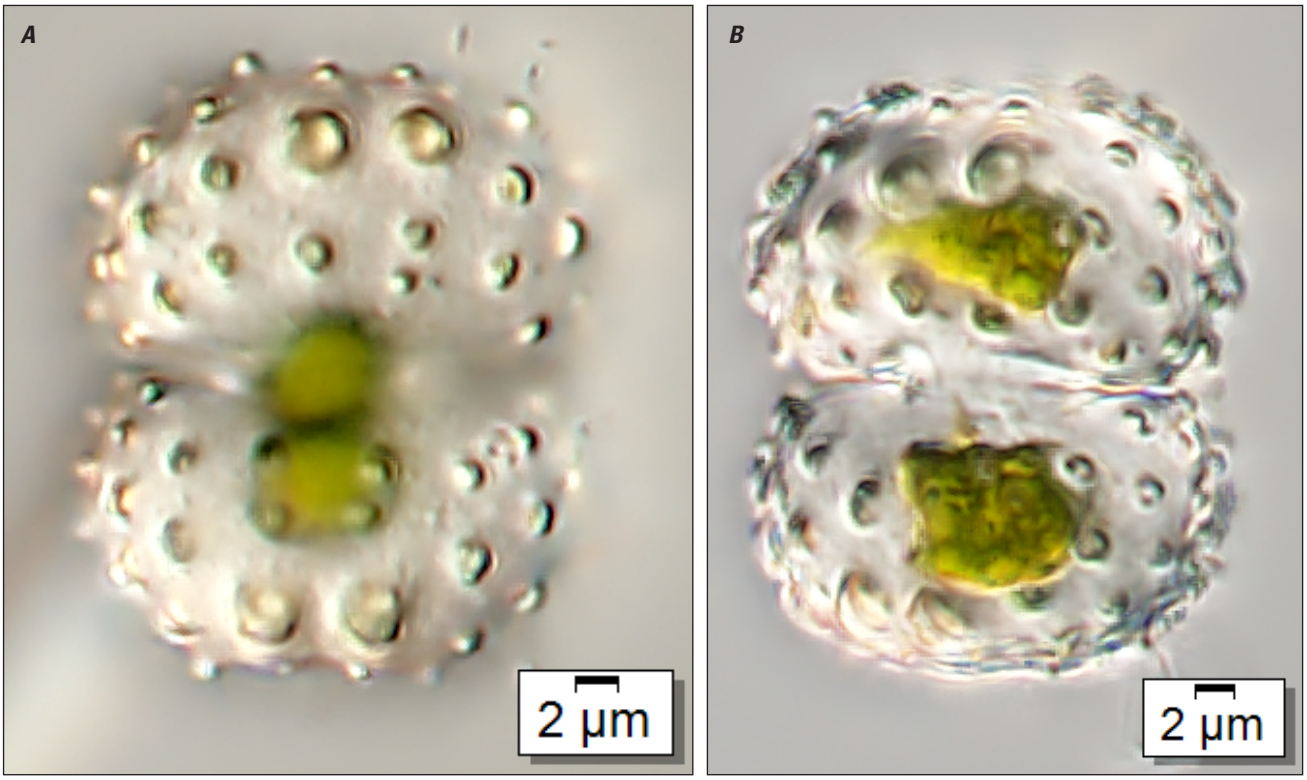


Figure 36. *Cosmarium bimamillatum* var. *evolutum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium binum* Nordstedt

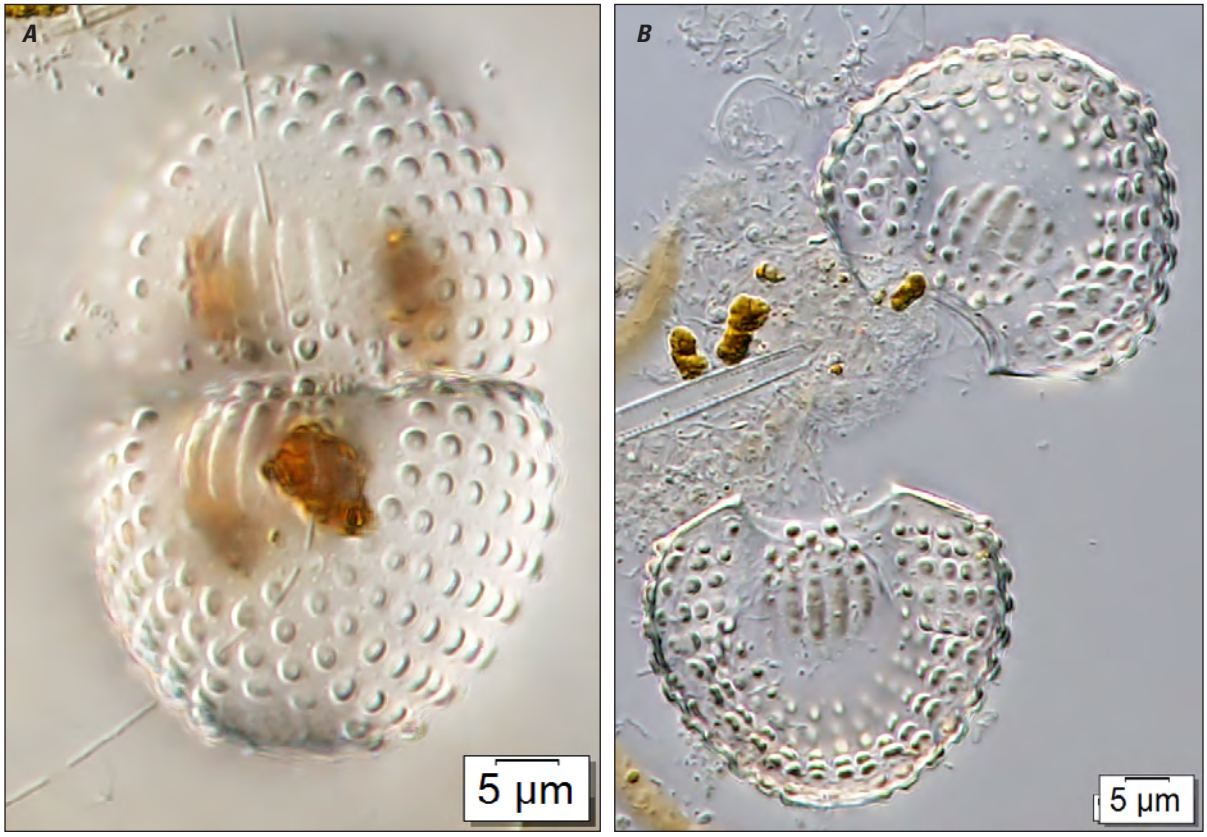


Figure 37. *Cosmarium binum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium bioculatum* var. *hians* West and West

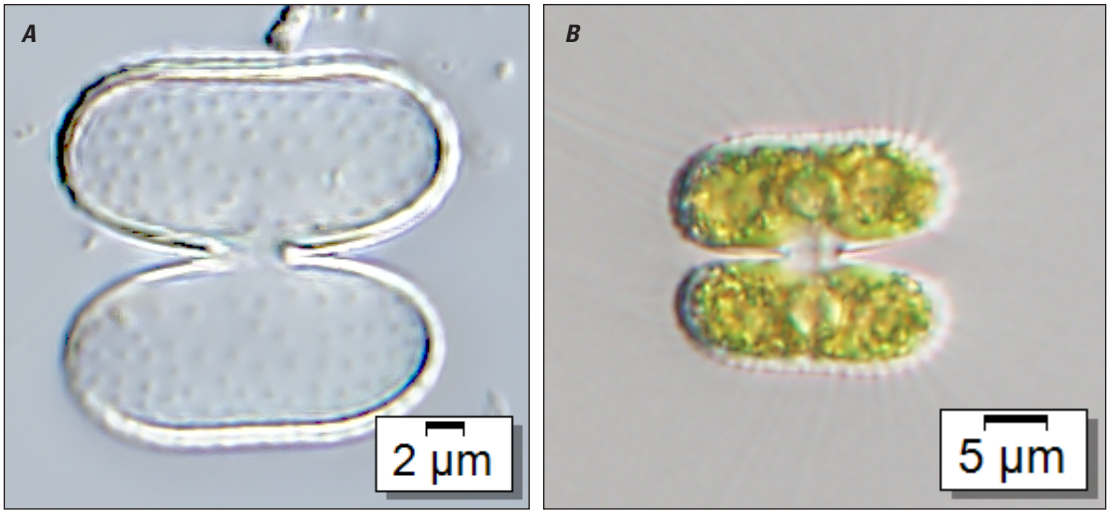


Figure 38. *Cosmarium bioculatum* var. *hians*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium botrytis* Meneghini ex Ralfs

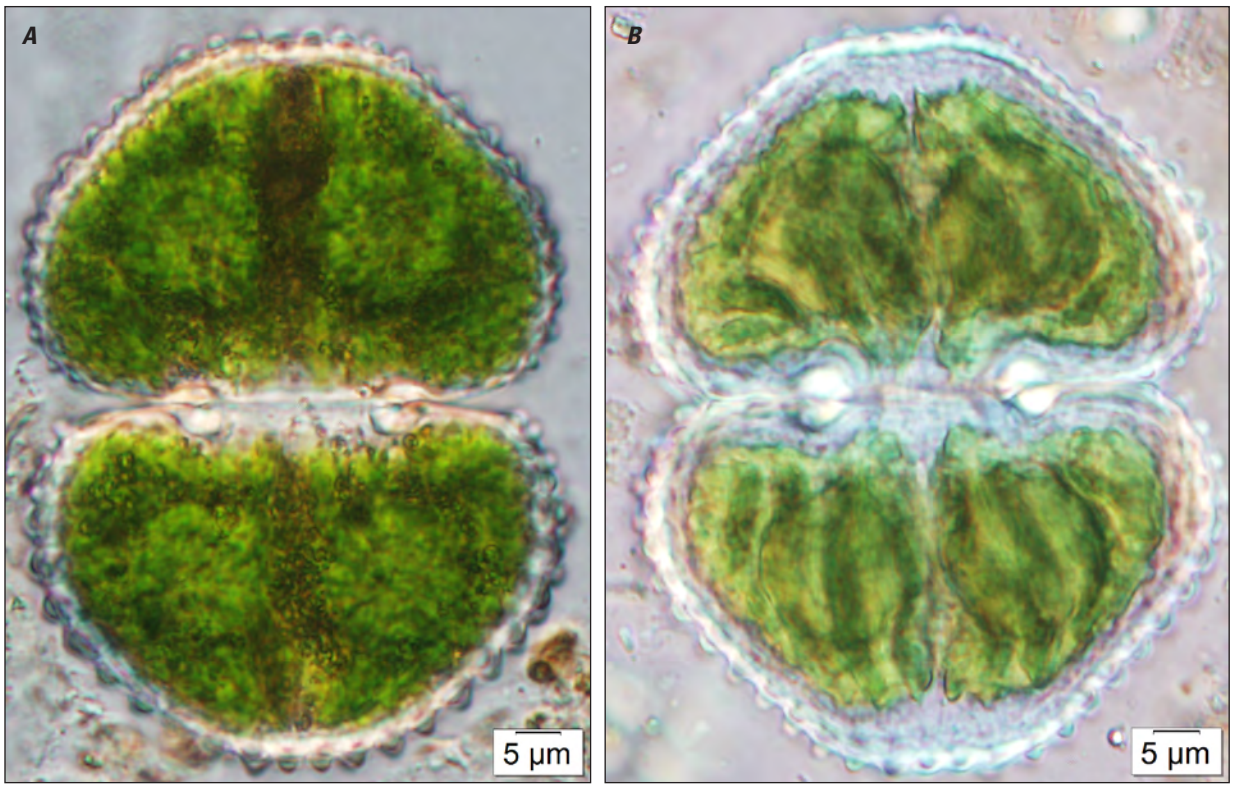


Figure 39. *Cosmarium botrytis*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium candianum* Delponte

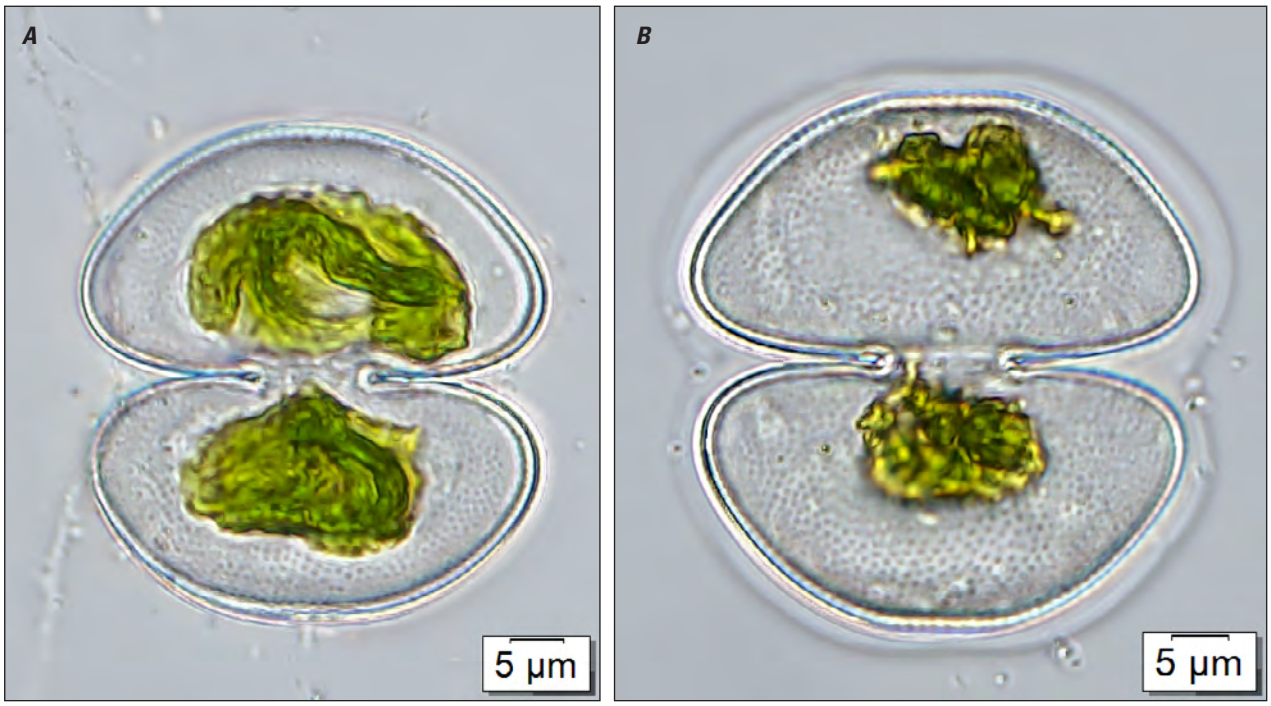


Figure 40. *Cosmarium candianum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium claviferum* Cushman

Figure 41. *Cosmarium claviferum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium clepsydra* Nordstedt

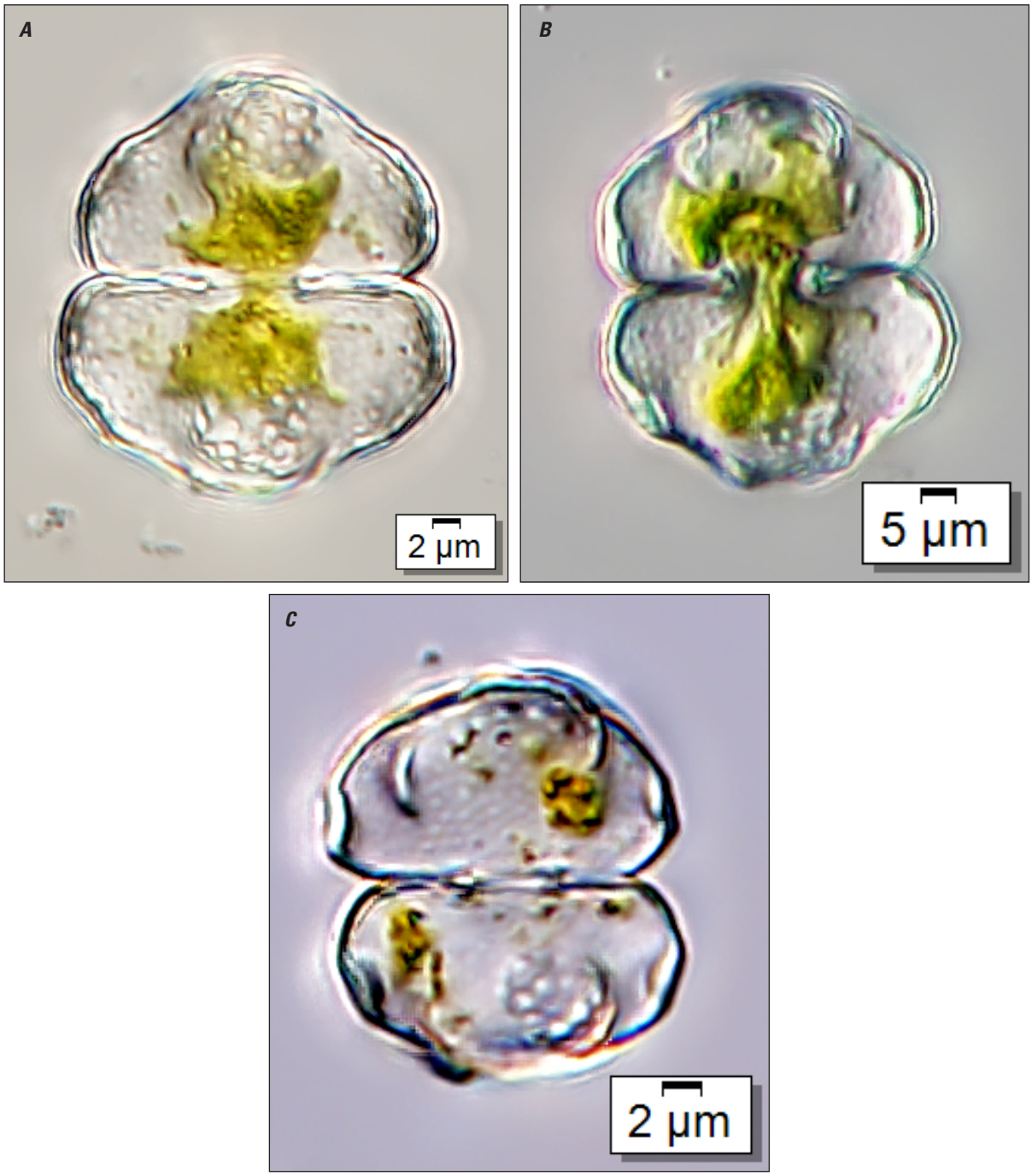


Figure 42. *Cosmarium clepsydra.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium contractum* Kirchner

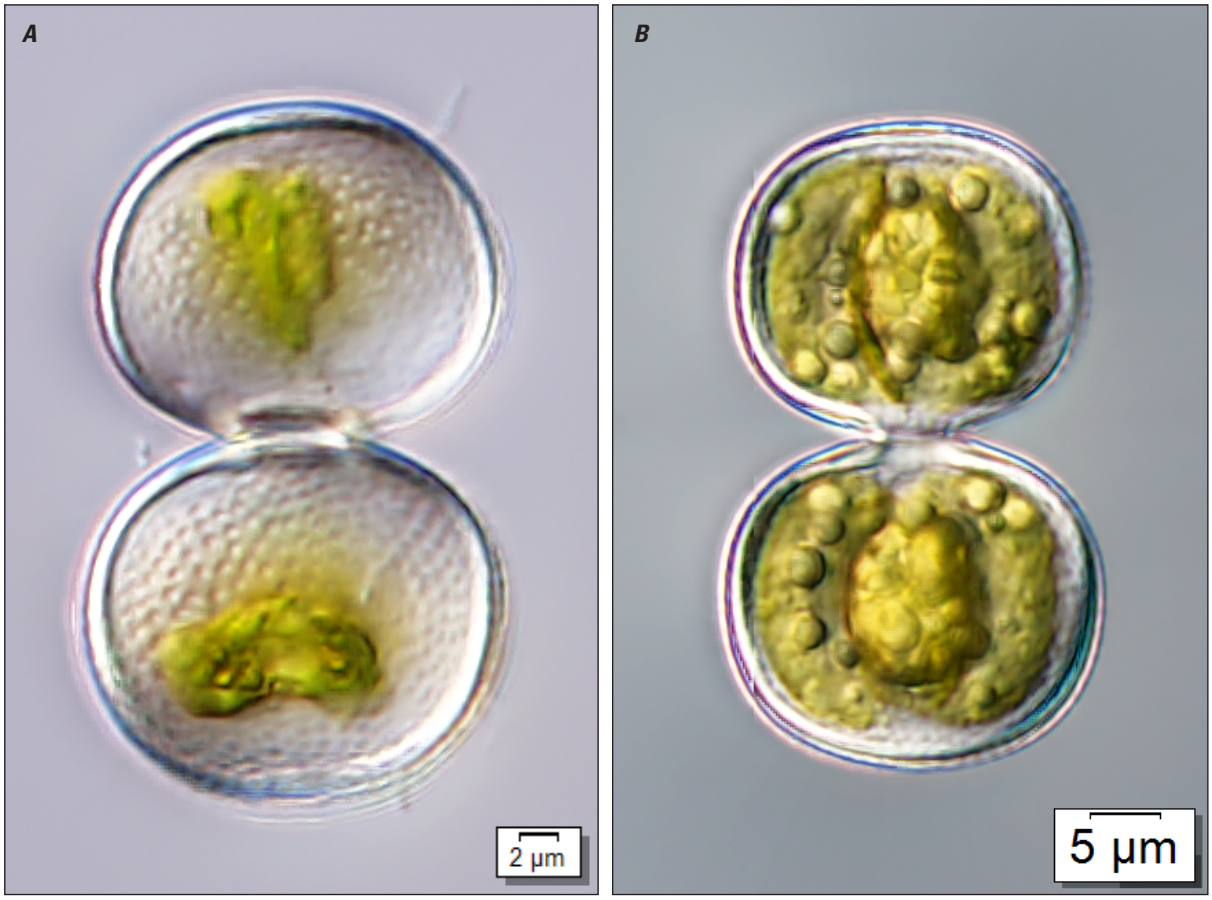


Figure 43. *Cosmarium contractum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium dentatum* Wolle

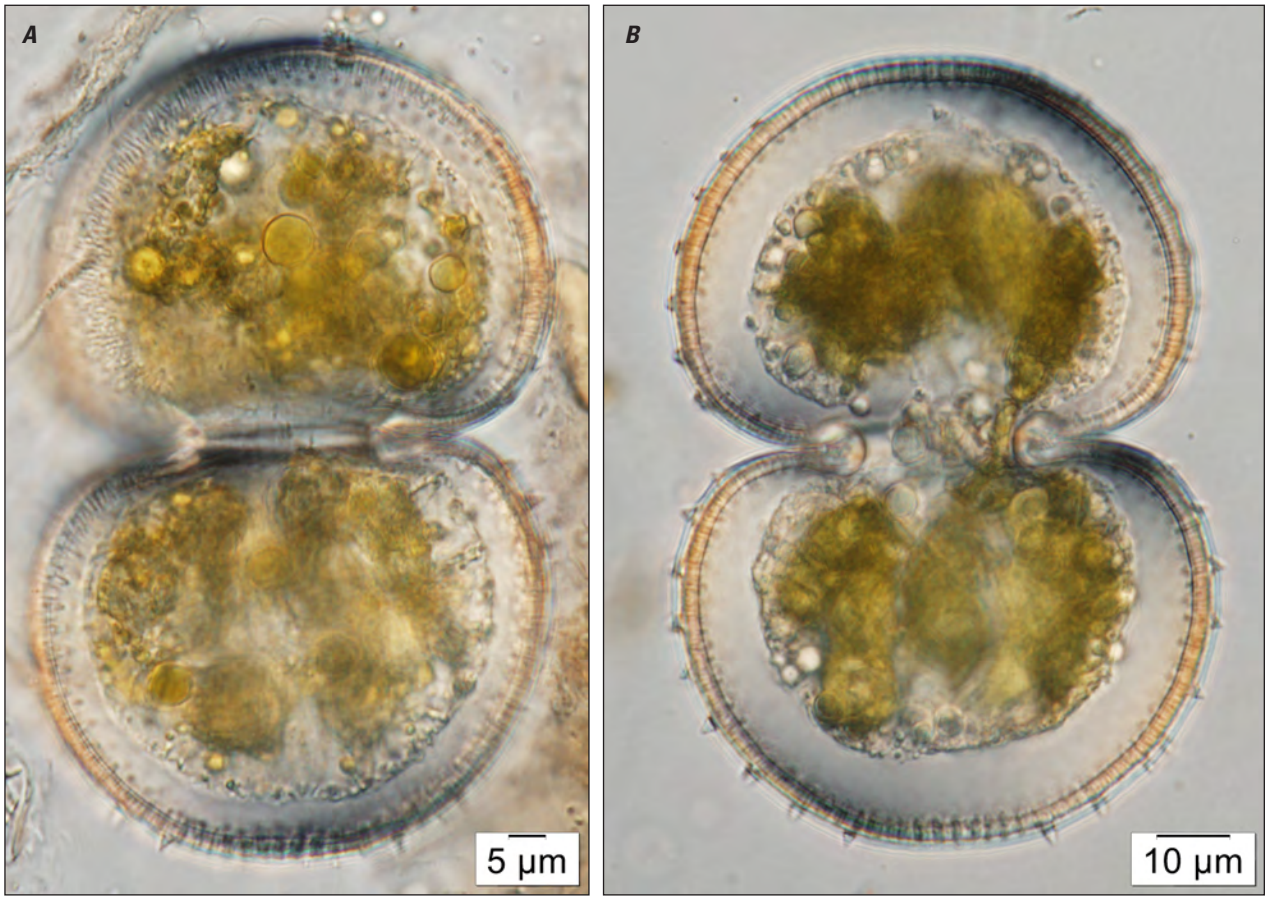


Figure 44. *Cosmarium dentatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium difficile* Lütkemüller

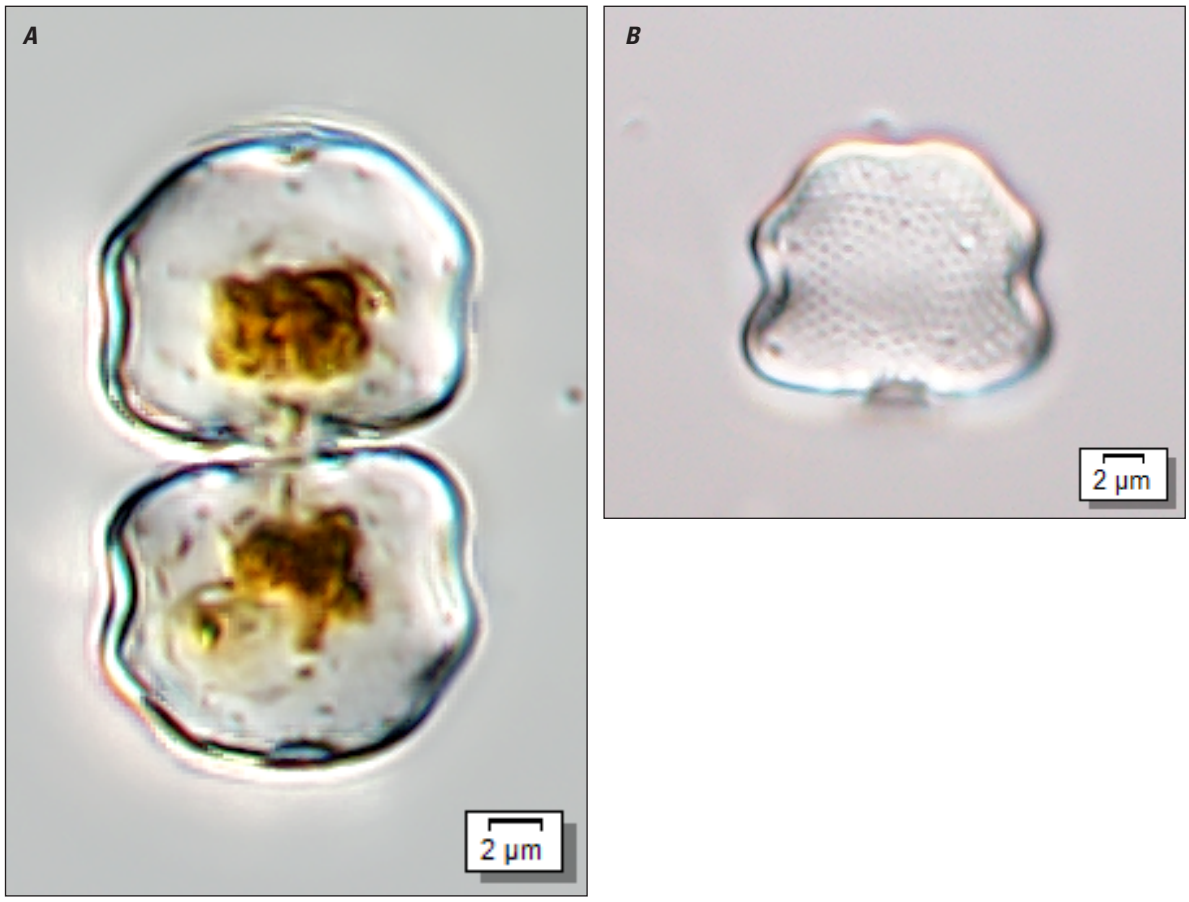


Figure 45. *Cosmarium difficile*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium difficile* var. *depressum* Scott & Grönblad

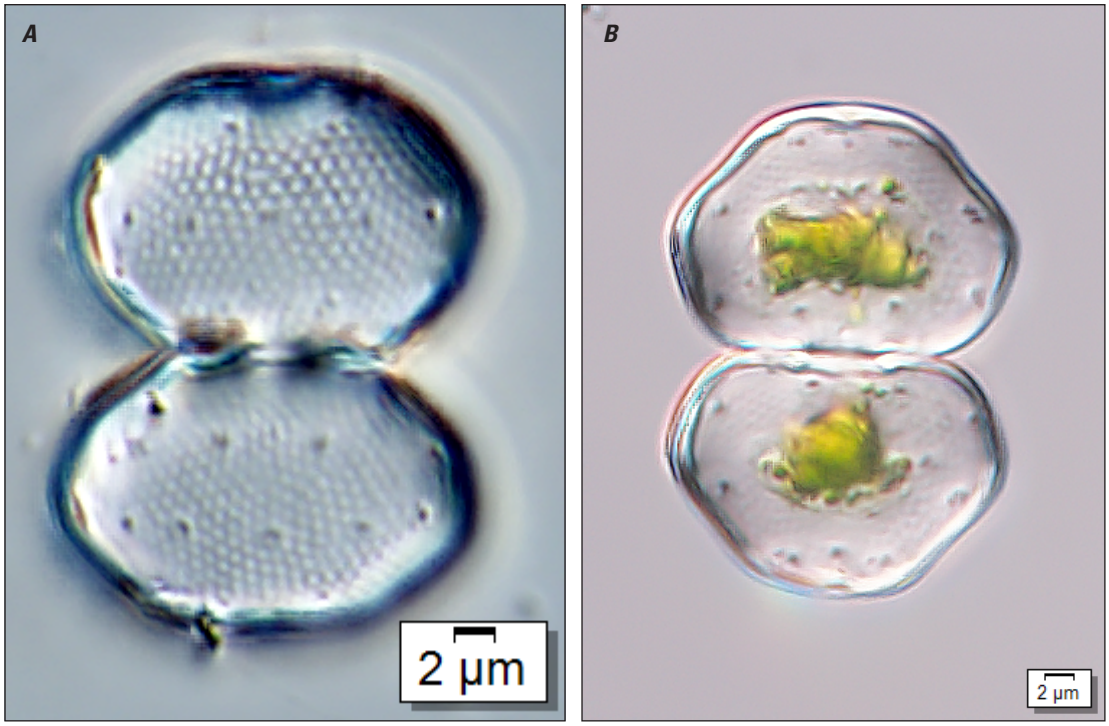


Figure 46. *Cosmarium difficile* var. *depressum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium excavatum* var. *duplo-maius* (Wille) Kurt Förster

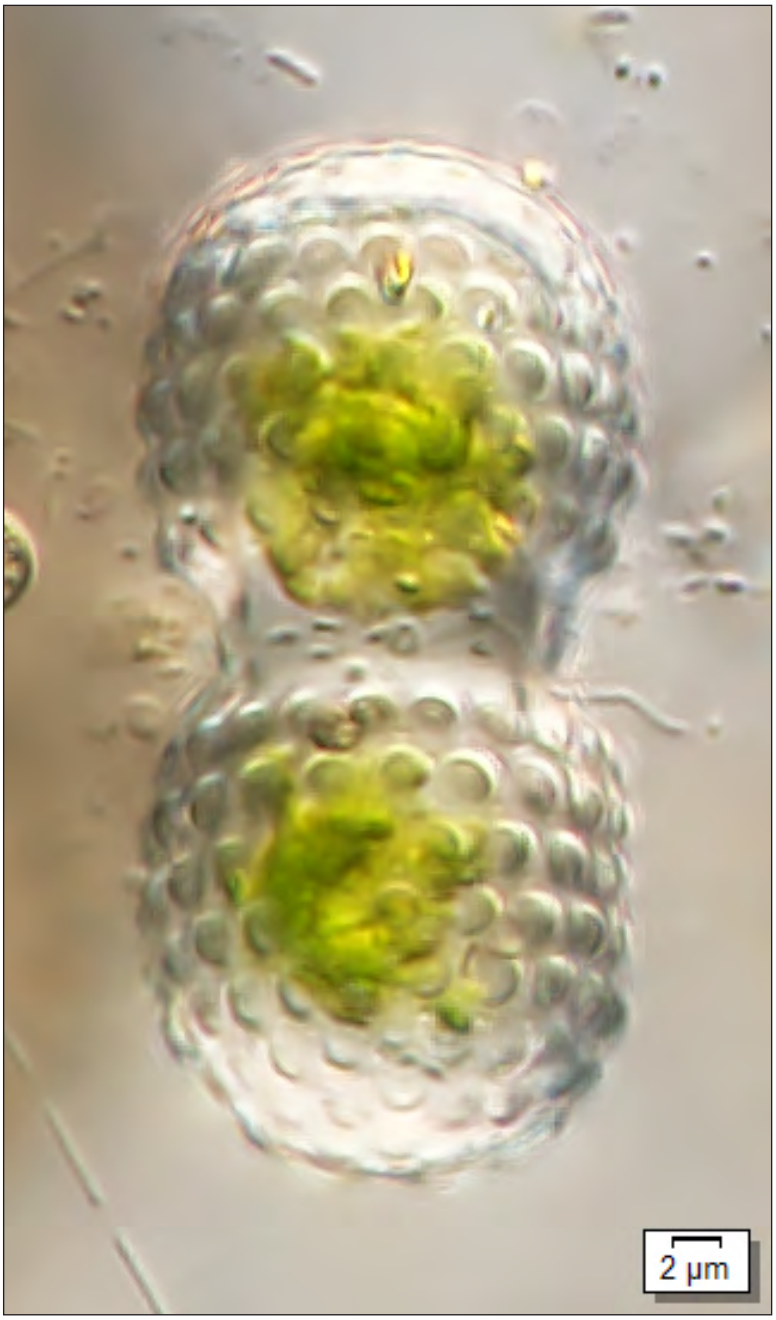


Figure 47. *Cosmarium excavatum* var. *duplo-maius*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium exiguum* Archer

Figure 48. *Cosmarium exiguum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium goniodes* West & West

Figure 49. *Cosmarium goniodes*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium granatum* Brébisson ex Ralfs

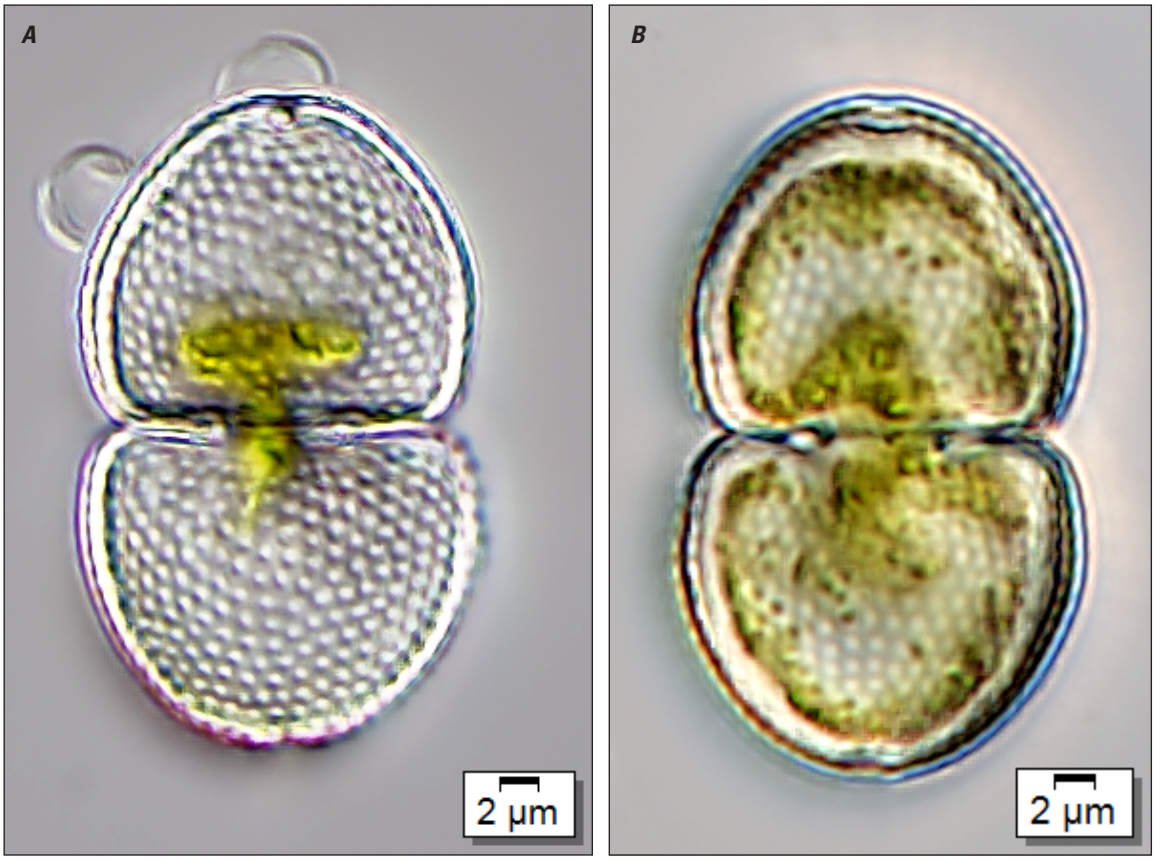


Figure 50. *Cosmarium granatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* cf. *hammeri* Reinsch

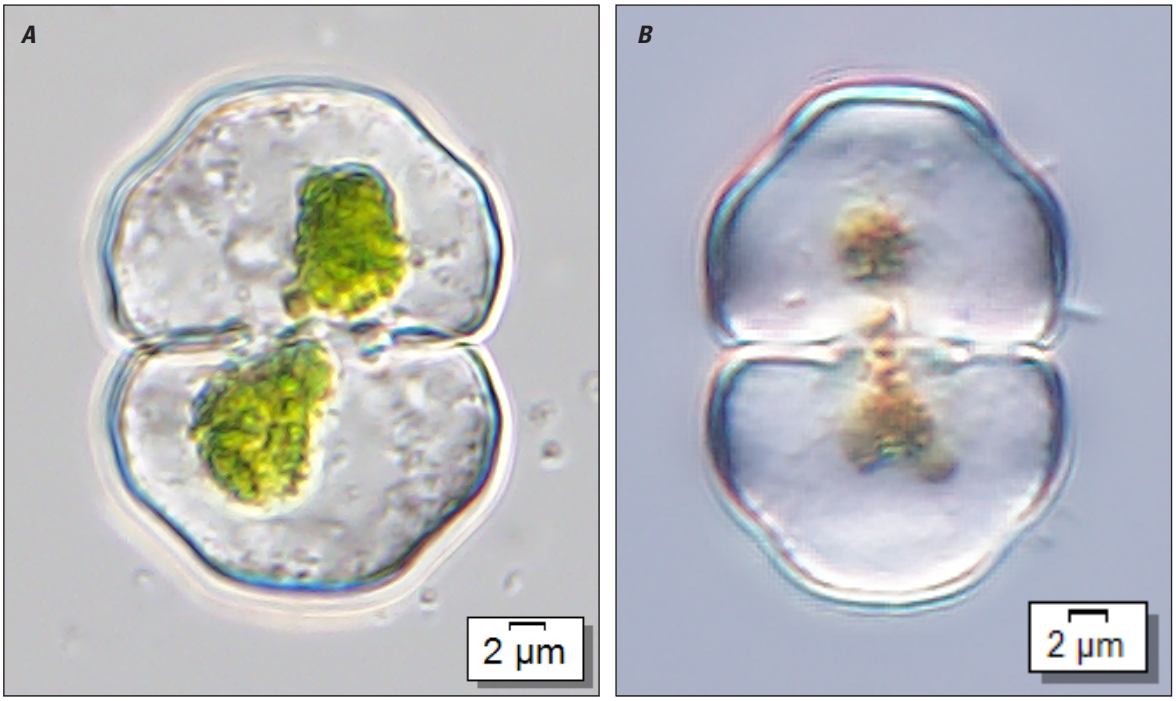


Figure 51. *Cosmarium* cf. *hammeri*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium impressulum* Elfving

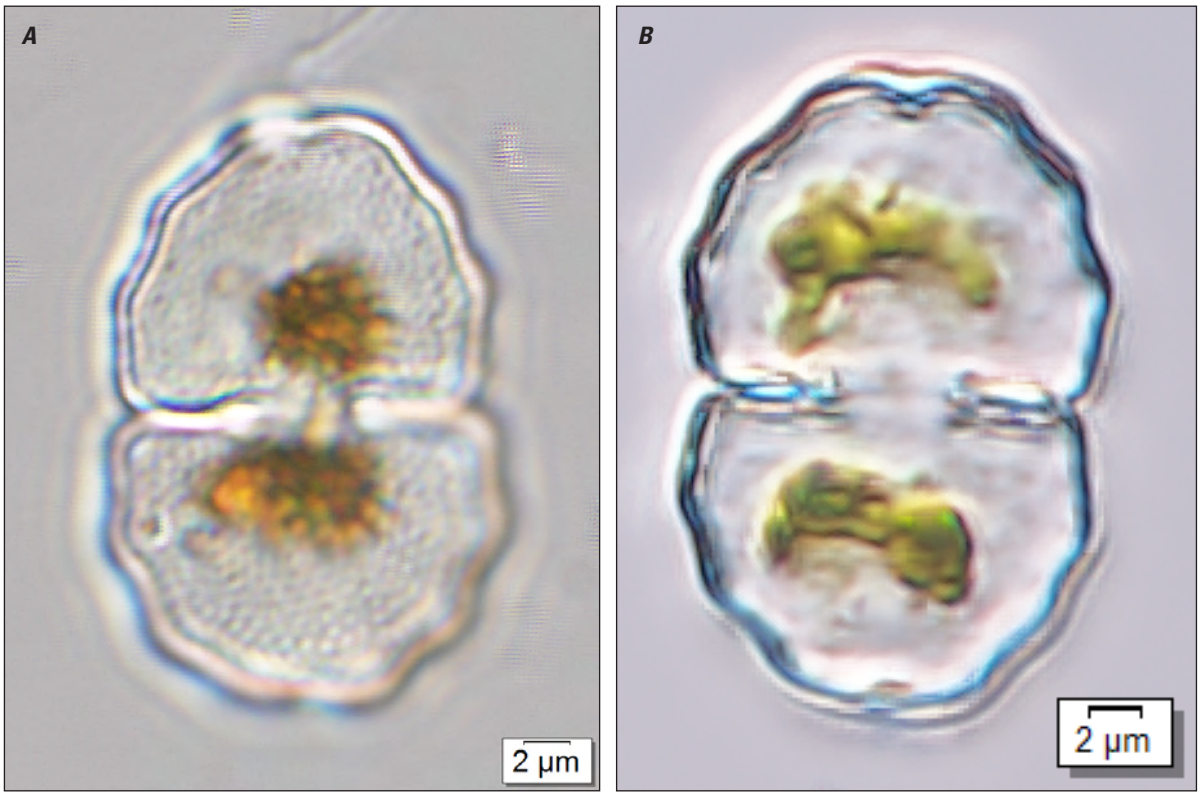


Figure 52. *Cosmarium impressulum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium inaequalinotatum* Scott & Grönblad

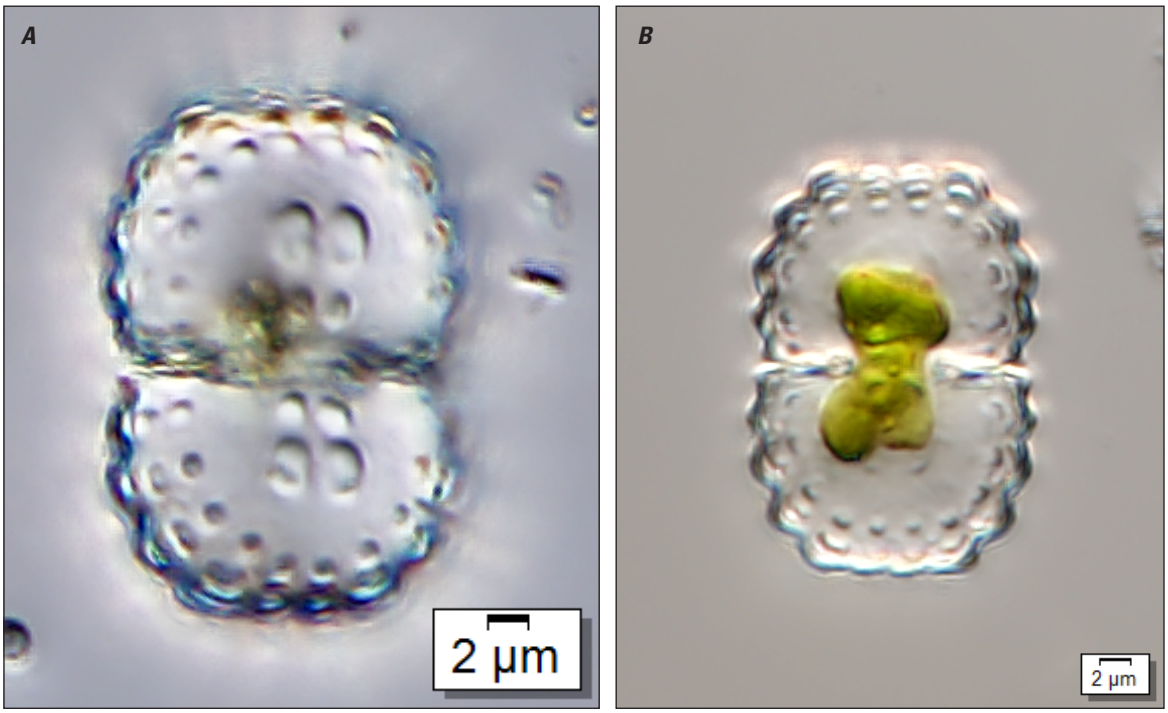


Figure 53. *Cosmarium inaequalinotatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium isthmochondrum* Nordstedt

Figure 54. *Cosmarium isthmochondrum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium lagoense* (Nordstedt) Nordstedt

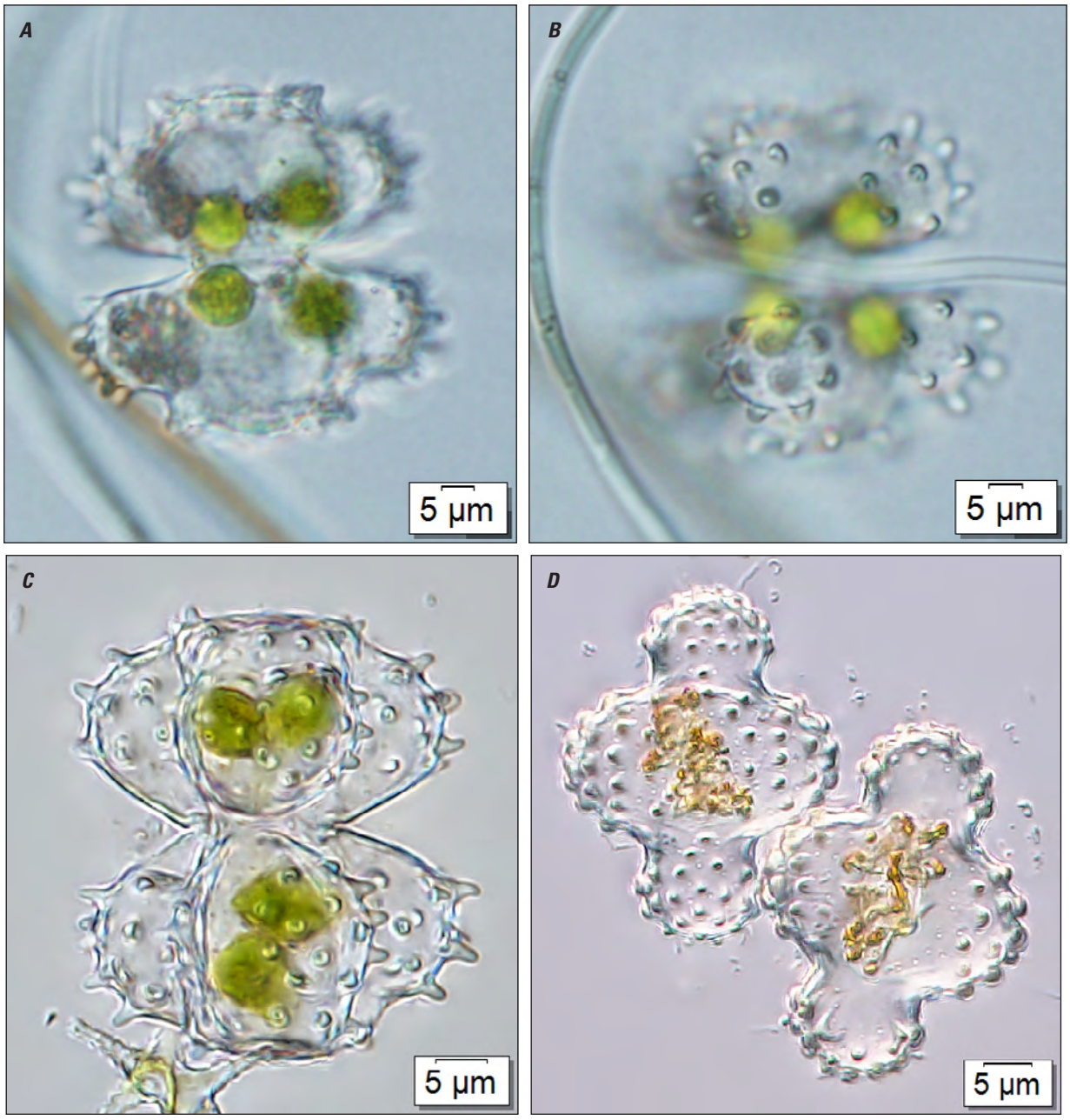


Figure 55. *Cosmarium lagoense.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium margaritatum* (P. Lundell) J. Roy & Bisset

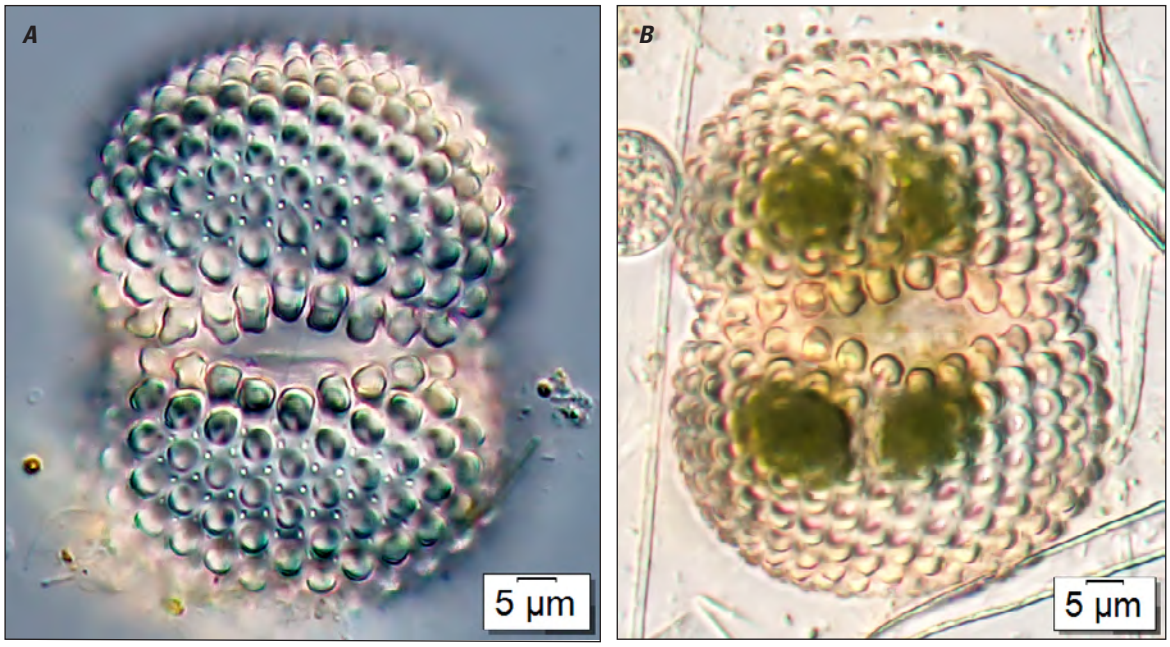


Figure 56. *Cosmarium margaritatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium margaritatum* var. *rotundatum* Hirano

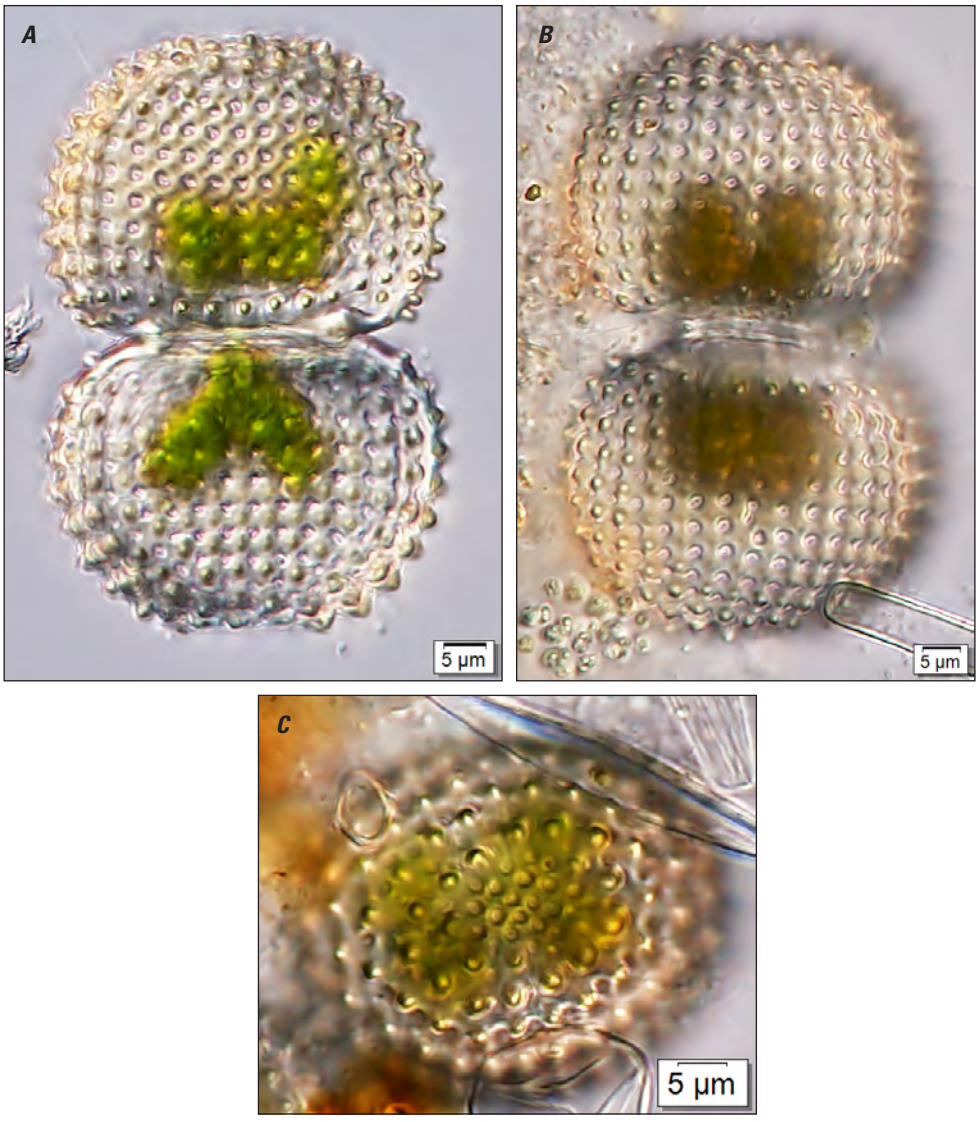


Figure 57. *Cosmarium margaritatum* var. *rotundatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium meneghinii* Brébisson ex Ralfs

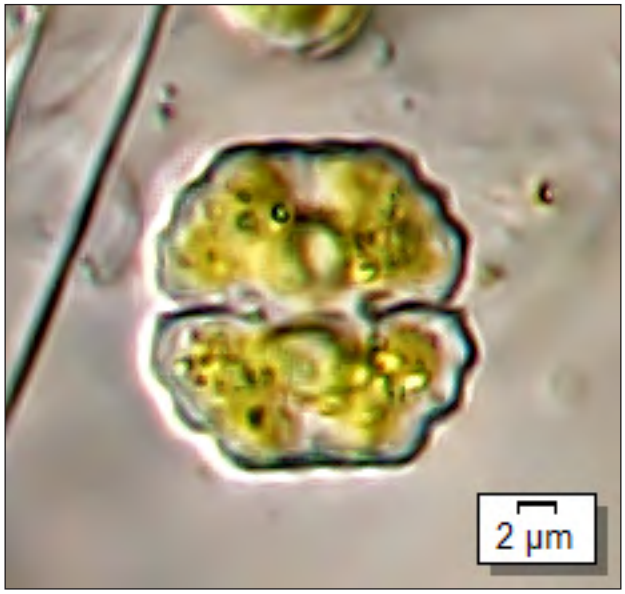


Figure 58. *Cosmarium meneghinii.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium moerlianum* var. *brasiliense* Borge

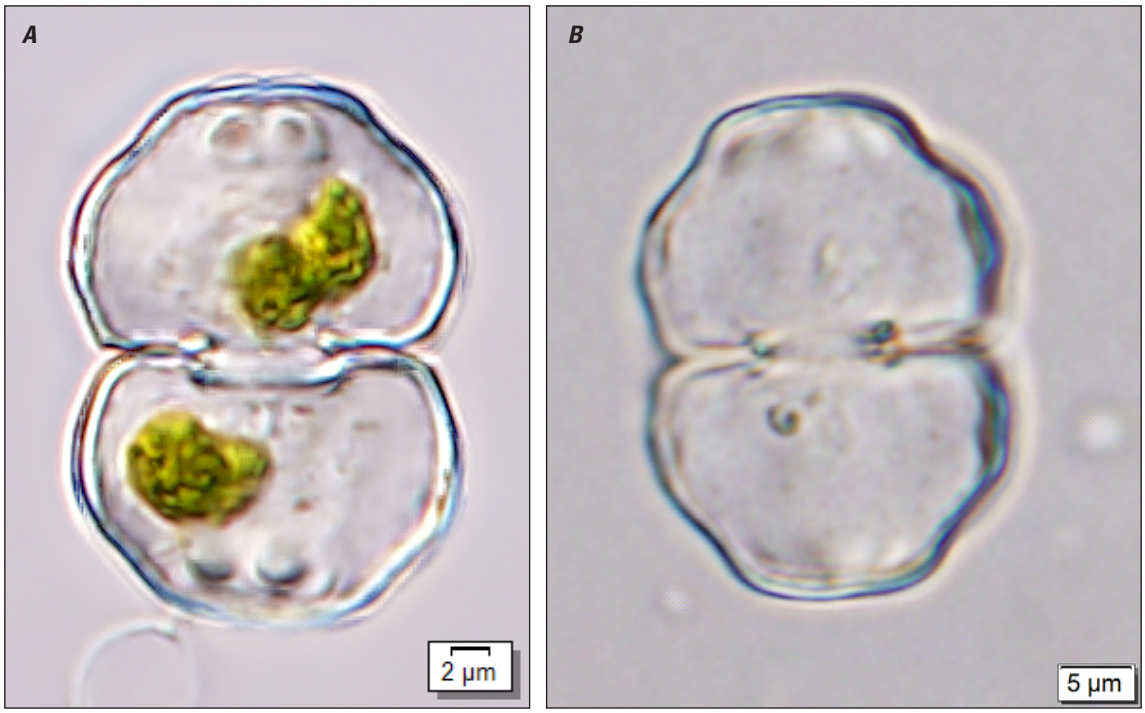


Figure 59. *Cosmarium moerlianum* var. *brasiliense*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium moniliforme* var. *indentatum* Scott & Grönblad

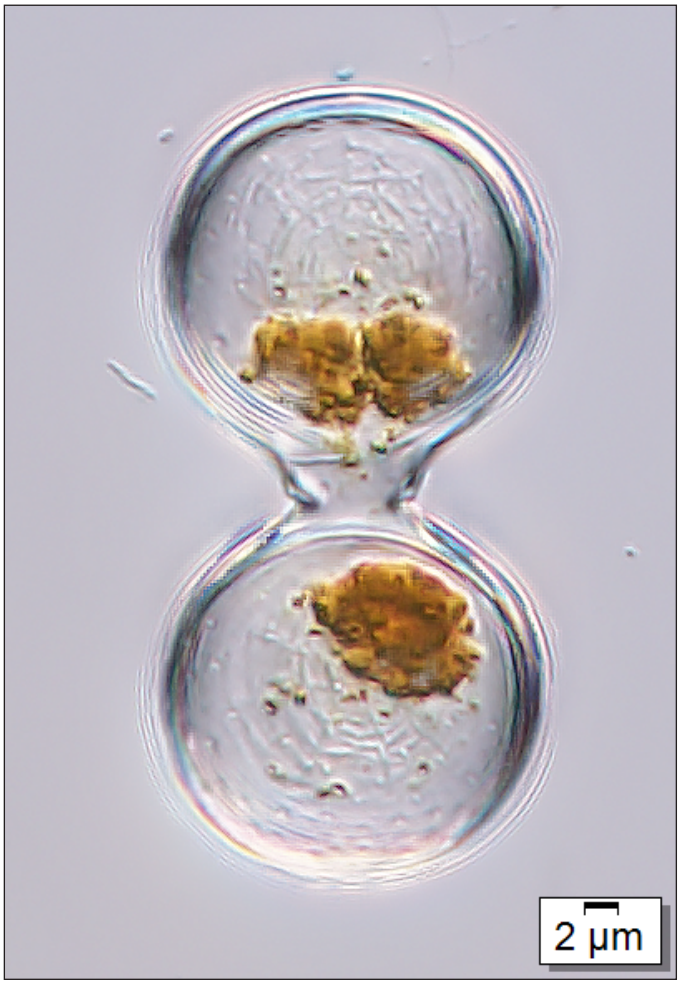


Figure 60. *Cosmarium moniliforme* var. *indentatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium monomazum* var. *americanum* (Borge) Scott & Grönblad

Figure 61. *Cosmarium monomazum* var. *americanum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium nymannianum* Grunow

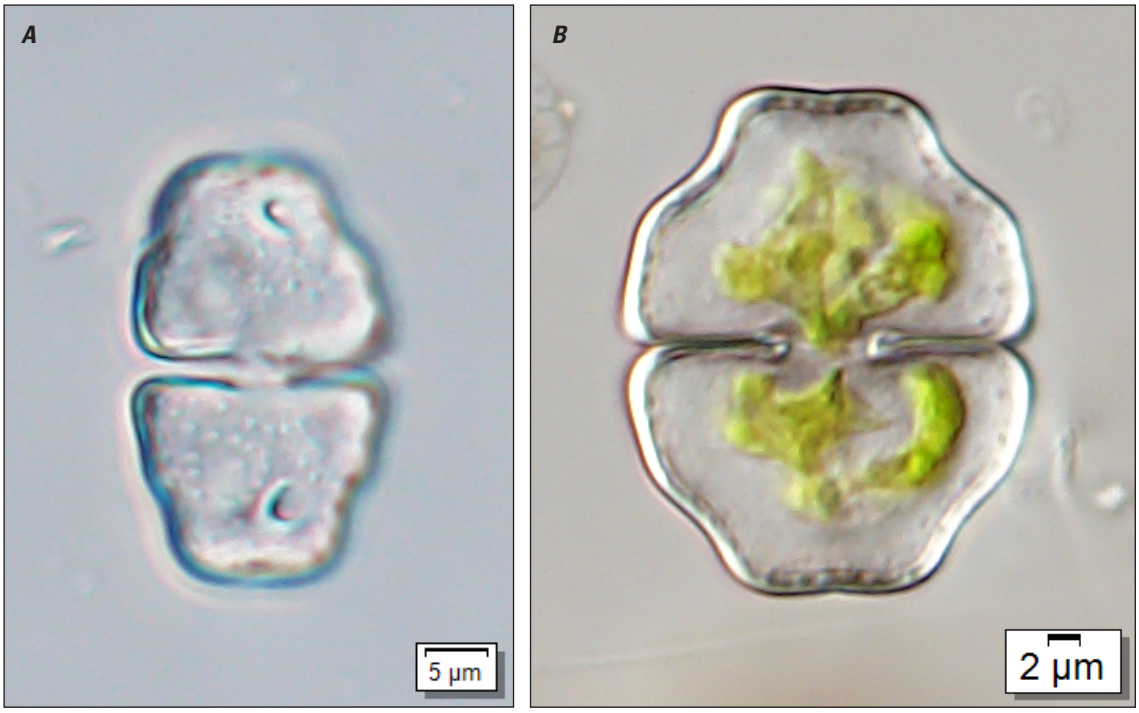


Figure 62. *Cosmarium nymannianum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium obsoletum* var. *minus* Krieger and Gerloff

Figure 63. *Cosmarium obsoletum* var. *minus*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium ordinatum* (Børgesen) West & G.S. West

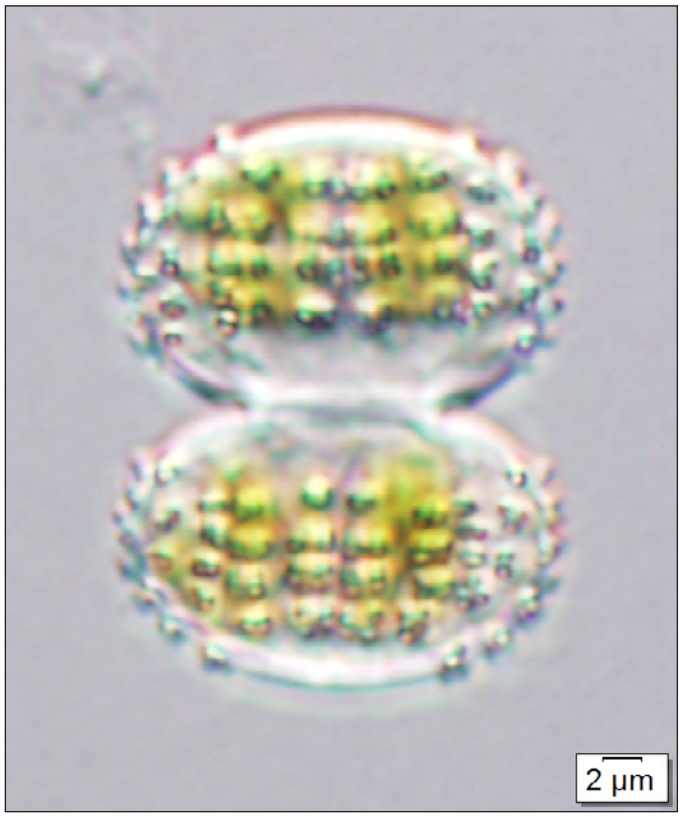


Figure 64. *Cosmarium ordinatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium ornatum* Ralfs ex Ralfs

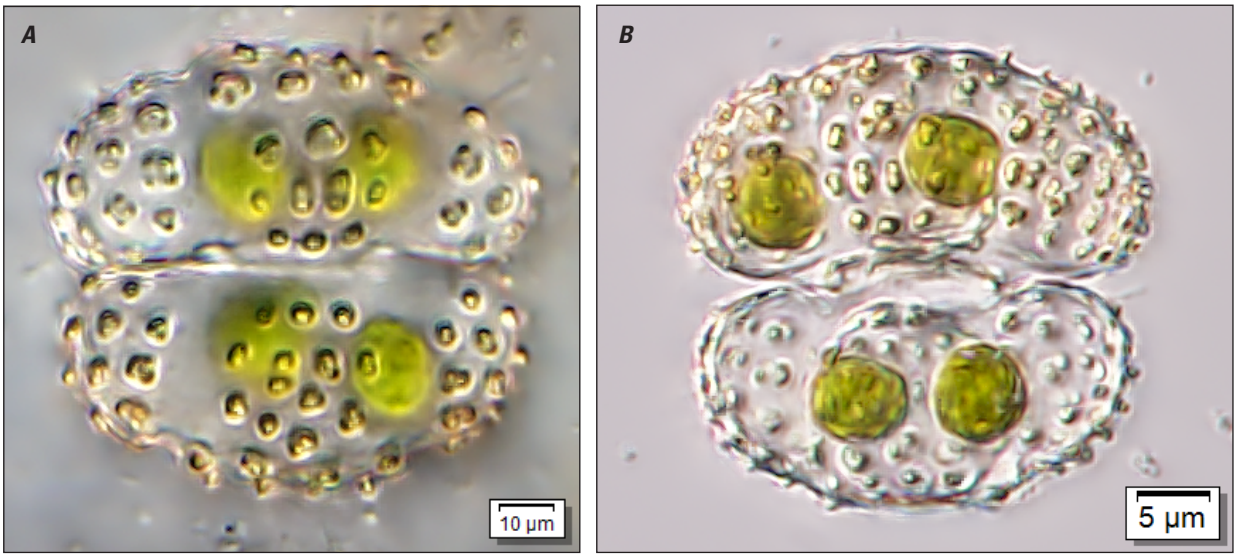


Figure 65. *Cosmarium ornatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium orthostichum* var. *compactum* (West & West)

Figure 66. *Cosmarium orthostichum* var. *compactum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium ovale* var. *subglabrum* West & West

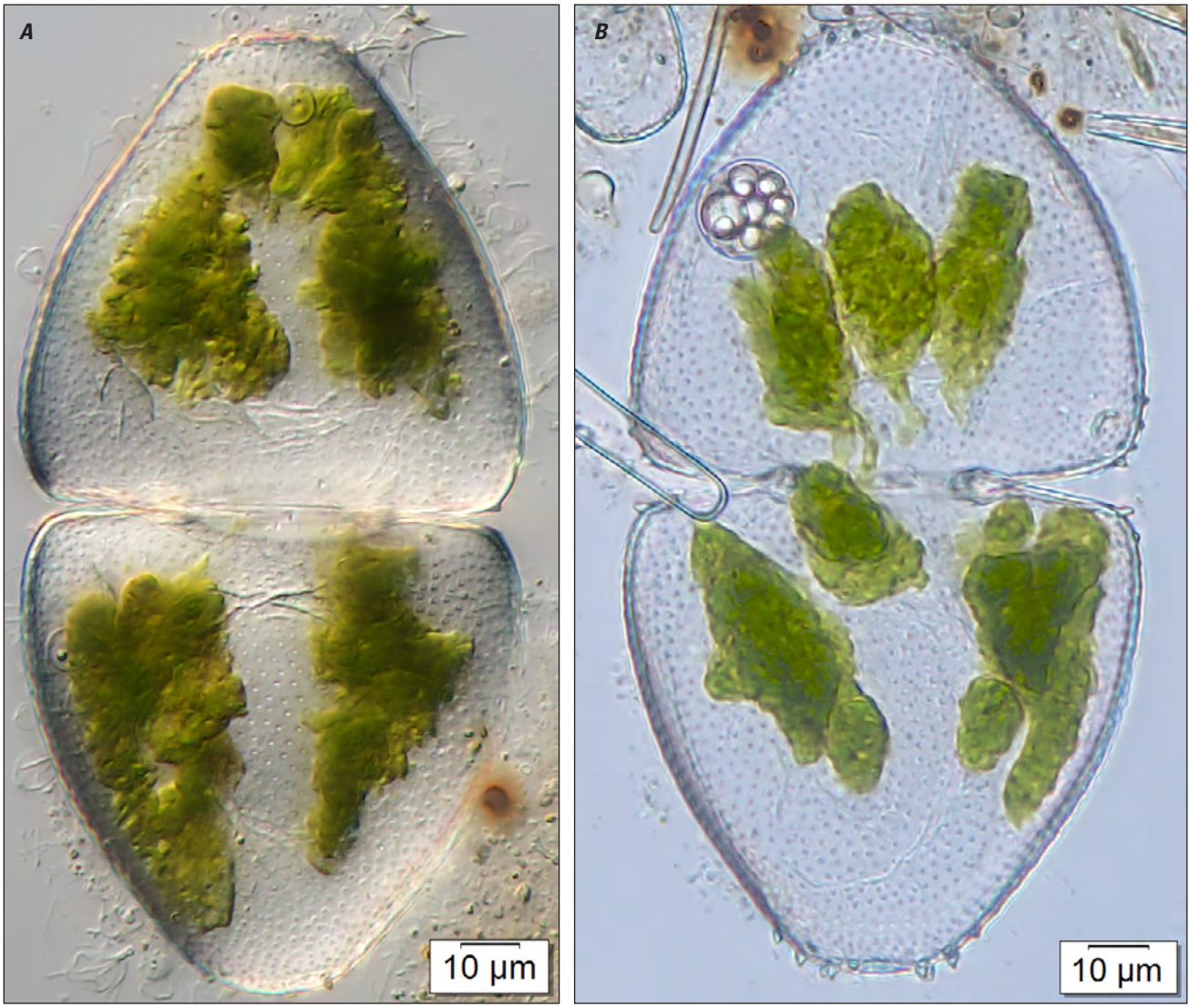


Figure 67. *Cosmarium ovale* var. *subglabrum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pachydermum* P. Lundell

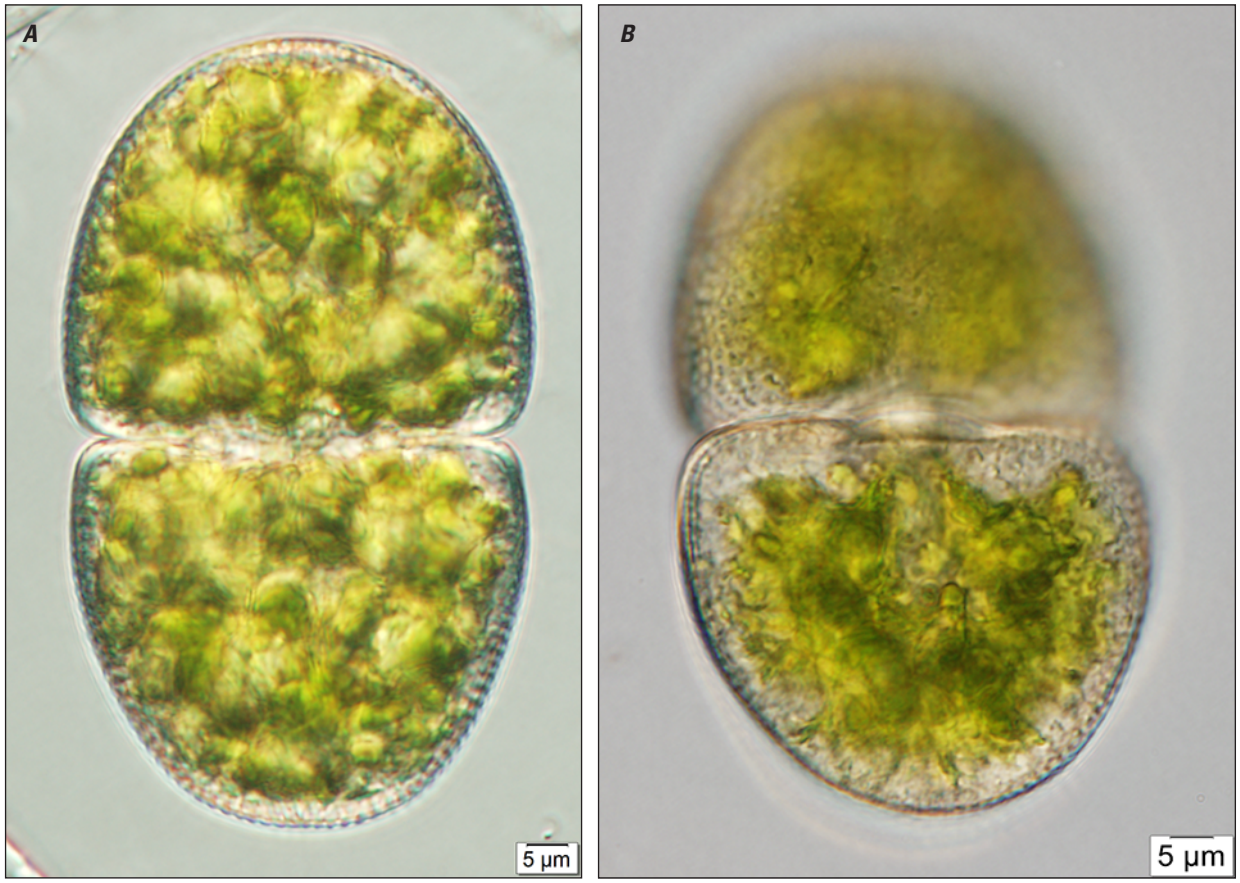


Figure 68. *Cosmarium pachydermum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium papilliferum* Schmidle

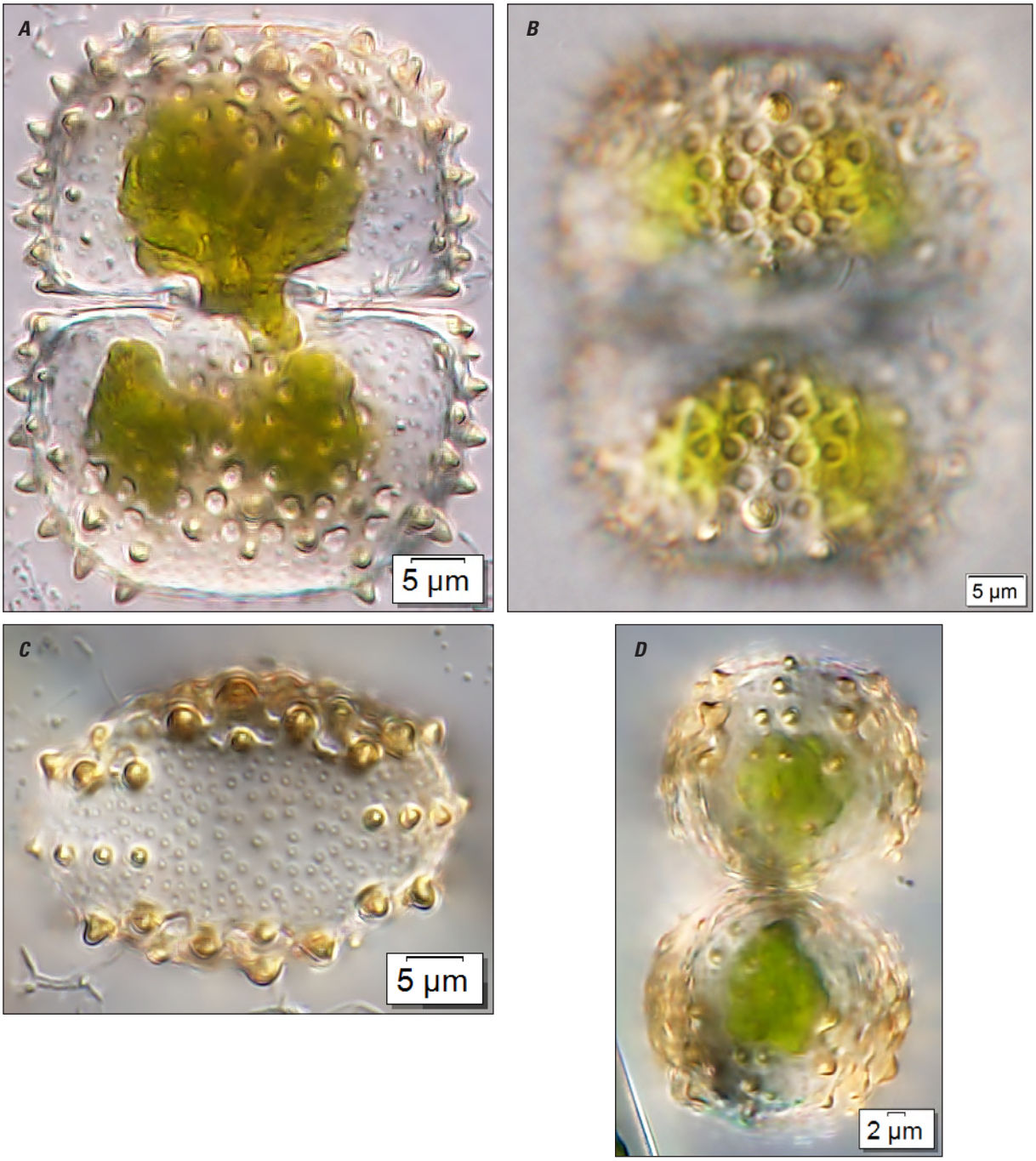


Figure 69. *Cosmarium papilliferum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium phaseolus* Brébisson ex Ralfs

Figure 70. *Cosmarium phaseolus.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium phaseolus* var. *minus* (Boldt) Willi Krieger & Gerloff

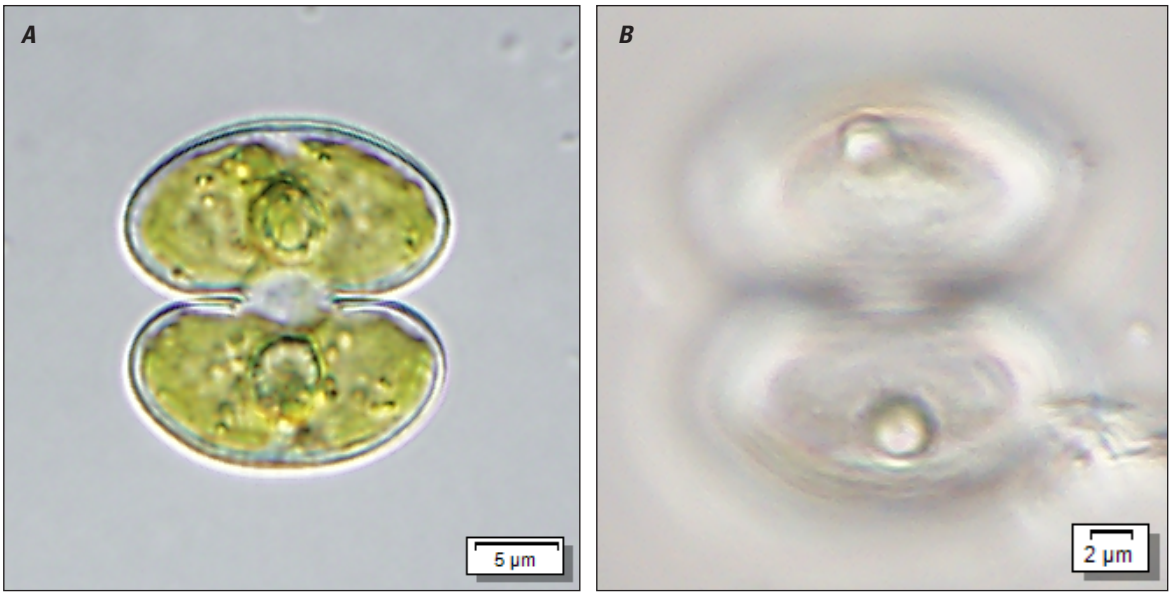


Figure 71. *Cosmarium phaseolus* var. *minus*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* cf. *polygonum* (Nägeli) Archer

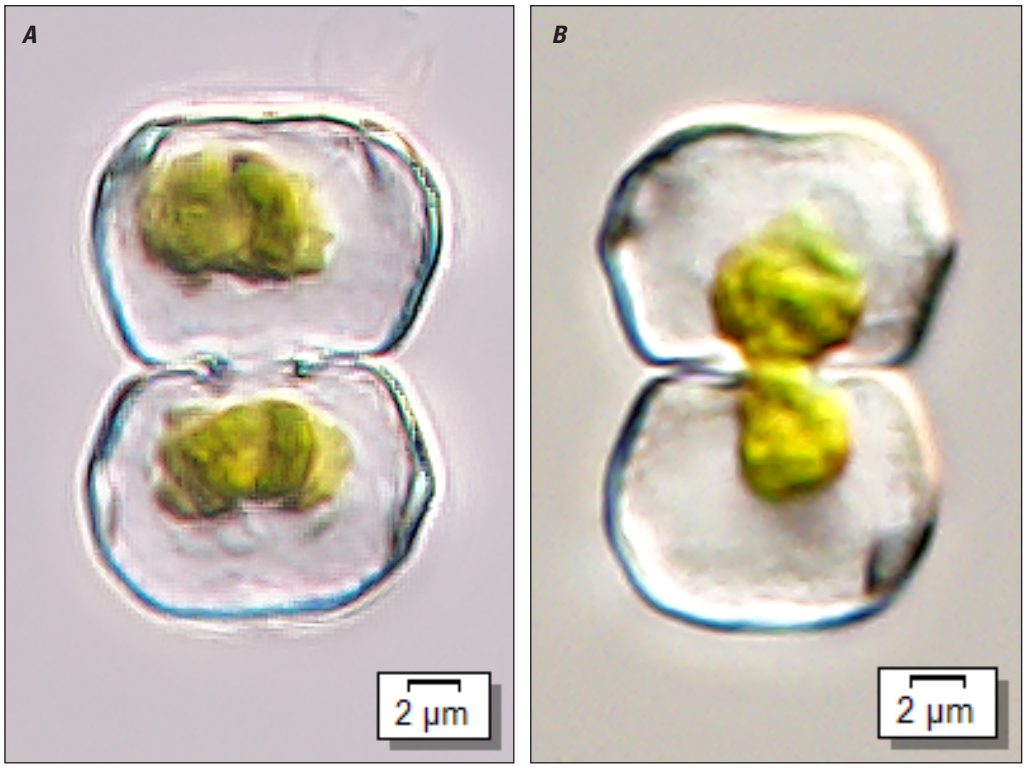


Figure 72. *Cosmarium* cf. *polygonum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium polygonum* f. *rectum* Bicudo

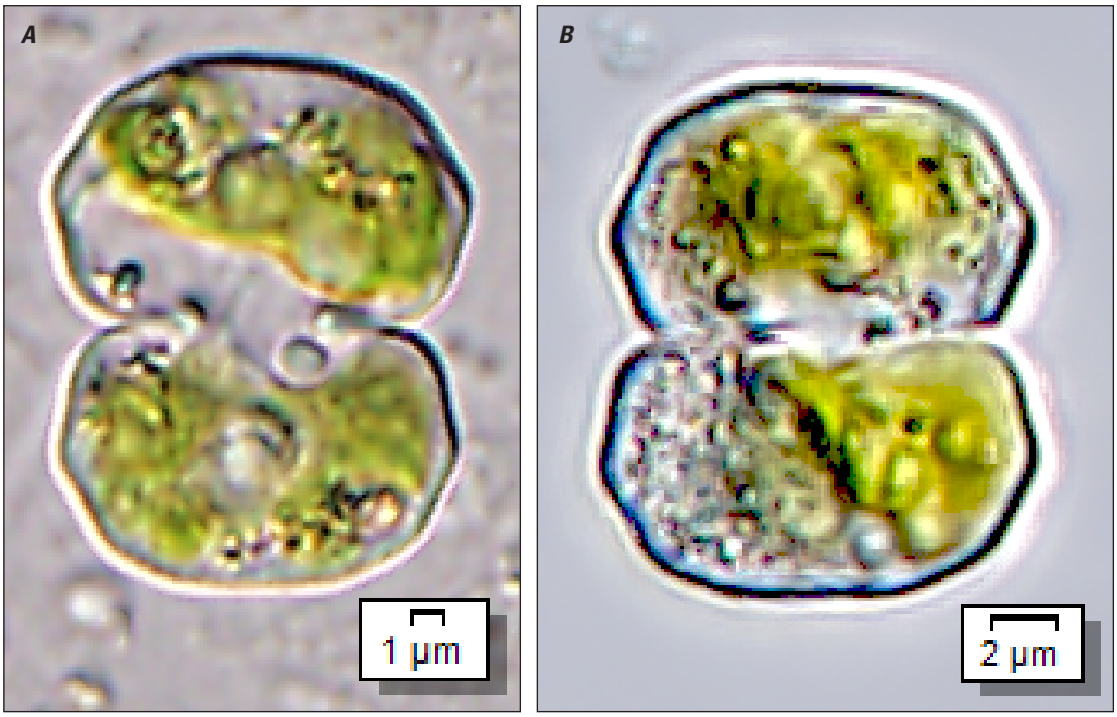


Figure 73. *Cosmarium polygonum* f. *rectum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* cf. *portianum* var. *orthostichum* Schmidle

Figure 74. *Cosmarium* cf. *portianum* var. *orthostichum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pseudoconnatum* Nordstedt

Figure 75. *Cosmarium pseudoconnatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pseudopyramidatum* P. Lundell

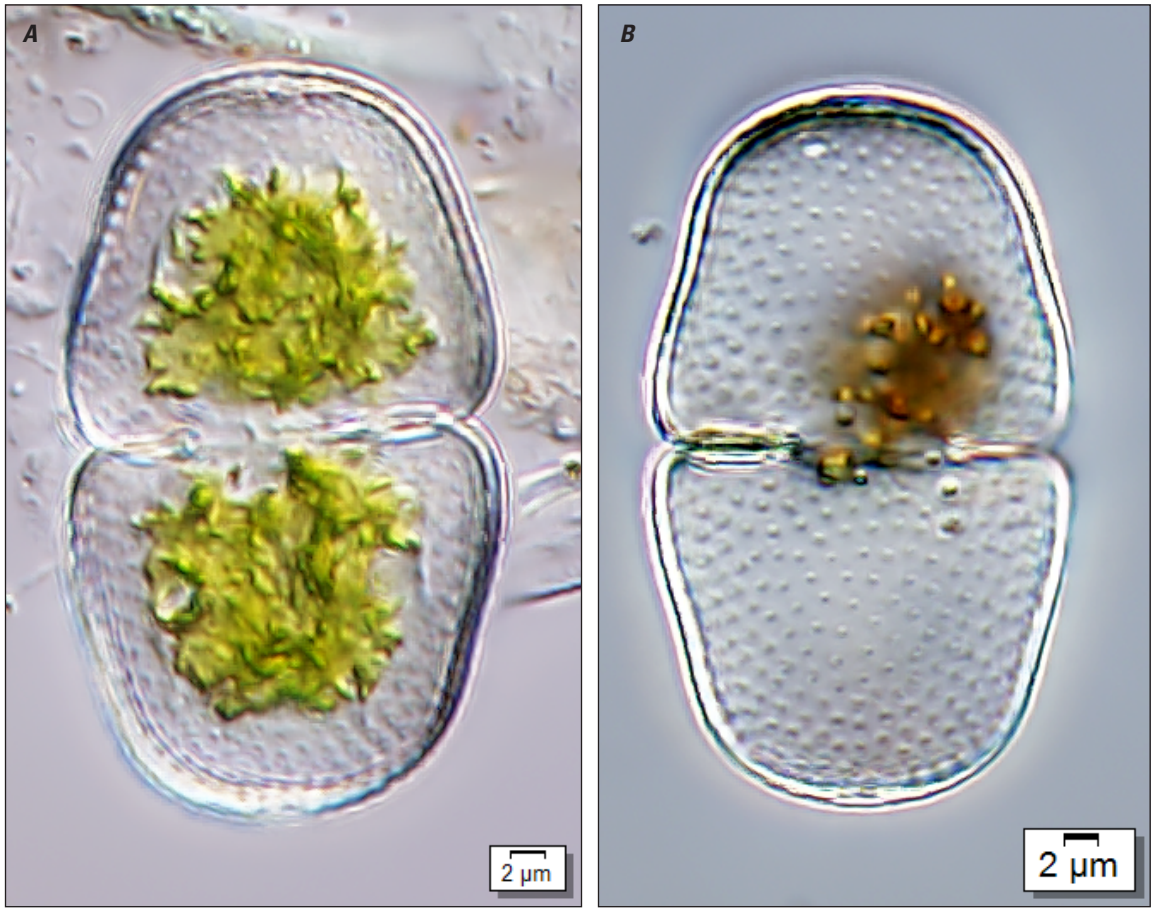


Figure 76. *Cosmarium pseudopyramidatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pseudoretusum* F. Ducellier

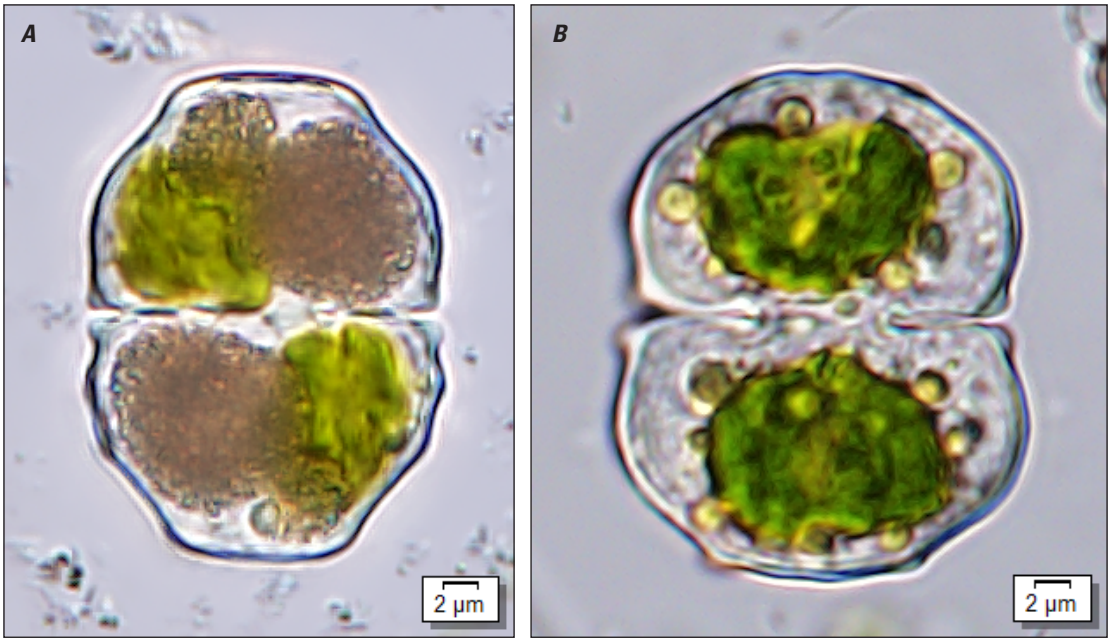


Figure 77. *Cosmarium pseudoretusum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pseudotaxichondrum* Nordstedt

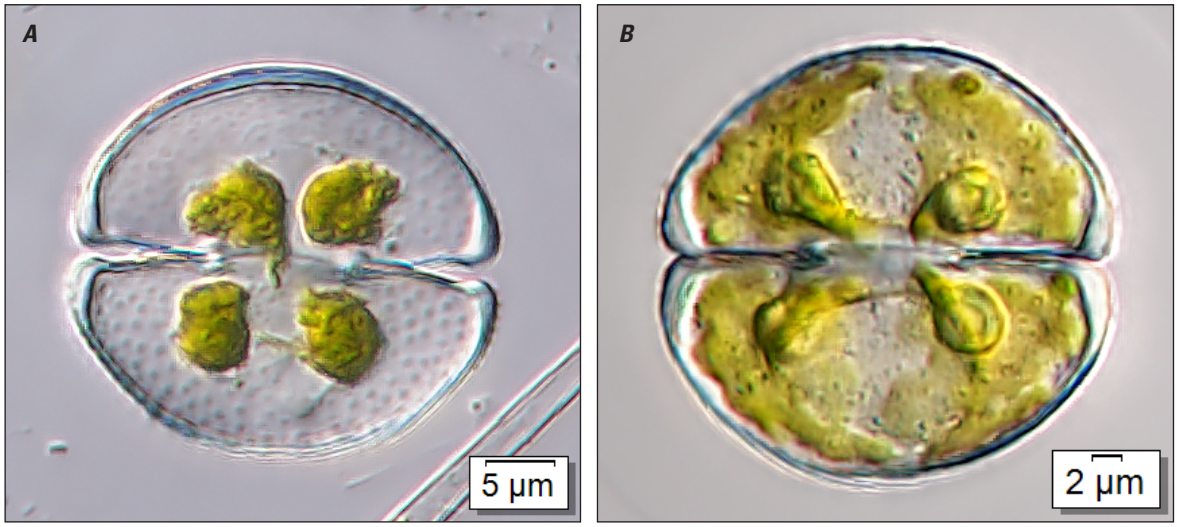


Figure 78. *Cosmarium pseudotaxichondrum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pseudotaxichondrum* var. *trichondum* f. *scottii* Prescott

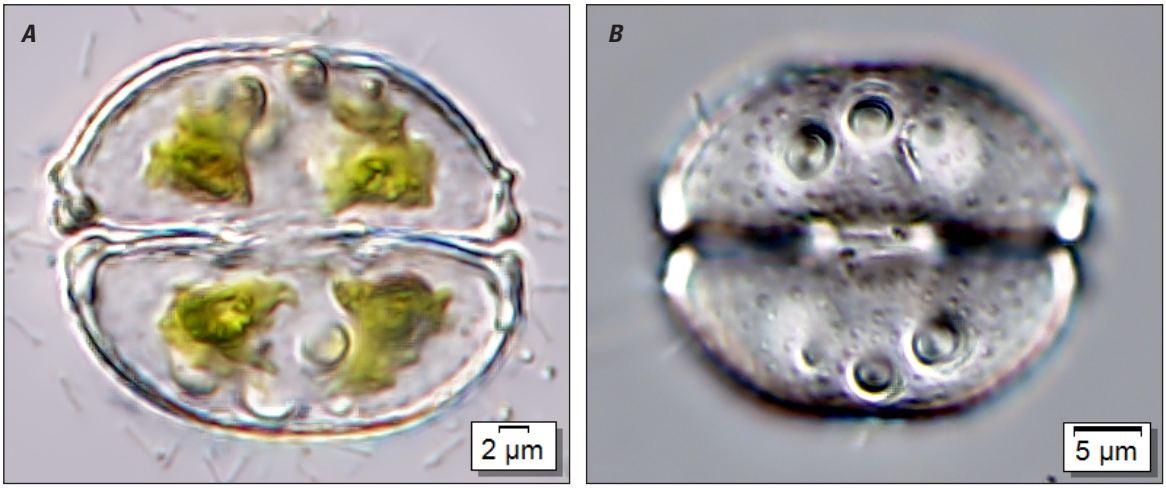


Figure 79. *Cosmarium pseudotaxichondrum* var. *trichondum* f. *scottii*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium pyramidatum* Brébisson ex Ralfs

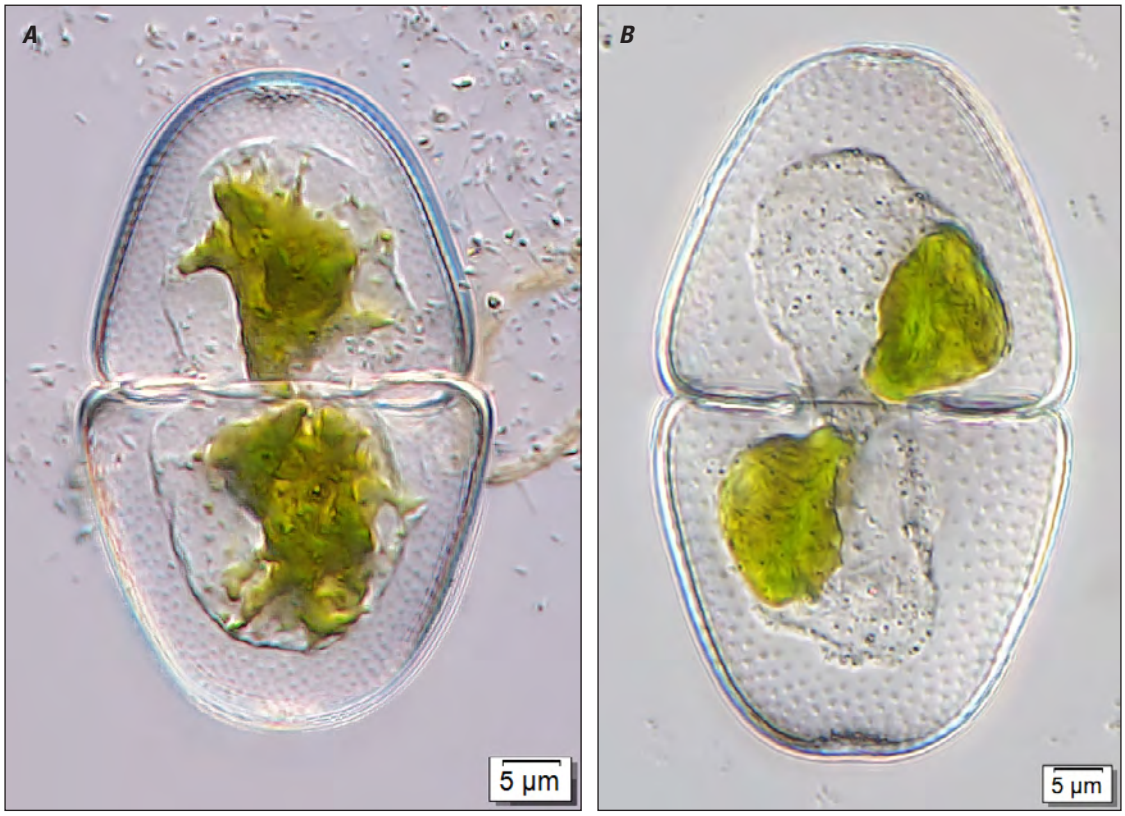


Figure 80. *Cosmarium pyramidatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium quinarium* Lundell

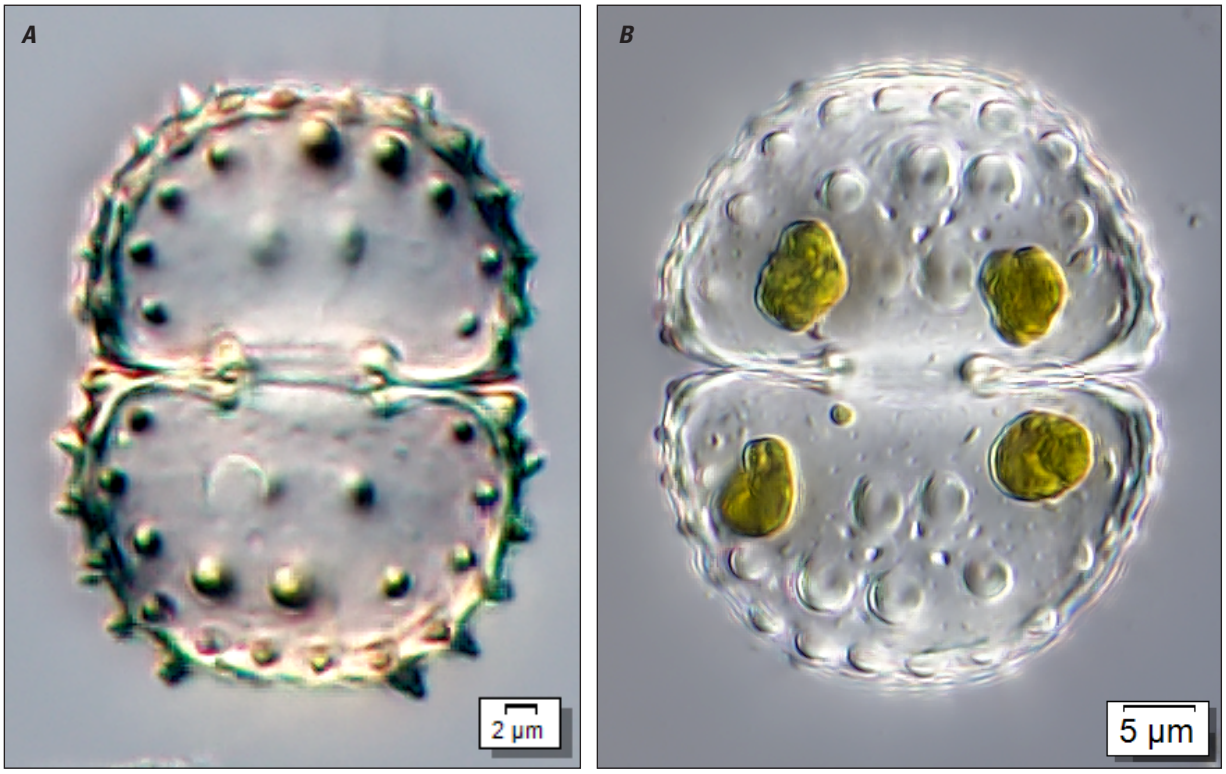


Figure 81. *Cosmarium quinarium.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium regnellii* var. *minimum* Eichler & Gutwinski

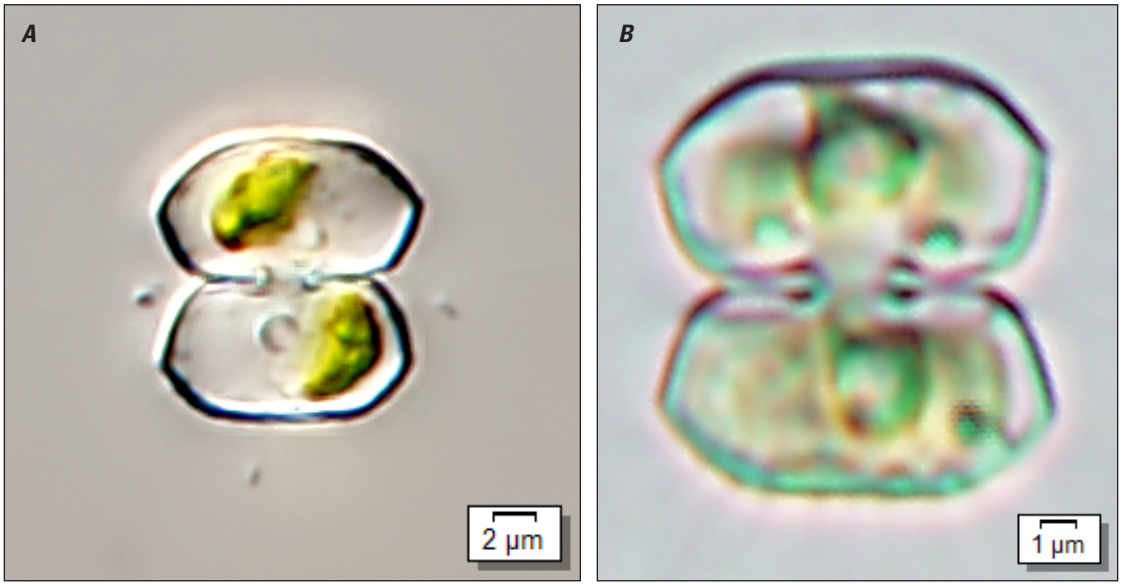


Figure 82. *Cosmarium regnellii* var. *minimum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium regnesi* Reinsch

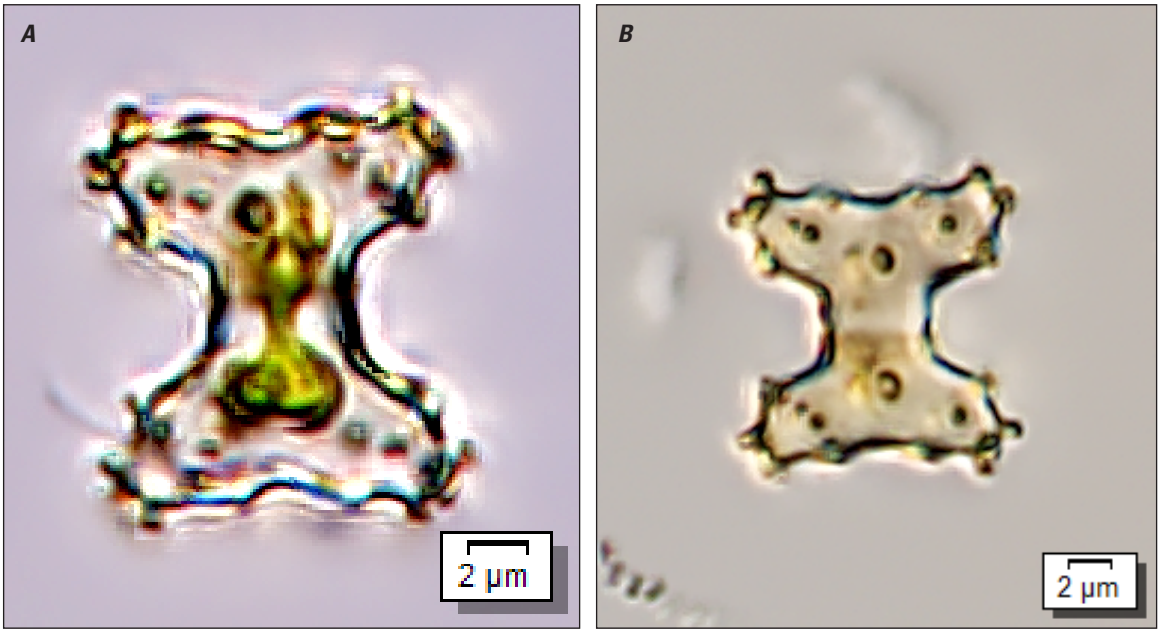


Figure 83. *Cosmarium regnesi.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* cf. *smolandicum* P. Lundell

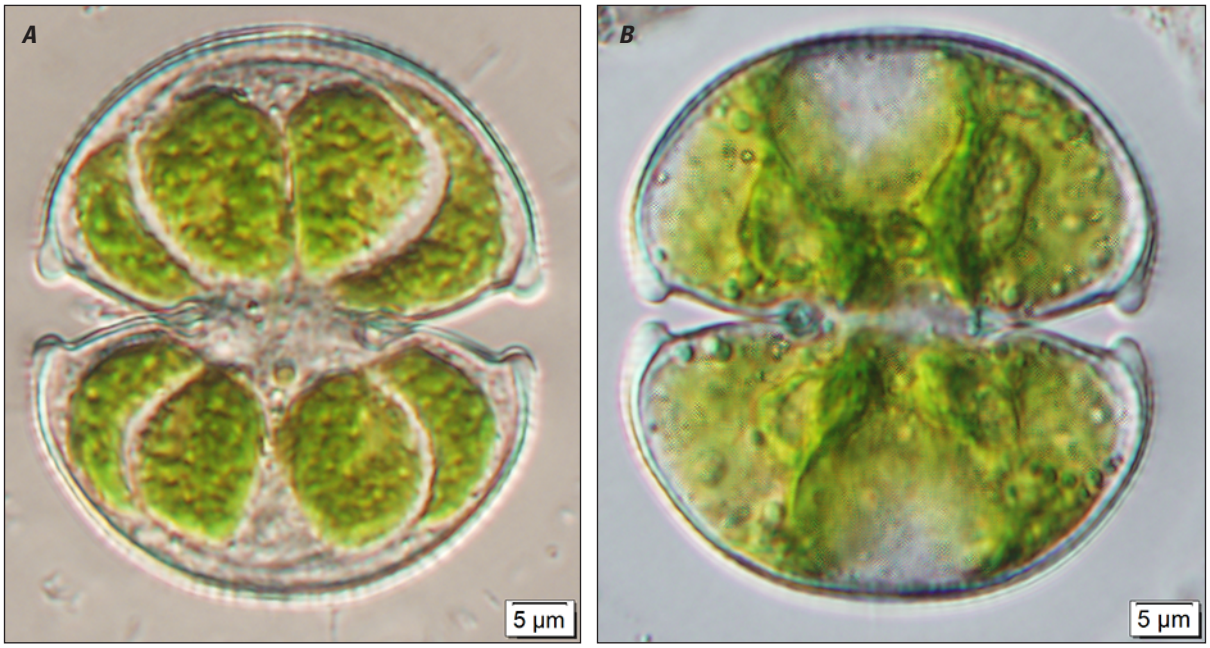


Figure 84. *Cosmarium* cf. *smolandicum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium streblon* Scott & Grönblad

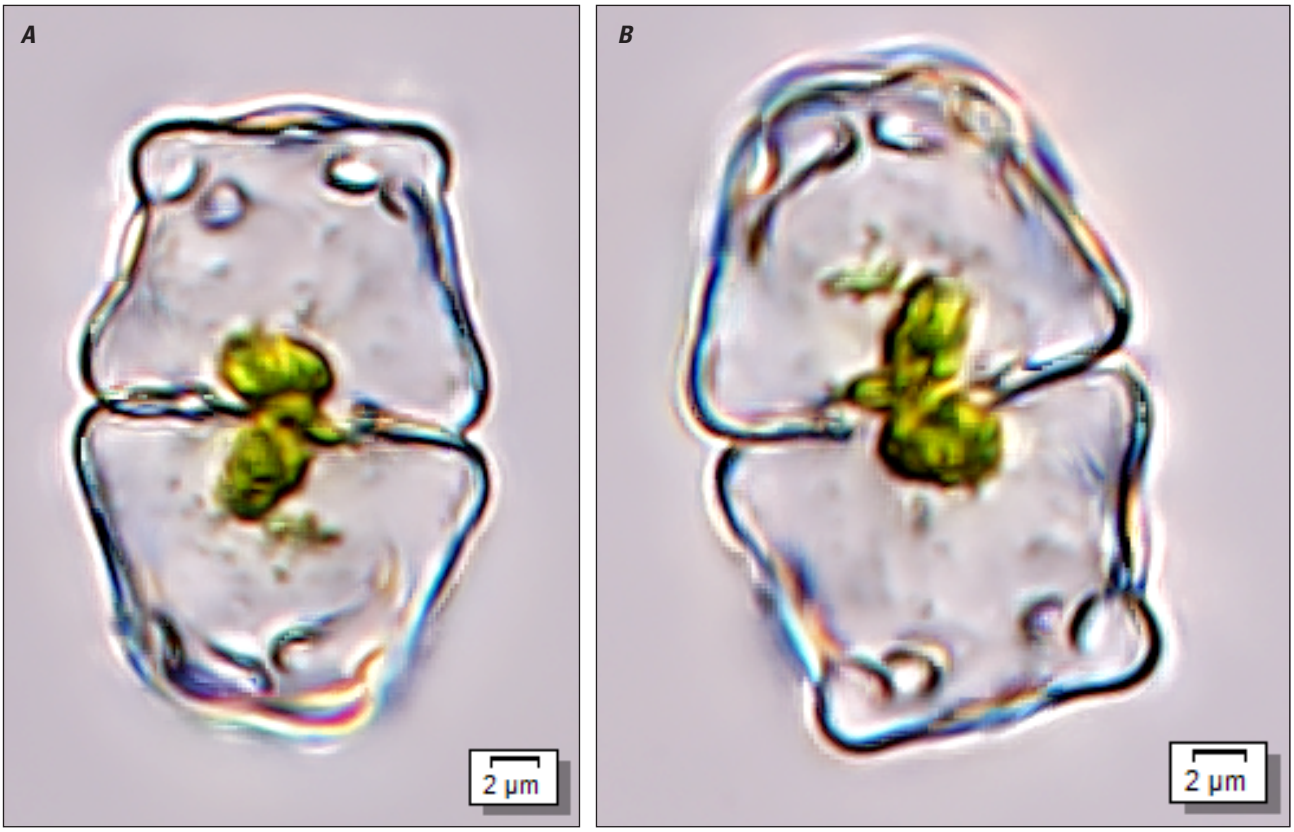


Figure 85. *Cosmarium streblon.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium subnudiceps* var. *angulare* Scott & Grönblad

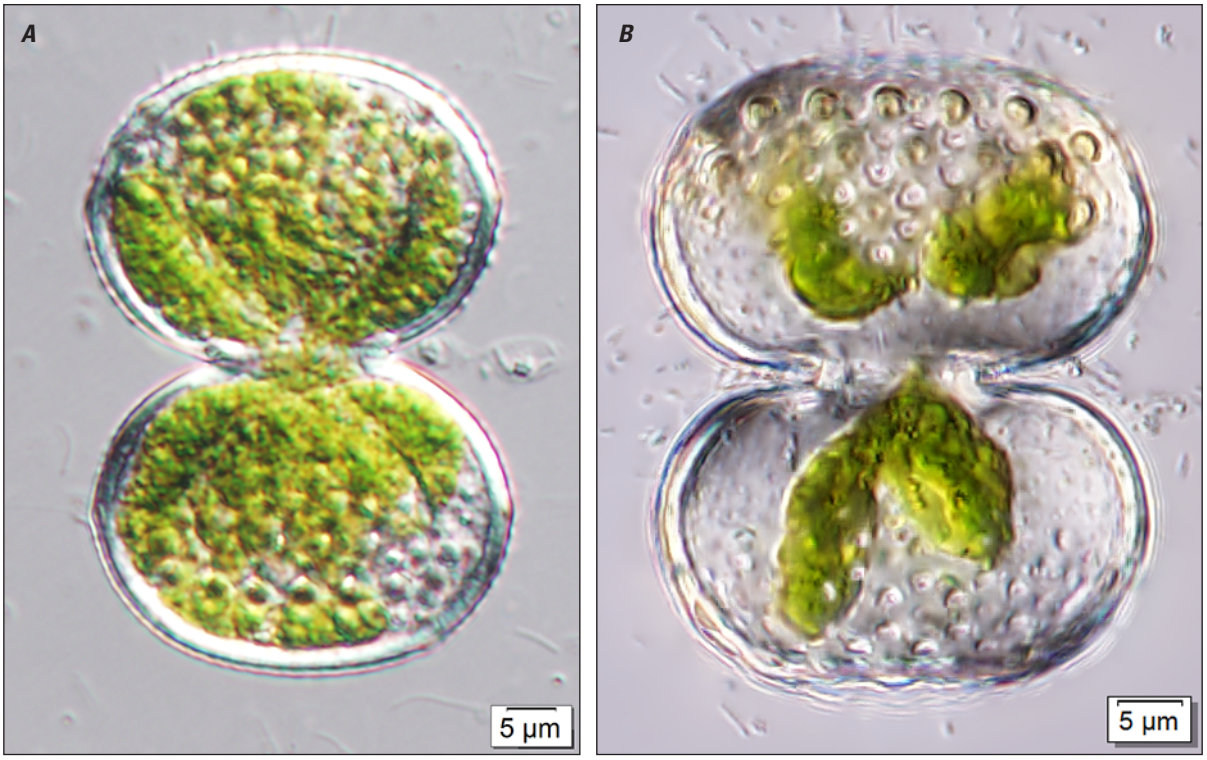


Figure 86. *Cosmarium subnudiceps* var. *angulare*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium subretusiforme* West & West

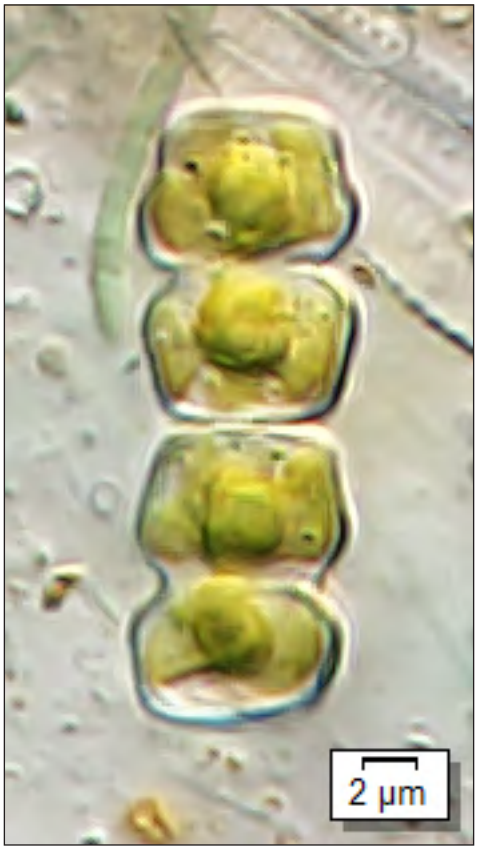


Figure 87. *Cosmarium subretusiforme*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium taxichondrum* var. *ellipticum* Förster

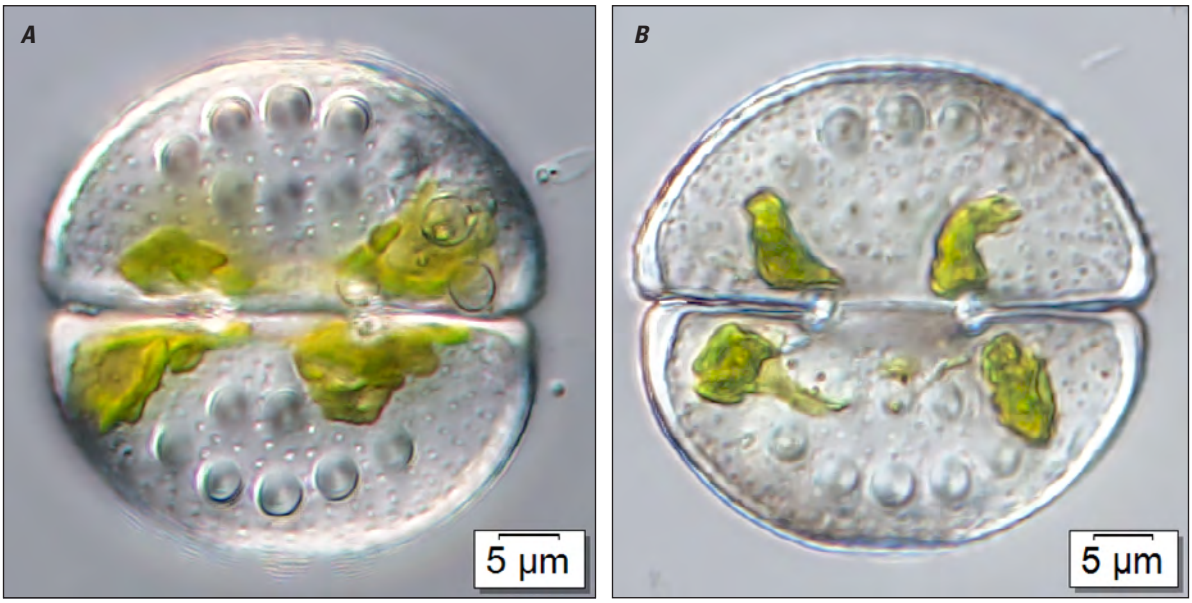


Figure 88. *Cosmarium taxichondrum* var. *ellipticum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium tenue* Archer

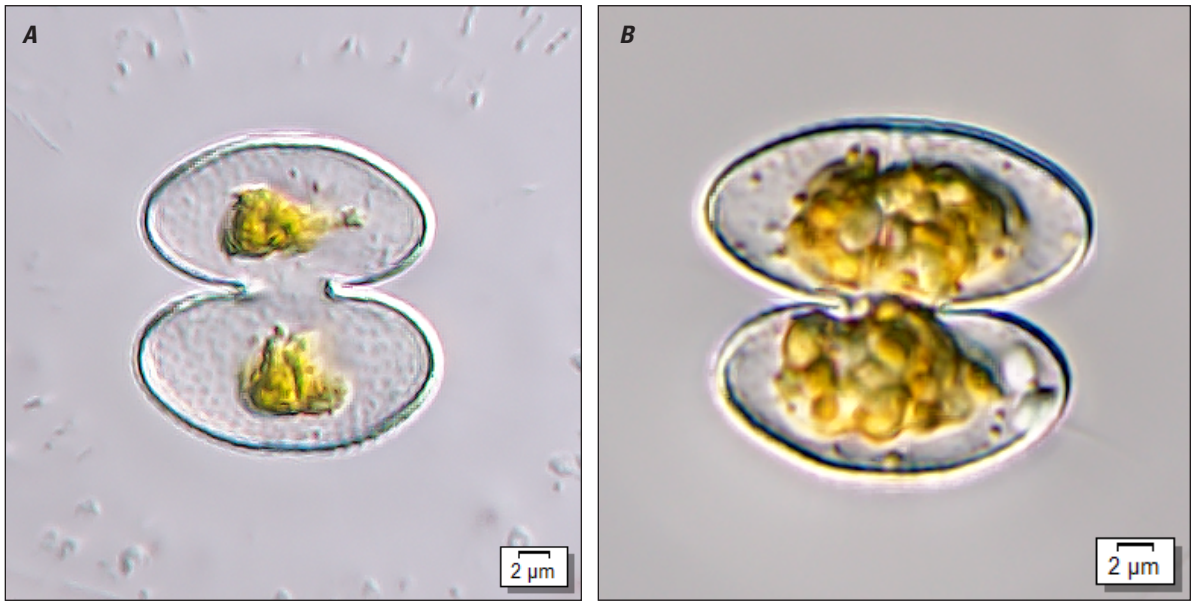


Figure 89. *Cosmarium tenue*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* cf. *tumidum* var. *tumidum* f. *minus* Messikommer

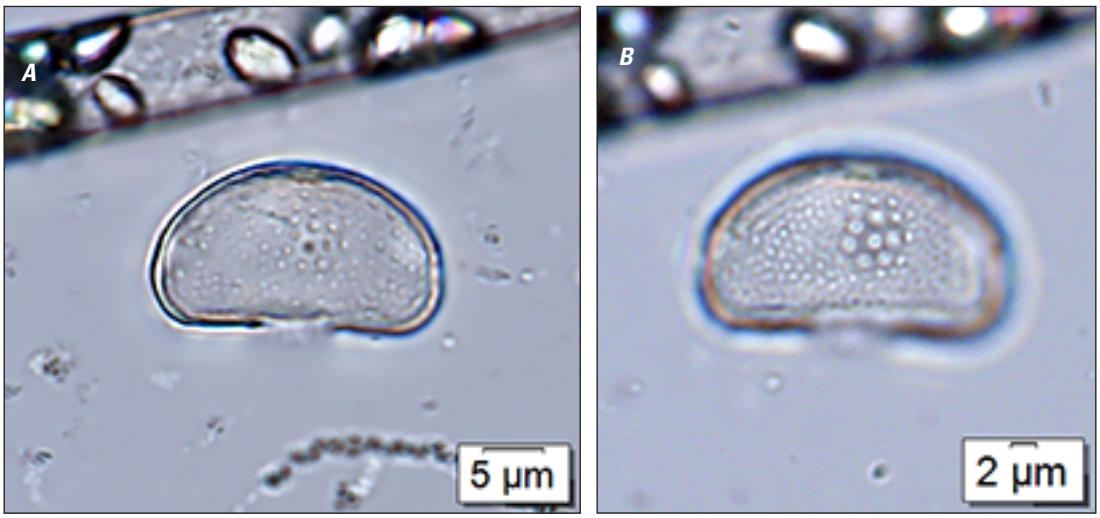


Figure 90. *Cosmarium* cf. *tumidum* var. *tumidum* f. *minus*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium variolatum* P. Lundell

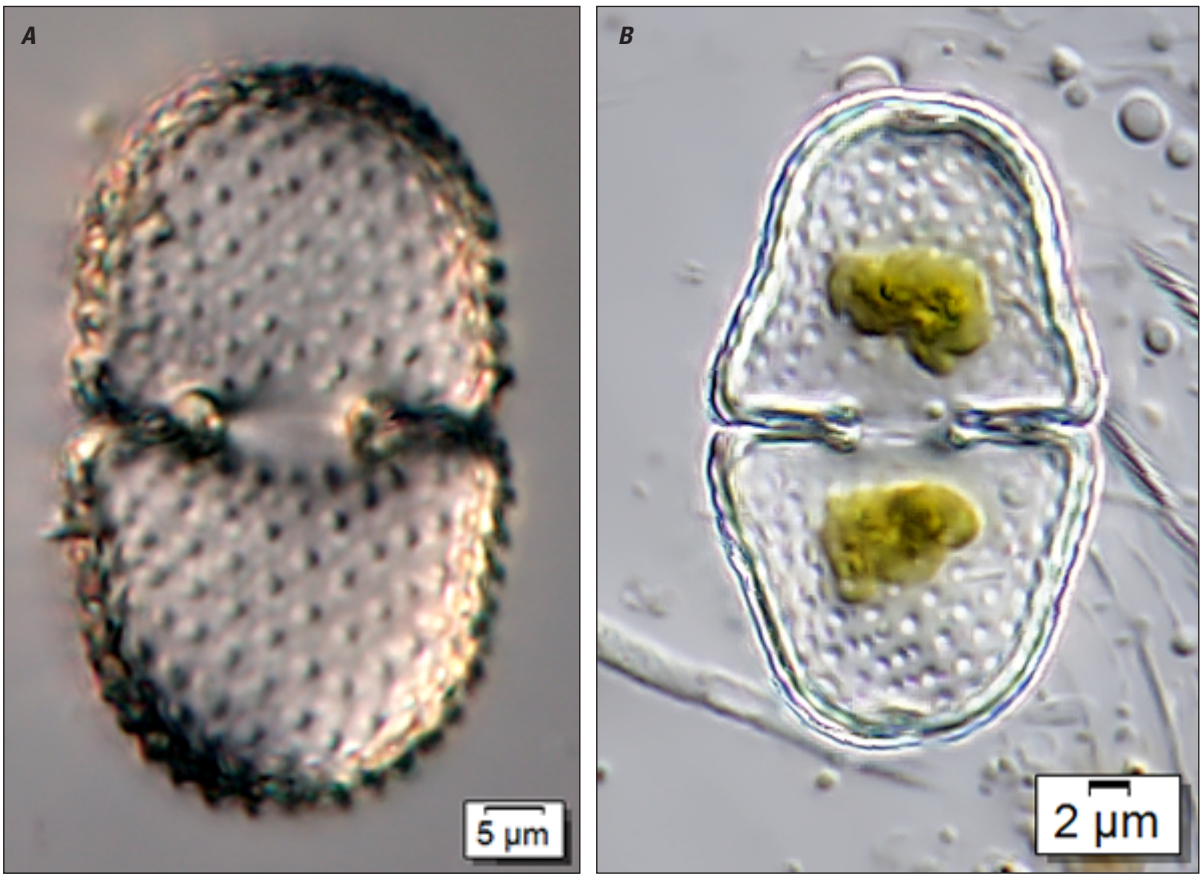


Figure 91. *Cosmarium variolatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium variolatum* var. *elongatum* Scott & Grönblad

Figure 92. *Cosmarium variolatum* var. *elongatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium variolatum* var. *incrassatum* Scott & Grönblad

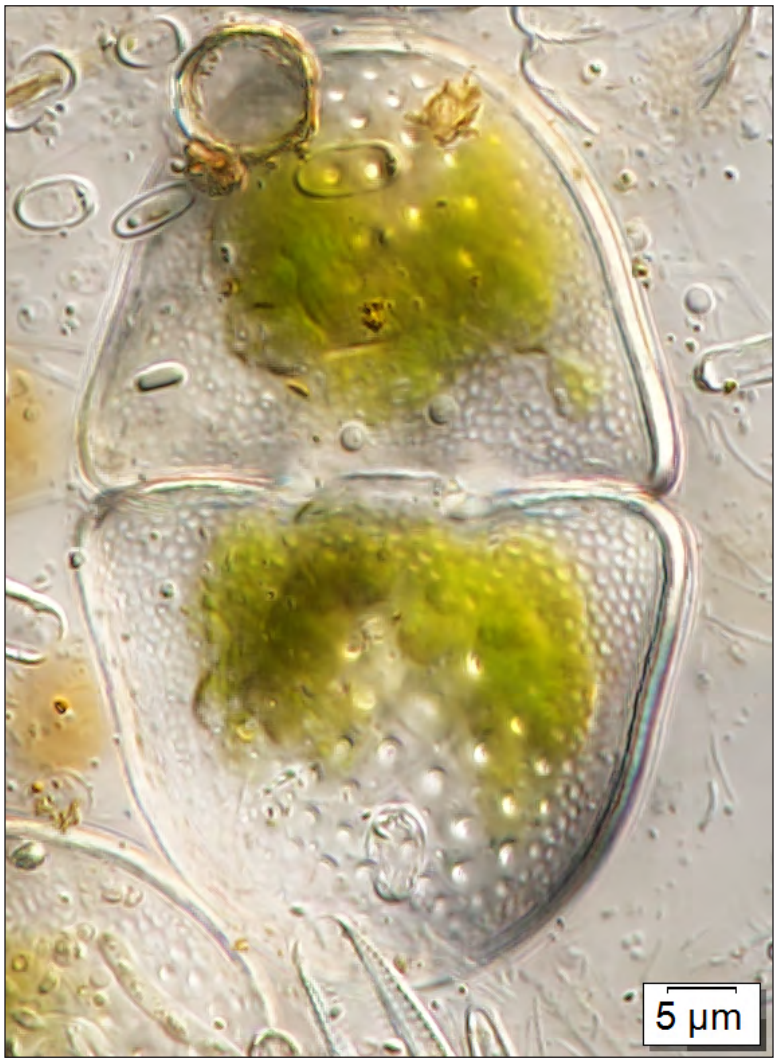


Figure 93. *Cosmarium variolatum* var. *incrassatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium zonatum* var. *subcirculare* A.M. Scott & Grönblad

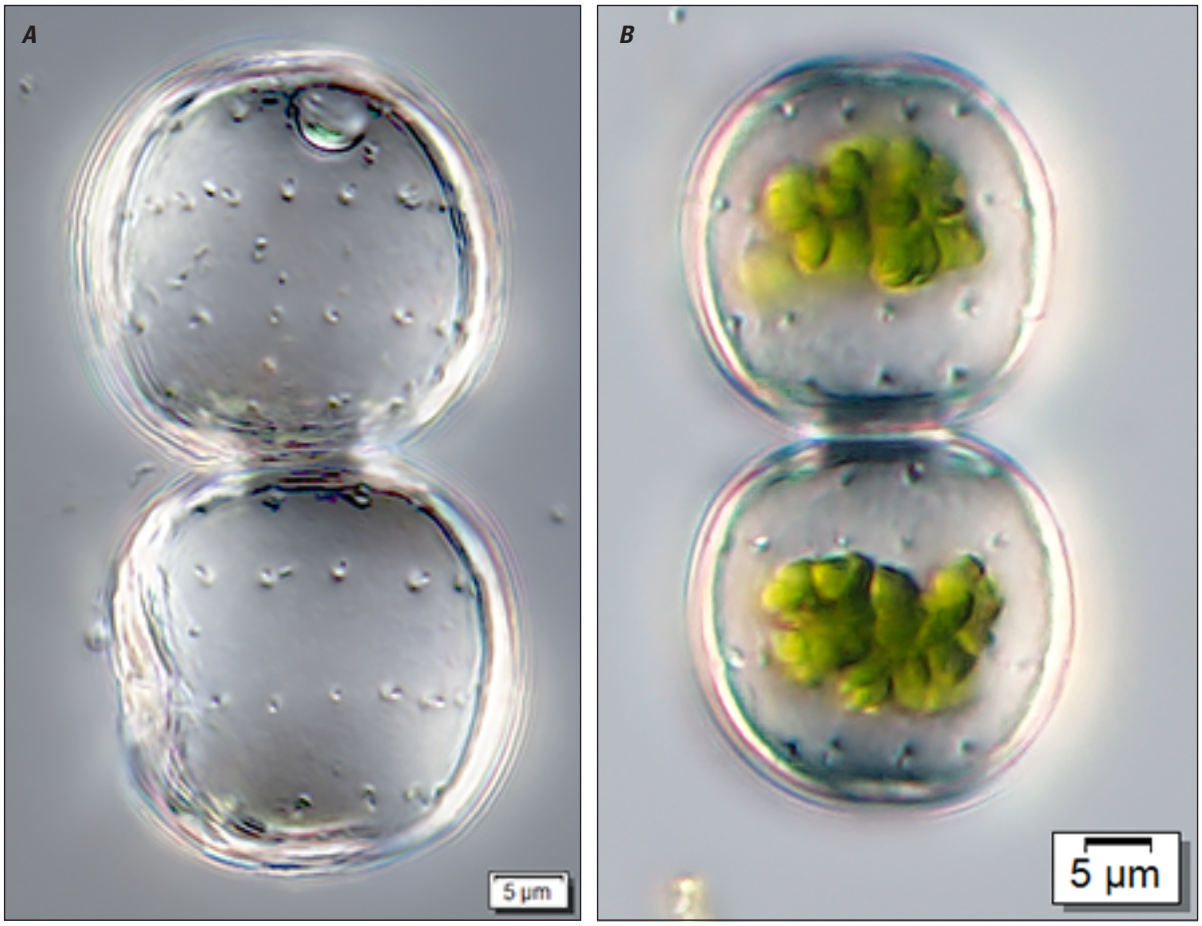


Figure 94. *Cosmarium zonatum* var. *subcirculare*.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* sp.

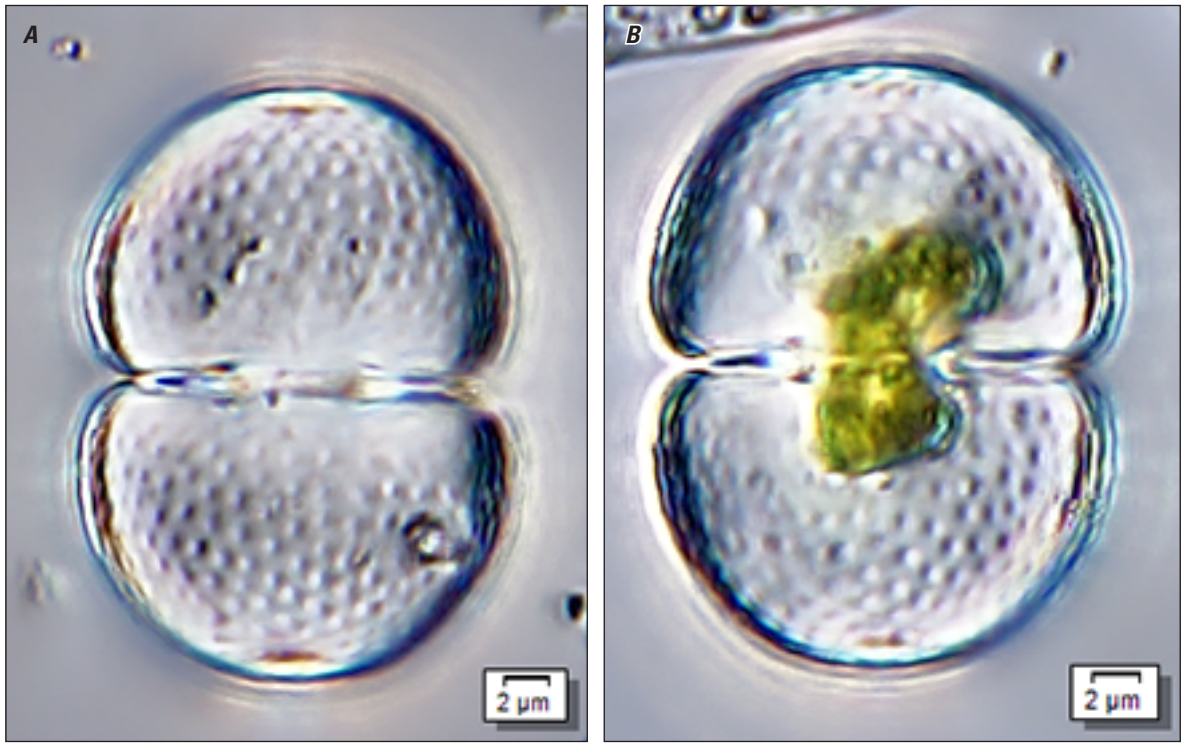


Figure 95. *Cosmarium* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* sp.

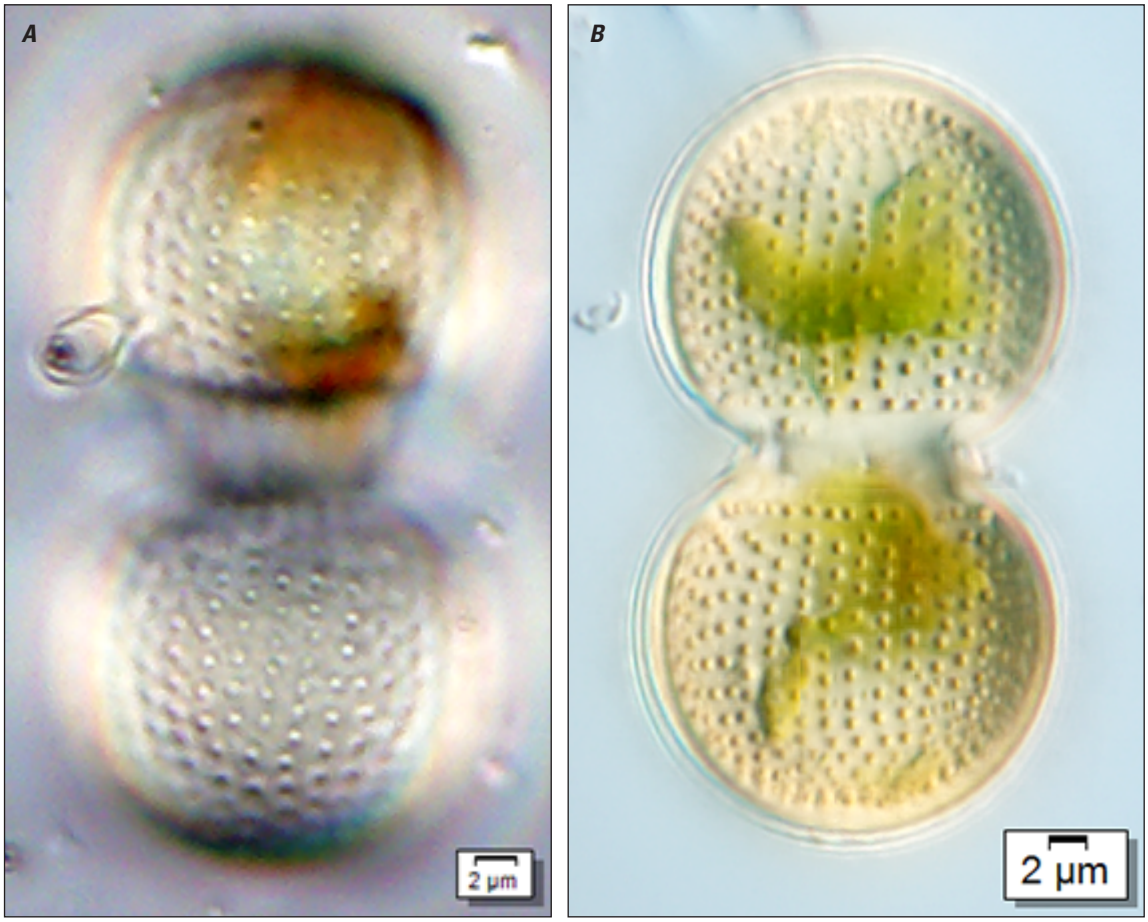


Figure 96. *Cosmarium* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* sp.

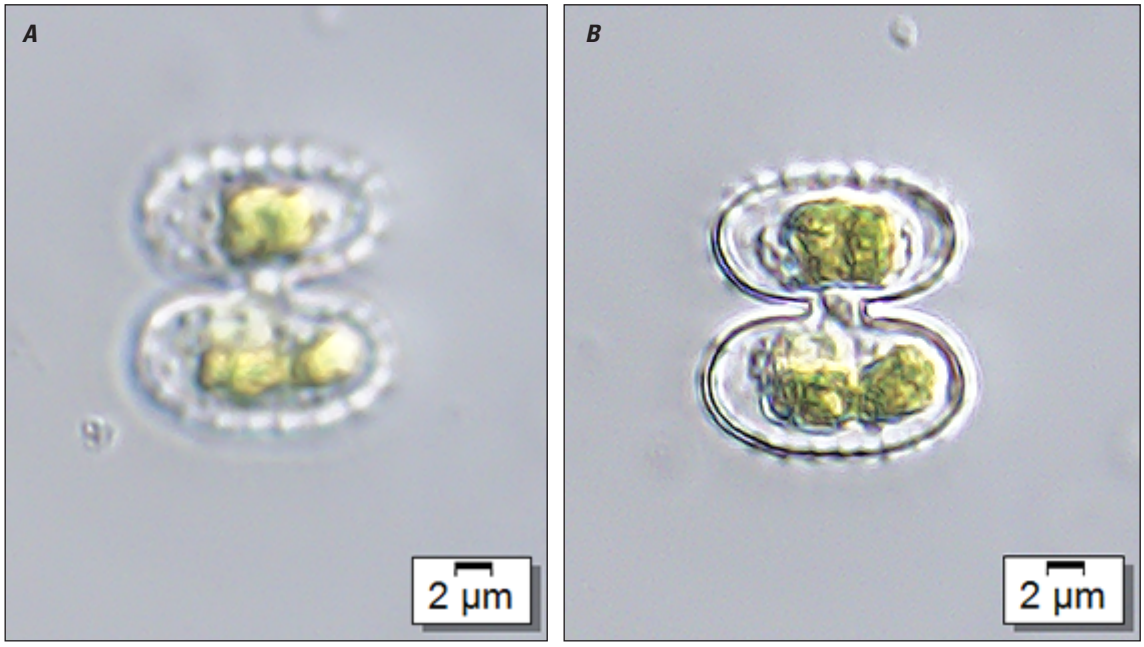


Figure 97. *Cosmarium* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmarium*

Species *Cosmarium* sp.

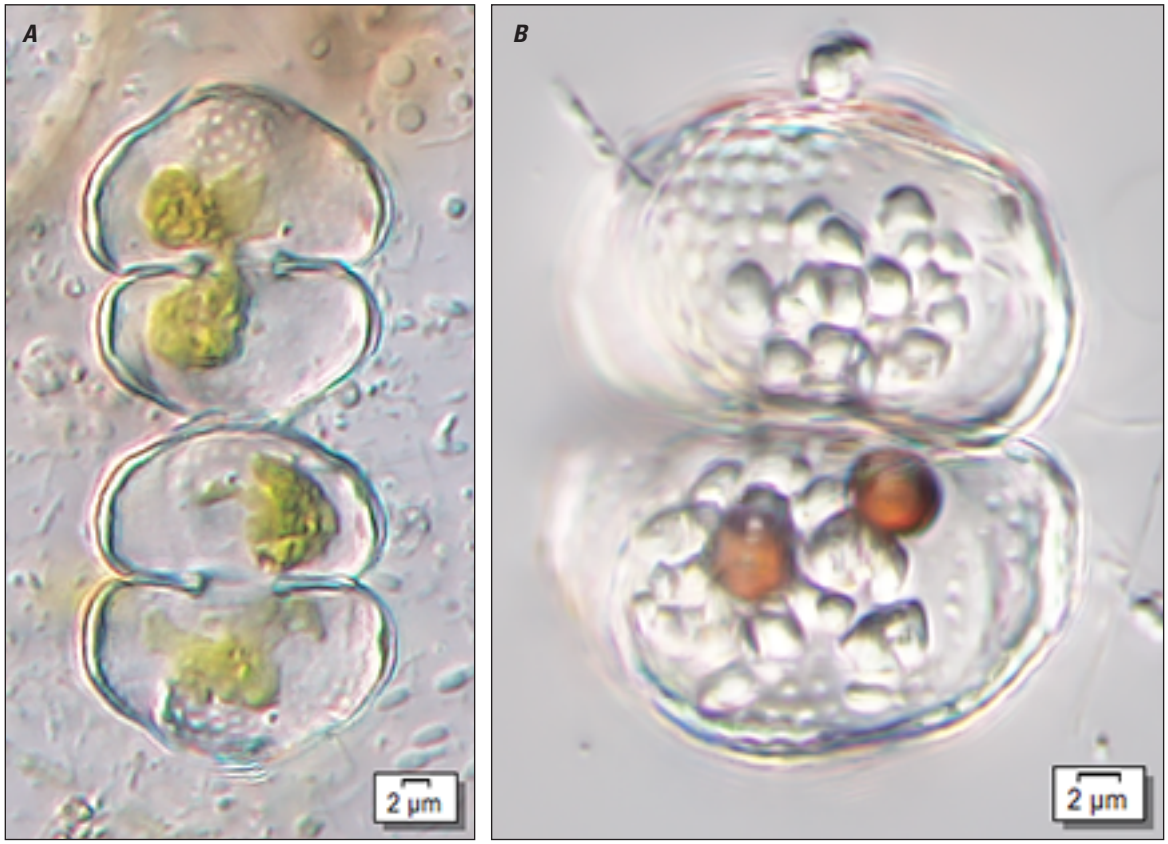


Figure 98. *Cosmarium* sp.

Cosmocladium Brébisson

Cells form colonies held together by gelatinous strands and enclosed in mucilage. The individual cells are small and constricted with elliptical semicells. By themselves, individual cells can be indistinguishable from small *Cosmarium* species.

Only one species, *Cosmocladium tuberculatum*, was identified in samples from the refuge (fig. 99). It was found at several sites, including the east interior and west perimeter sites.

Order Desmidiales

Family Desmidiaceae

Genus *Cosmocladium*

Species *Cosmocladium tuberculatum* Prescott

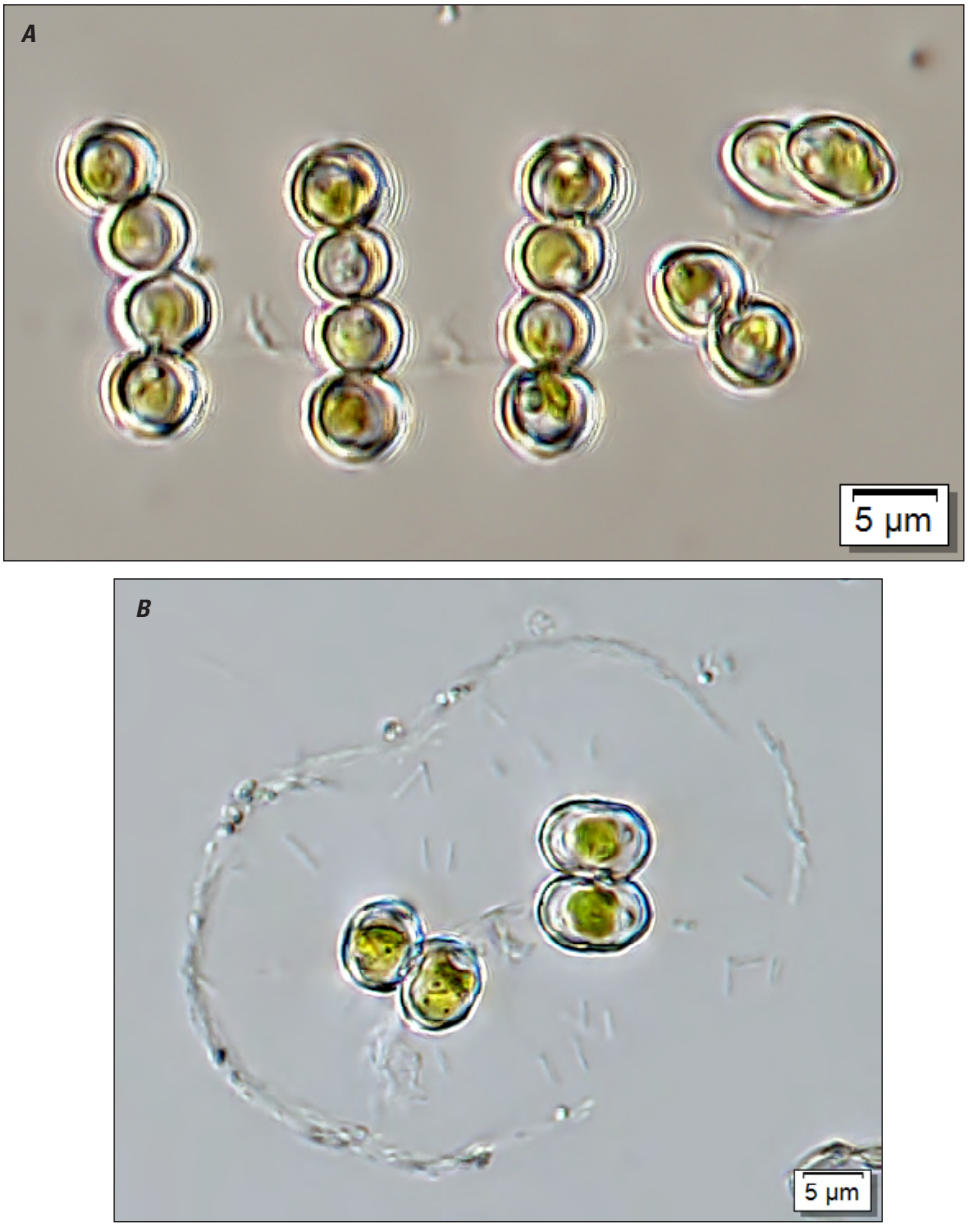


Figure 99. *Cosmocladium tuberculatum.*

Desmidium C. Agardh ex Ralfs

Cells are attached by apical processes to form filaments. Filaments often twist along the long axis of the filament, giving it a distinctive appearance. They are typically rectangular in side view with a slight constriction in the midregion; some species are triangular in apical view. The chloroplast is axial and has paired lobes that extend into each angle of the semicell.

Five *Desmidium* taxa were identified in samples from the refuge (figs. 100–104). They were found at all sites except the west perimeter site. This genus, particularly the species *Desmidium aptogonum,* was common in most samples. Only a single filament of *Desmidium swartzii* was found, making it very rare in the refuge.

Order Desmidiales

Family Desmidiaceae

Genus *Desmidium*

Species *Desmidium aptogonum* Brébisson ex Kützing

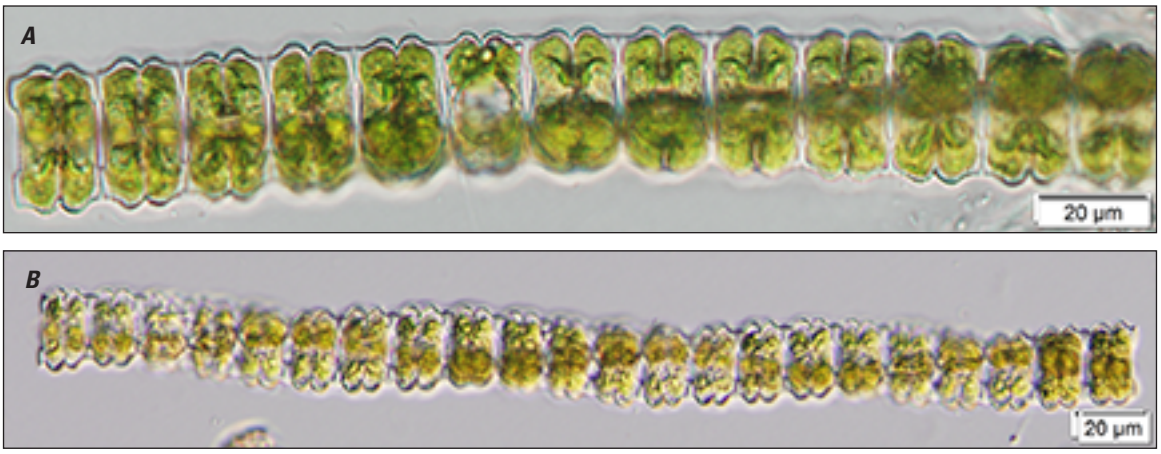


Figure 100. *Desmidium aptogonum.*

Order Desmidiales

Family Desmidiaceae

Genus *Desmidium*

Species *Desmidium aptogonum* var. *ehrenbergii* Kützing

Figure 101. *Desmidium aptogonum* var. *ehrenbergii*.

Order Desmidiales

Family Desmidiaceae

Genus *Desmidium*

Species *Desmidium baileyi* (Ralfs) Nordstedt

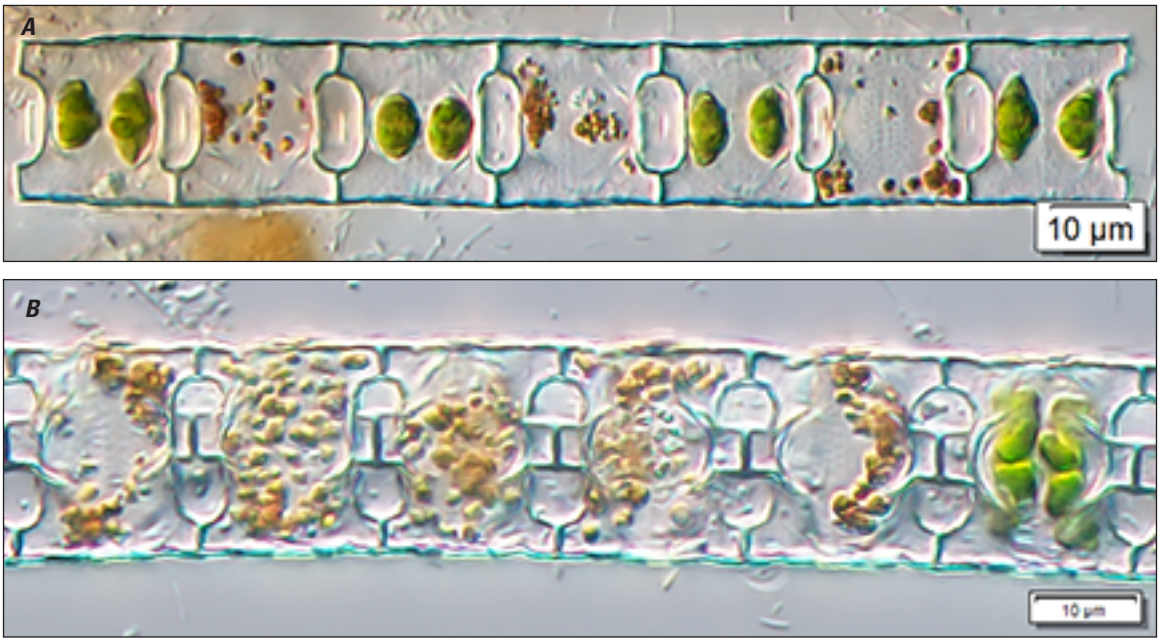


Figure 102. *Desmidium baileyi.*

Order Desmidiales

Family Desmidiaceae

Genus *Desmidium*

Species *Desmidium graciliceps* (Nordstedt) Lagerheim

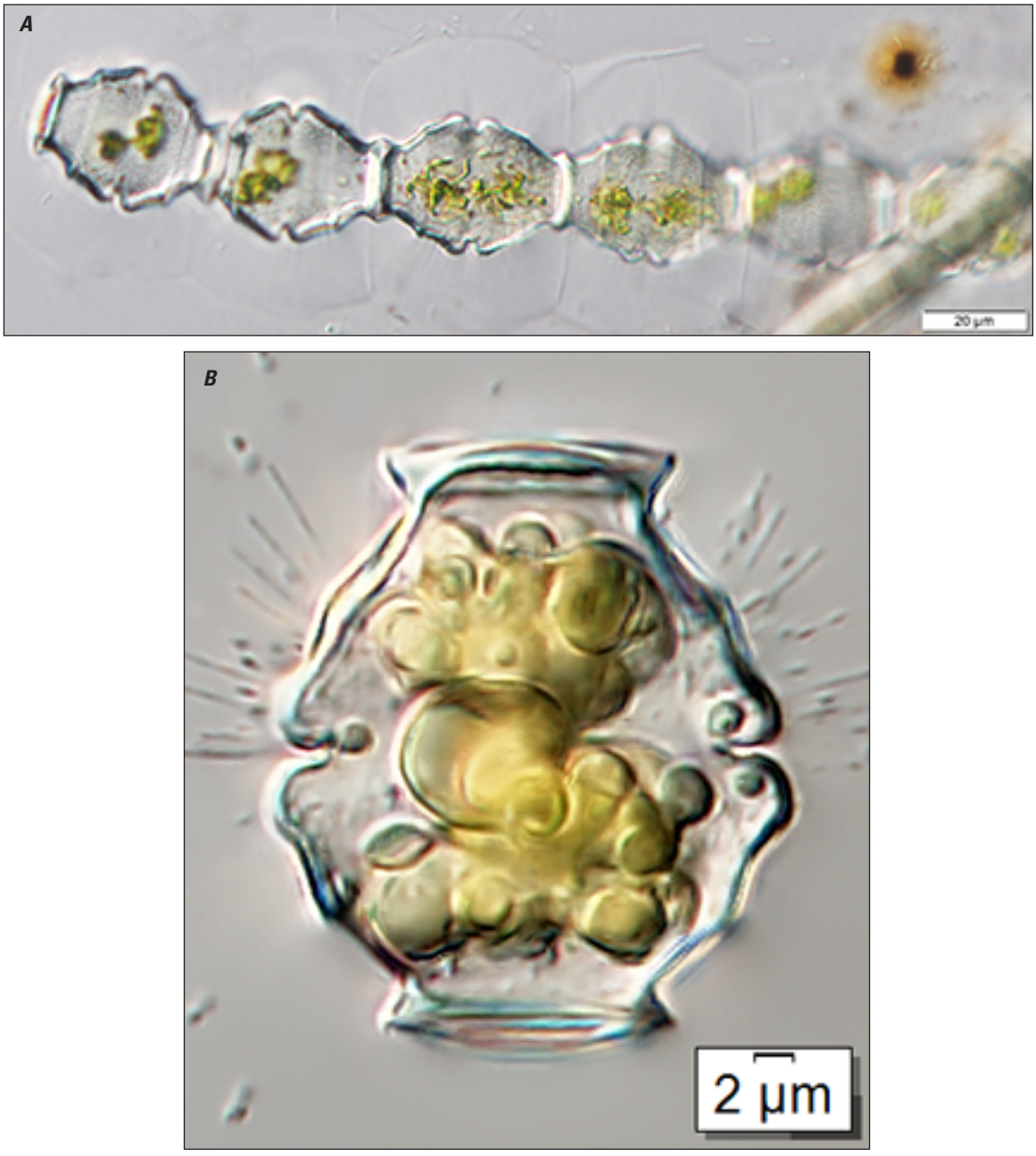


Figure 103. *Desmidium graciliceps*.

Order Desmidiales

Family Desmidiaceae

Genus *Desmidium*

Species *Desmidium swartzii* C. Agardh ex Ralfs

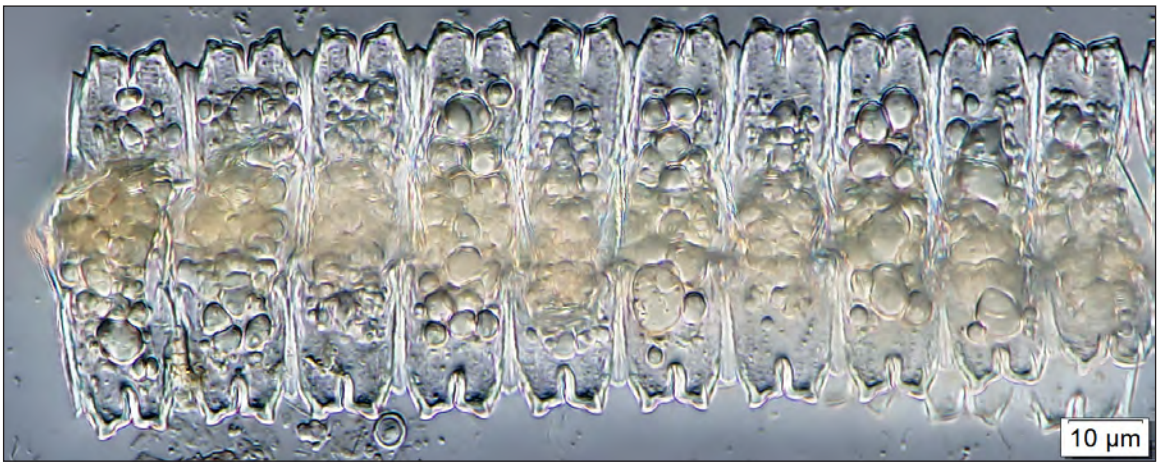


Figure 104. *Desmidium swartzii.*

Docidium Brébisson ex Ralfs

Cells are long and cylindrical with two rows of granules along the midregion of the cell. The apex is usually smooth but can have teeth in some species. The cell wall is smooth or punctate. The chloroplasts are axial and stellate with pyrenoids down the length of the cell.

Two species, *Docidium baculum* and *Docidium undulatum*, were identified in samples from the refuge (figs. 105–106). This genus was not abundant at any site and was absent from the west perimeter.

Order Desmidiales

Family Desmidiaceae

Genus *Docidium*

Species *Docidium baculum* Brébisson ex Ralfs

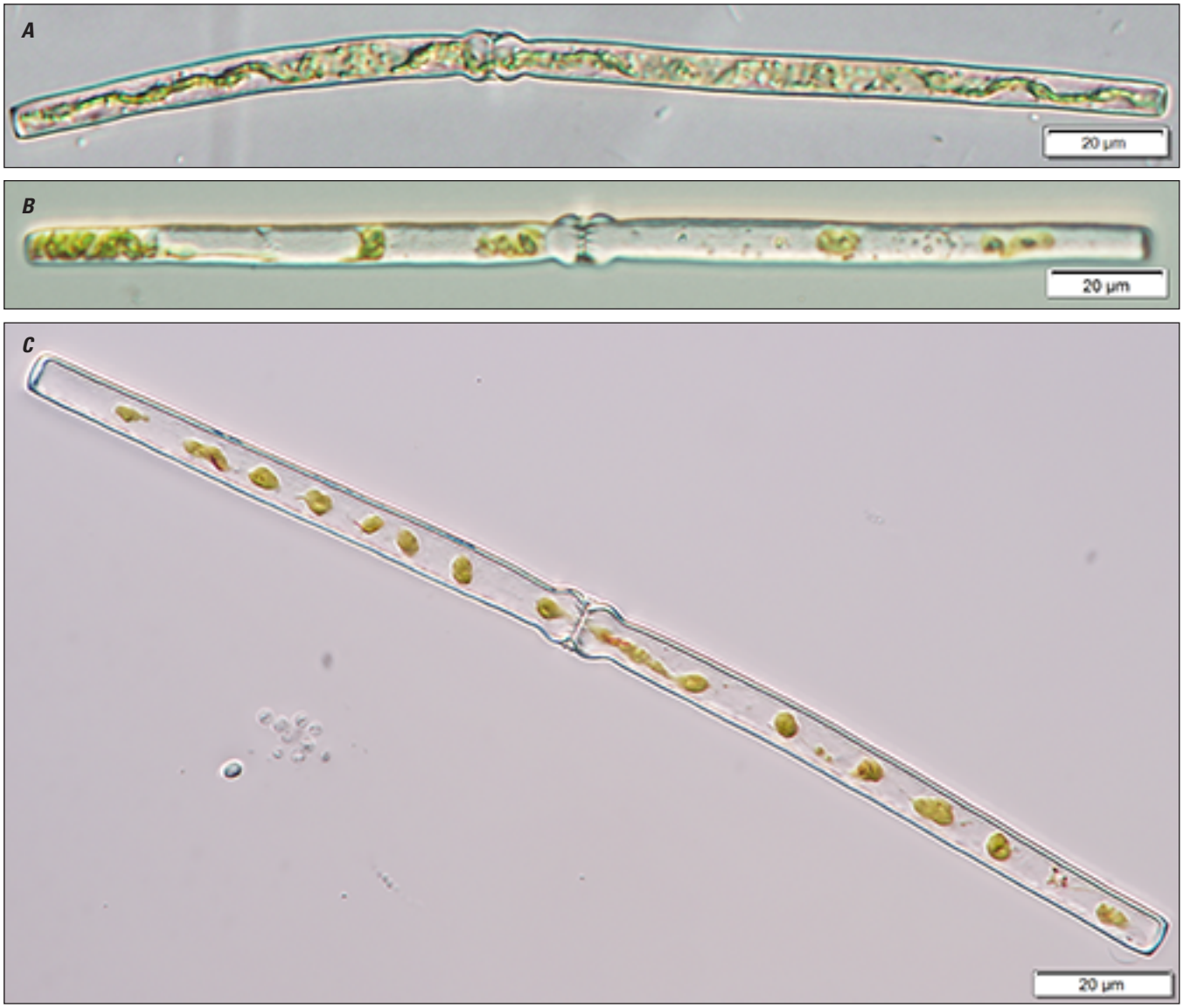


Figure 105. *Docidium baculum.*

Order Desmidiales

Family Desmidiaceae

Genus *Docidium*

Species *Docidium undulatum* Bailey

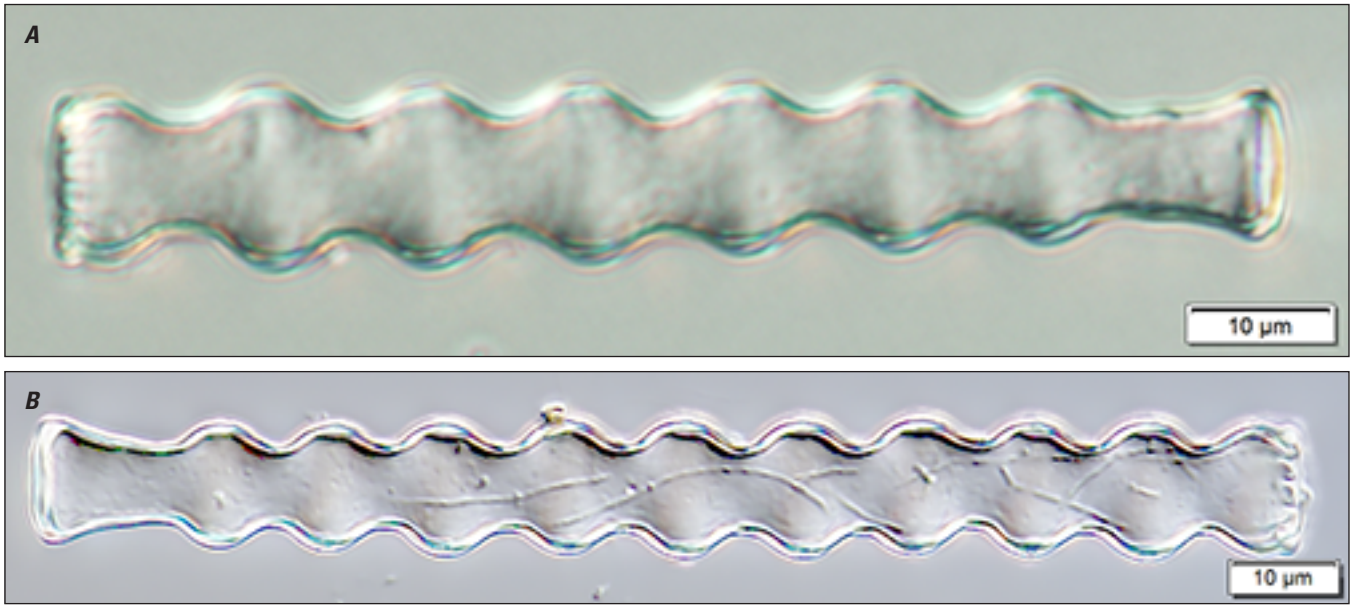


Figure 106. *Docidium undulatum.*

Euastrum Ehrenberg ex Ralfs

Cells are solitary and vary in size and shape. The semicell is divided into an incised polar lobe and one or more lateral lobes. The cells are often ornamented with granules, spines, pores, or verrucae (fig. 107). Sometimes the cell has a single pore that completely penetrates the cell wall, creating a pore organ. A single chloroplast is in each semicell.

Twenty-seven *Euastrum* taxa were identified in samples from the refuge (figs. 108–134). Only one of these, *Euastrum elegans*, was found at the west perimeter site. Several species were rare, such as *Euastrum marianopoliense*, *Euastrum pectinatum* var. *lobuliferum*, and *Euastrum ventricosum* var. *rectangulare*.

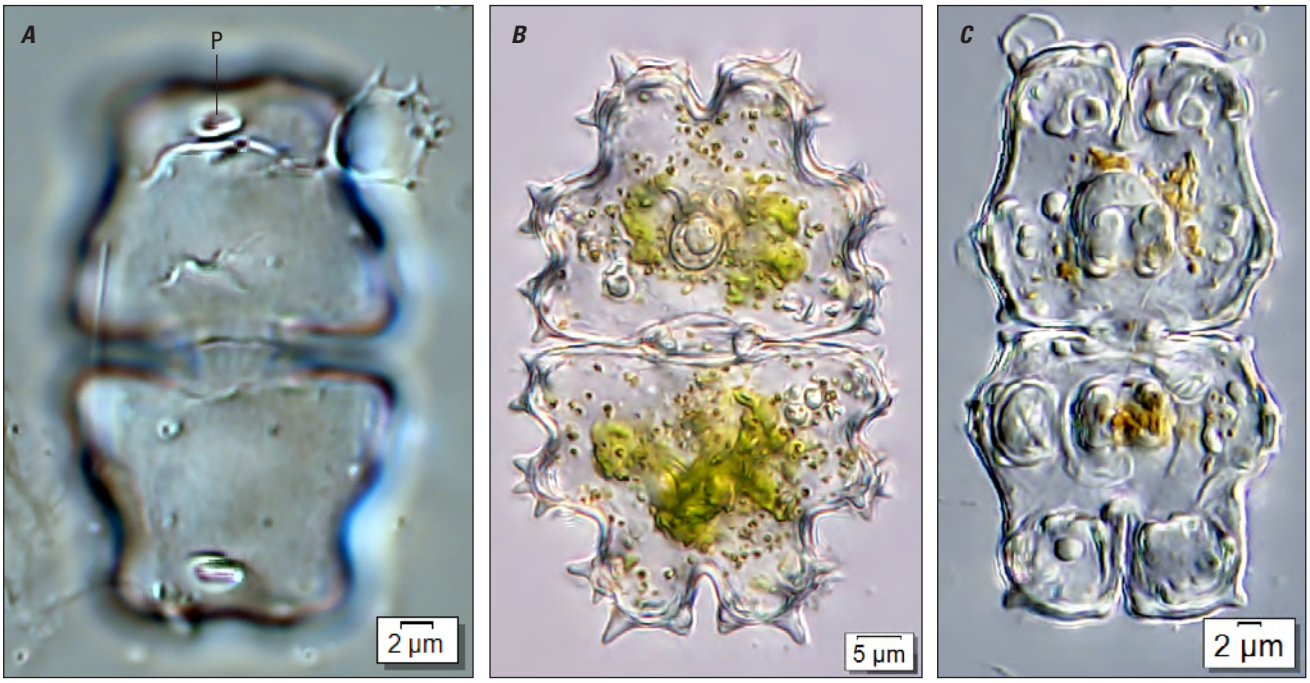


Figure 107. *A*, *Euastrum validum* var. *glabrum* f. *inflatum* has a very large pore organ (P) on either side of the cell. *B*, *Euastrum evolutum* cells are ornamented with spines and granules. *C*, *Euastrum ciastonii* has a central protuberance with four granules, as well as short spines at the apex.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum attenuatum* var. *splendens* (Fritsch & Rich) Grönblad & A.M. Scott

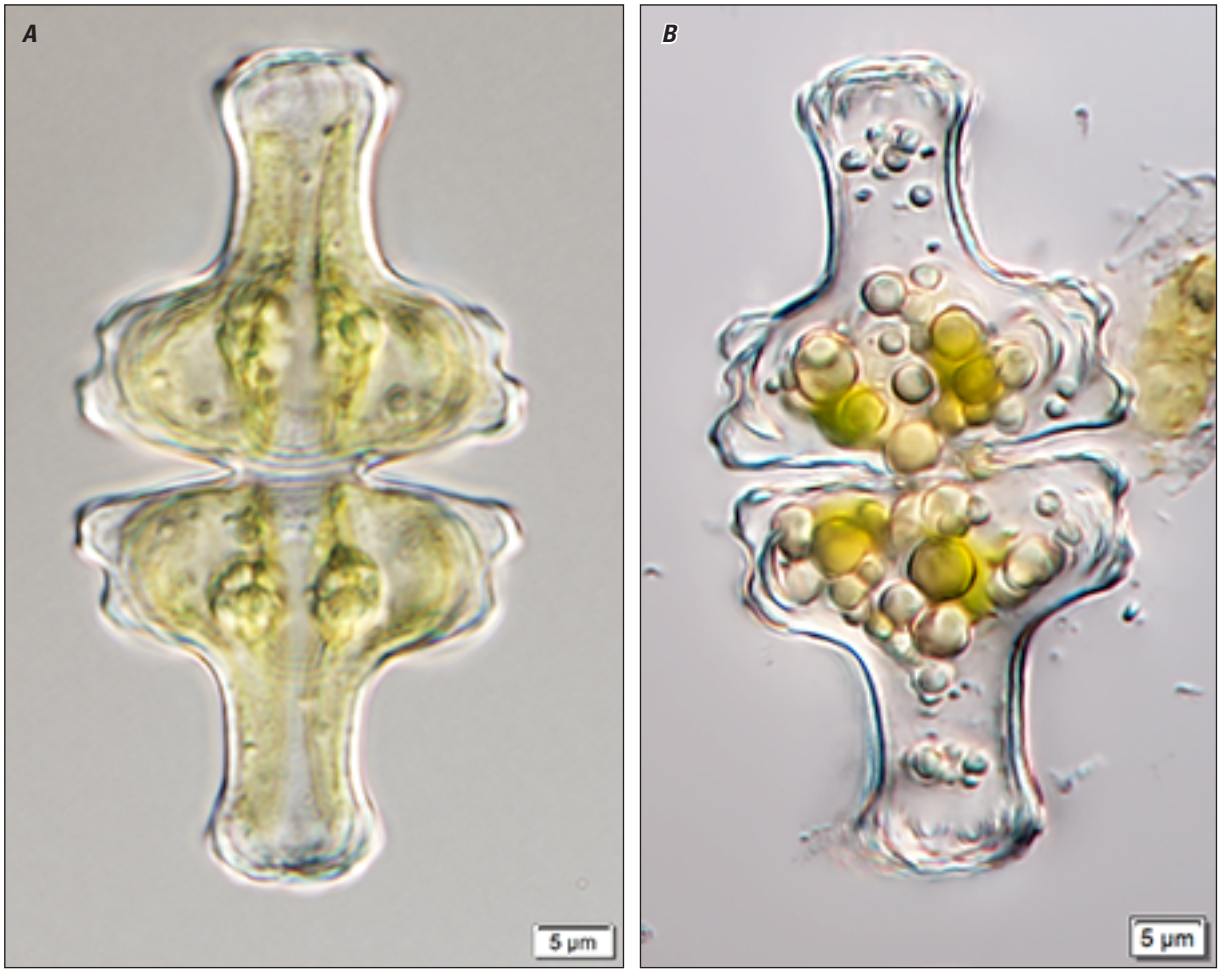


Figure 108. *Euastrum attenuatum* var. *splendens*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum bidentatum* var. *quadrioculatum* Scott & Prescott

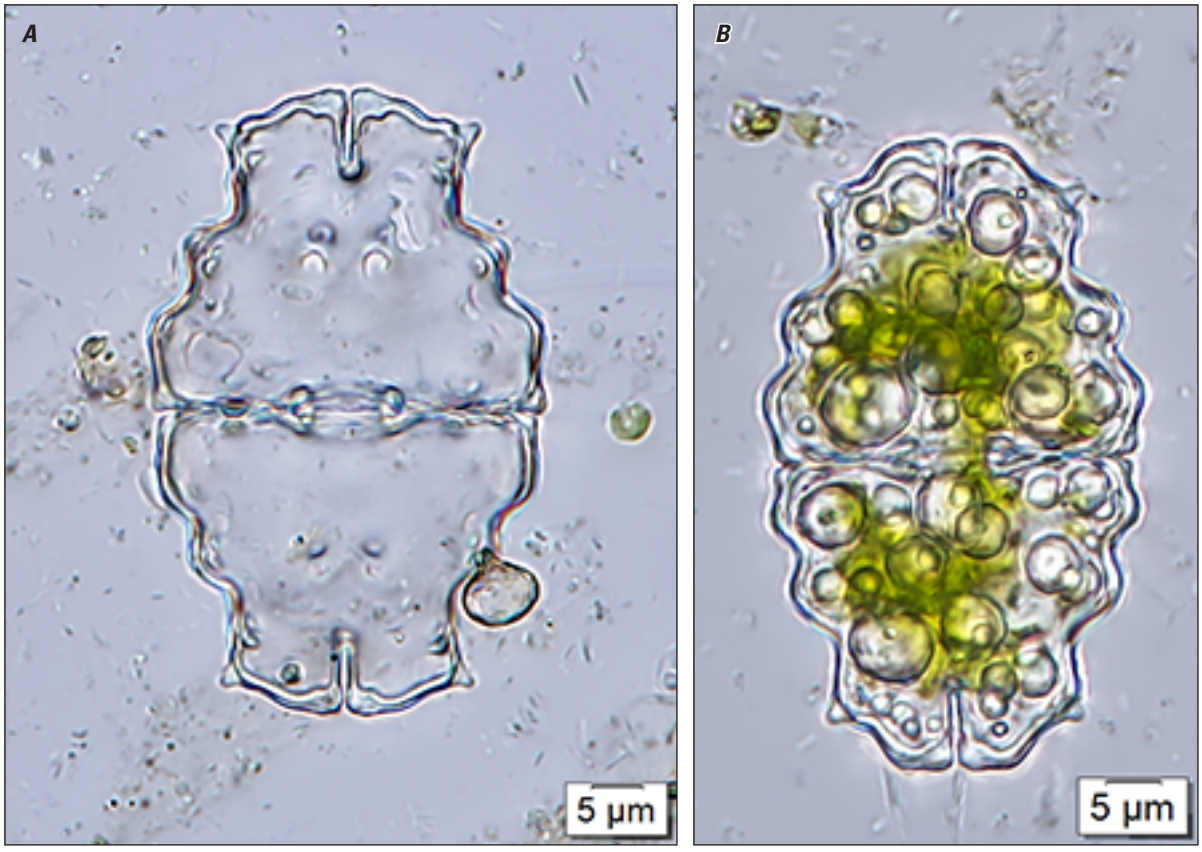


Figure 109. *Euastrum bidentatum* var. *quadrioculatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum* cf. *binale* Ehrenberg ex Ralfs

Figure 110. *Euastrum* cf. *binale*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum ciastonii* Raciborski

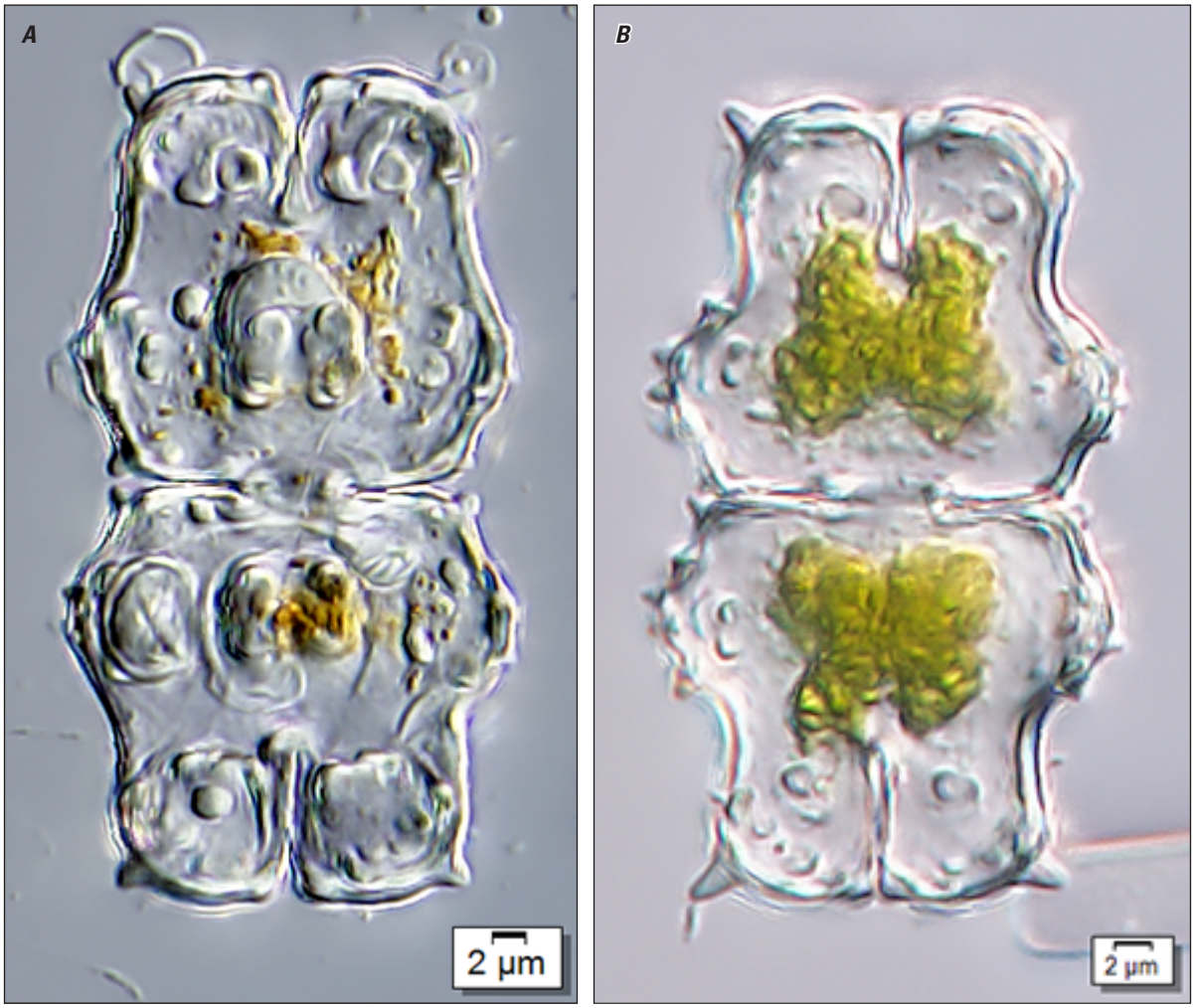


Figure 111. *Euastrum ciastonii.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum cornubiense* West & West

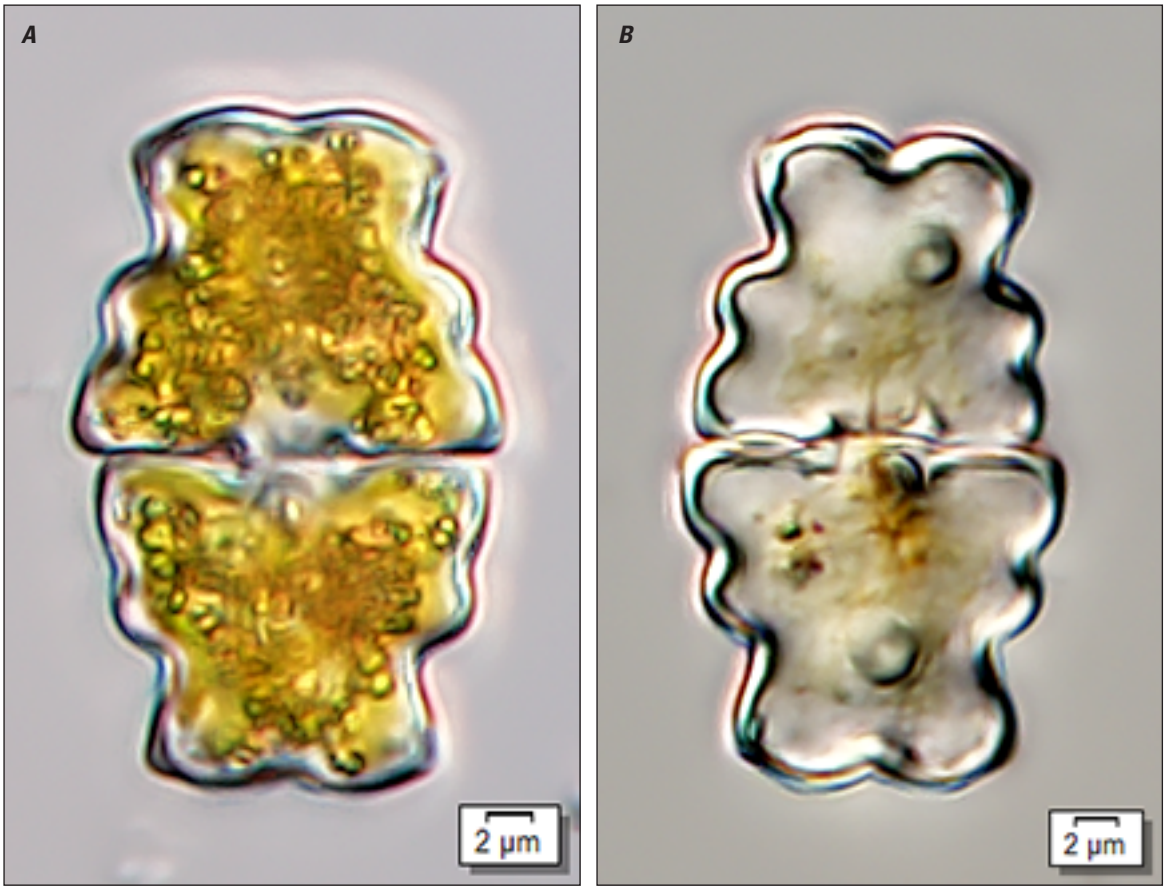


Figure 112. *Euastrum cornubiense*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum crassum* Ralfs

Figure 113. *Euastrum crassum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum denticulatum* F. Gay

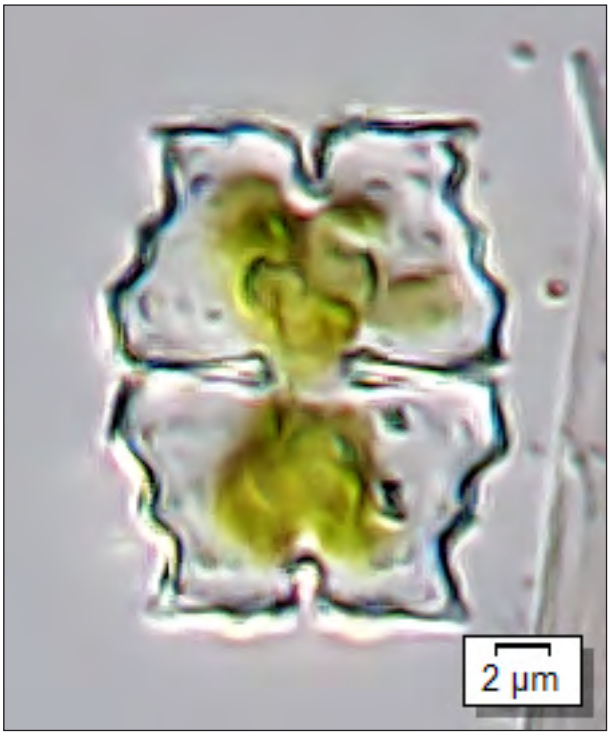


Figure 114. *Euastrum denticulatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum didelta* var. *crassum* Ralfs

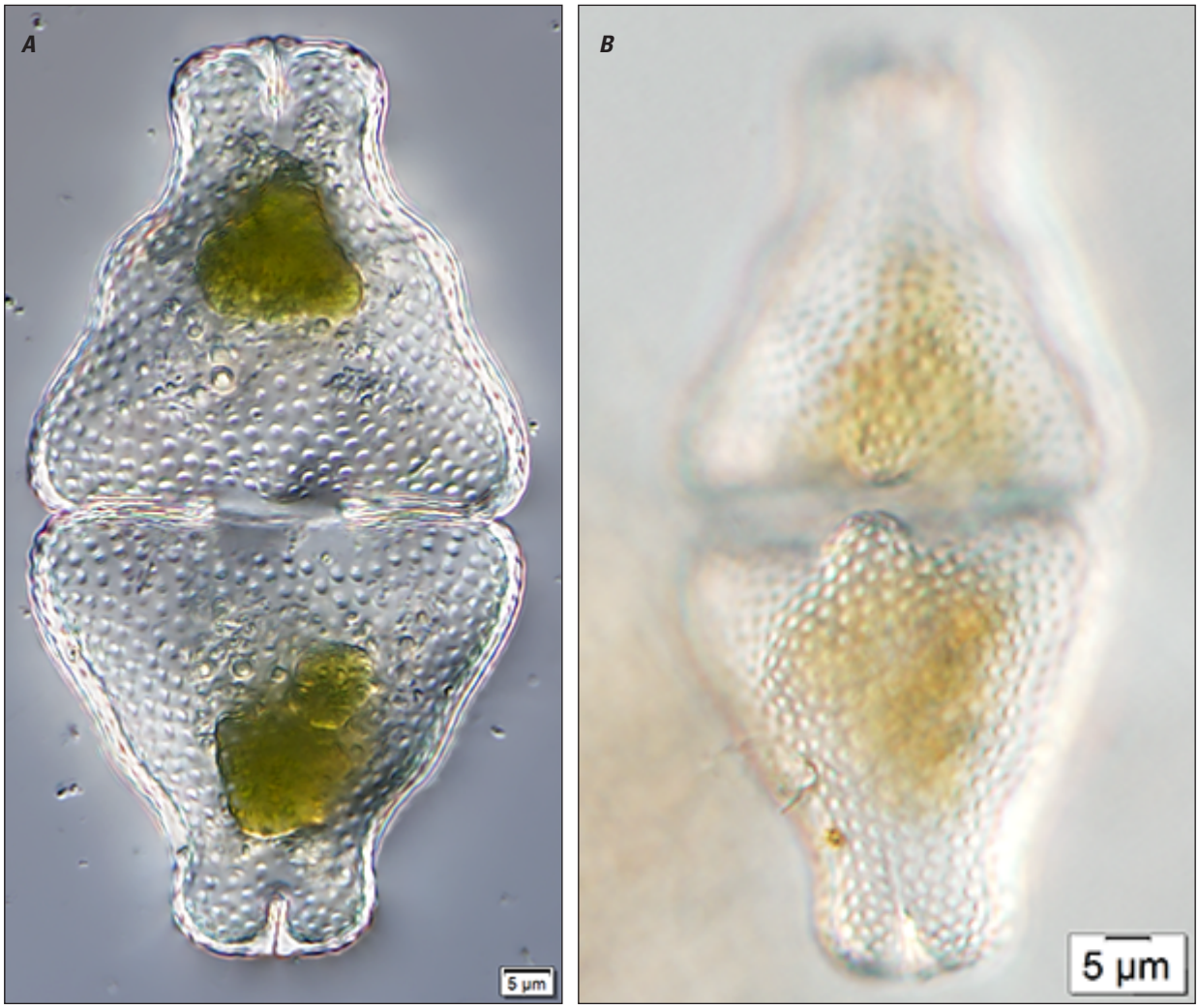


Figure 115. *Euastrum didelta* var. *crassum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum elegans* Ralfs

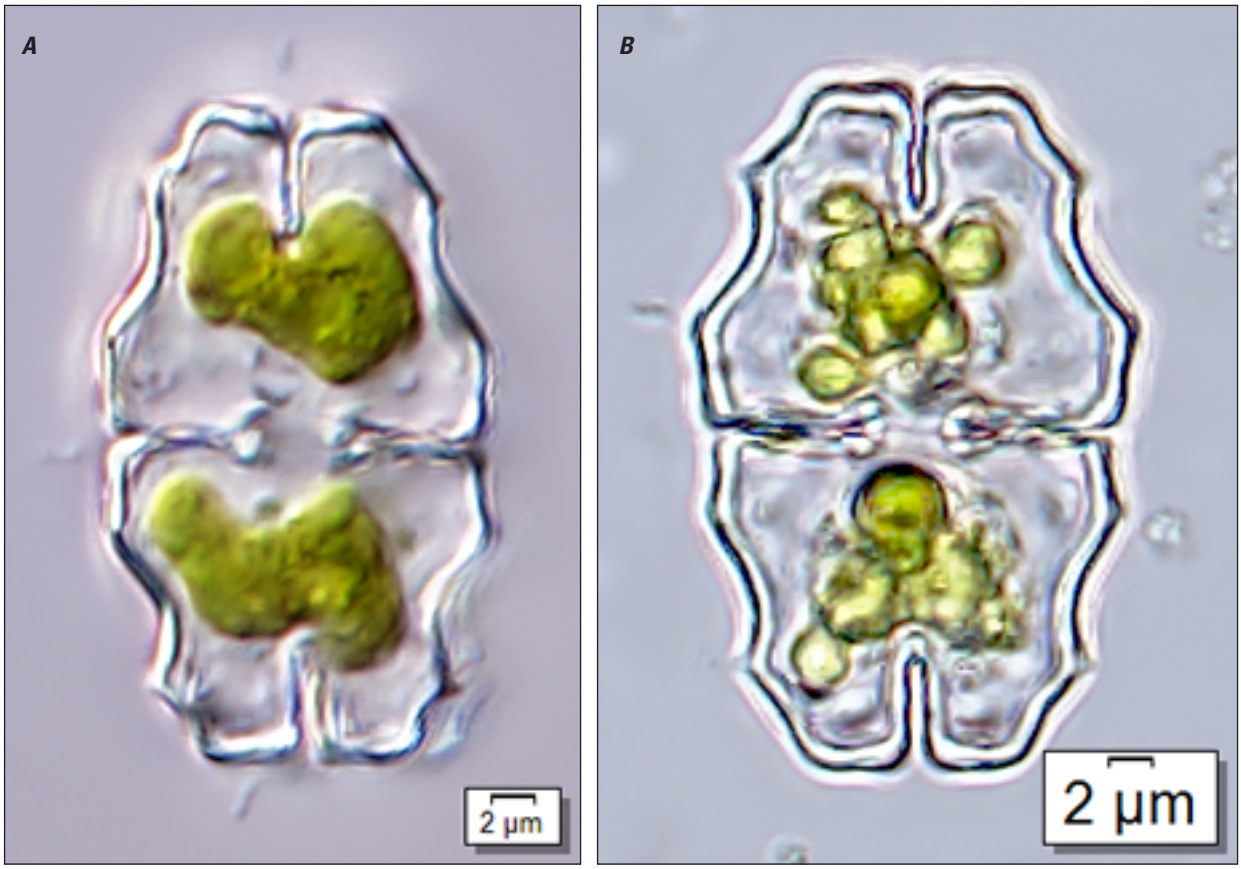


Figure 116. *Euastrum elegans.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum evolutum* (Nordstedt) West & West

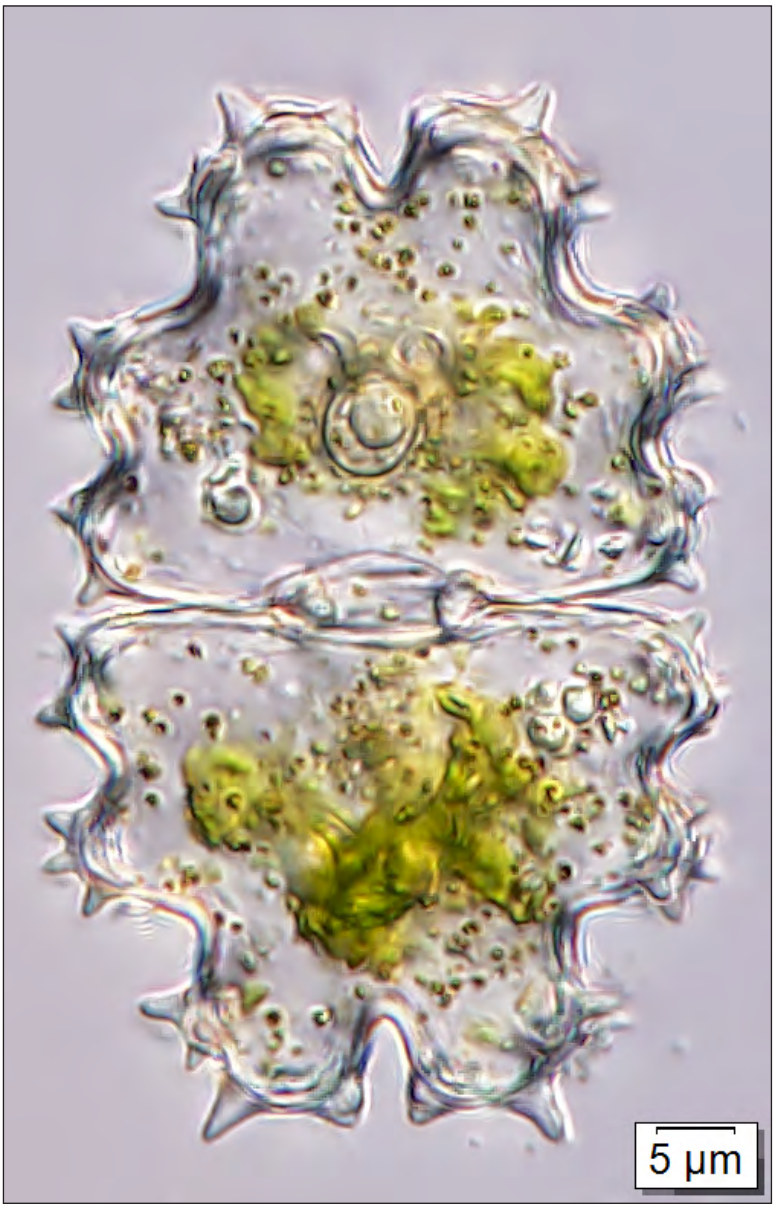


Figure 117. *Euastrum evolutum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum evolutum* var. *glaziovii* (Børgesen) West & G.S. West

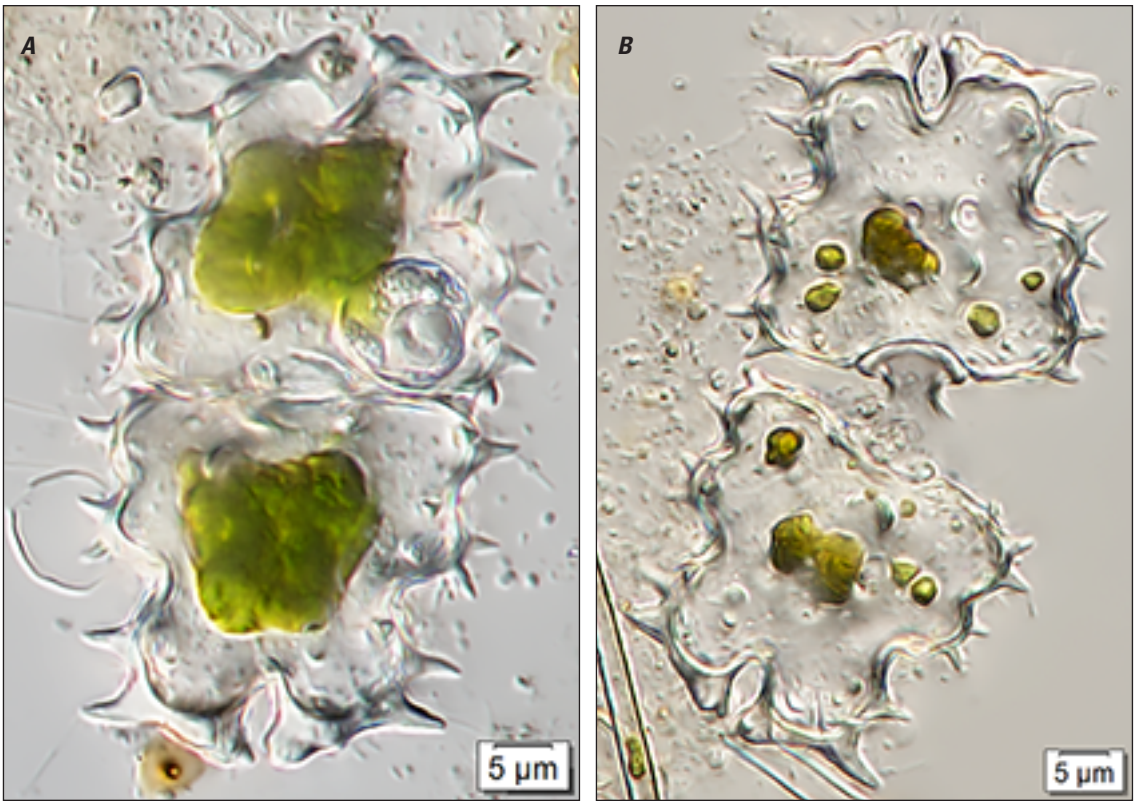


Figure 118. *Euastrum evolutum* var. *glaziovii*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum hypochondrum* Nordstedt

Figure 119. *Euastrum hypochondrum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum informe* f. *oculatum* Scott and Prescott

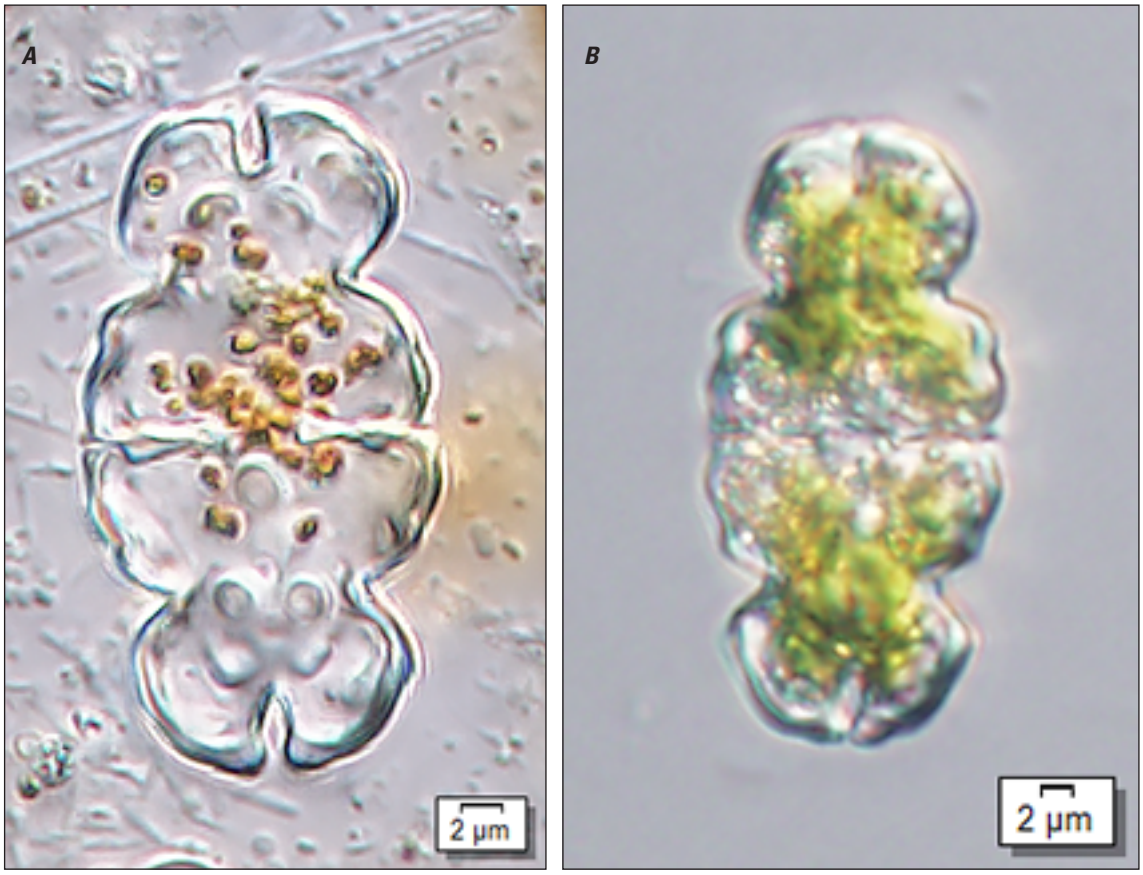


Figure 120. *Euastrum informe* f. *oculatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum insulare* var. *lacustre* (Messikommer) Krieger

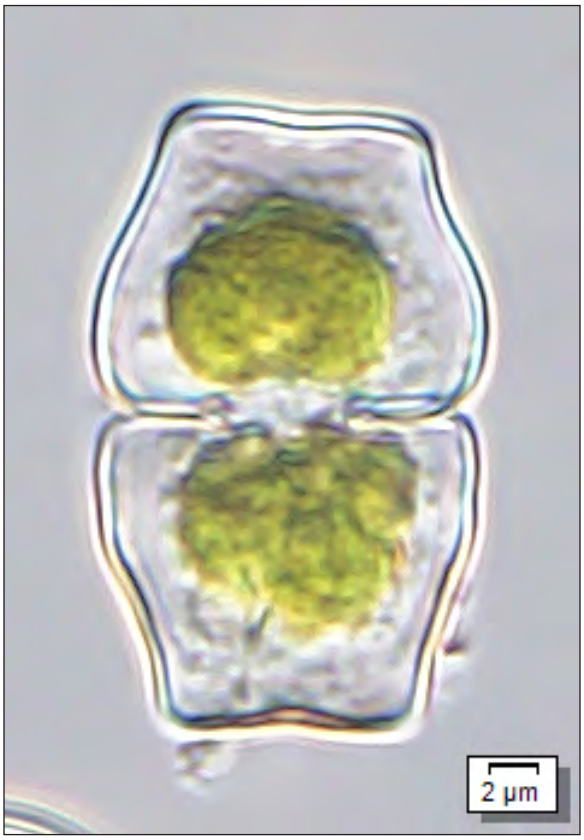


Figure 121. *Euastrum insulare* var. *lacustre*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum intermedium* var. *longicolle* Borge

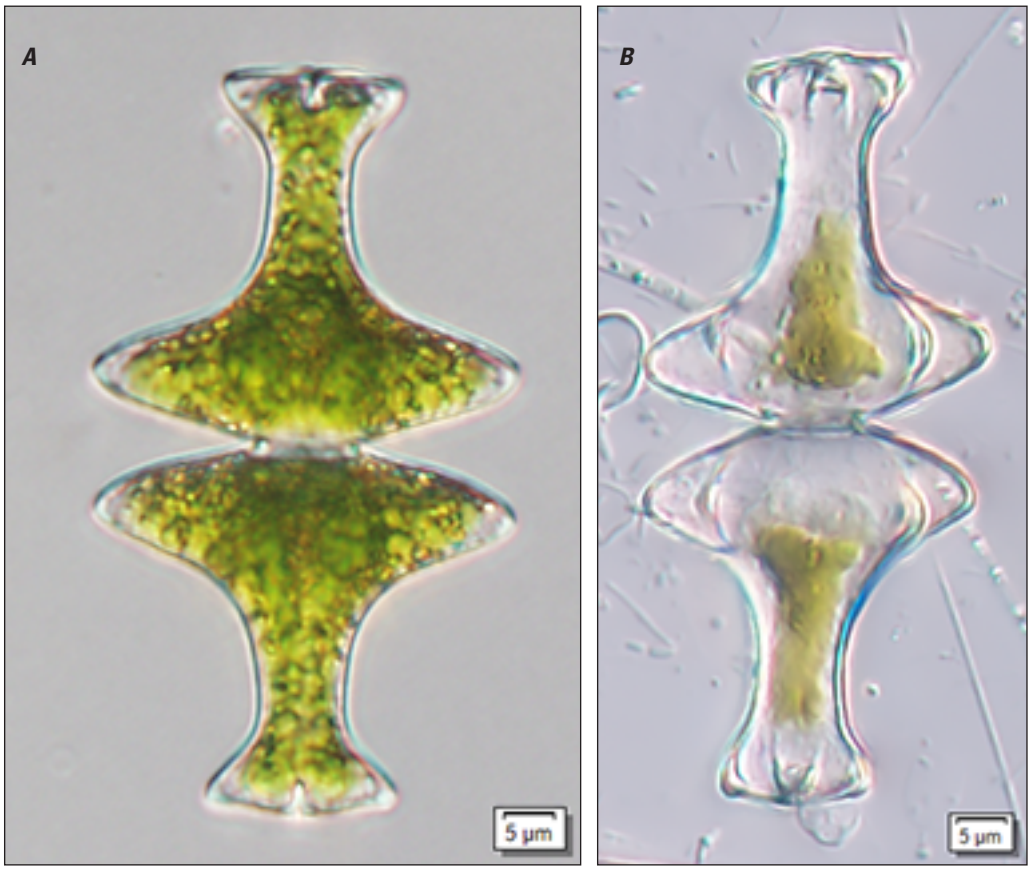


Figure 122. *Euastrum intermedium* var. *longicolle.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum lapponicum* var. *protuberans* Prescott

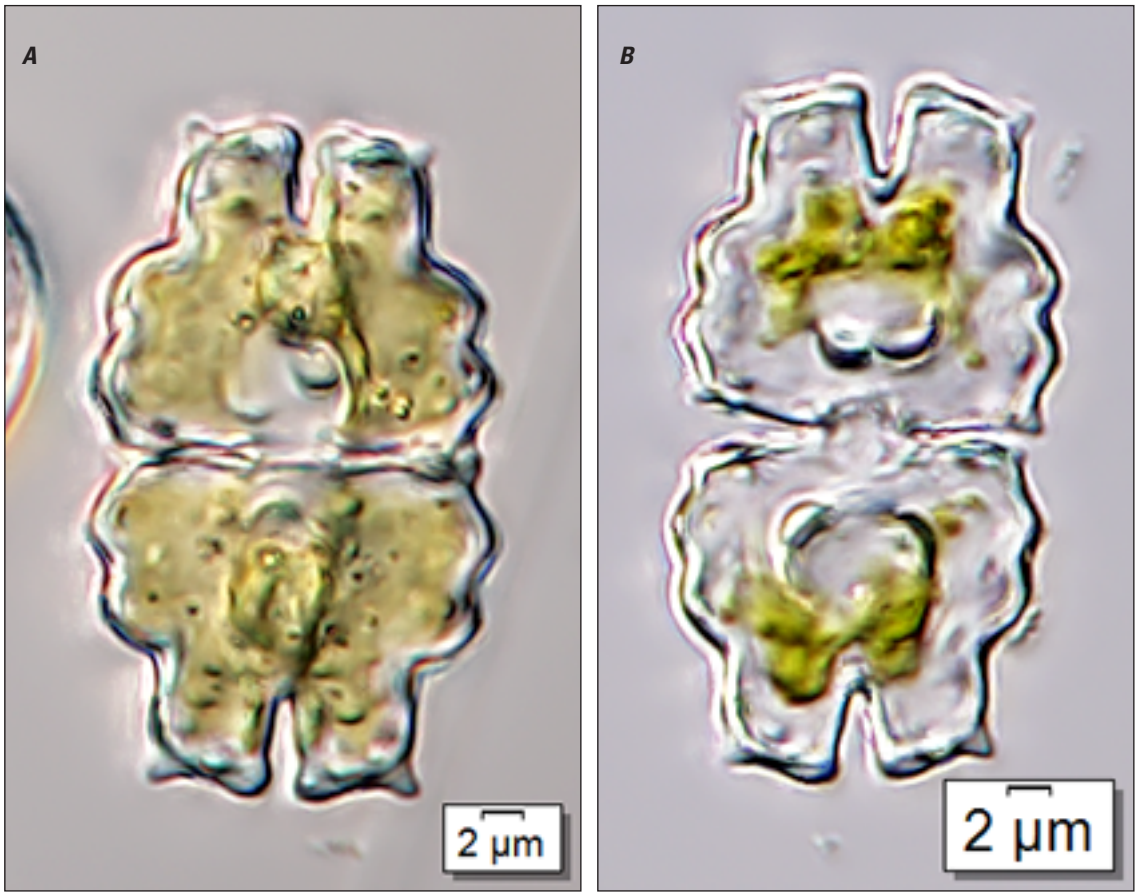


Figure 123. *Euastrum lapponicum* var. *protuberans*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum luetkemuelleri* Ducellier

Figure 124. *Euastrum luetkemuelleri.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum marianopoliense* Irénée-Marie

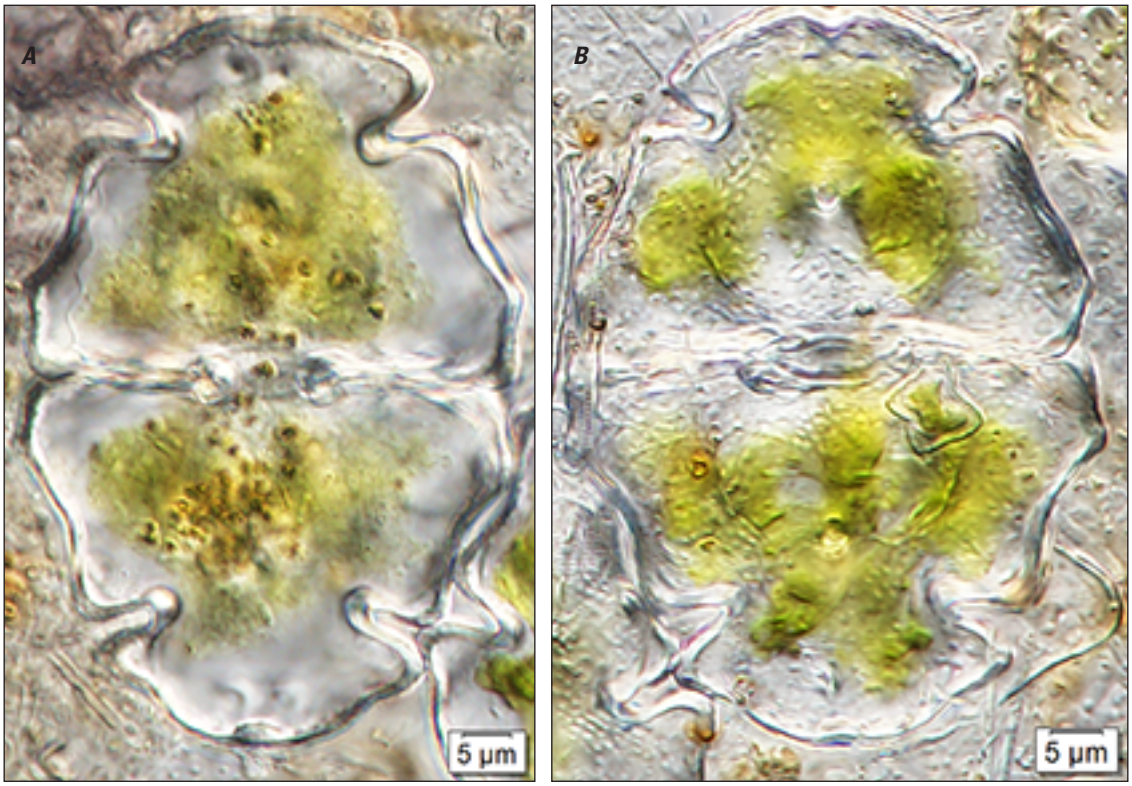


Figure 125. *Euastrum marianopoliense*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum oblongum* Ralfs

Figure 126. *Euastrum oblongum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum pectinatum* var. *lobuliferum* Scott & Prescott

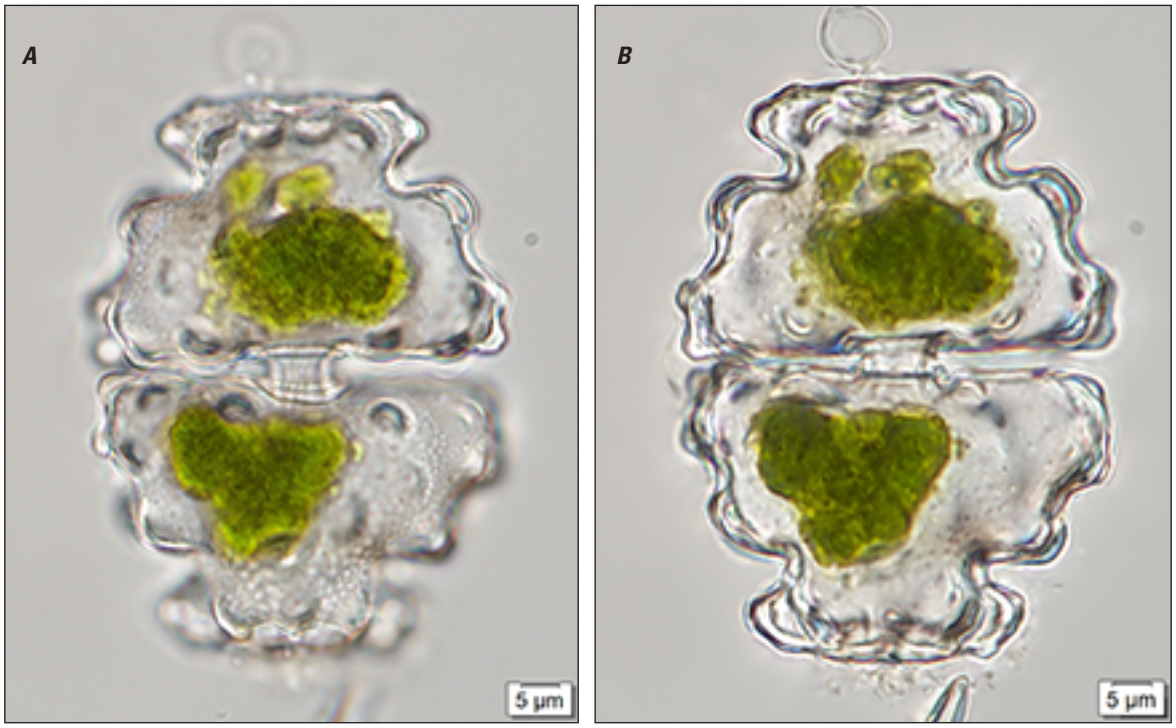


Figure 127. *Euastrum pectinatum* var. *lobuliferum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum pinnatum* Ralfs

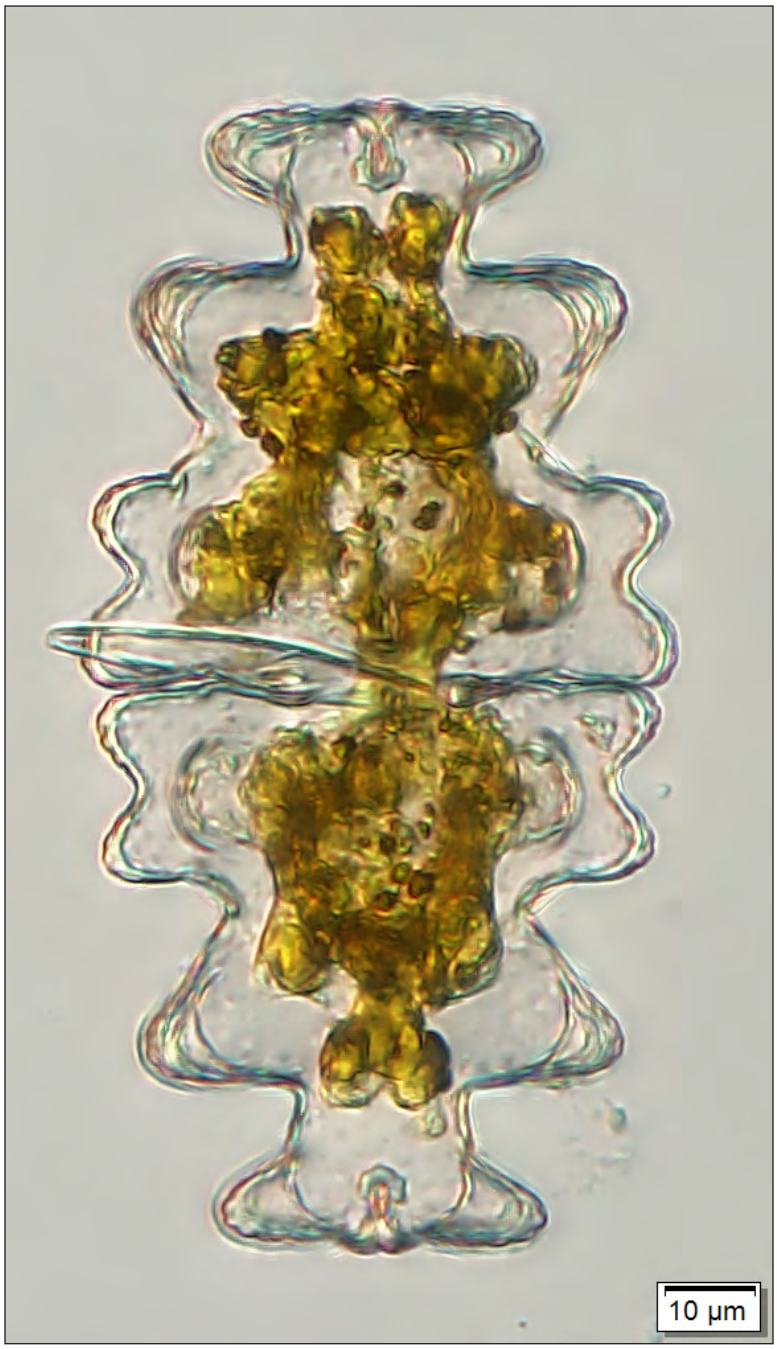


Figure 128. *Euastrum pinnatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum sibiricum* var. *reductum* Prescott & Scott

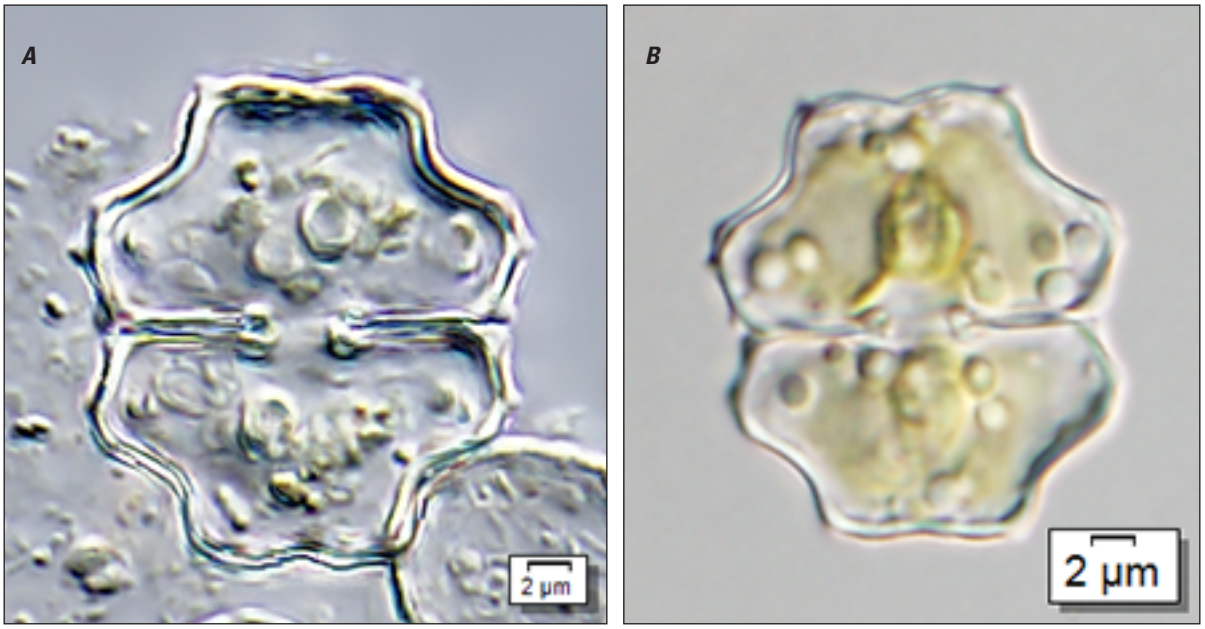


Figure 129. *Euastrum sibiricum* var. *reductum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum sublobatum* Brébisson ex Ralfs

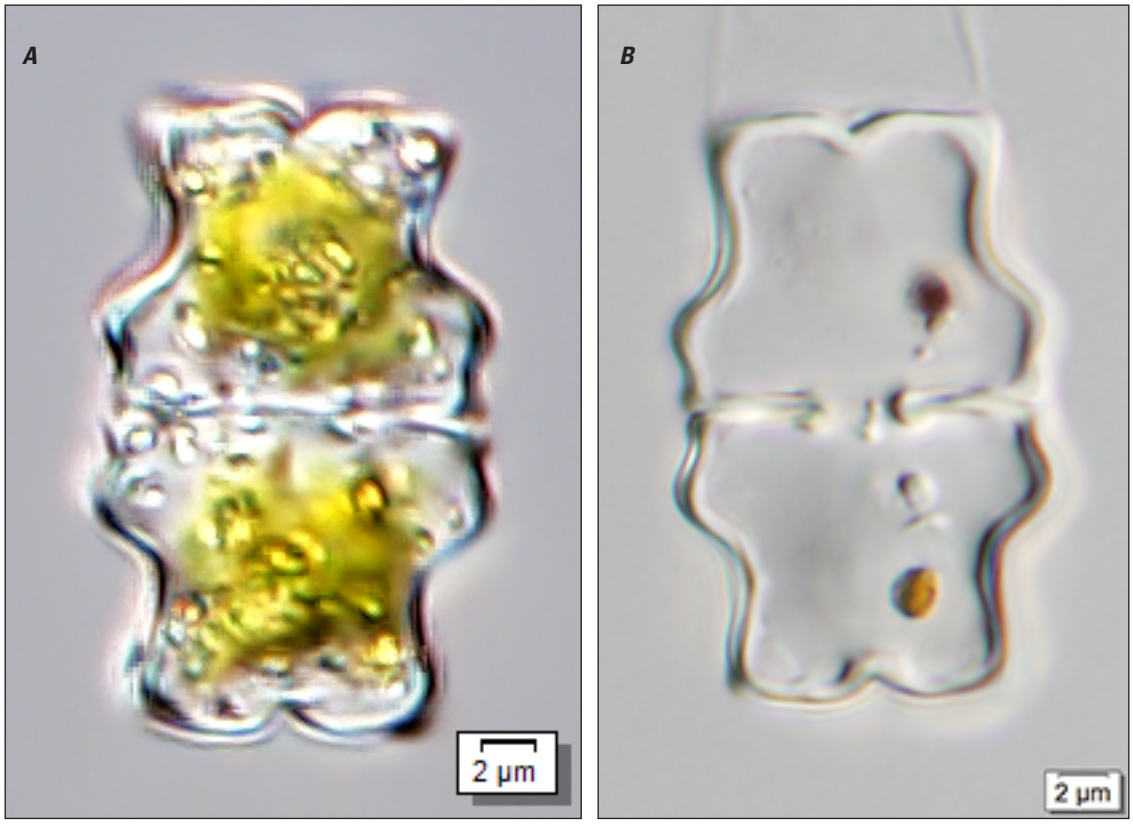


Figure 130. *Euastrum sublobatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum turneri* West

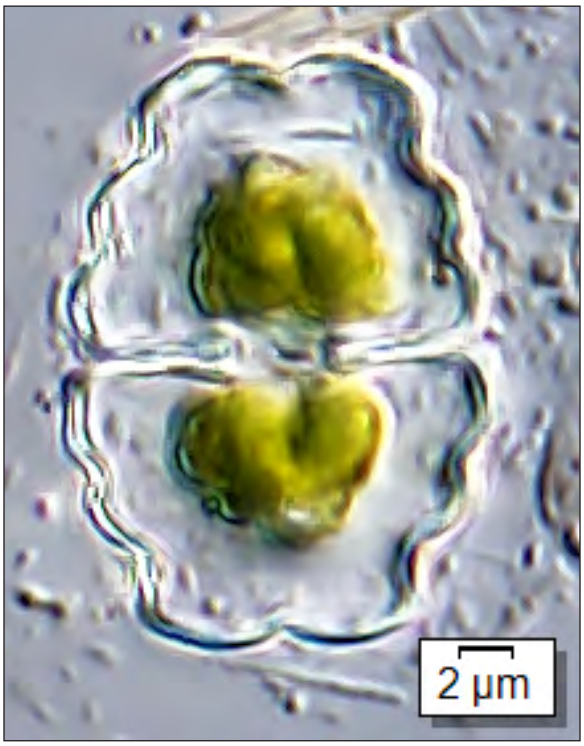


Figure 131. *Euastrum turneri.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum validum* West & West

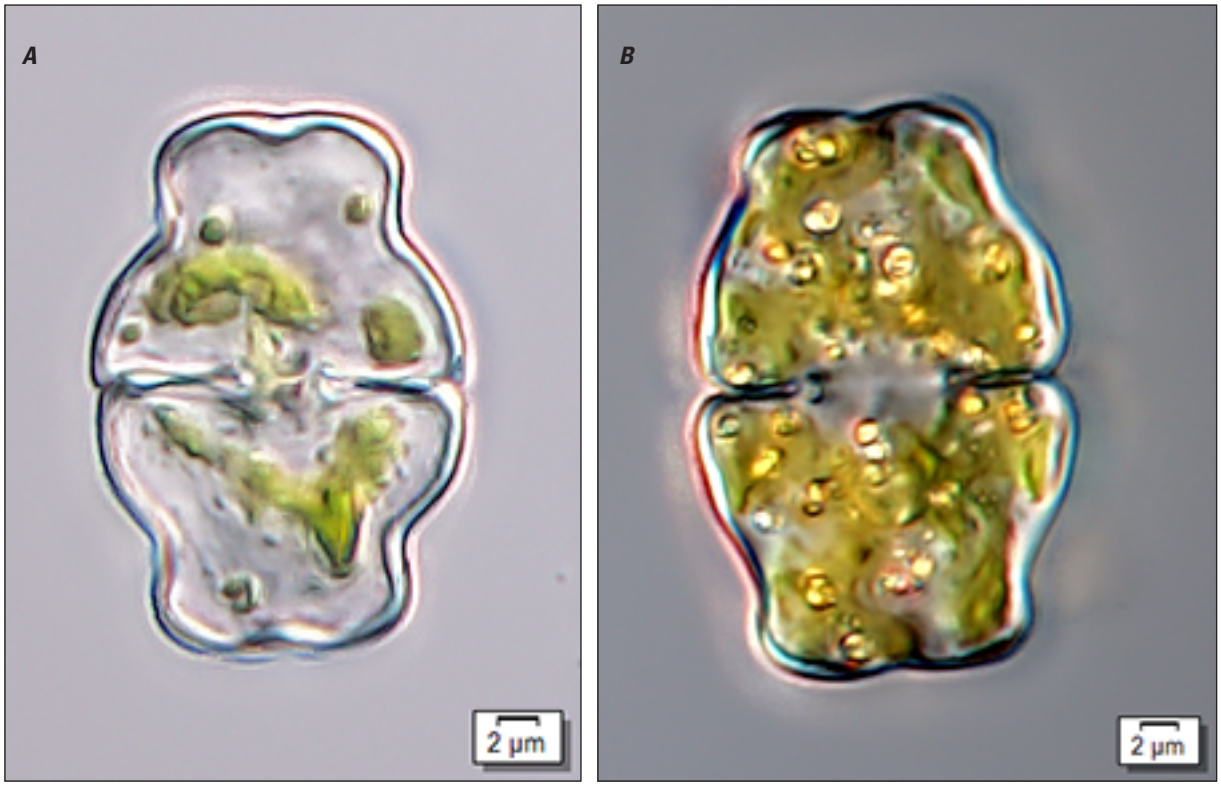


Figure 132. *Euastrum validum.*

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum* cf. *validum* var. *glabrum* f. *inflatum* Prescott

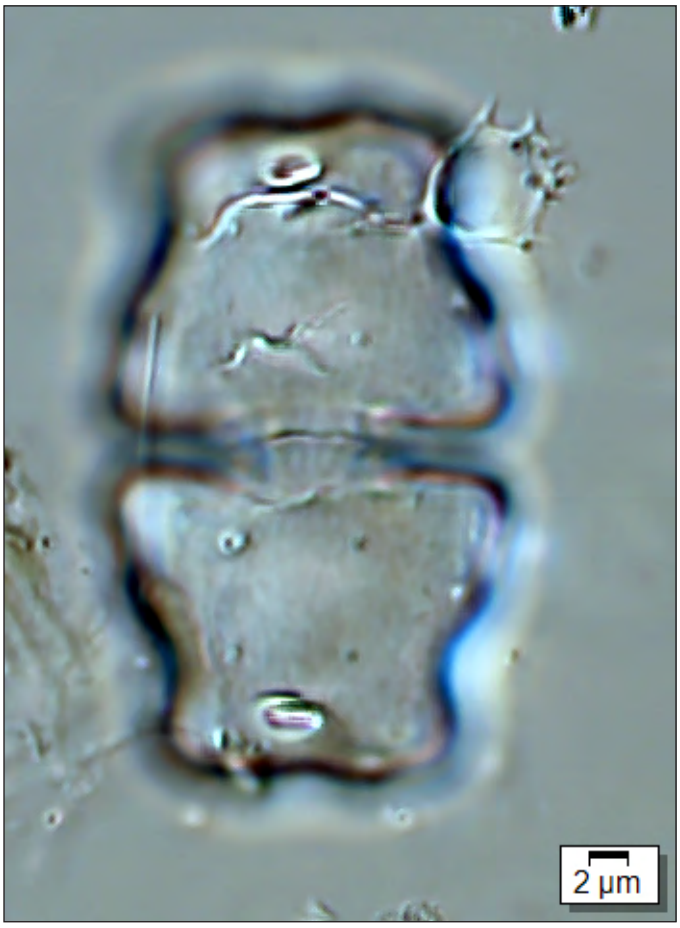


Figure 133. *Euastrum* cf. *validum* var. *glabrum* f. *inflatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Euastrum*

Species *Euastrum ventricosum* var. *rectangulare* Prescott & Scott

Figure 134. *Euastrum ventricosum* var. *rectangulare*.

Groenbladia Teiling

Cells are cylindrical and form filaments. The median constriction may be distinct and shallow or inconspicuous. The surface of the cell is smooth, and the filaments are often surrounded by a mucilaginous sheath. A single plate-like chloroplast is in each cell.

Only one species from this genus, *Groenbladia undulata* var. *perundulata*, was identified in samples from the refuge. It was found in all sites except the west perimeter site (fig. 135).

Order Desmidiales

Family Desmidiaceae

Genus *Groenbladia*

Species *Groenbladia undulata* var. *perundulata* (Grönblad) Kurt Förster

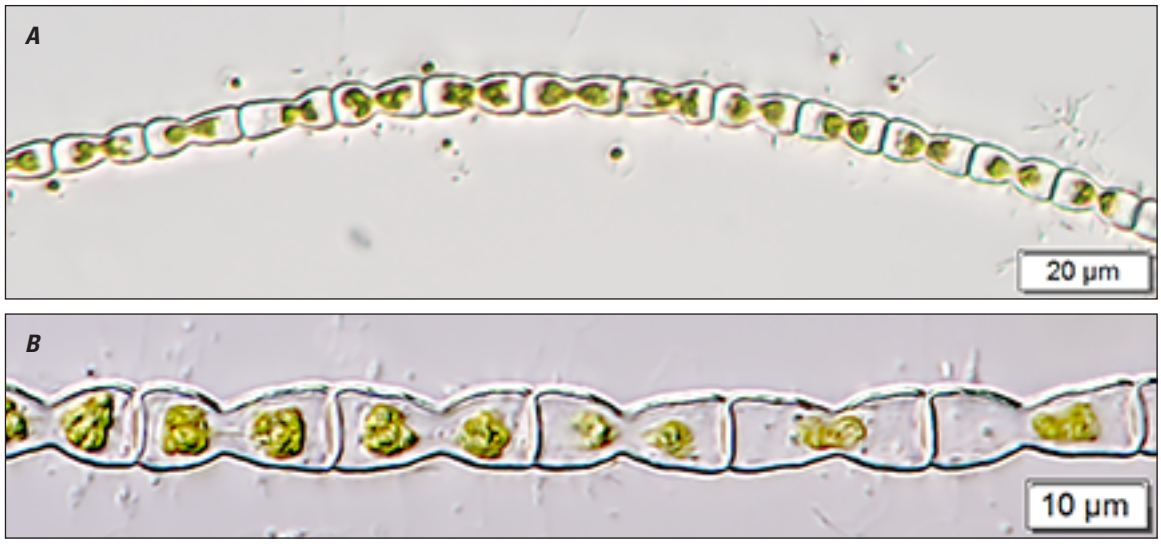


Figure 135. *Groenbladia undulata* var. *perundulata*.

Haplotaenium Bando

Cells of this genus are straight and cylindrical. The midregion is slightly inflated and constricted, and the apices are round and unornamented. The cell wall lacks ornamentation and there is no terminal vacuole, which differentiate this genus from *Pleurotaenium.*

Two species and a total of four taxa were identified from the refuge (figs. 136–139). These cells were common and are one of the most common cell types found in periphyton mats (Swift and Nicholas, 1987).

Order Desmidiales

Family Desmidiaceae

Genus *Haplotaenium*

Species *Haplotaenium minutum* (Ralfs) Bando

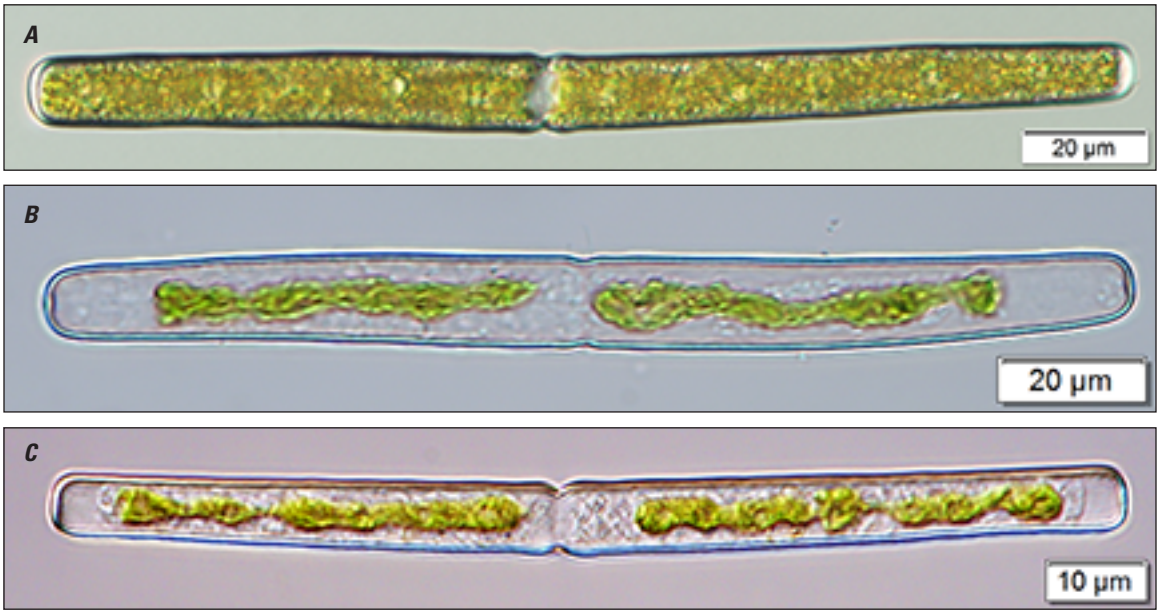


Figure 136. *Haplotaenium minutum.*

Order Desmidiales

Family Desmidiaceae

Genus *Haplotaenium*

Species *Haplotaenium minutum* var. *crassum* (West) Cambra Sánchez

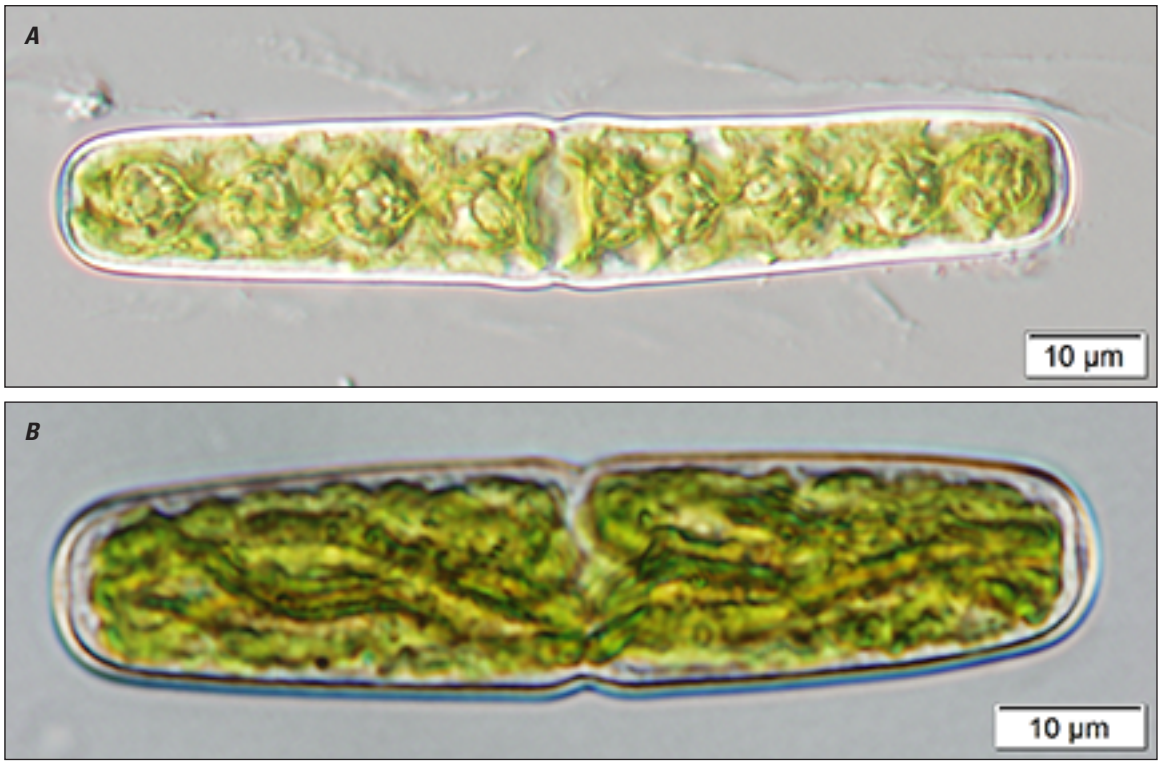


Figure 137. *Haplotaenium minutum* var. *crassum*.

Order Desmidiales

Family Desmidiaceae

Genus *Haplotaenium*

Species *Haplotaenium minutum* var. *excavatum* (Ralfs) Bando

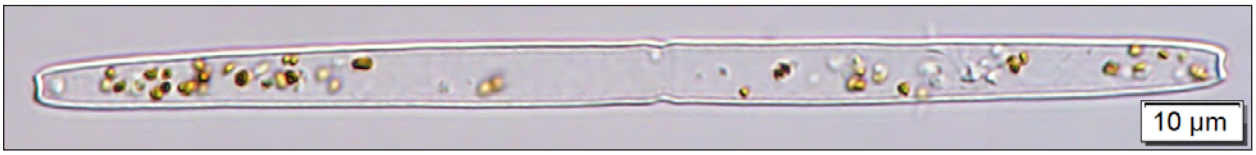


Figure 138. *Haplotaenium minutum* var. *excavatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Haplotaenium*

Species *Haplotaenium rectum* (Delponte) Bando

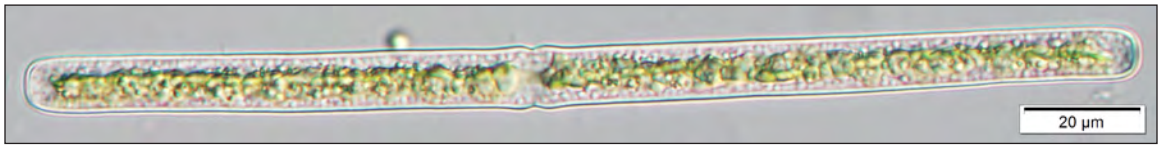


Figure 139. *Haplotaenium rectum.*

Hyalotheca Ehrenberg ex Ralfs

The cells of this genus are cylindrical and about as long as they are broad. They are slightly constricted, and rows of pores surround the cell near the apices. The chloroplast is axial and lobed.

Hyalotheca dissiliens was the only species of this genus found in the refuge (fig. 140). These cells were uncommon and typically found at the east and west interior sites.

Order Desmidiales

Family Desmidiaceae

Genus *Hyalotheca*

Species *Hyalotheca dissiliens* Brébisson ex Ralfs

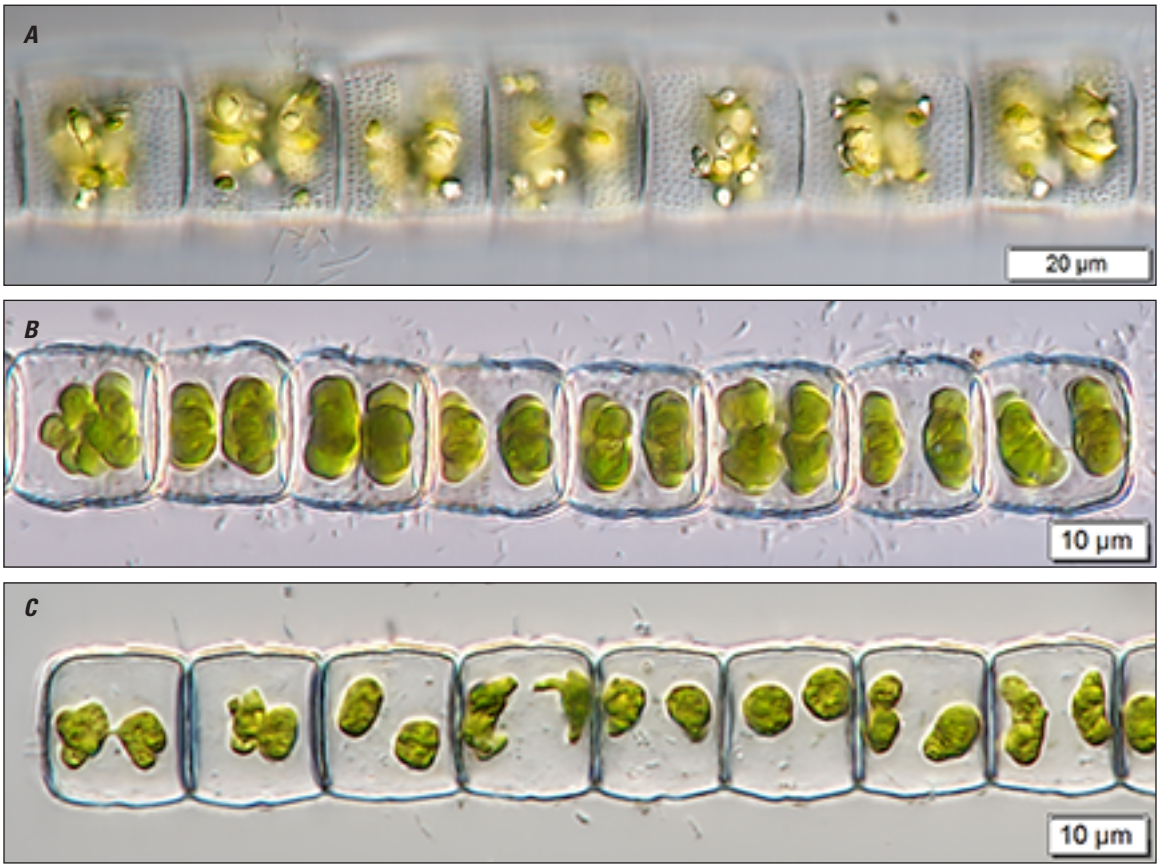


Figure 140. *Hyalotheca dissiliens.*

Micrasterias C. Agardh ex Ralfs

Cells are large and laterally compressed. Each semicell has a polar lobe and one or more lateral lobes, which may be divided many times, depending on the species. Some cells are ornamented with spines or granules (fig. 141). There is one chloroplast per semicell that almost entirely fills the cell.

Fourteen *Micrasterias* taxa were identified in samples from the refuge (figs. 142–155). Most of the cells occurred at the east interior site, with none found at the west perimeter site.

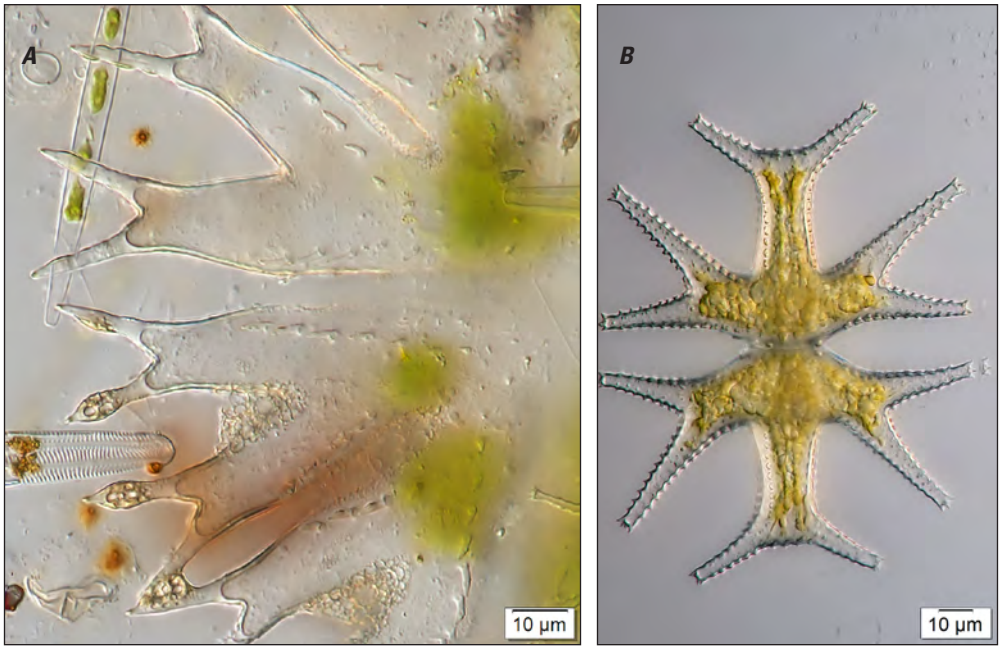


Figure 141. *A*, *Micrasterias johnsonii* has two spines at the end of each lobe, as well as short rows of spines on the surface of the cell along the incisions. *B*, *Micrasterias mahabuleshwarensis* var. *ringens* f. *glabra* has granules along the margins of the cell.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias abrupta* West & G.S. West

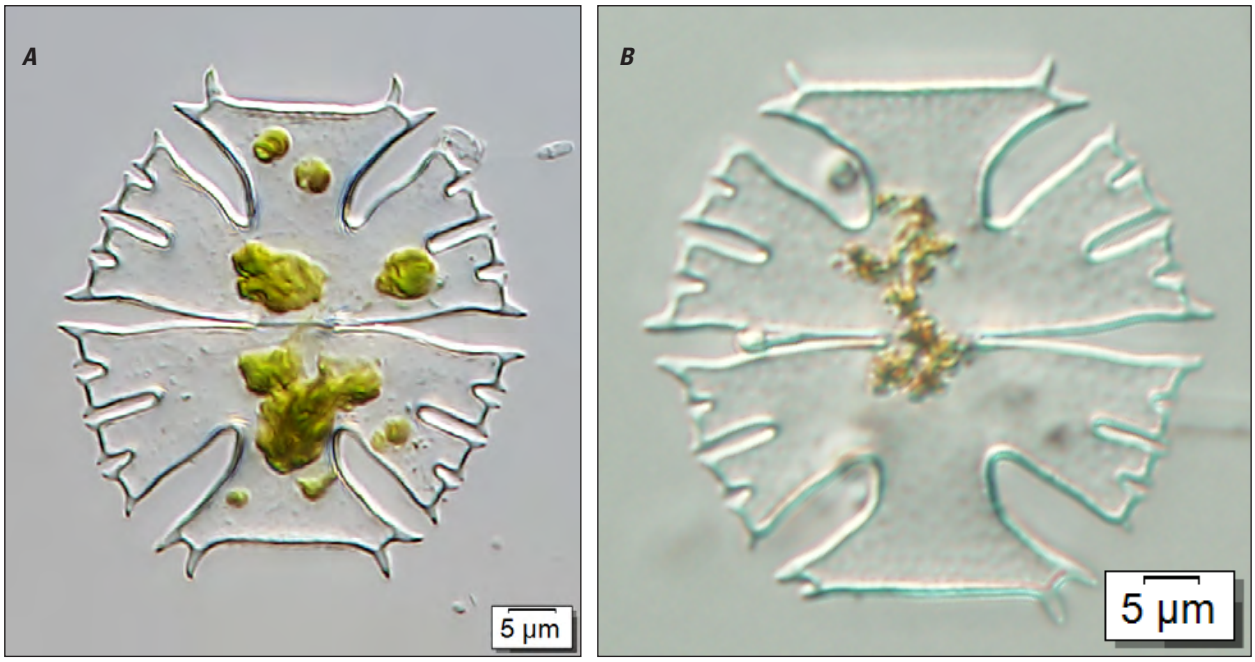


Figure 142. *Micrasterias abrupta.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias alata* Wallich

Figure 143. *Micrasterias alata*.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias dichotoma* Wolle

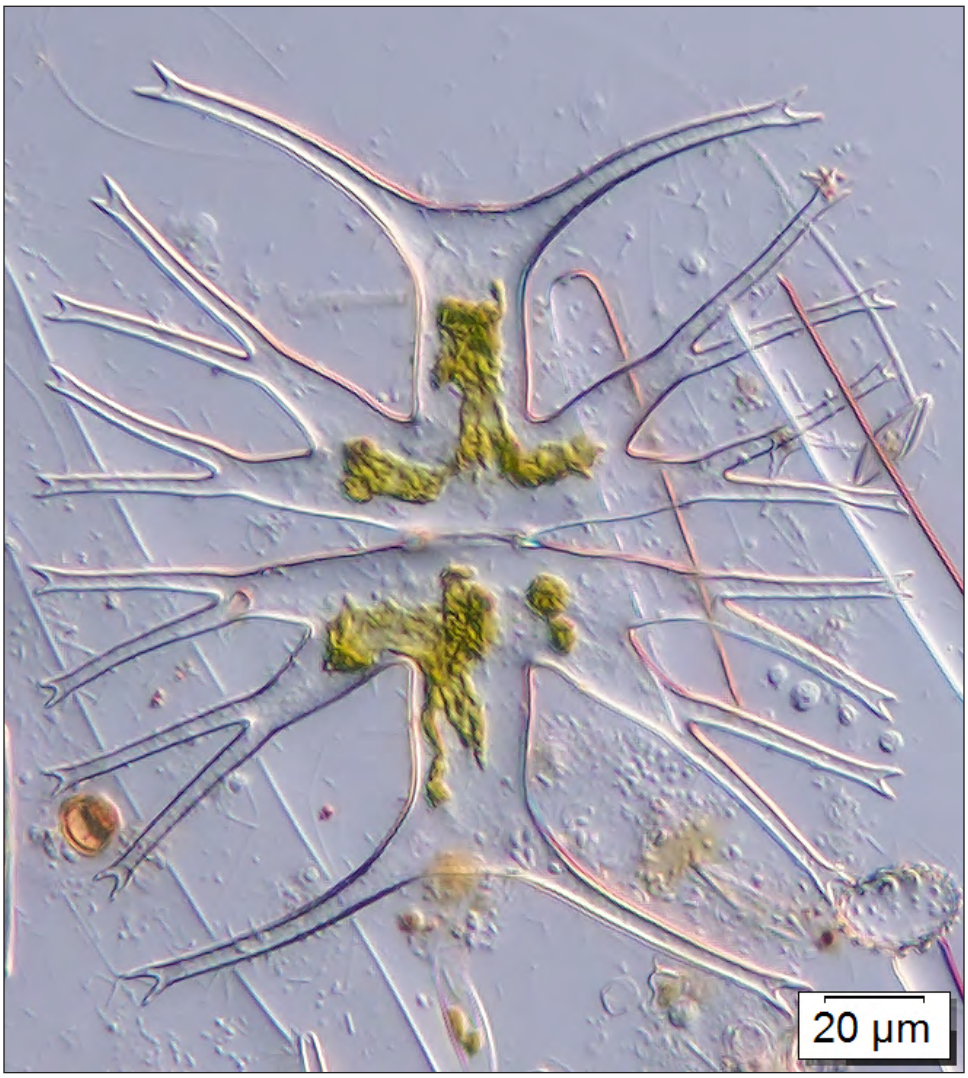


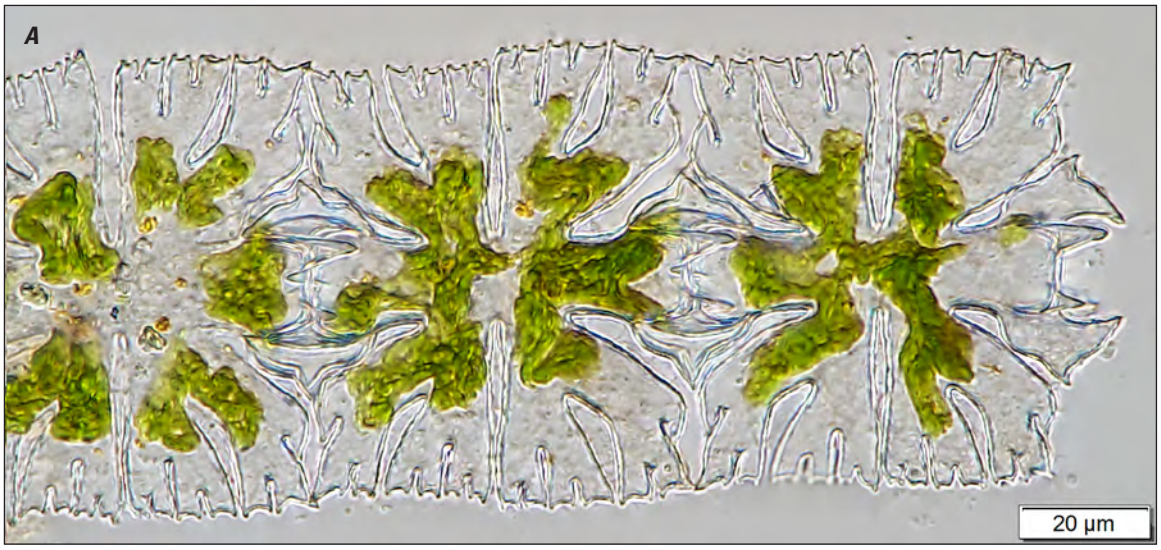
Figure 144. *Micrasterias dichotoma.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias foliacea* Bailey ex Ralfs



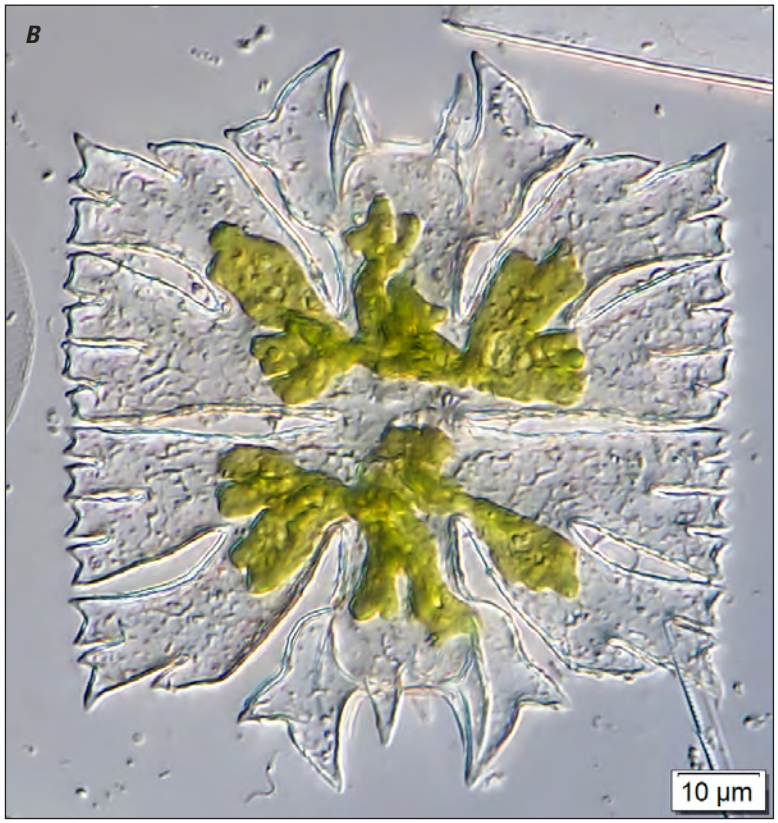


Figure 145. *Micrasterias foliacea.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias furcata* C. Agardh ex Ralfs

Figure 146. *Micrasterias furcata.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias furcata* var. *alata* (Prescott & A.M. Scott) K. Förster

Figure 147. *Micrasterias furcata* var. *alata*.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias johnsonii* var. *johnsonii* f. *bispinata* Prescott & Scott

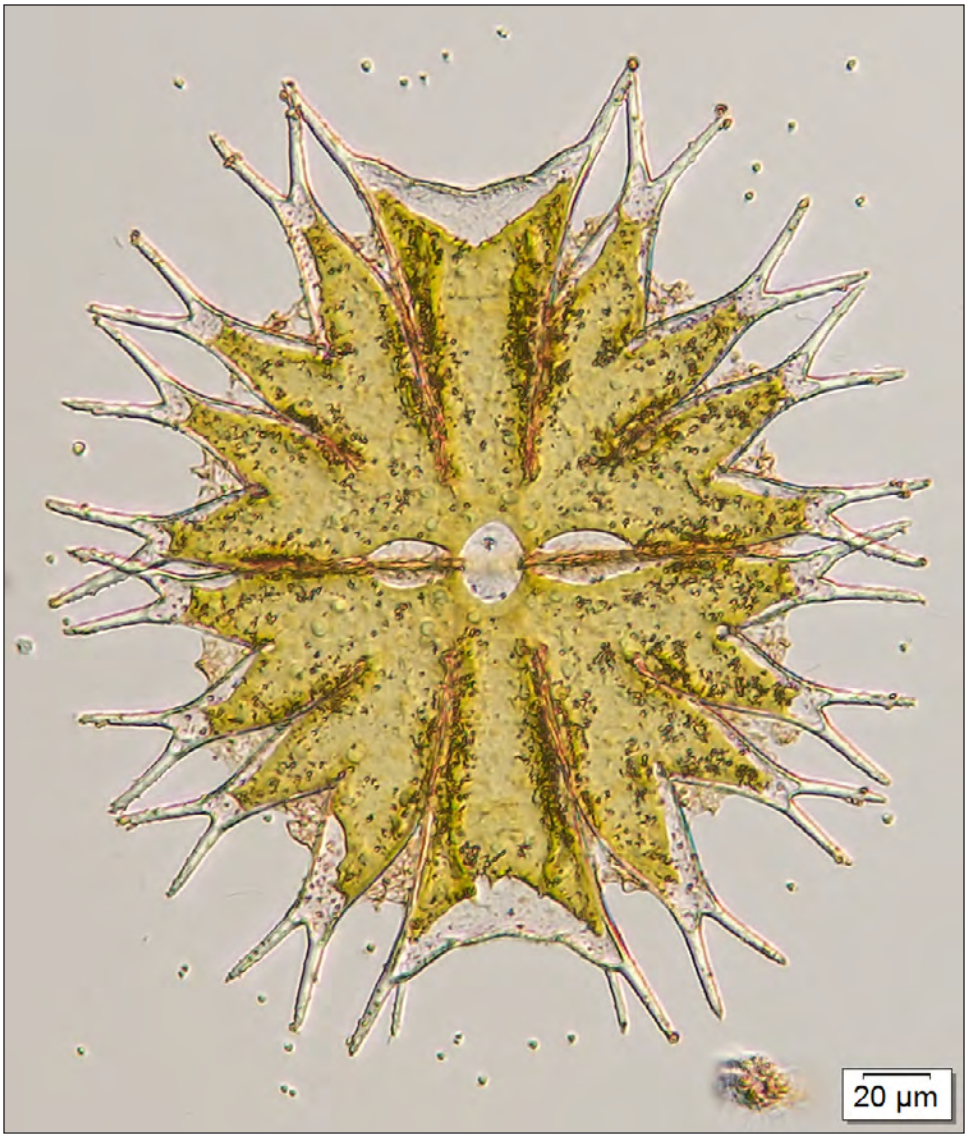


Figure 148. *Micrasterias johnsonii* var. *johnsonii* f. *bispinata*.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias laticeps* Nordstedt

Figure 149. *Micrasterias laticeps*.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias mahabuleshwarensis* var. *ringens* f. *glabra* Prescott & Scott

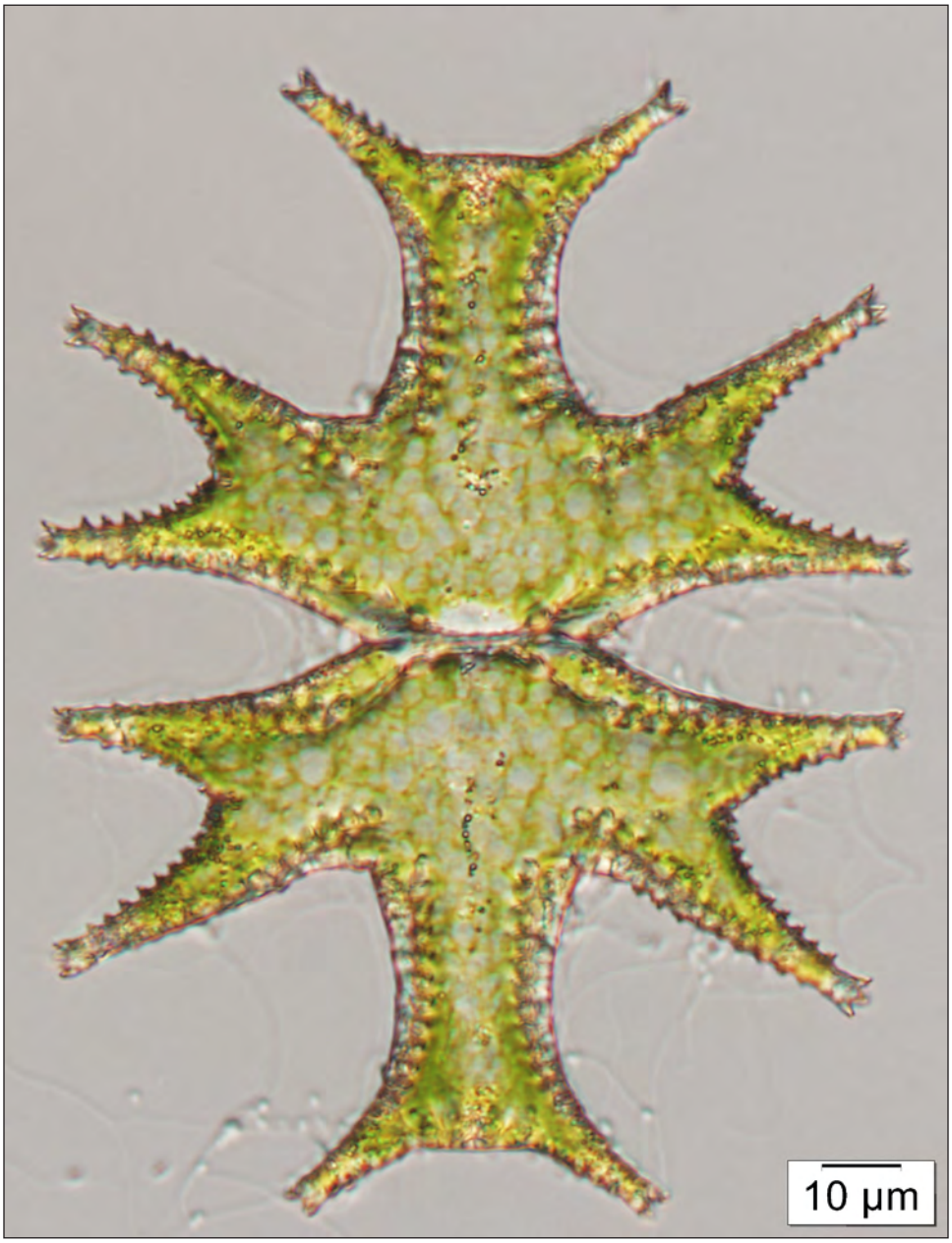


Figure 150. *Micrasterias mahabuleshwarensis* var. *ringens* f. *glabra*.

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias pinnatifida* (Kützing) Ralfs

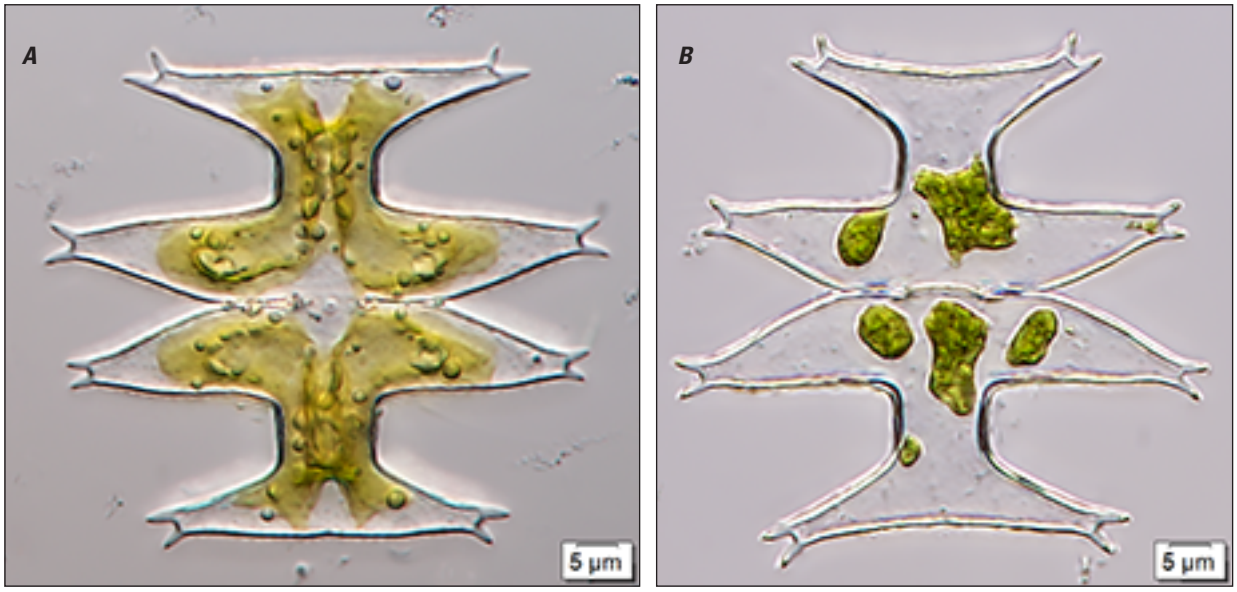


Figure 151. *Micrasterias pinnatifid.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias radiosa* Ralfs

Figure 152. *Micrasterias radiosa.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias radiosa* var. *elegantior* (G.S. West) Croasdale

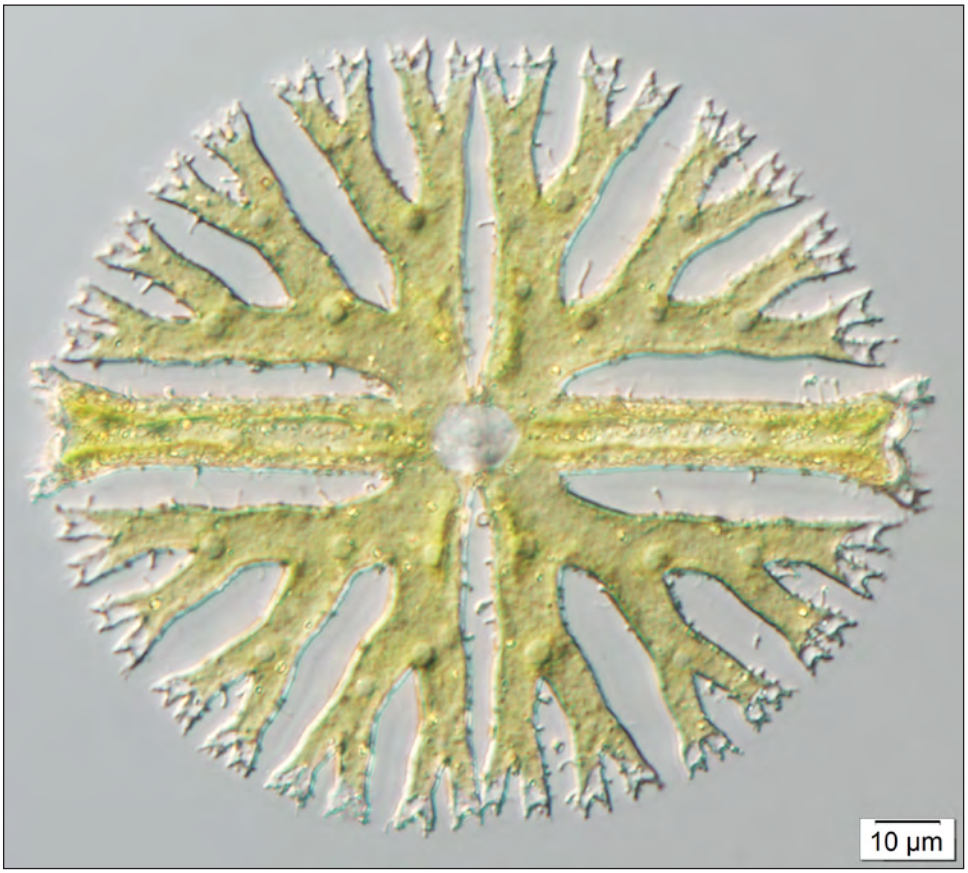


Figure 153. *Micrasterias radiosa* var. *elegantor.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias torreyi* Bailey ex Ralfs

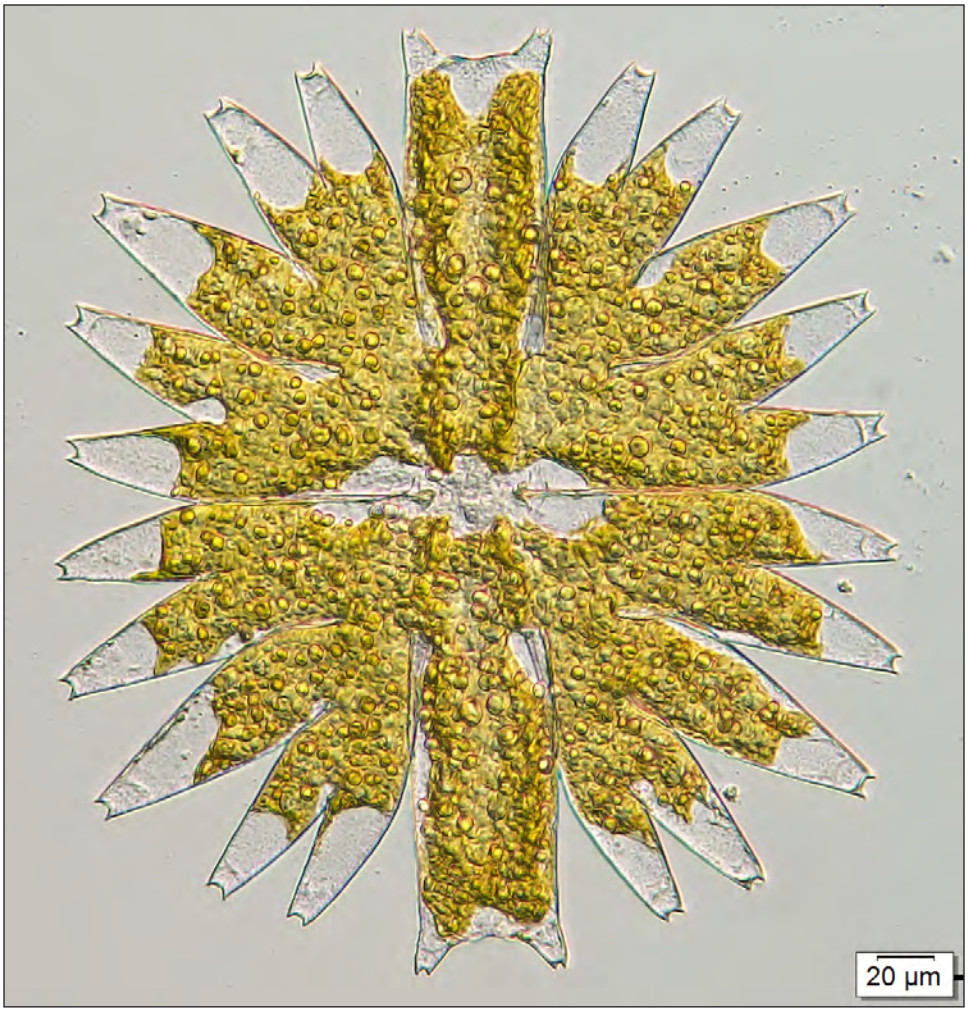


Figure 154. *Micrasterias torreyi.*

Order Desmidiales

Family Desmidiaceae

Genus *Micrasterias*

Species *Micrasterias truncata* Brébisson ex Ralfs

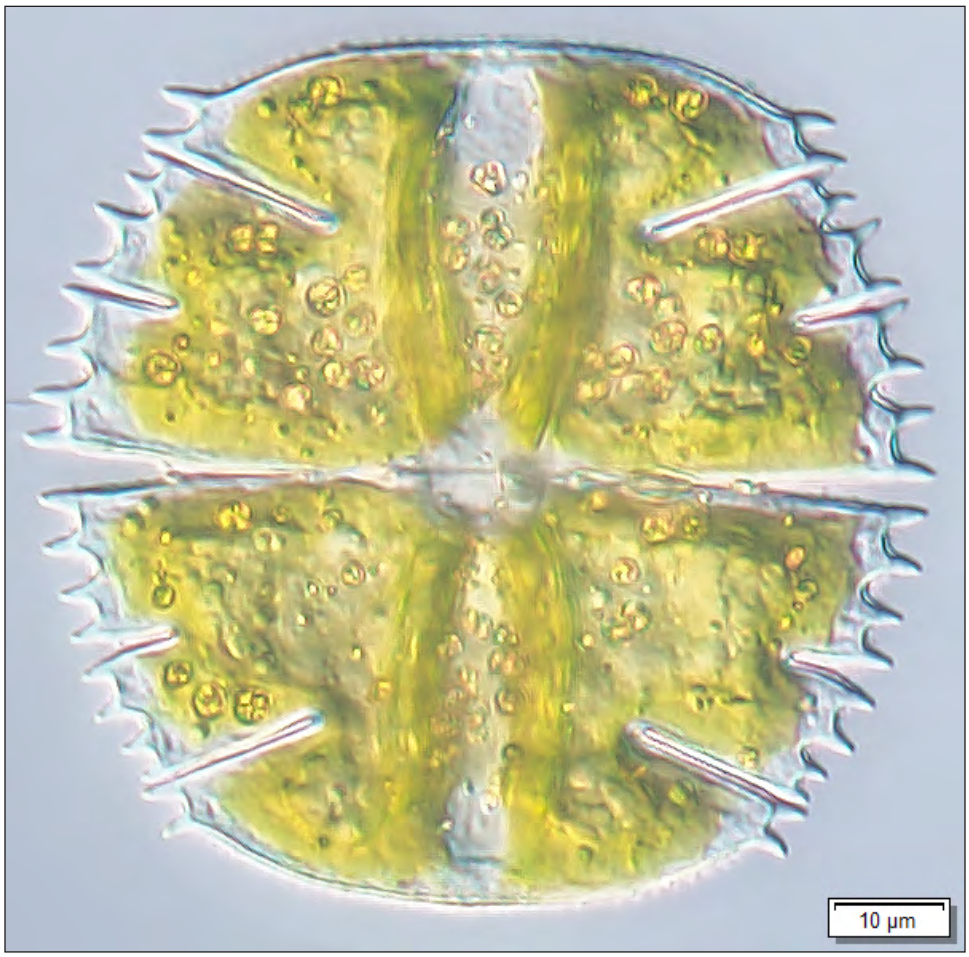


Figure 155. *Micrasterias truncata*.

Phymatodocis Nordstedt

Cells are asymmetric in all views and form filaments. The cells have a rectangular outline with rounded processes and a constriction between the semicells. The cell walls are covered with fine, dense pores. The single chloroplast in each semicell extends into the processes of the semicells.

Only one species of this genus was found in the refuge (figs. 156–157). These cells were not uncommon but tended to be found at more pristine sites like the east interior and east transition sites.

Figure 156. *Phymatodocis nordstedtiana* cell viewed from top. The fine pores on the cell walls and the four rounded processes are evident in this image.

Order Desmidiales

Family Desmidiaceae

Genus *Phymatodocis*

Species *Phymatodocis nordstedtiana* Wolle

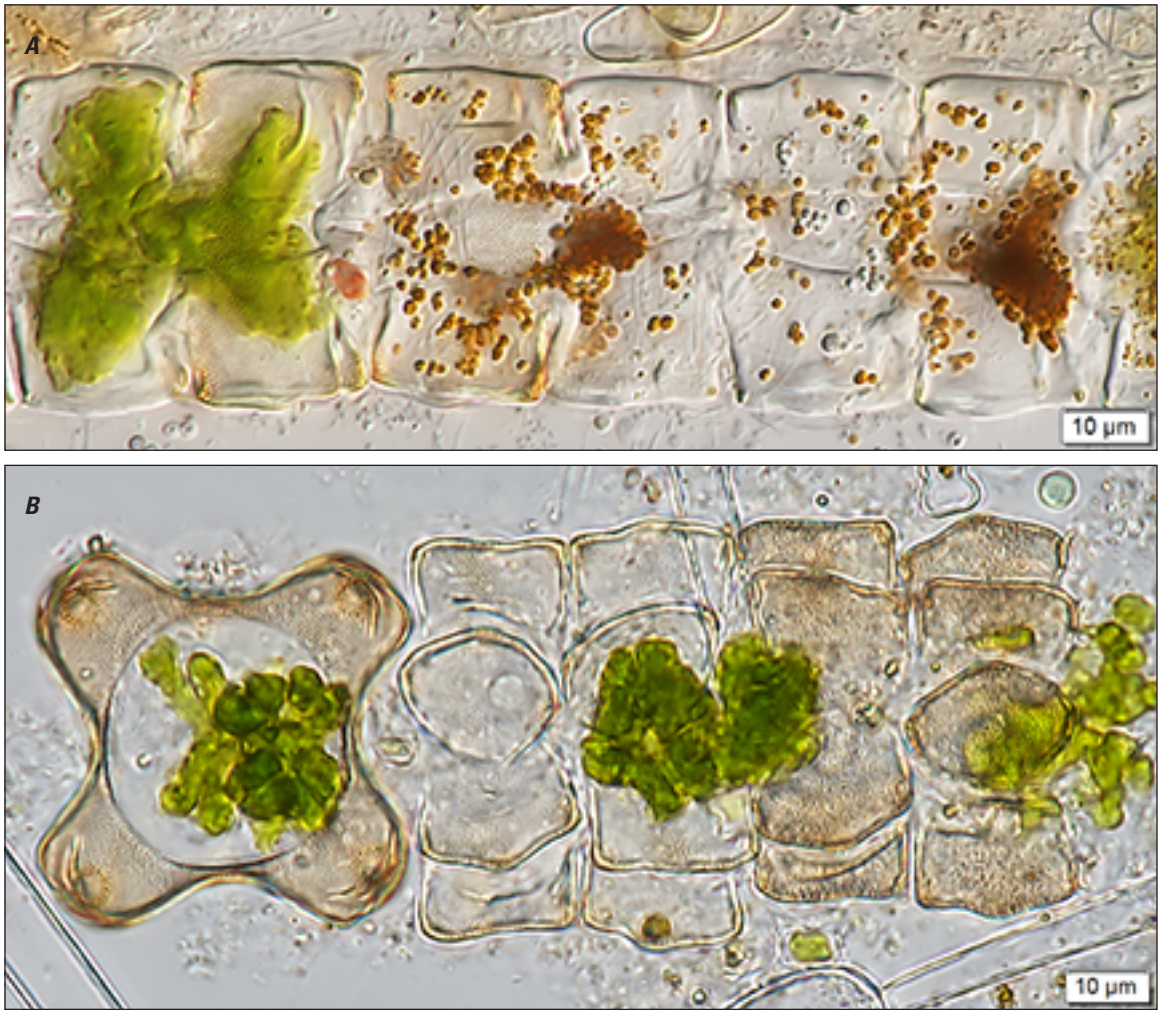


Figure 157. *Phymatodocis nordstedtiana.*

Pleurotaenium Nägeli

Cells are straight and cylindrical. The base of each semicell is slightly inflated, divided by a shallow median constriction. The cell wall can be smooth, punctate, or have other surface features (fig. 158). The apices may have teeth or granules. Each cell has several chloroplasts and a large vacuole, often with granules, at the apex of each semicell.

Five *Pleurotaenium* species were found in the refuge (figs. 158–163). *Pleurotaenium trabecula* was the only species of this genus found at the west interior site.

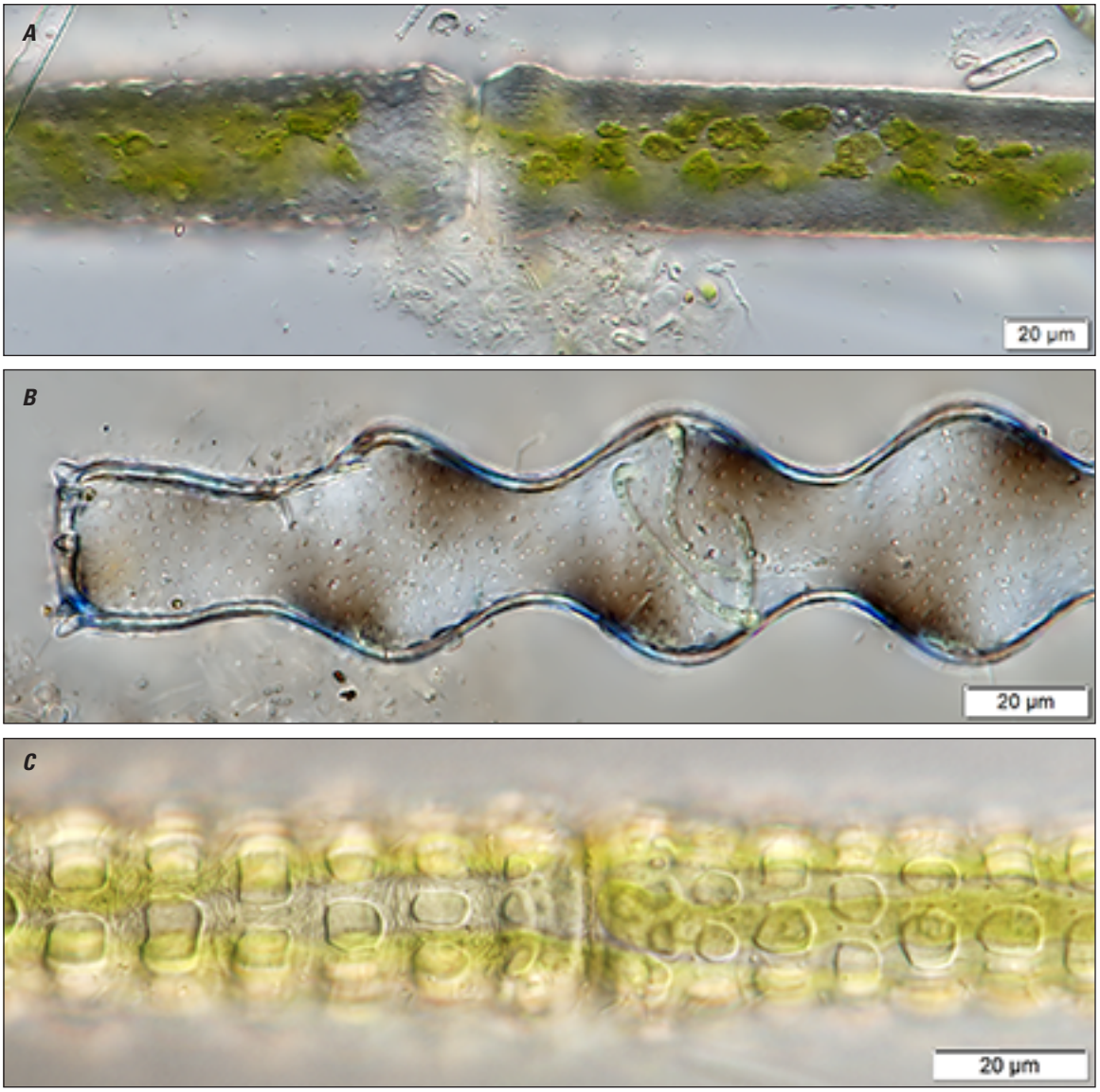


Figure 158. *A*, *Pleurotaenium trabecula* has fine pores on the surface of the cell wall. *B*, *Pleurotaenium constrictum* has granules at the apex of each semicell and fine pores scattered along the cell wall. *C*, *Pleurotaenium verrucosum* has large, thin, rectangular areas that are smaller and more irregular at the base of the semicell.

Order Desmidiales

Family Desmidiaceae

Genus *Pleurotaenium*

Species *Pleurotaenium constrictum* (Bailey) H.C. Wood

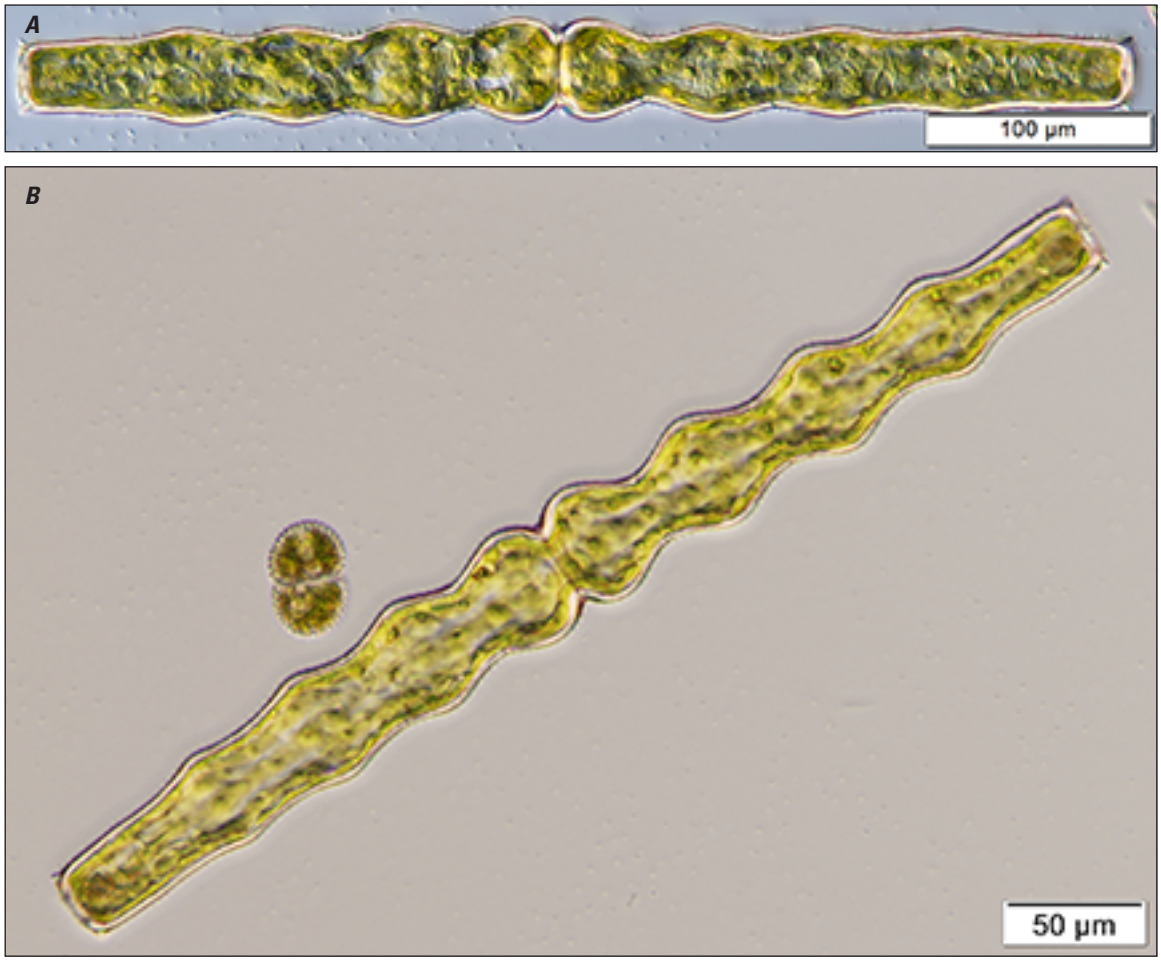


Figure 159. *Pleurotaenium constrictum.*

Order Desmidiales

Family Desmidiaceae

Genus *Pleurotaenium*

Species *Pleurotaenium* cf. *maximum* (Reinsch) Lundell

Figure 160. *Pleurotaenium* cf. *maximum*.

Order Desmidiales

Family Desmidiaceae

Genus *Pleurotaenium*

Species *Pleurotaenium subcoronulatum* (Turner) West & West

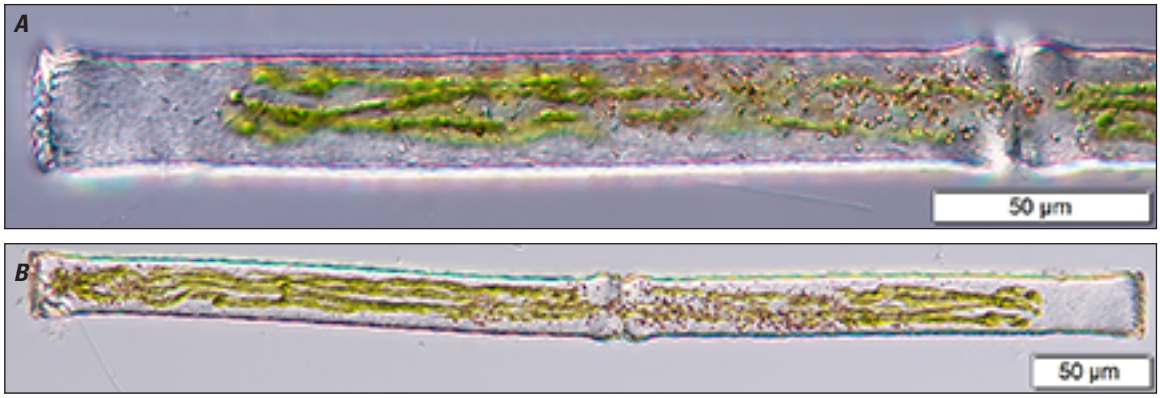


Figure 161. *Pleurotaenium subcoronulatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Pleurotaenium*

Species *Pleurotaenium trabecula* (Ehrenberg) Nägeli

Figure 162. *Pleurotaenium trabecula.*

Order Desmidiales

Family Desmidiaceae

Genus *Pleurotaenium*

Species *Pleurotaenium verrucosum* (Ralfs) H.C. Wood

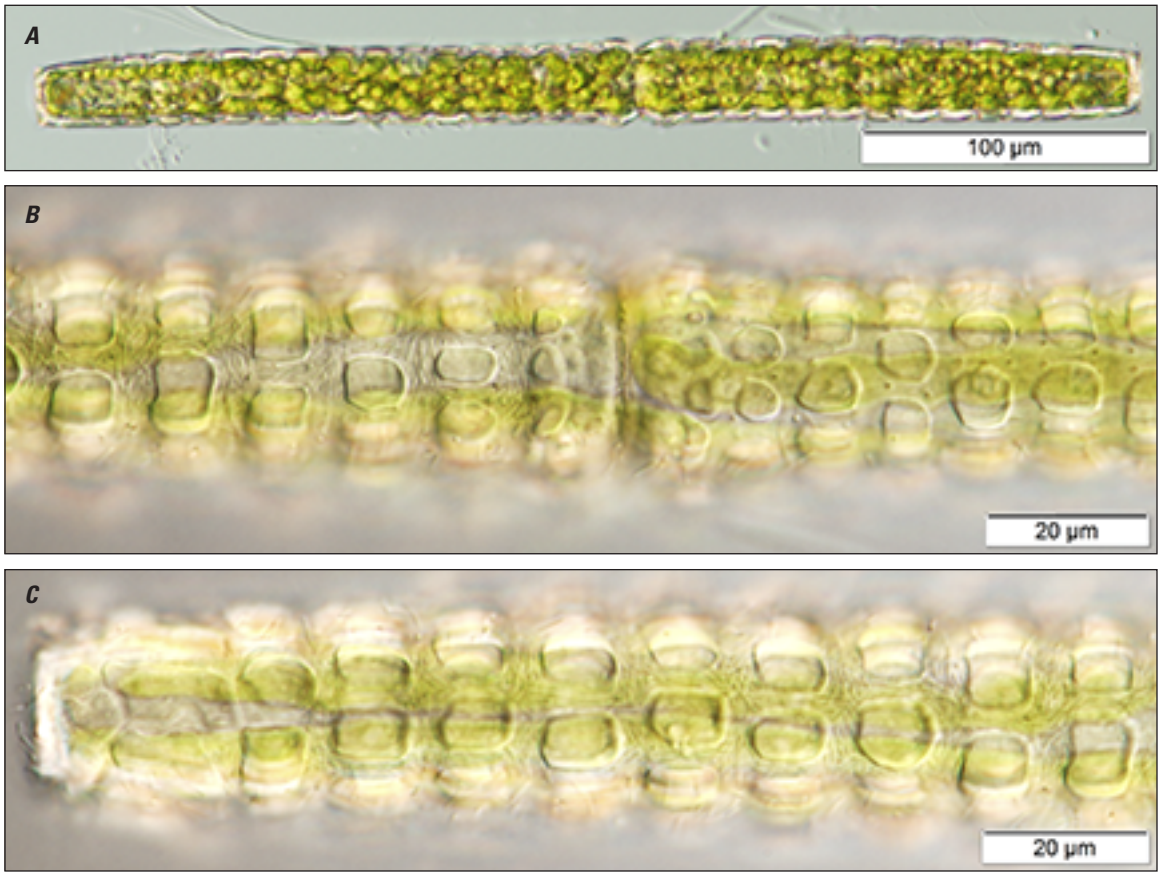


Figure 163. *Pleurotaenium verrucosum.*

Sphaerozosma Ralfs

Semicells reniform and form filaments. They are connected by two apical processes on opposite sides of the cell (fig. 164). The cell wall is smooth or can have rows of pores. The chloroplasts are axial and lobed.

Sphaerozosma filiforme, *Sphaerozosma laeve*, and *Sphaerozosma laeve* var. *latum* were found in the refuge (figs. 165–167). They were common at the east interior site and were not found in the west perimeter site.

Figure 164. This filament of *Sphaerozosma laeve* cells shows the apical processes that connect the cells together on opposite sides. Two of these processes are on each semicell.

Order Desmidiales

Family Desmidiaceae

Genus *Sphaerozosma*

Species *Sphaerozosma filiforme* Ralfs

Figure 165. *Sphaerozosma filiforme*.

Order Desmidiales

Family Desmidiaceae

Genus *Sphaerozosma*

Species *Sphaerozosma laeve* (Nordstedt) Thomasson

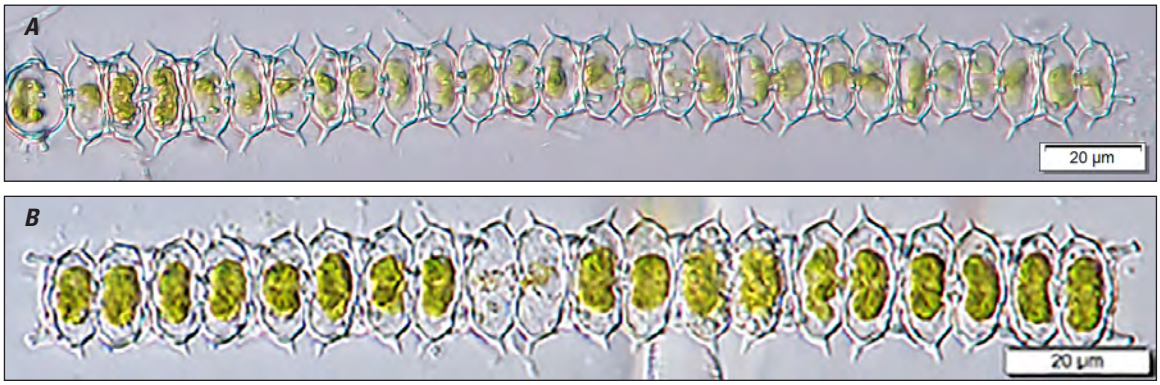


Figure 166. *Sphaerozosma laeve.*

Order Desmidiales

Family Desmidiaceae

Genus *Sphaerozosma*

Species *Sphaerozosma laeve* var. *latum* West & West

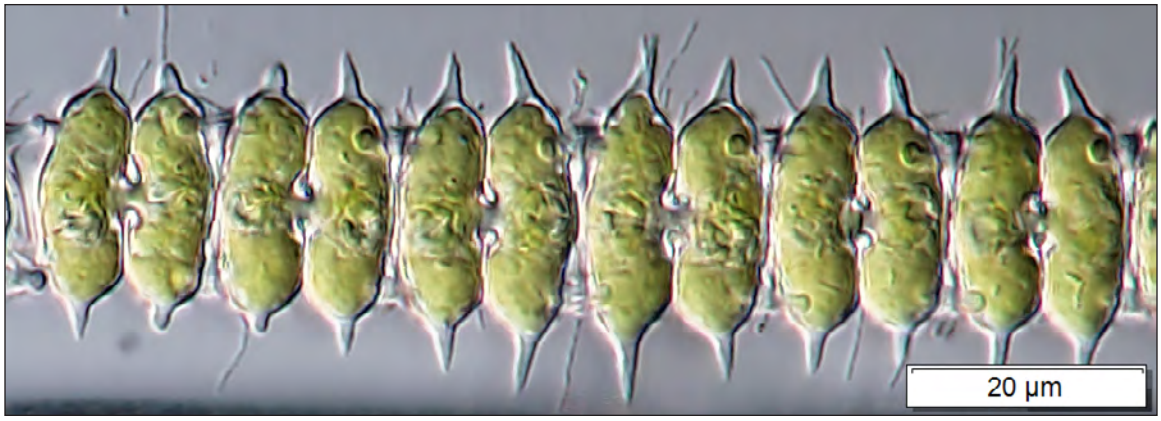


Figure 167. *Sphaerozosma laeve* var. *latum*.

Spinocosmarium Prescott & A.M. Scott

Cells are elliptical or semicircular with a deep constriction. The basal angles of the semicells have either a single spine or a pair of spines. The surface of the cell is often ornamented with granules or verrucae.

One species, *Spinocosmarium quadridens*, was identified in samples from the refuge (fig. 168). It was found at all sites except the west perimeter site.

Order Desmidiales

Family Desmidiaceae

Genus *Spinocosmarium*

Species *Spinocosmarium quadridens* (H. C. Wood) Prescott & A. M. Scott

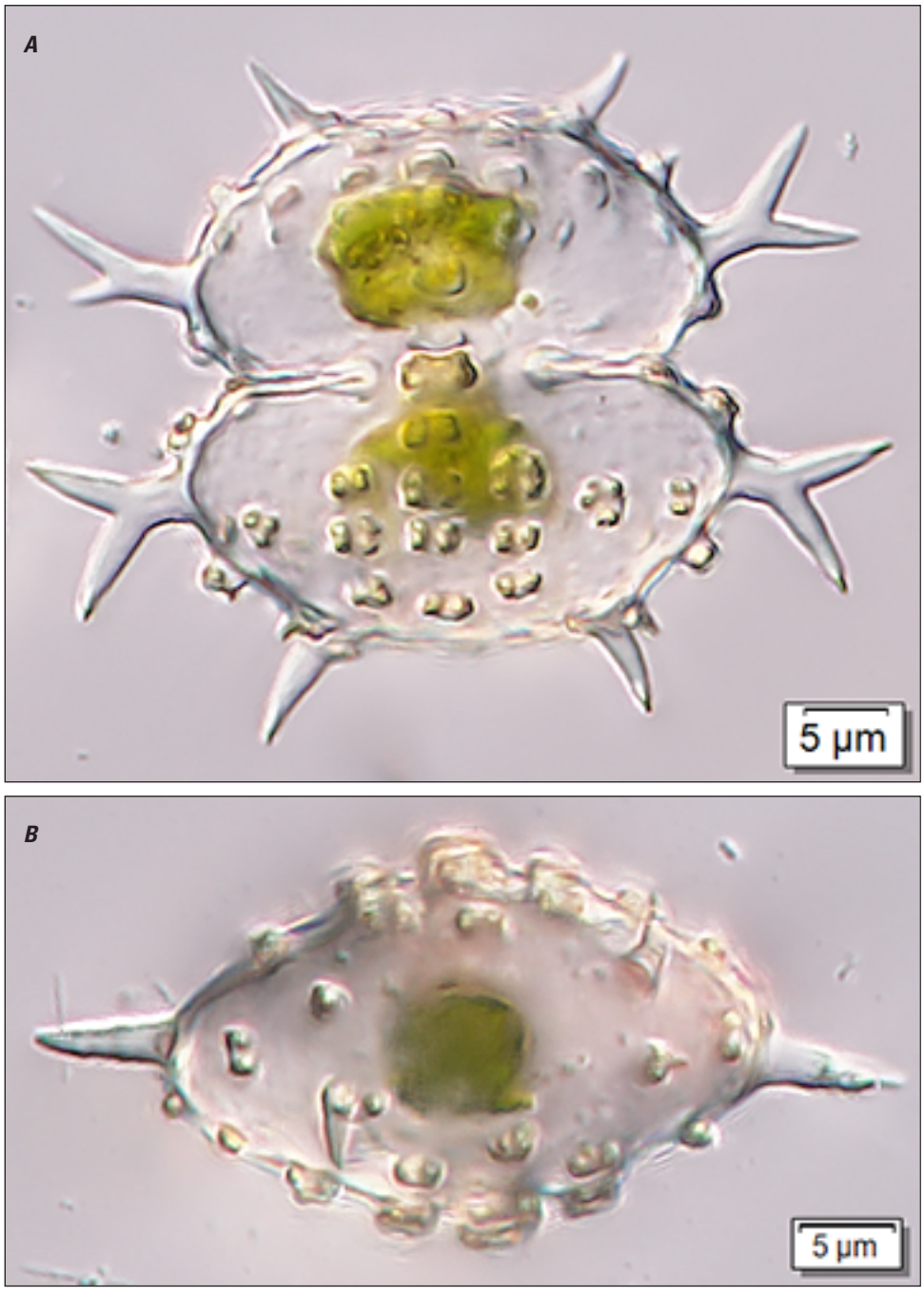


Figure 168. *Spinocosmarium quadridens*.

Spondylosium Brébisson ex Kützing

Cells are variable in shape and size and form filaments, with the entire apex of each cell joined to the adjacent cell and always with a distinct constriction at the joining of the semicells. This separates *Spondylosium* from *Hyalotheca* or *Desmidium*. The cell surface is smooth, sometimes with fine pores.

Two species, *Spondylosium planum* and *Spondylosium pulchrum*, were identified in samples from the refuge (figs. 169–170). This genus was common at all sites except the west perimeter site.

Order Desmidiales

Family Desmidiaceae

Genus *Spondylosium*

Species *Spondylosium planum* (Wolle) West & G.S. West

Figure 169. *Spondylosium planum.*

Order Desmidiales

Family Desmidiaceae

Genus *Spondylosium*

Species *Spondylosium pulchrum* (Bailey) W. Archer

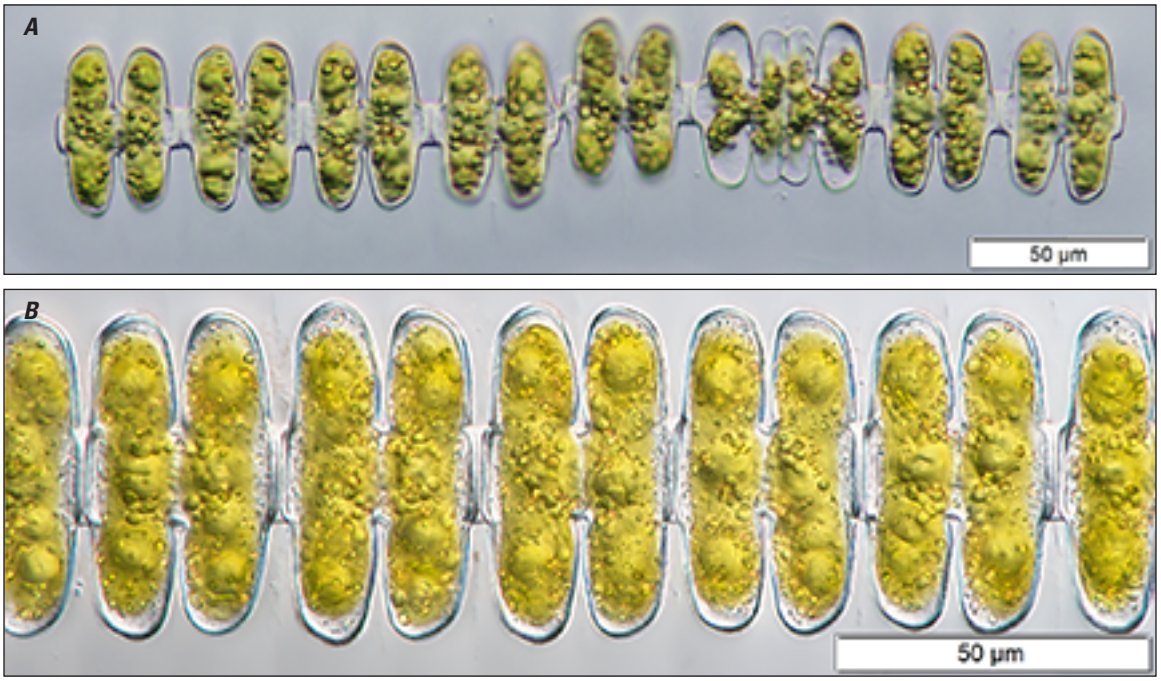


Figure 170. *Spondylosium pulchrum.*

Staurastrum Meyen ex Ralfs

Cell shape and size are variable. In most species, the cell is drawn out into two or more processes, lobes, or spines. The cell wall can have granules, verrucae, spines, or pores. The processes can also be ornamented (fig. 171). The chloroplast is axial and extends to each angle of the cell.

Fifty-six taxa from this genus were identified in samples from the refuge (figs. 172–227). Some of the more common species were *Staurastrum connatum* var. *isthmosum*, *Staurastrum inconspicuum*, and *Staurastrum tetracerum*. Some species were very rare, such as *Staurastrum arctiscon* var. *truncatum* and *Staurastrum tohopekaligense.* While only some species from this genus were found at the west perimeter site, they were all considered common in the samples and found at other sites in the refuge.

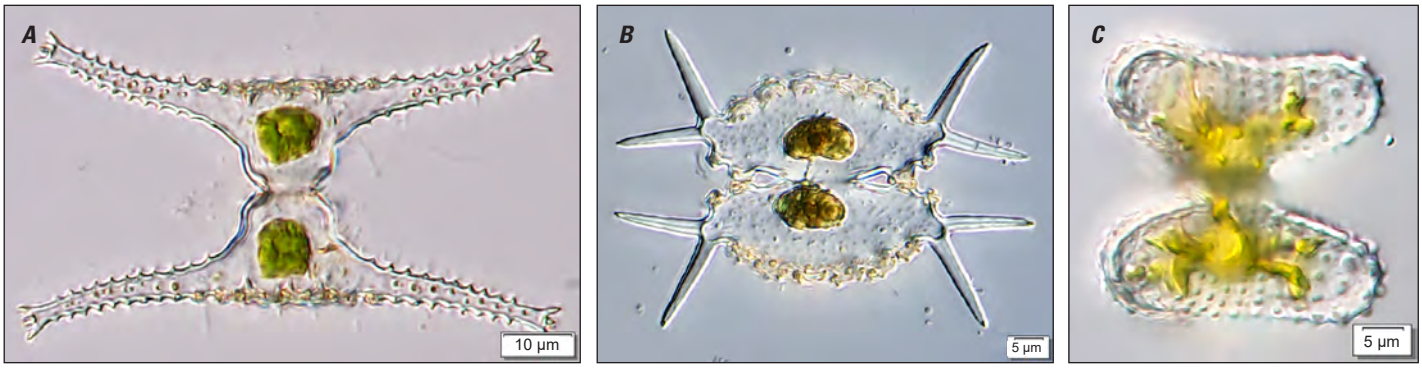


Figure 171. *A*, *Staurastrum grallatorium* has arms that are ornamented down the length and tipped with three teeth, as well as apical verrucae. *B*, *Staurastrum magnottae* var. *biradiatum* has two pairs of diverging spines on opposite sides of each semicell. The margins of the cell are also ornamented with verrucae. *C*, *Staurastrum striolatum* has rounded lobes, which are covered in small granules arranged in concentric circles around each lobe.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum anatinum* Cooke & Wills

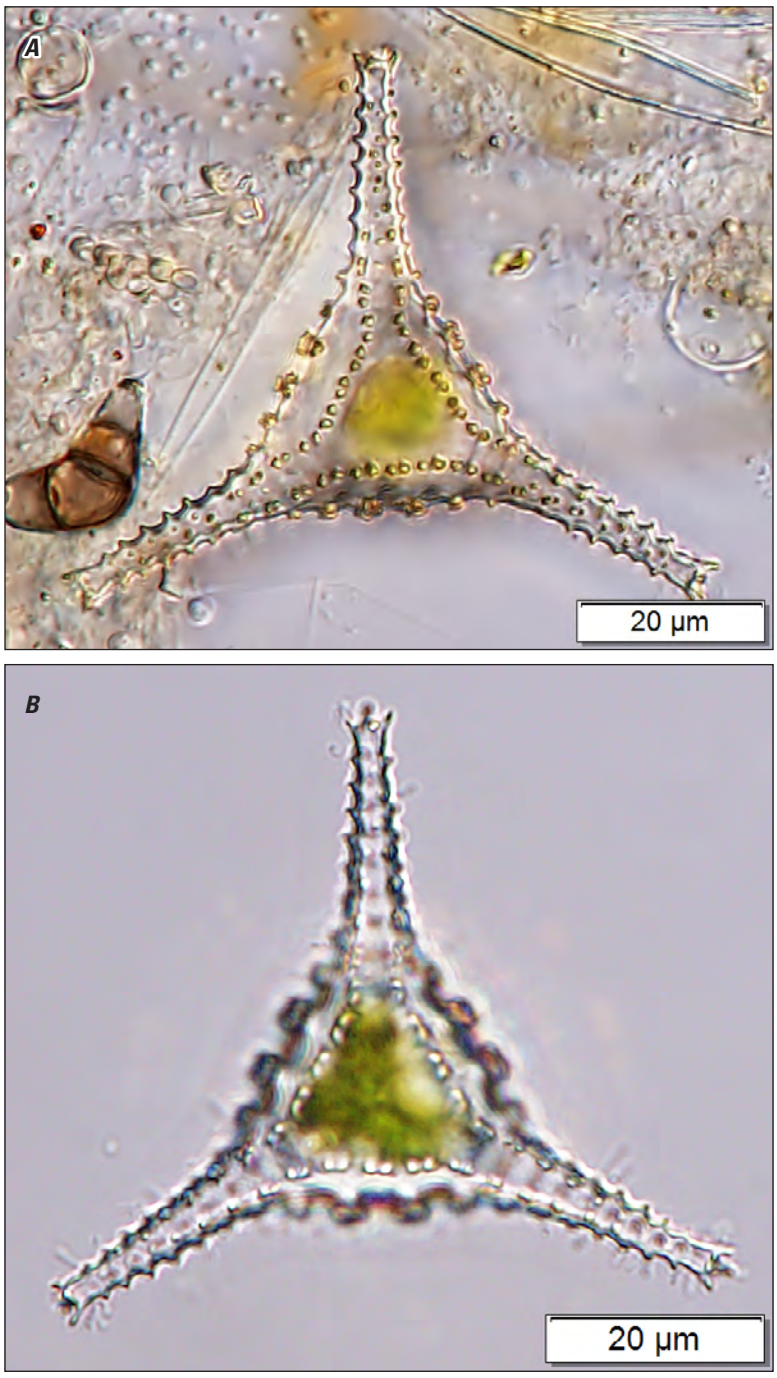


Figure 172. *Staurastrum anatinum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum anatinum* var. *truncatum* West

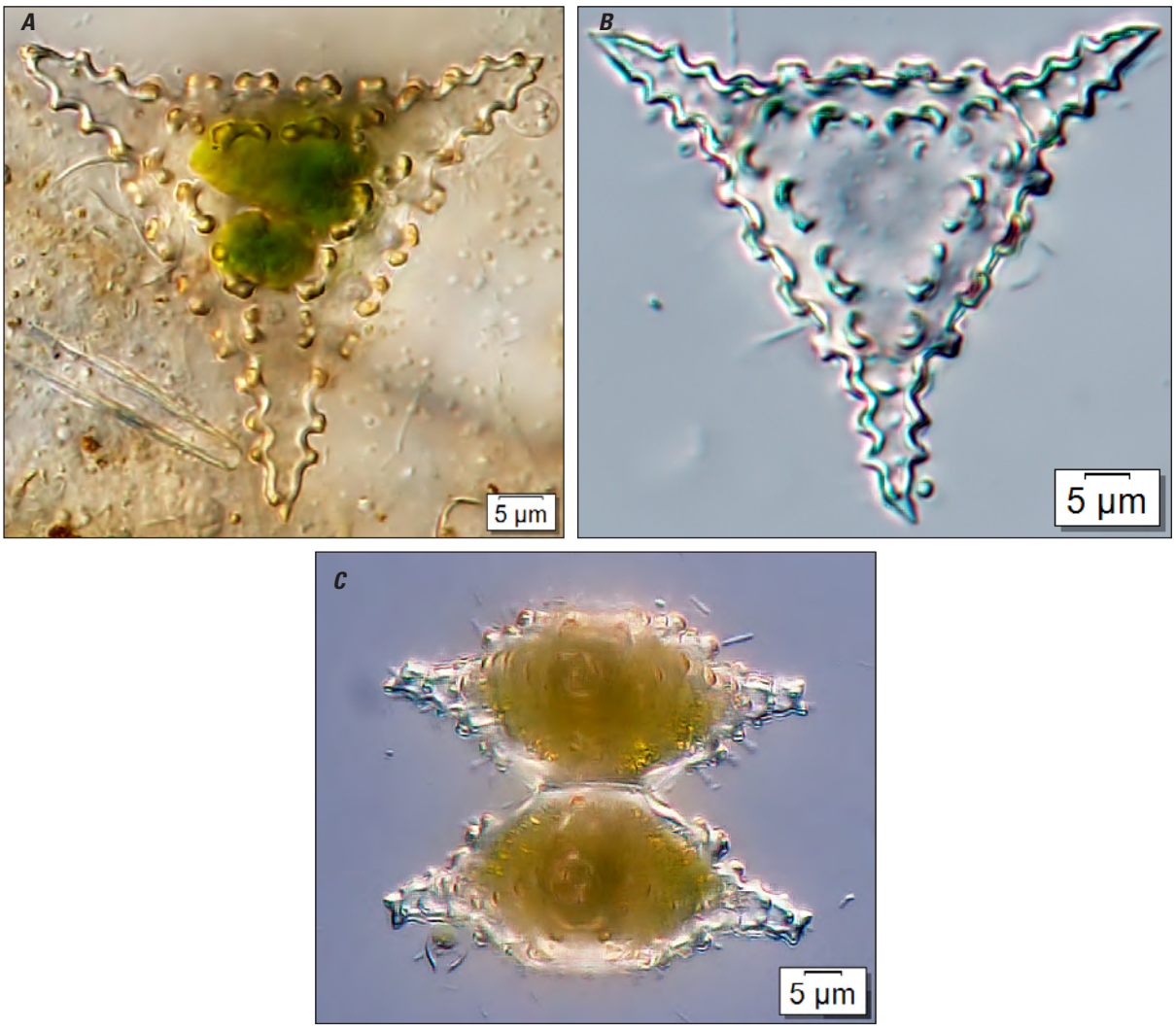


Figure 173. *Staurastrum anatinum* var. *truncatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum anchora* West & G.S. West

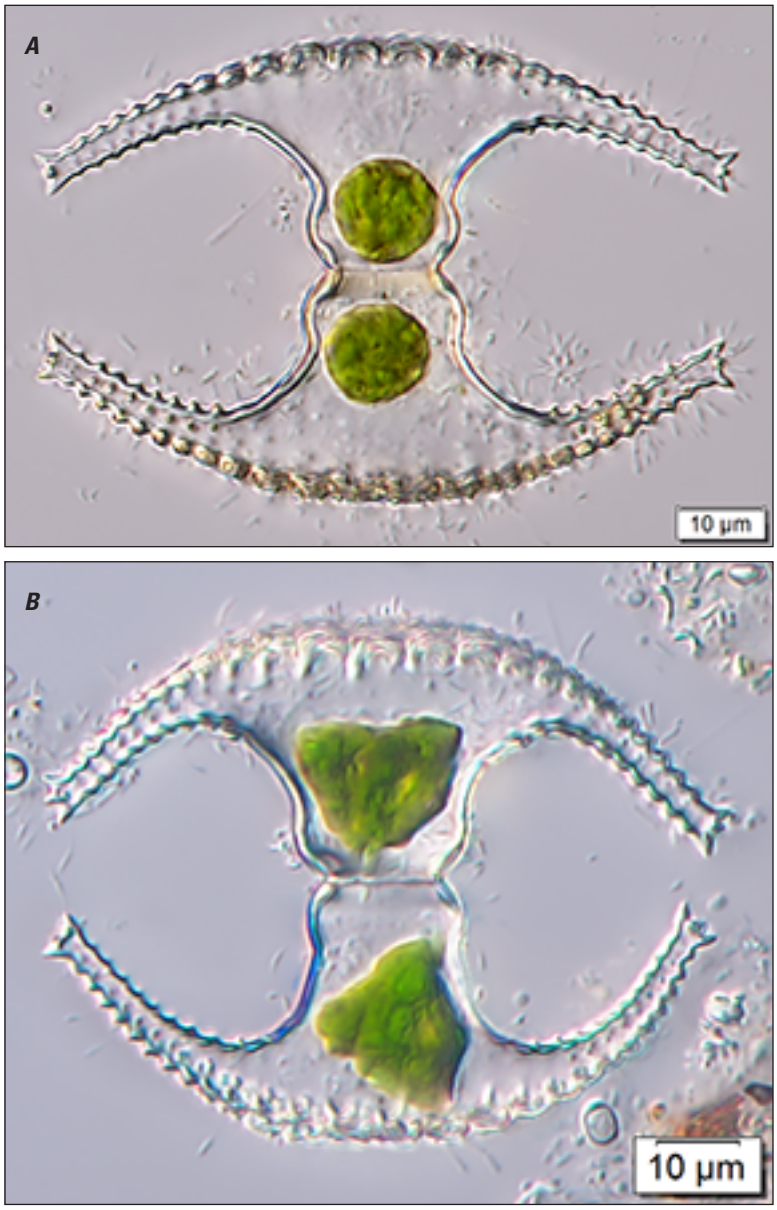


Figure 174. *Staurastrum anchora.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* cf. *ankyroides* var. *pentacladum* G.M. Smith

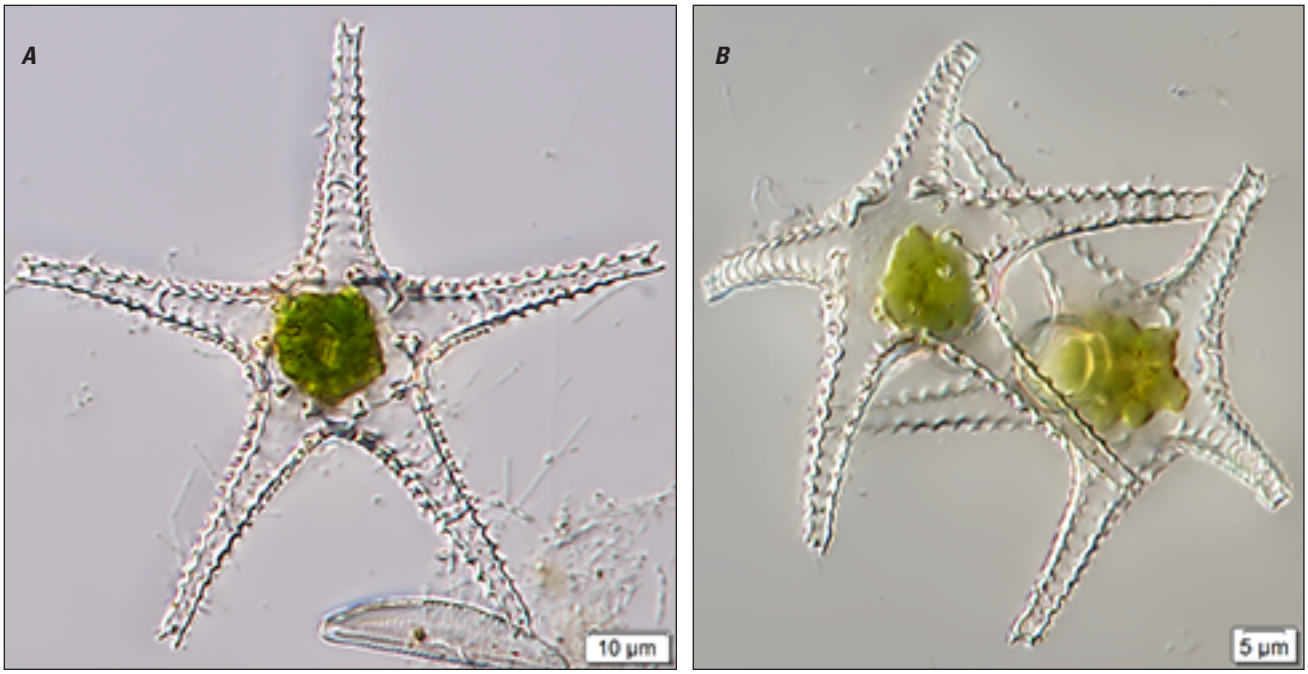


Figure 175. *Staurastrum* cf. *ankyroides* var. *pentacladum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum arachne* var. *gyrans* (L.N. Johnson) A.M. Scott & Grönblad

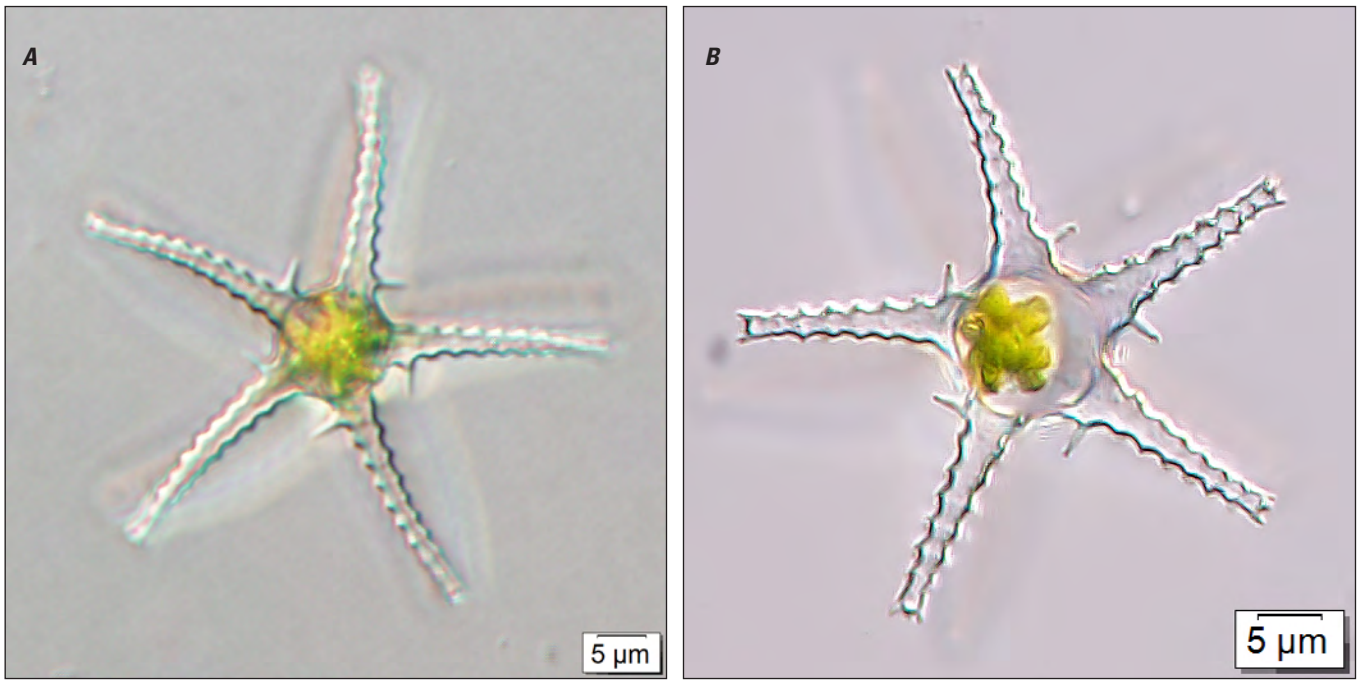


Figure 176. *Staurastrum arachne* var. *gyrans*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum arctiscon* var. *truncatum* Irénée-Marie

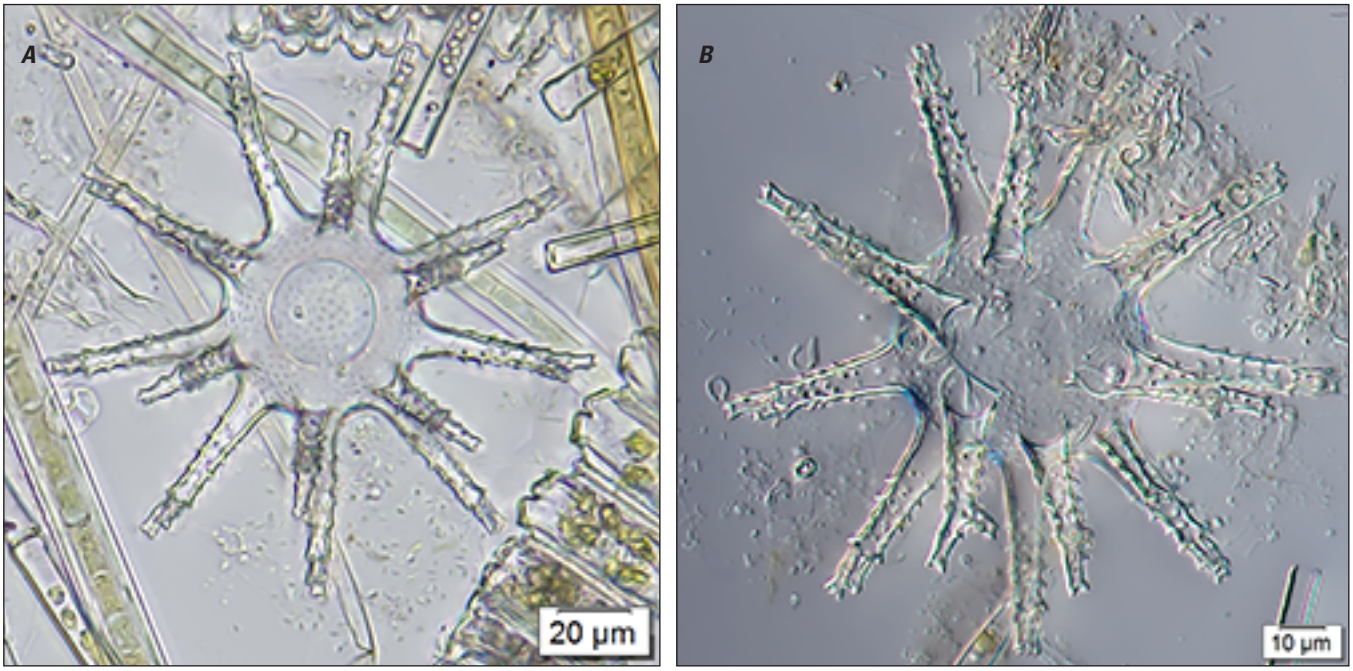


Figure 177. *Staurastrum arcticosum* var. *truncatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum brachioprominens* var. *ventricosum* Scott & Grönblad

Figure 178. *Staurastrum brachioprominens* var. *ventricosum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum brasiliense* var. *lundellii* West & G.S. West

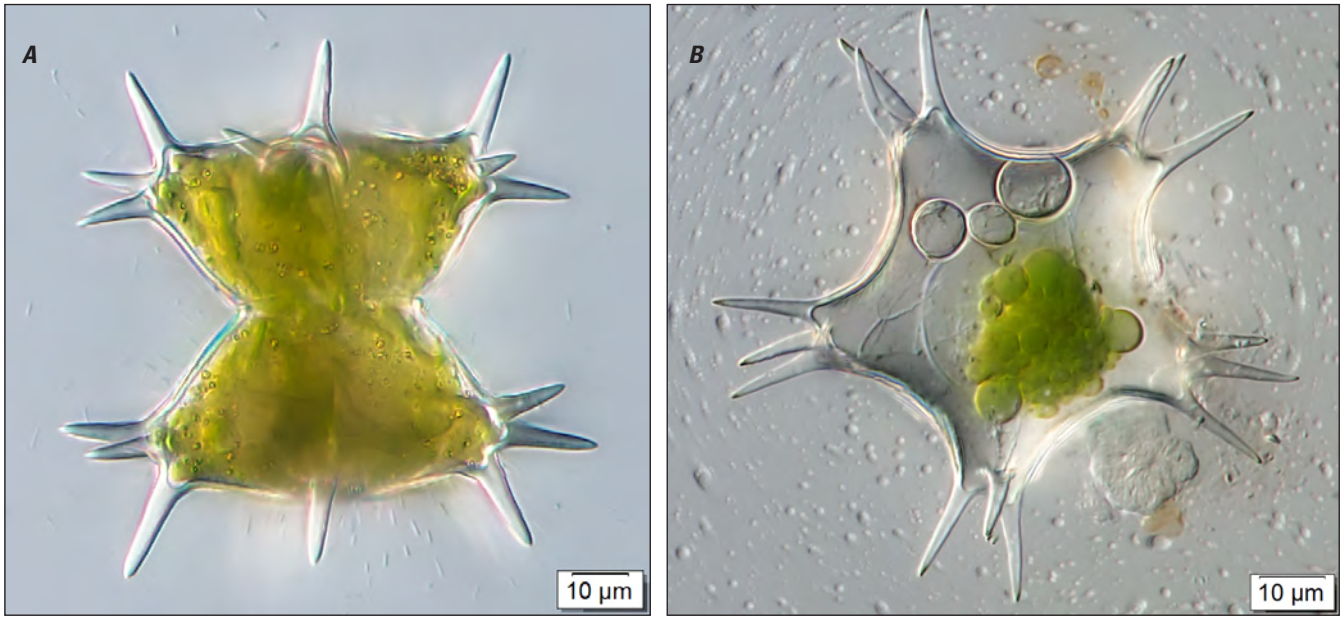


Figure 179. *Staurastrum brasiliense* var. *lundellii*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum capitulum* Brébisson

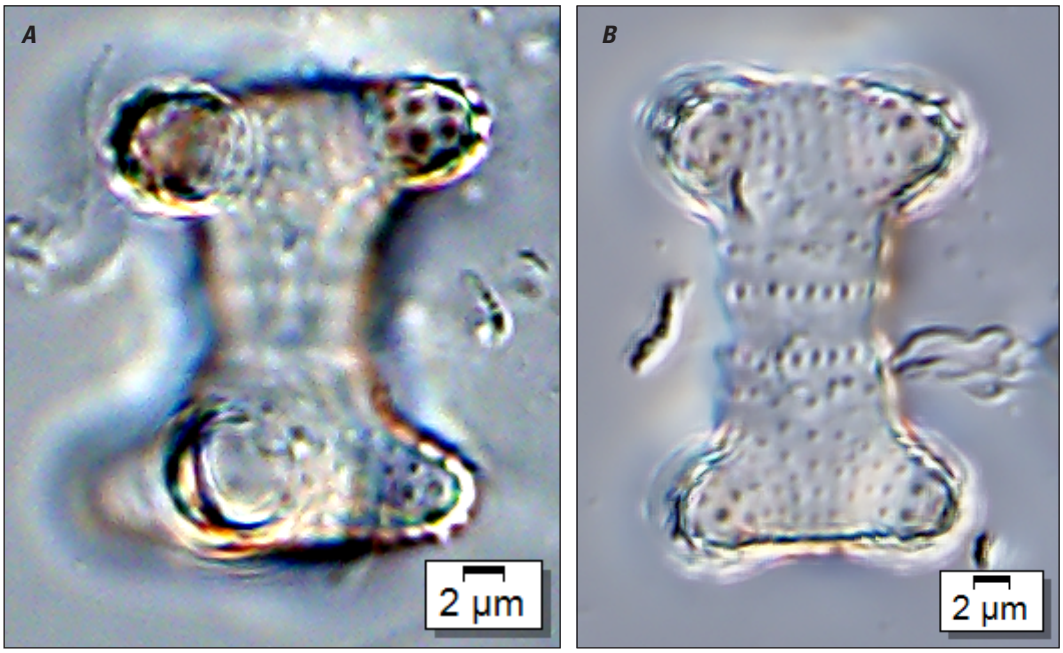


Figure 180. *Staurastrum capitulum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum cerastes* Lundell

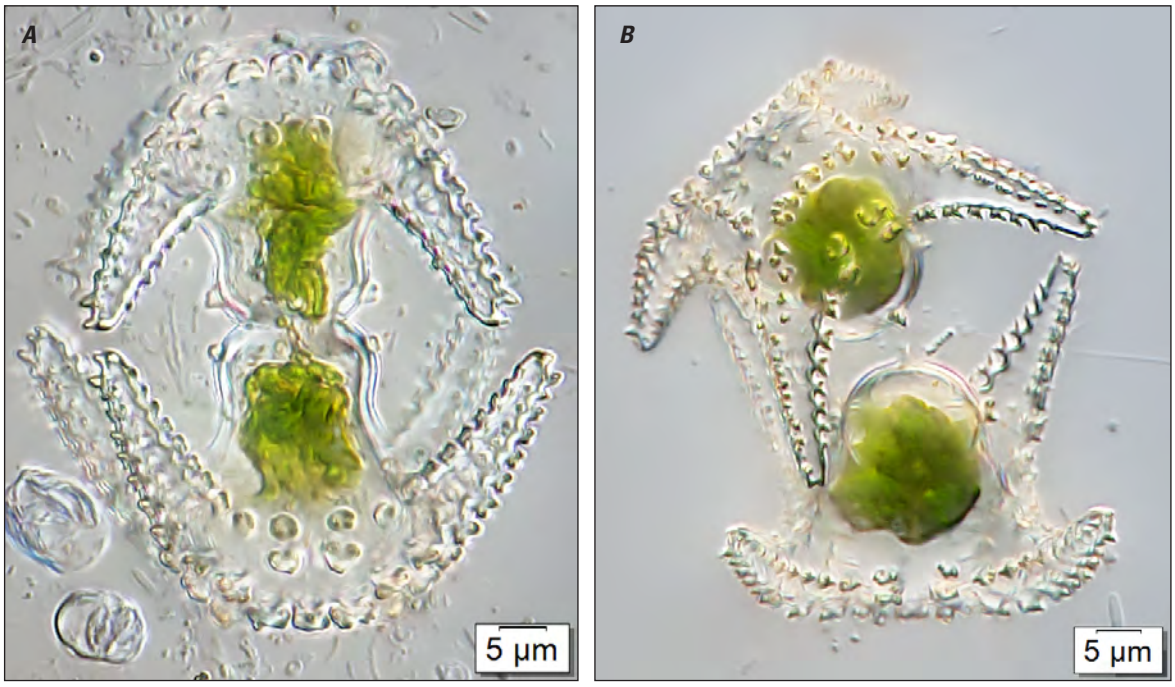


Figure 181. *Staurastrum cerastes*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum connatum* var. *isthmosum* A.M. Scott & Grönblad

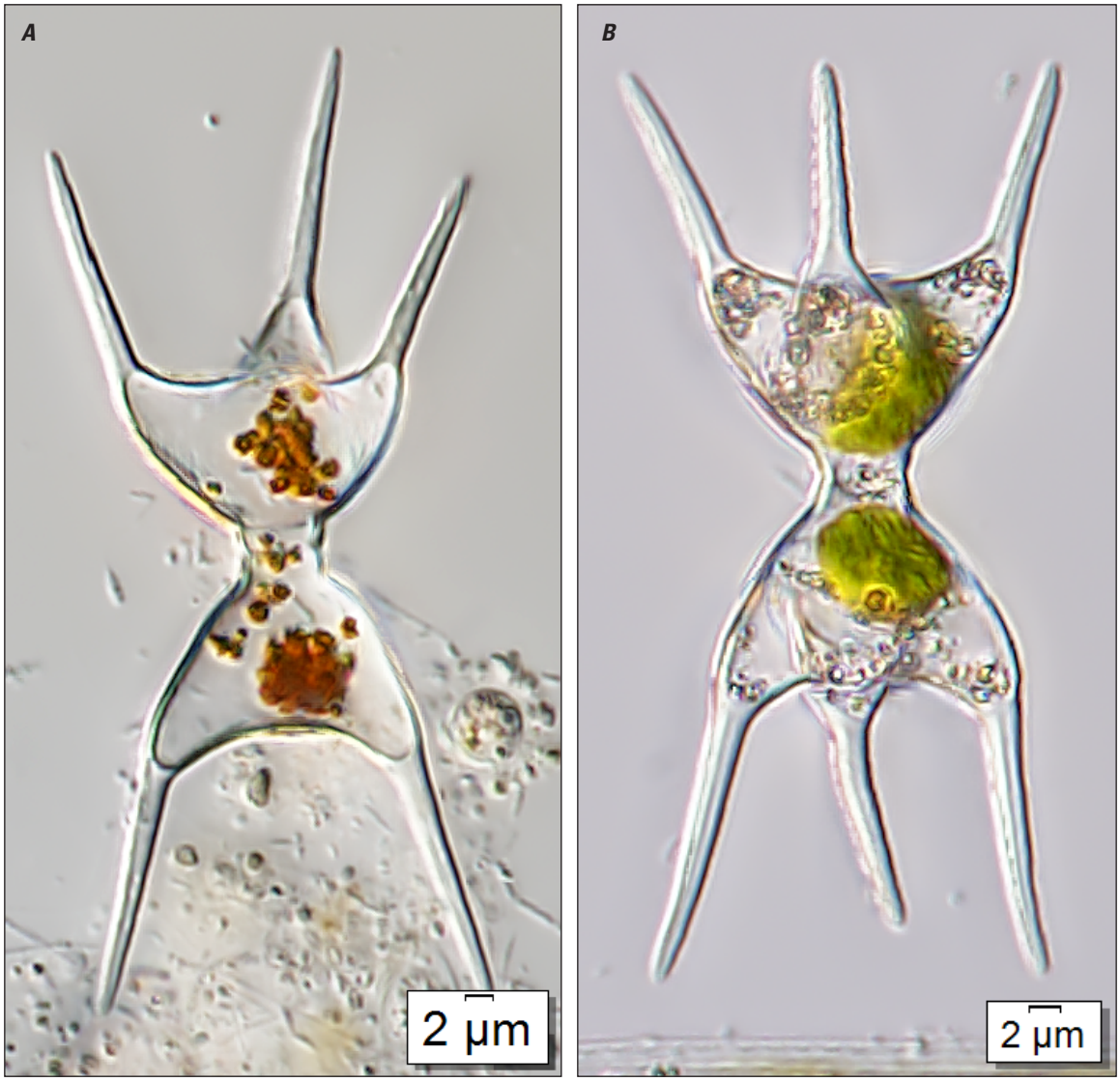


Figure 182. *Staurastrum connatum* var. *isthmosum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum depressiceps* A.M. Scott & G.L. Grönblad

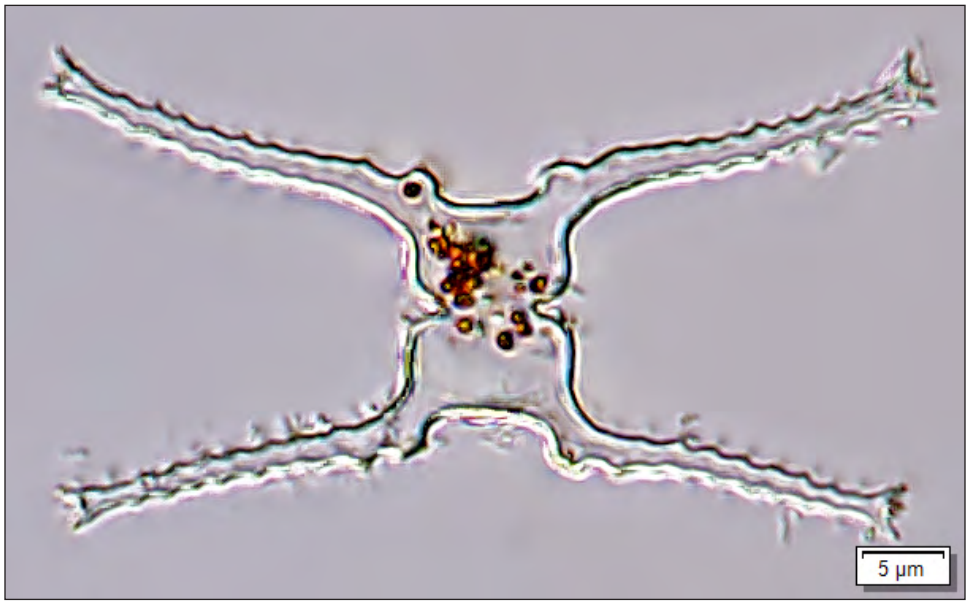


Figure 183. *Staurastrum depressiceps*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum dilatatum* (Ehrenberg) Ralfs

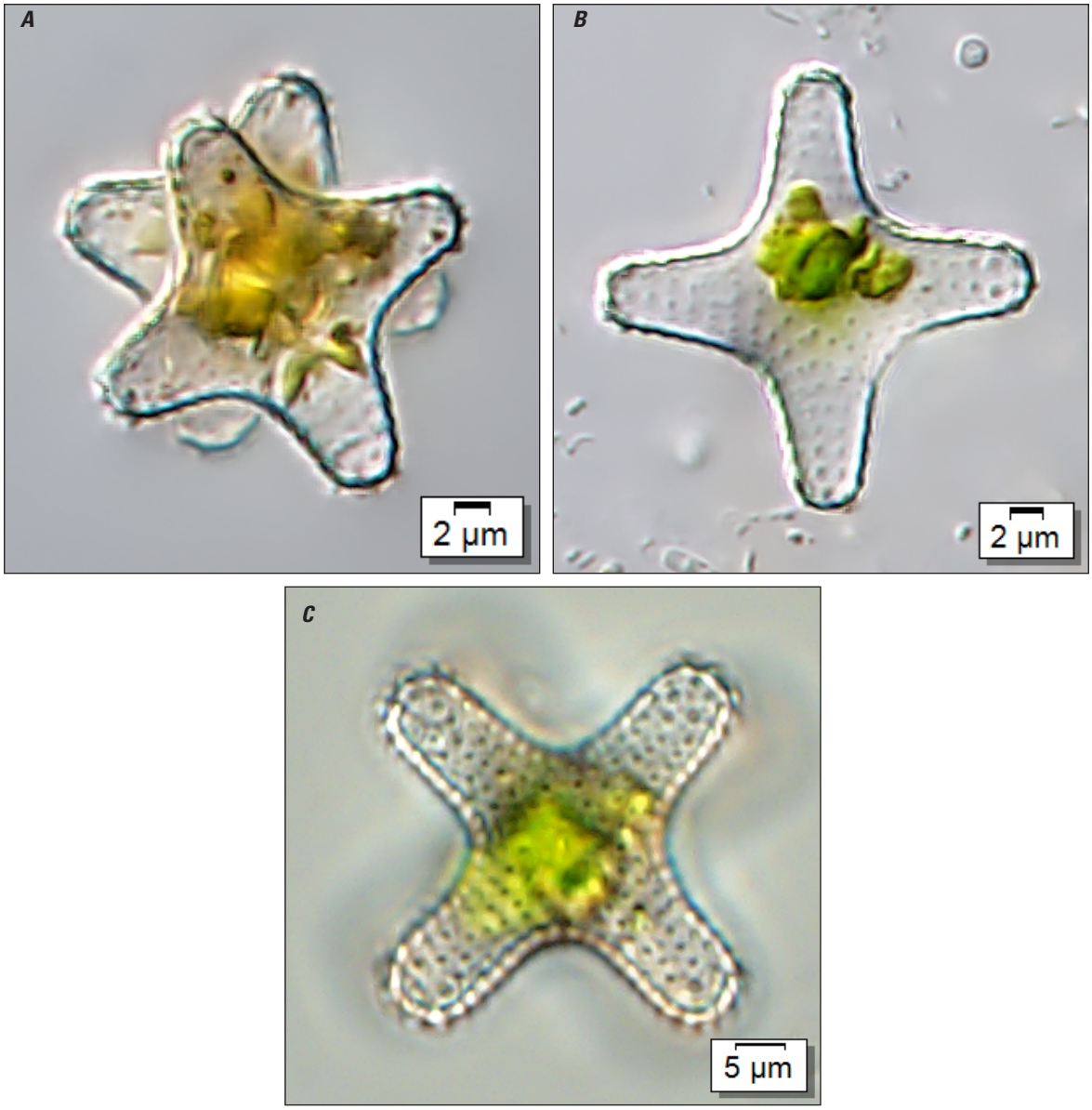


Figure 184. *Staurastrum dilatatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum geminatum* Nordstedt

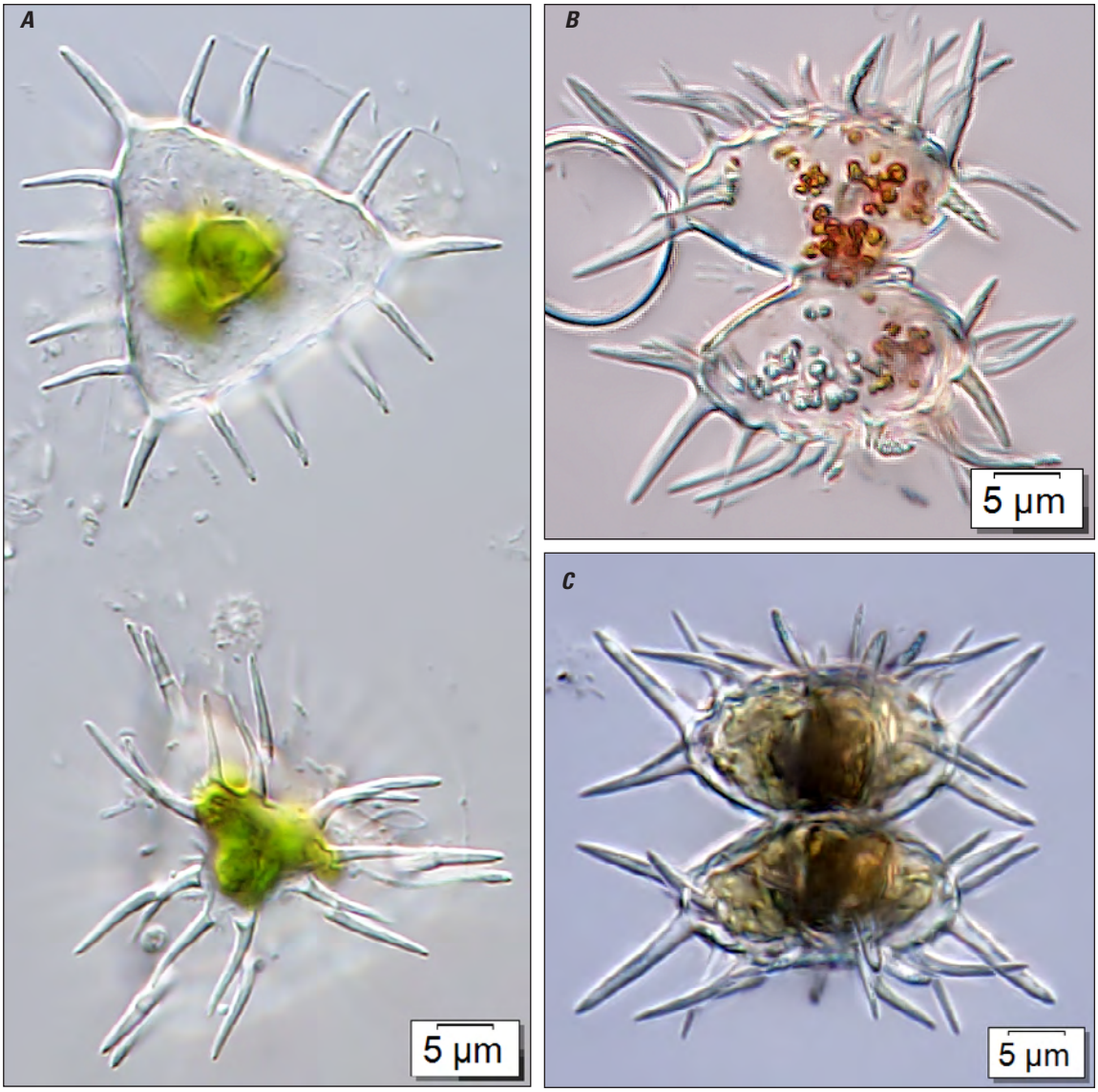


Figure 185. *Staurastrum geminatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum grallatorium* Nordstedt

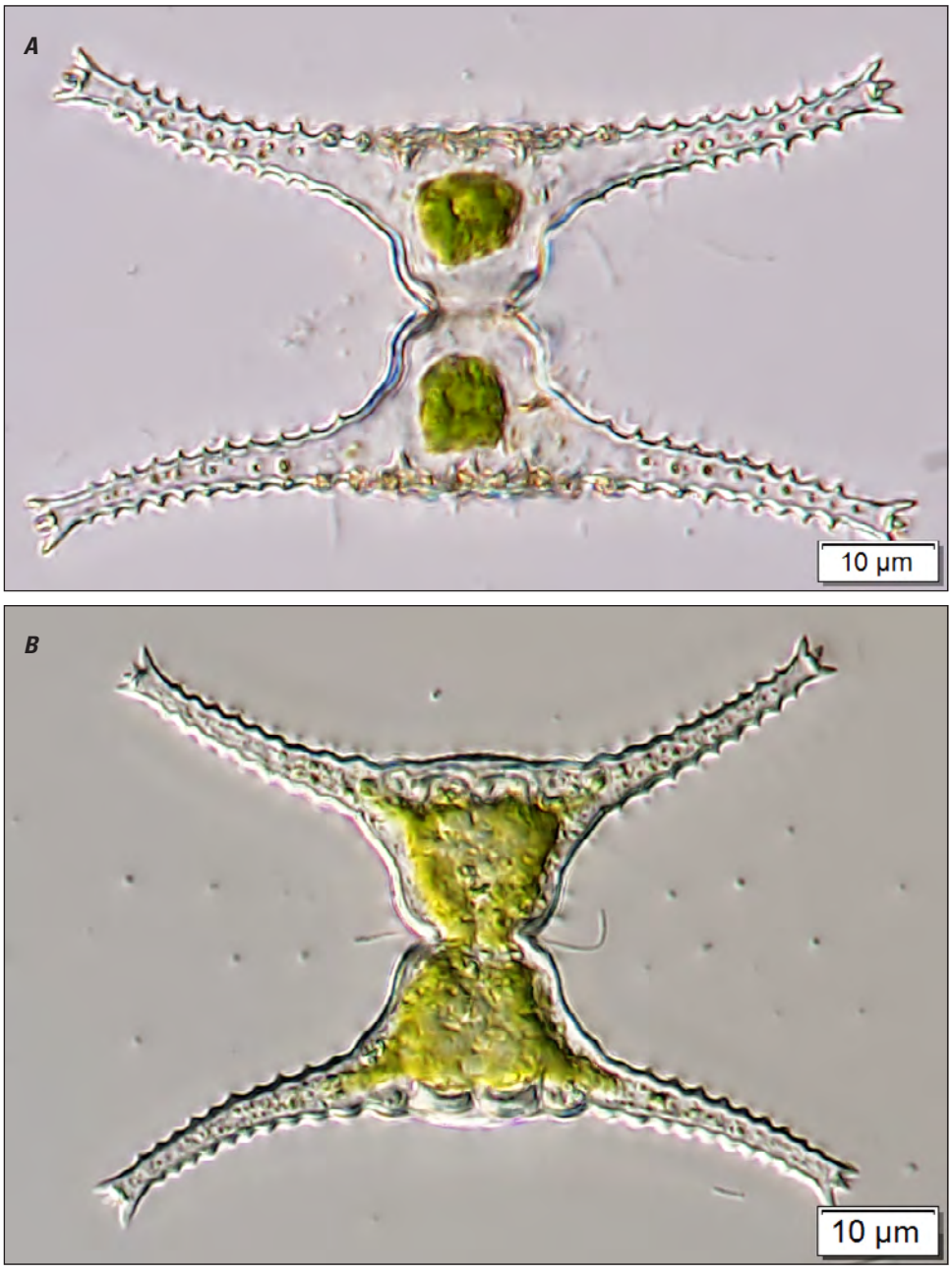


Figure 186. *Staurastrum grallatorium.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum grallatorium* var. *forcipigerum* Lagerheim

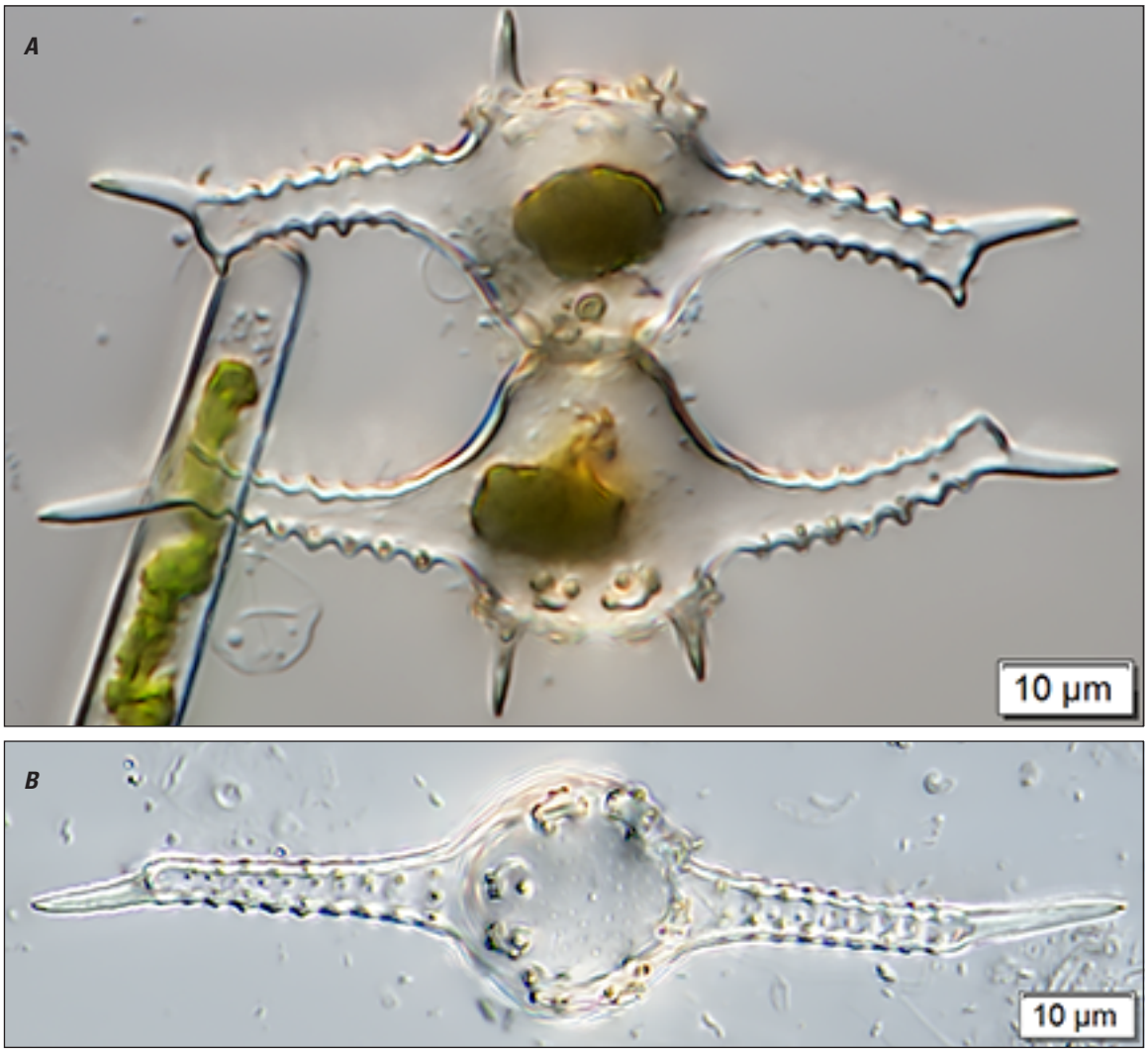


Figure 187. *Staurastrum grallatorium* var. *forcipigerum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum hystrix* Ralfs

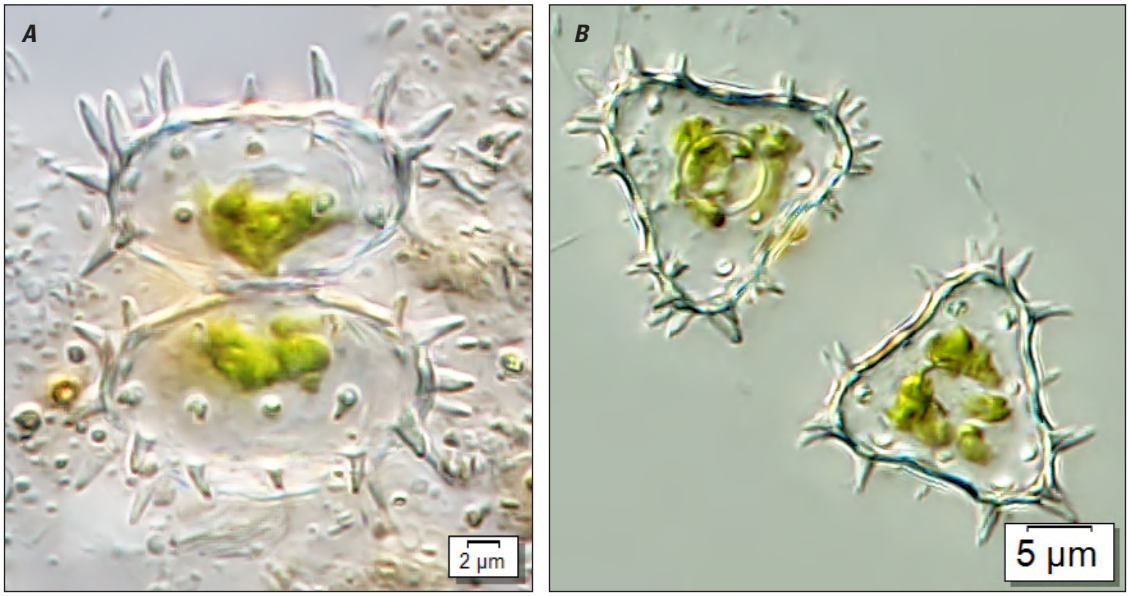


Figure 188. *Staurastrum hystrix.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum inconspicuum* Nordstedt

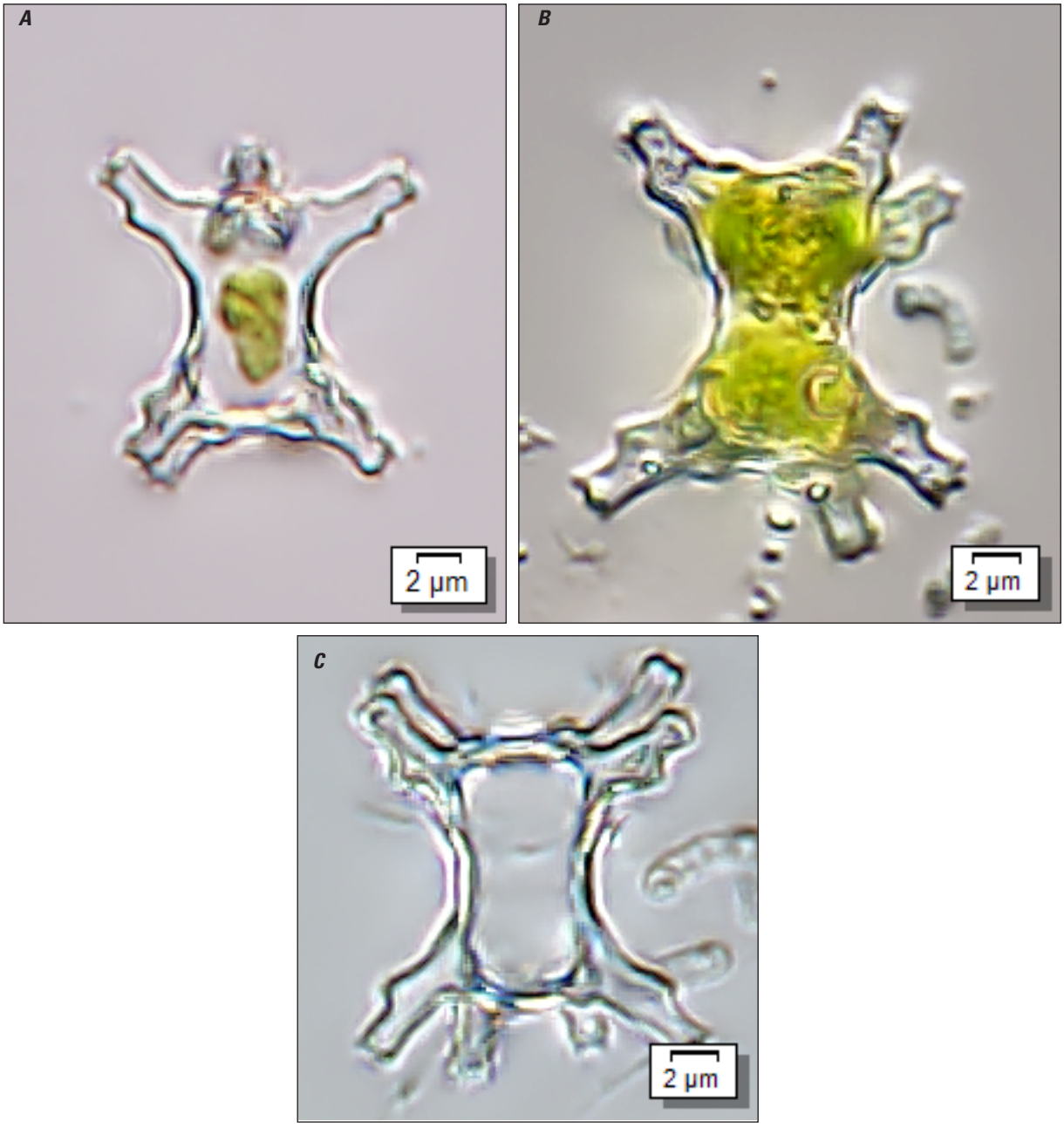


Figure 189. *Staurastrum inconspicuum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum iotanum* Wolle

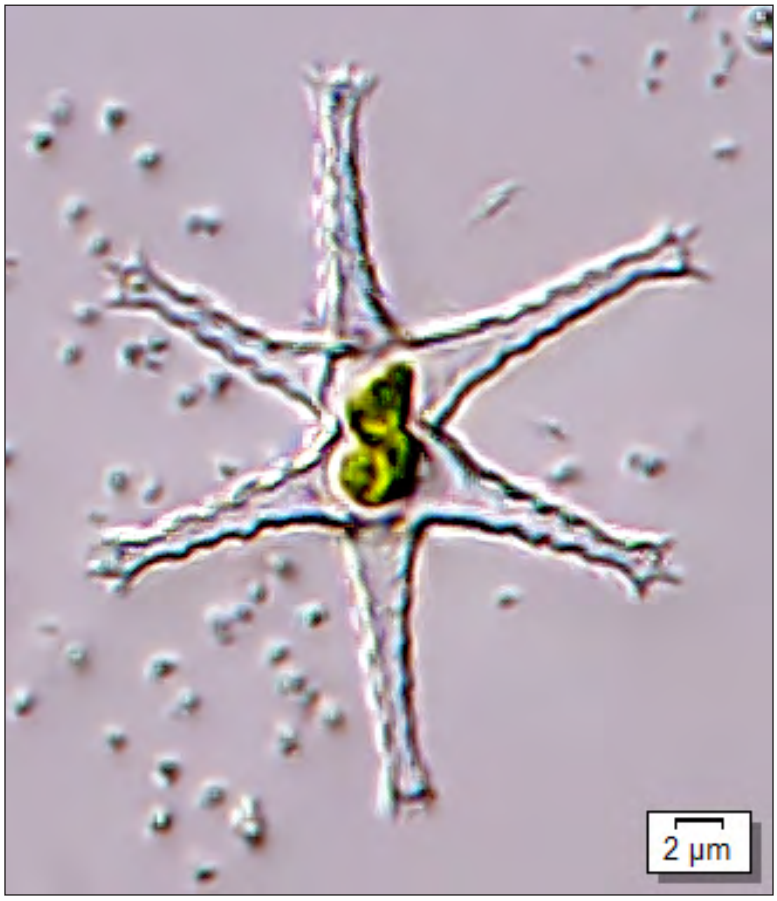


Figure 190. *Staurastrum iotanum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum johnsonii* var. *bifurcatum* Scott & Grönblad

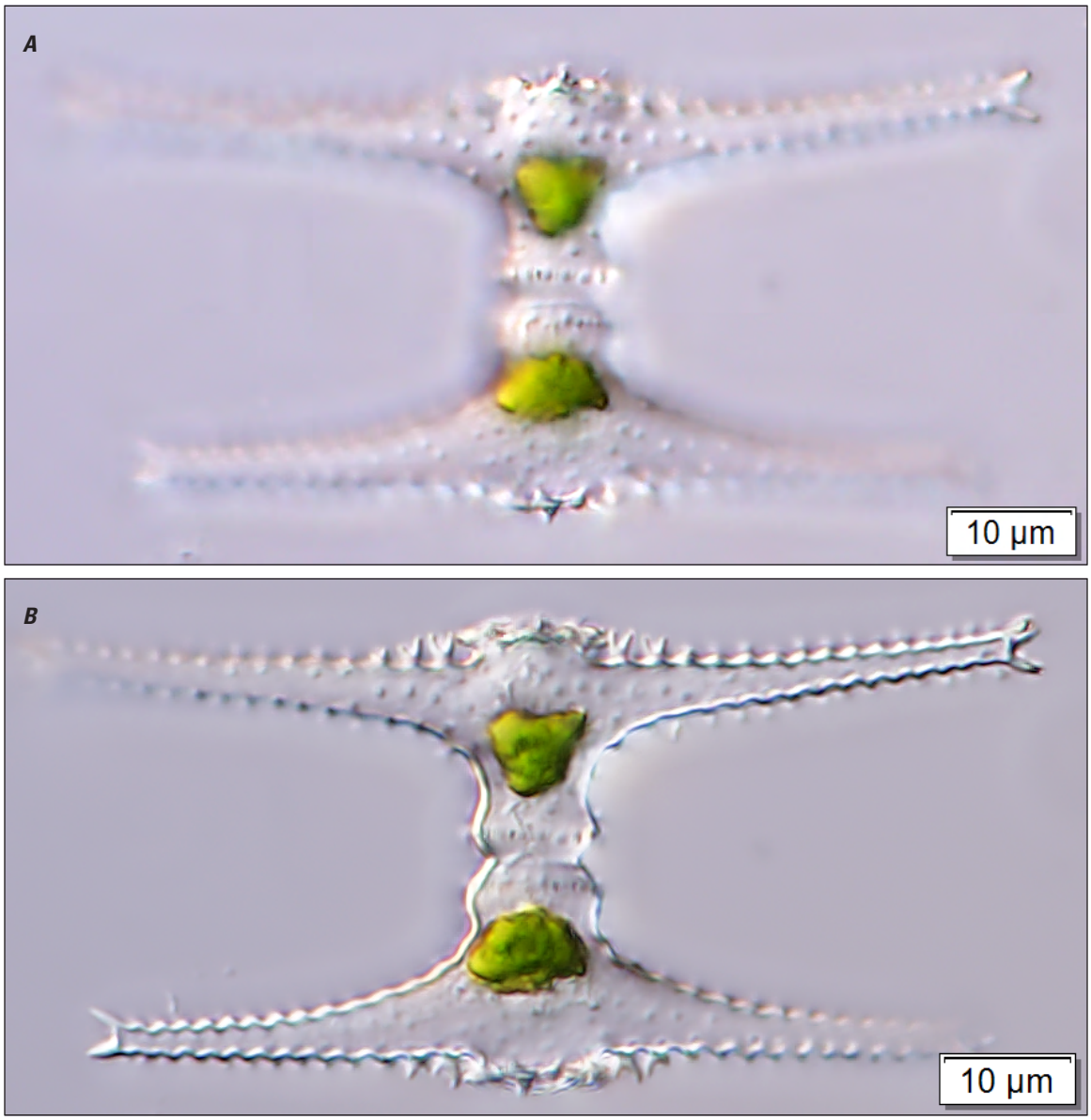


Figure 191. *Staurastrum johnsonii* var. *bifurcatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum laeve* var. *latidivergens* Scott & Grönblad

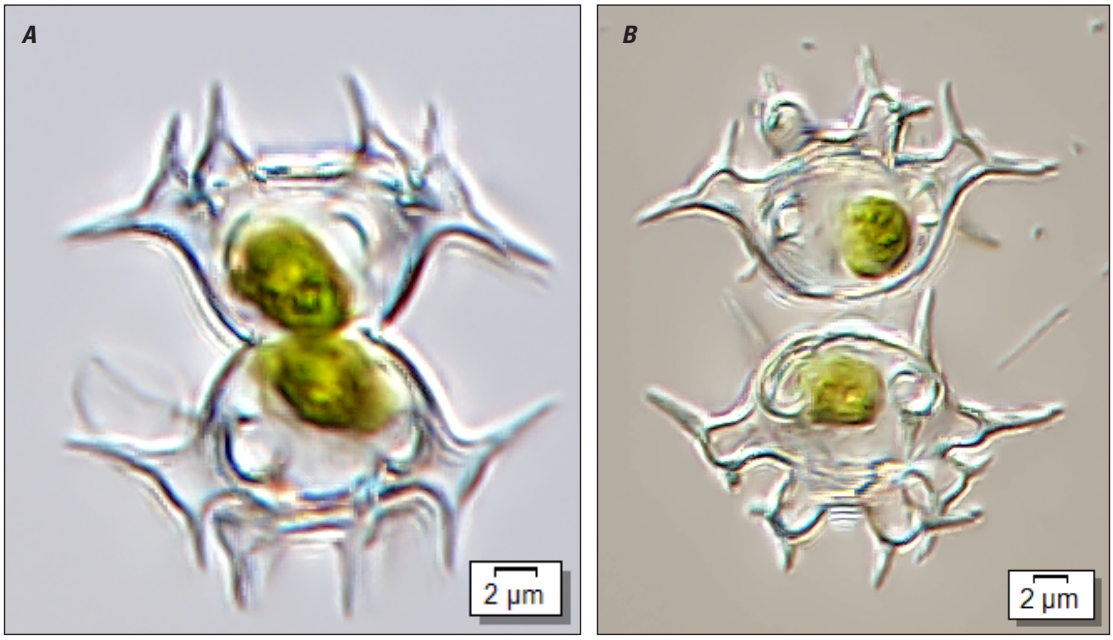


Figure 192. *Staurastrum laeve* var. *latidivergens*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum lativenter* Scott & Grönblad

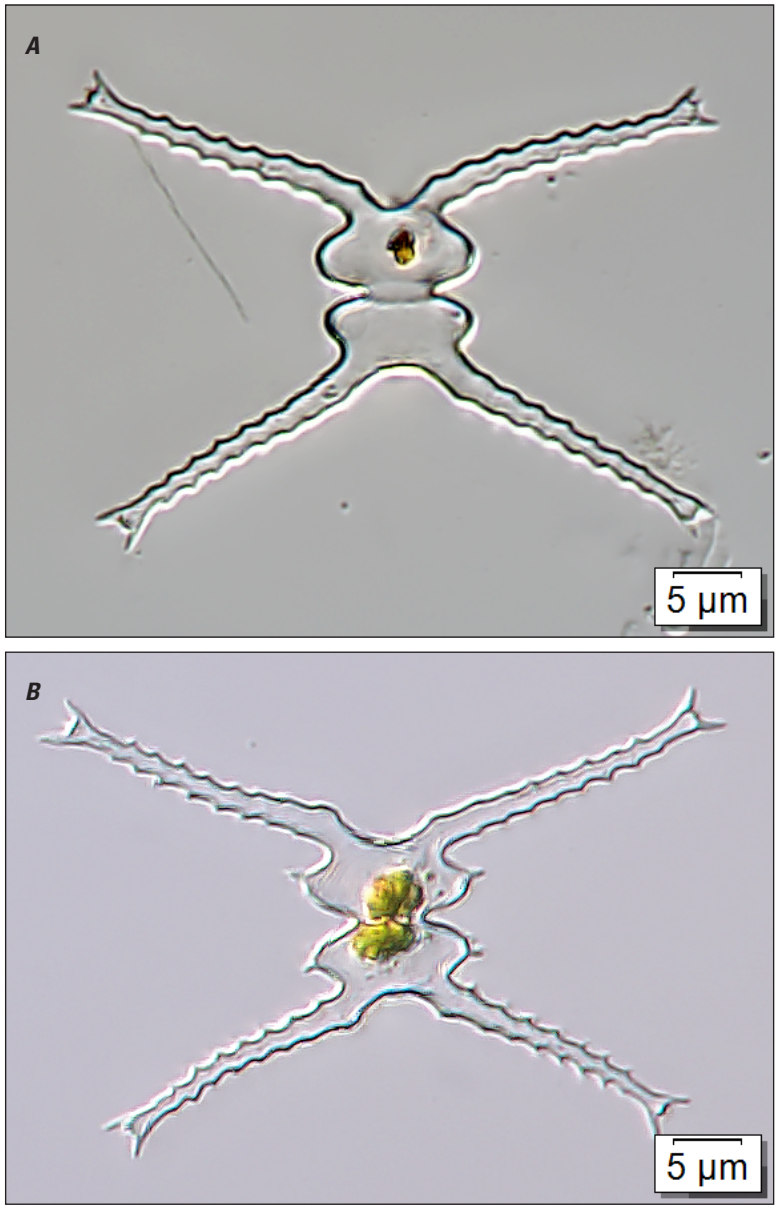


Figure 193. *Staurastrum lativenter.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum leptacanthum* var. *brachycerum* Scott & Grönblad

Figure 194. *Staurastrum leptacanthum* var. *brachycerum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum leptocladum* var. *cornutum* Wille

Figure 195. *Staurastrum leptocladum* var. *cornutum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum leptocladum* var. *sinuatum* f. *planum* G.M. Smith

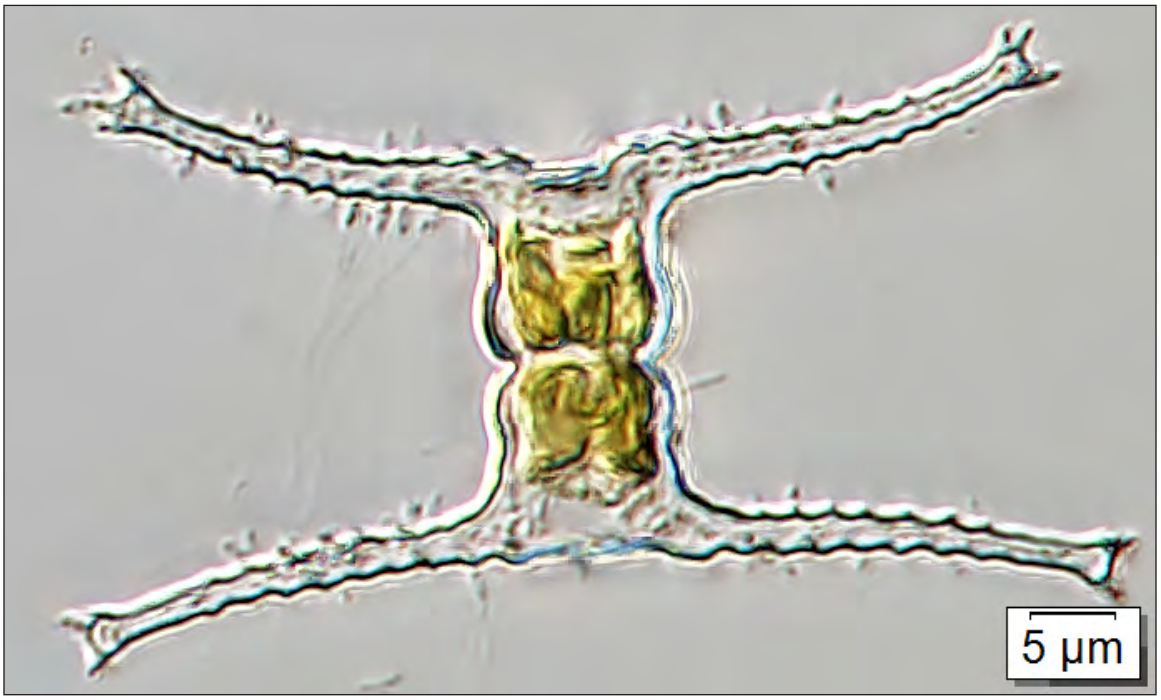


Figure 196. *Staurastrum leptocladum* var. *sinuatum* f. *planum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum longebrachiatum* f. *inflatum* Scott & Grönblad

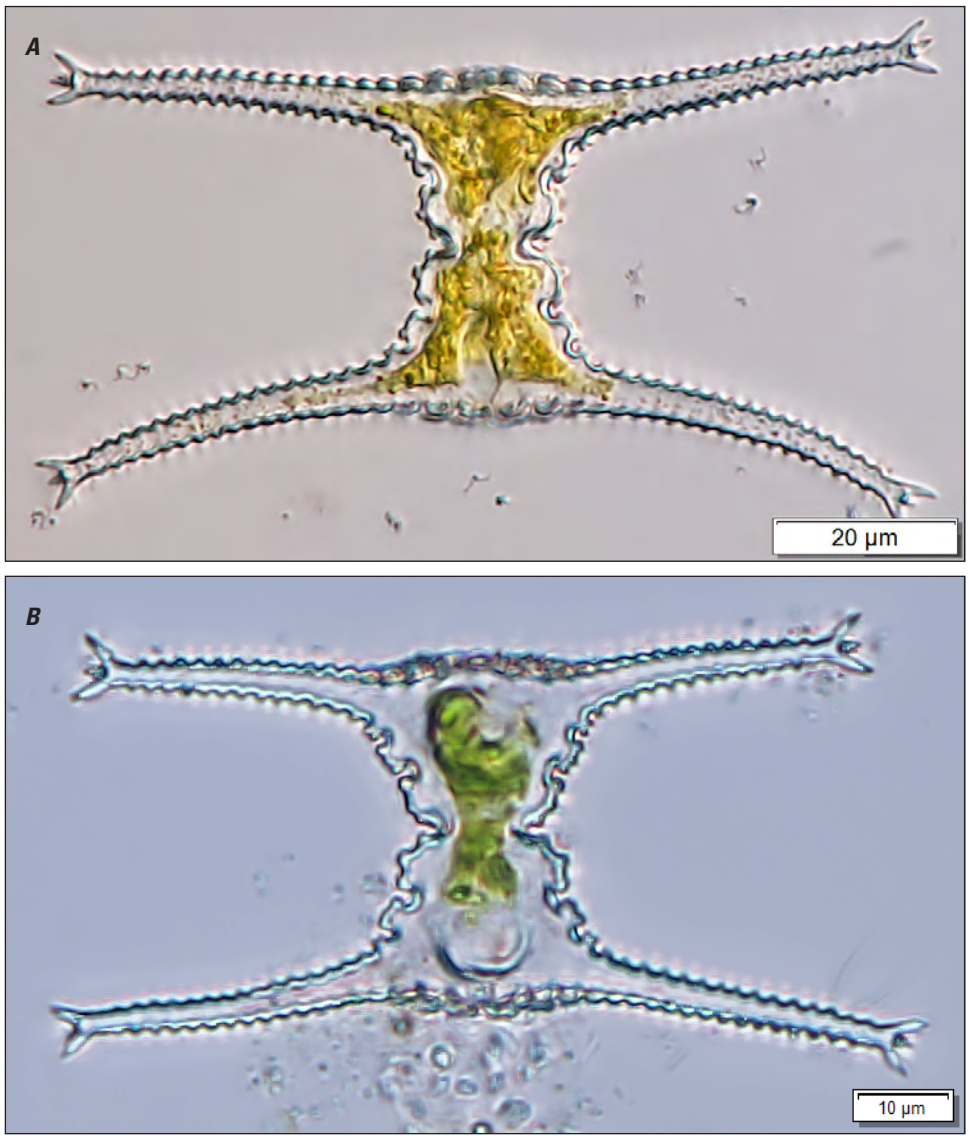


Figure 197. *Staurastrum longebrachiatum* f. *inflatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum magnottae* var. *biradiatum* A.M. Scott & Grönblad

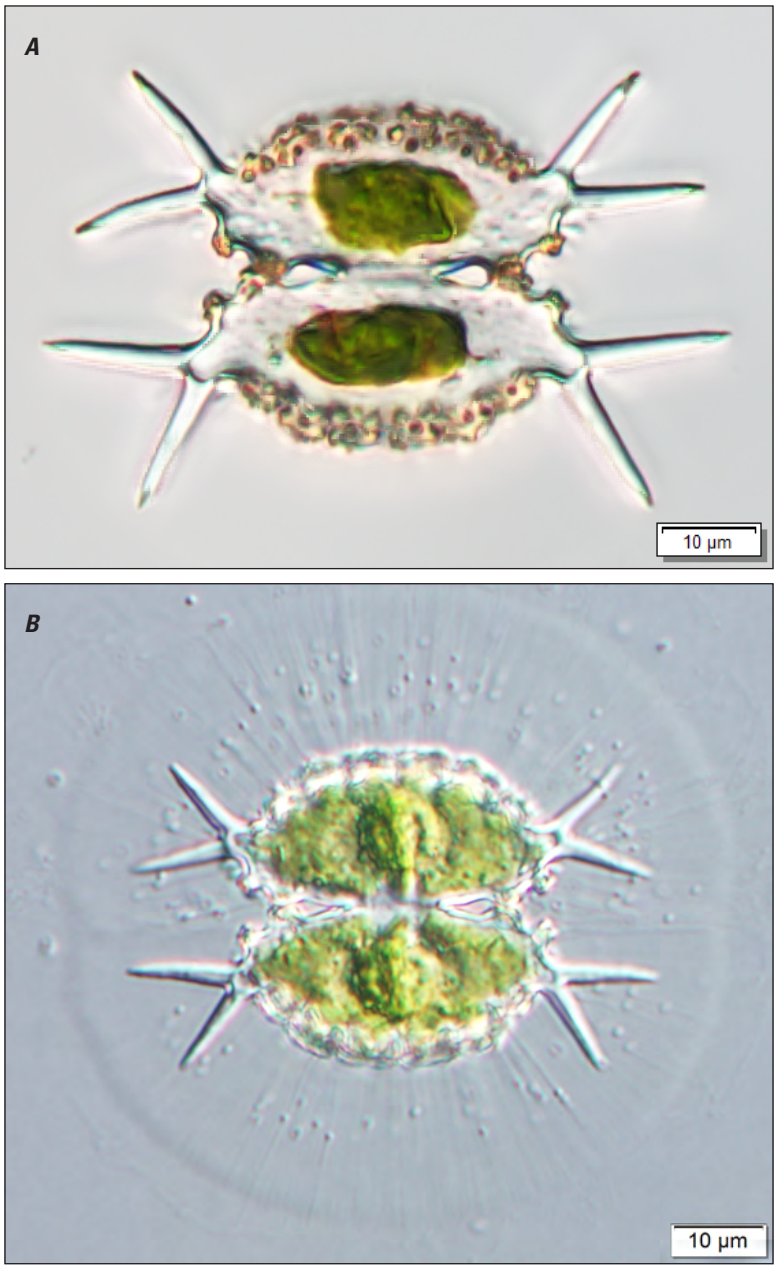


Figure 198. *Staurastrum magnottae* var. *biradiatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum minnesotense* Wolle

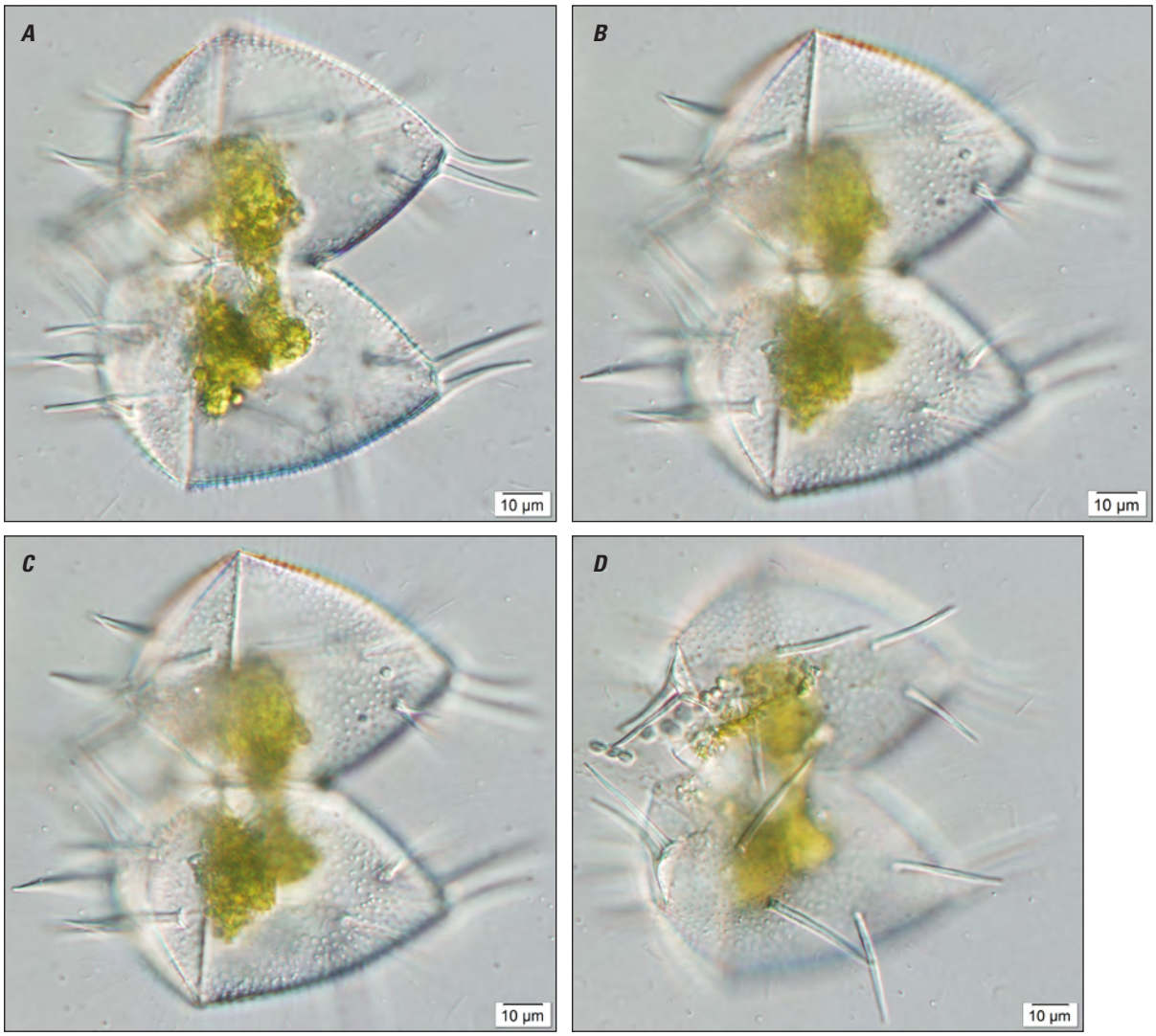


Figure 199. *Staurastrum minnesotense.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum neglectum* G.S. West

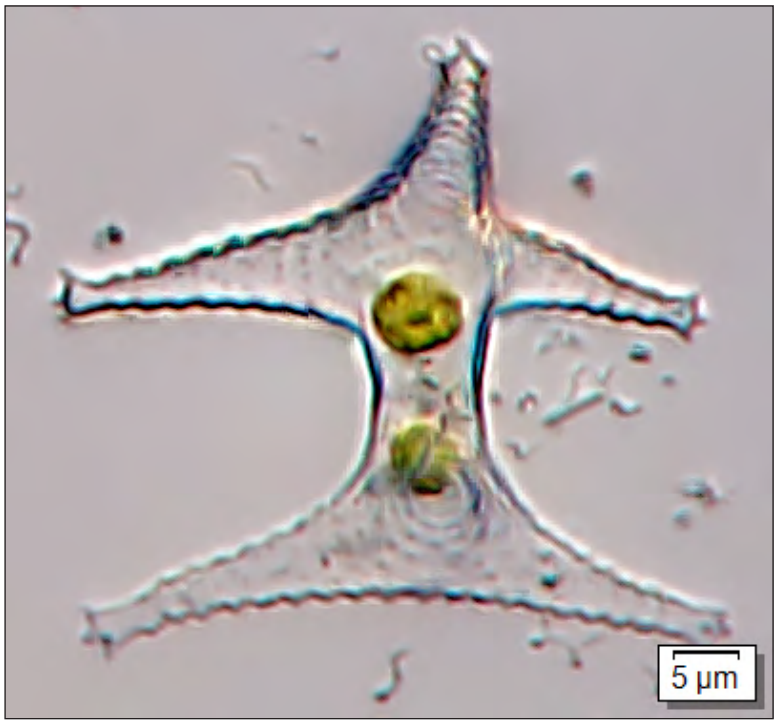


Figure 200. *Staurastrum neglectum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum nova-caesareae* Wolle

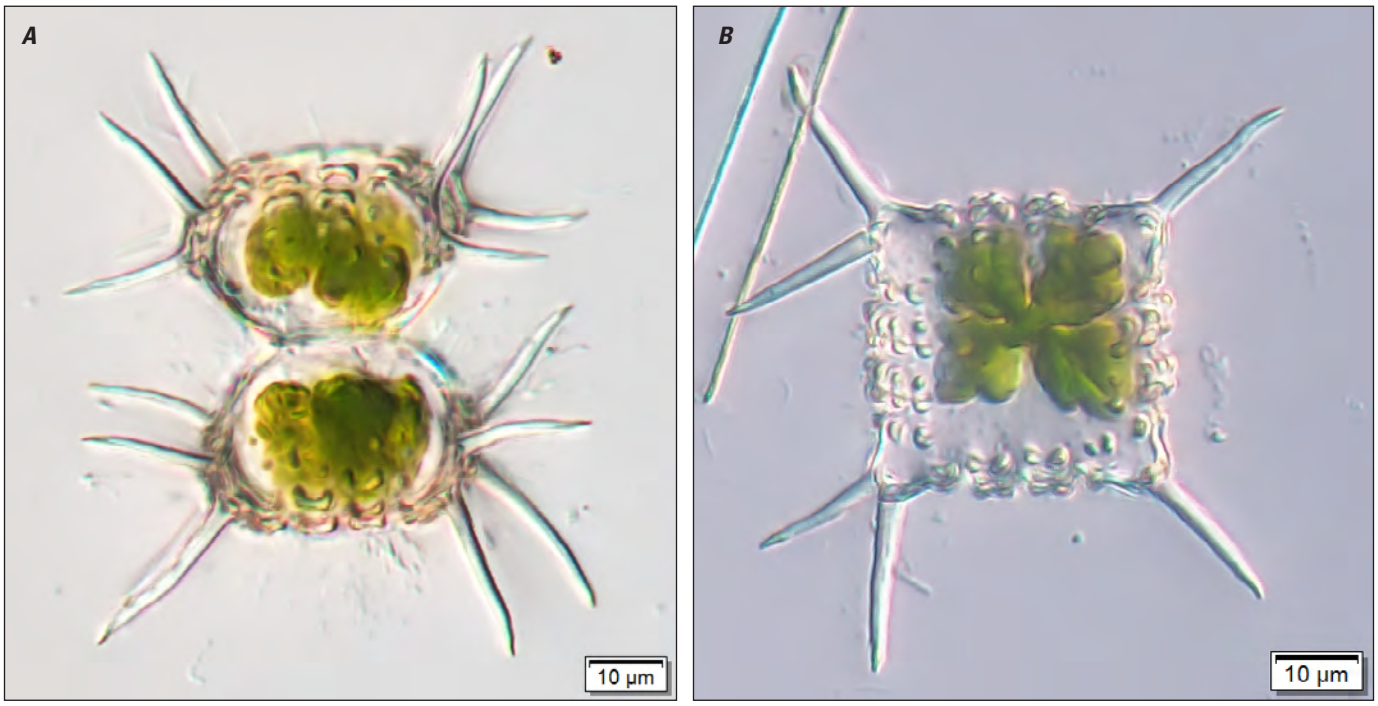


Figure 201. *Staurastrum nova-caesareae.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum octodontum* var. *tetrodontum* A.M. Scott & Grönblad

Figure 202. *Staurastrum octodontum* var. *tetrodontum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* cf. *octoverrucosum* A.M. Scott & Grönblad

Figure 203. *Staurastrum* cf. *octoverrucosum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum orbiculare* var. *denticulatum* Nordstedt

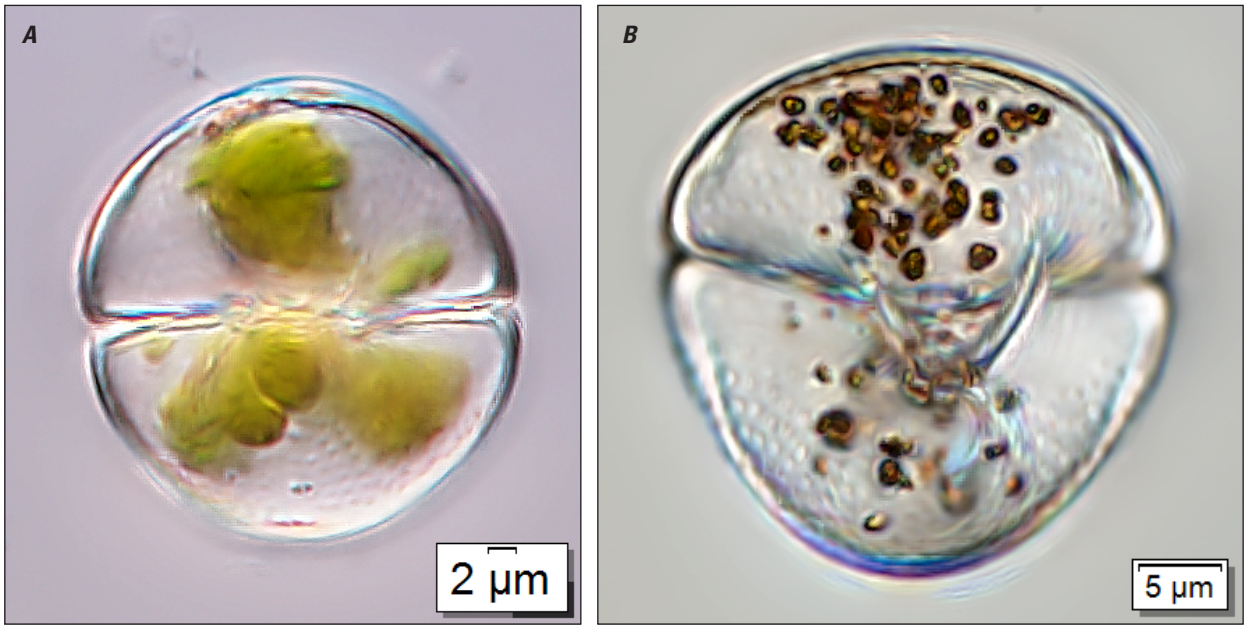


Figure 204. *Staurastrum orbiculare* var. *denticulatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum pingue* var. *evolutum* (W. West & G.S. West) G.W. Prescott

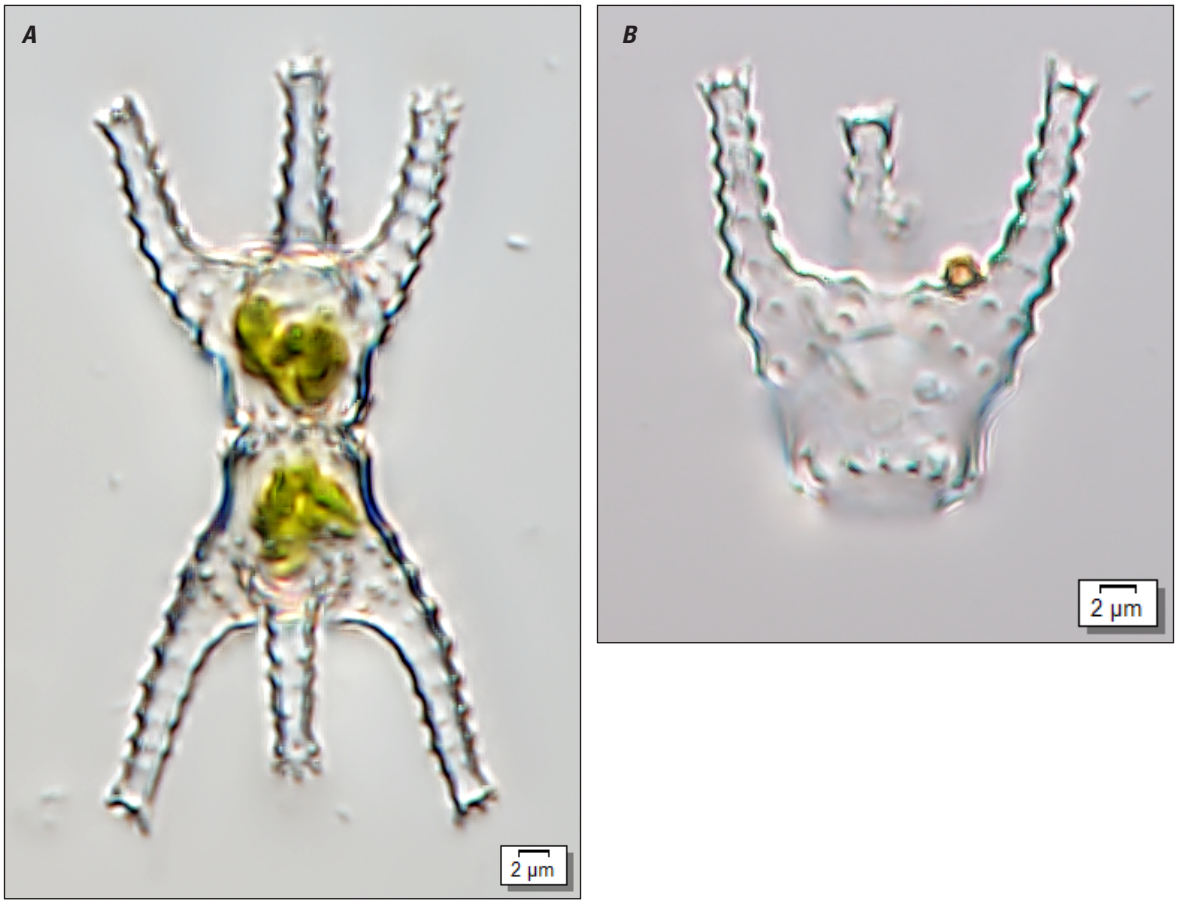


Figure 205. *Staurastrum pingue* var. *evolutum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* cf. *pinnatum* var. *floridense* A.M. Scott & Grönblad

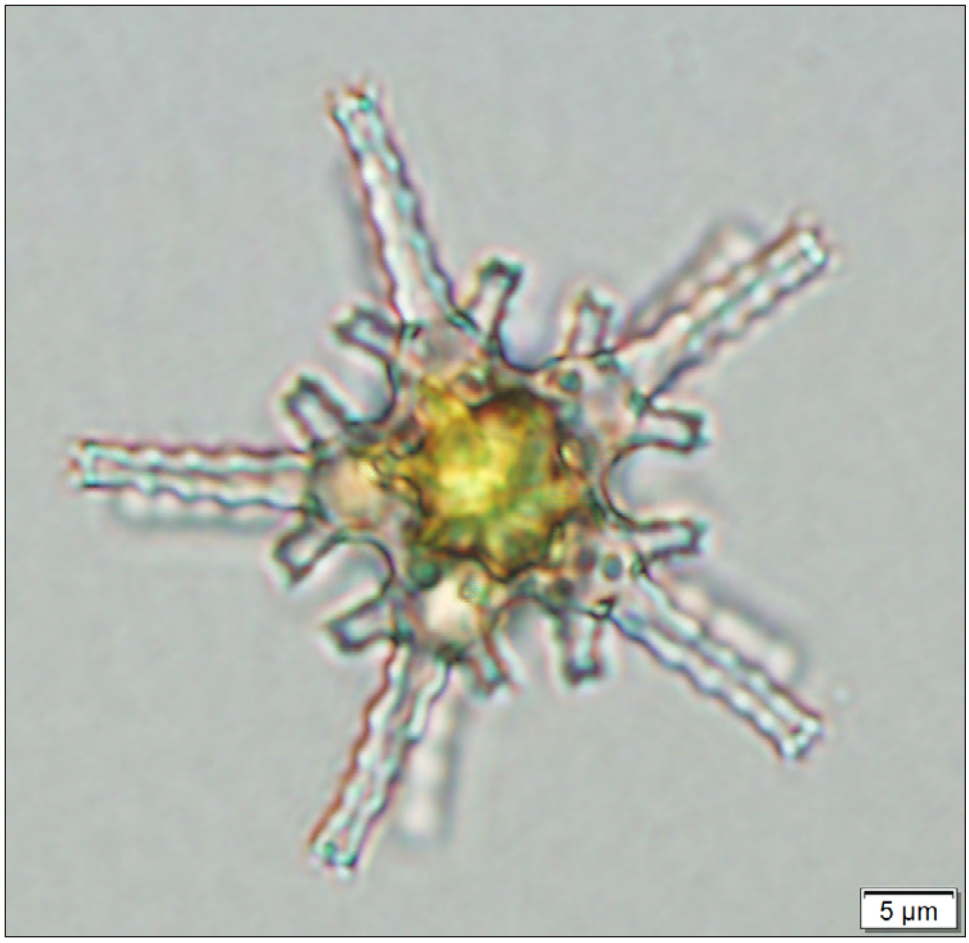


Figure 206. *Staurastrum* cf. *pinnatum* var. *floridense*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum pinnatum* var. *reductum* Krieger

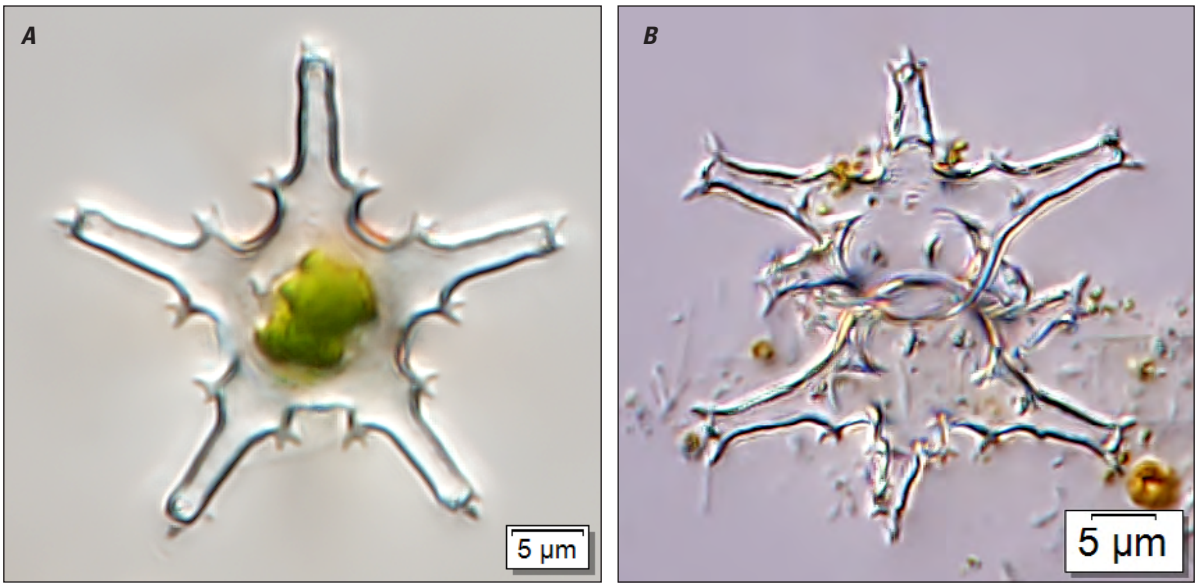


Figure 207. *Staurastrum pinnatum* var. *reductum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum polytrichum* (Perty) Rabenhorst

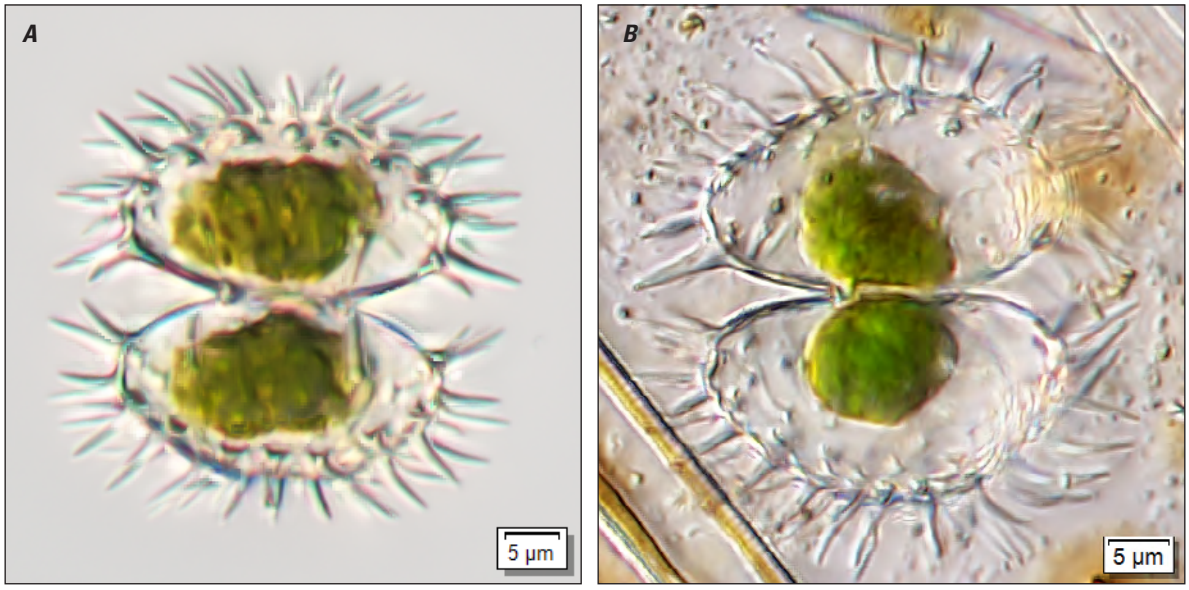


Figure 208. *Staurastrum polytrichum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum pseudoneglectum* Scott & Grönblad

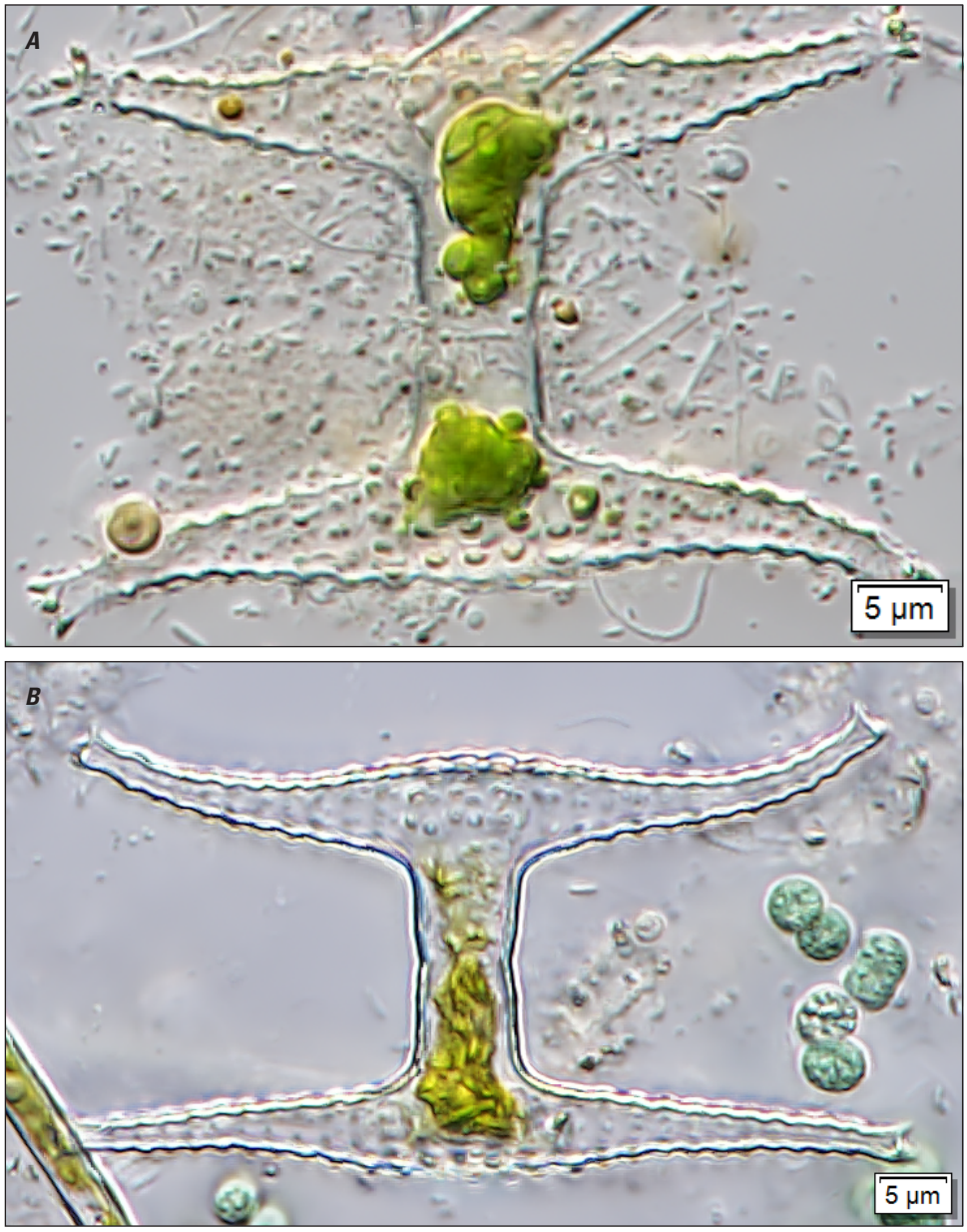


Figure 209. *Staurastrum pseudoneglectum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum quadrangulare* Brébisson

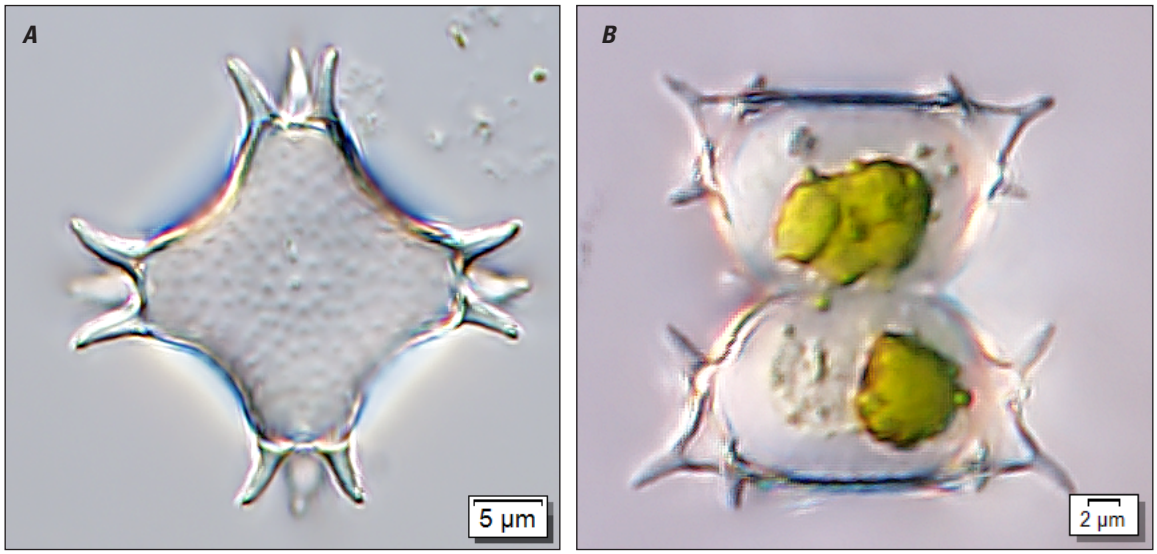


Figure 210. *Staurastrum quadrangulare.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum radians* West & West

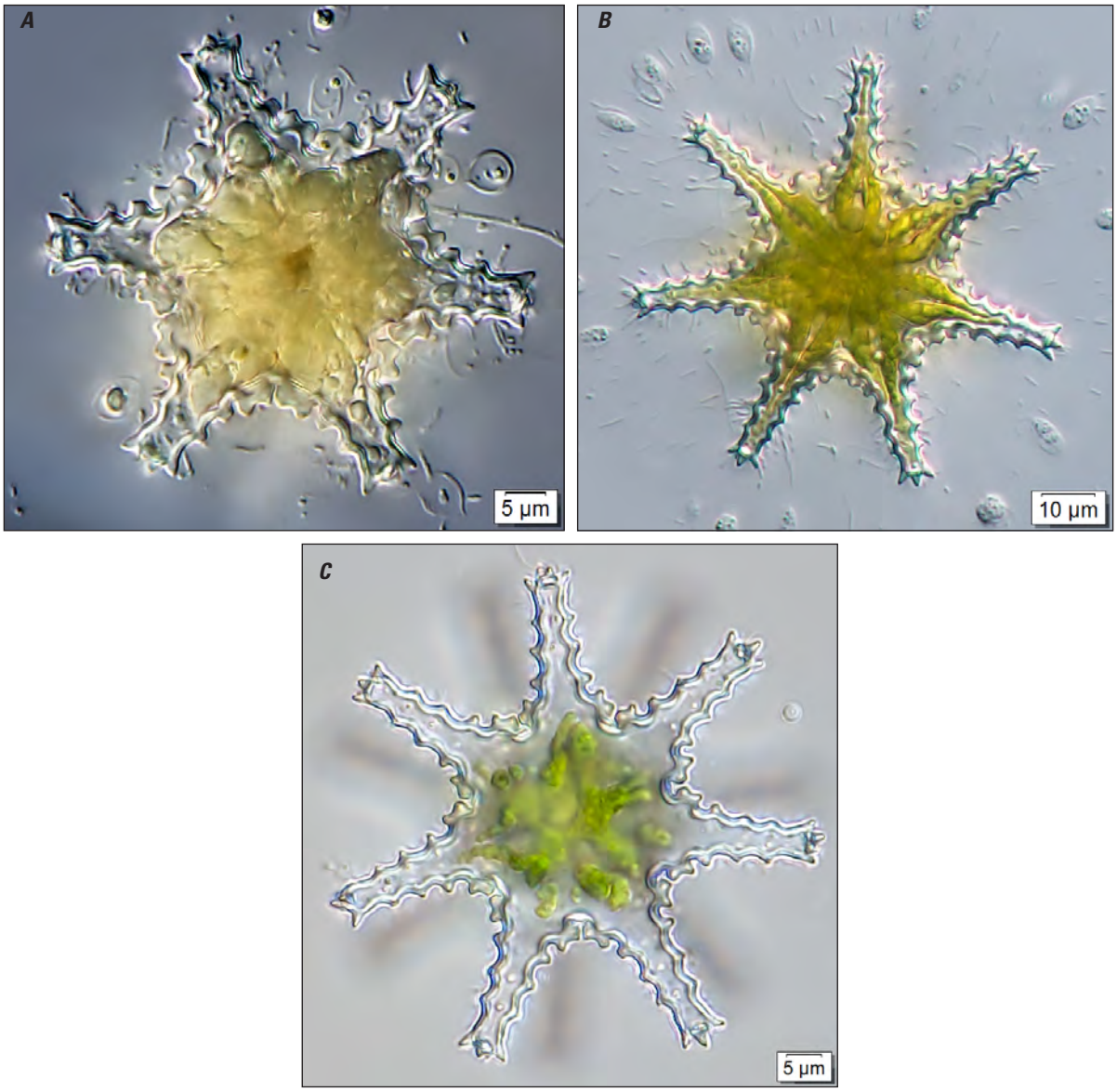


Figure 211. *Staurastrum radians*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum rotula* Nordstedt

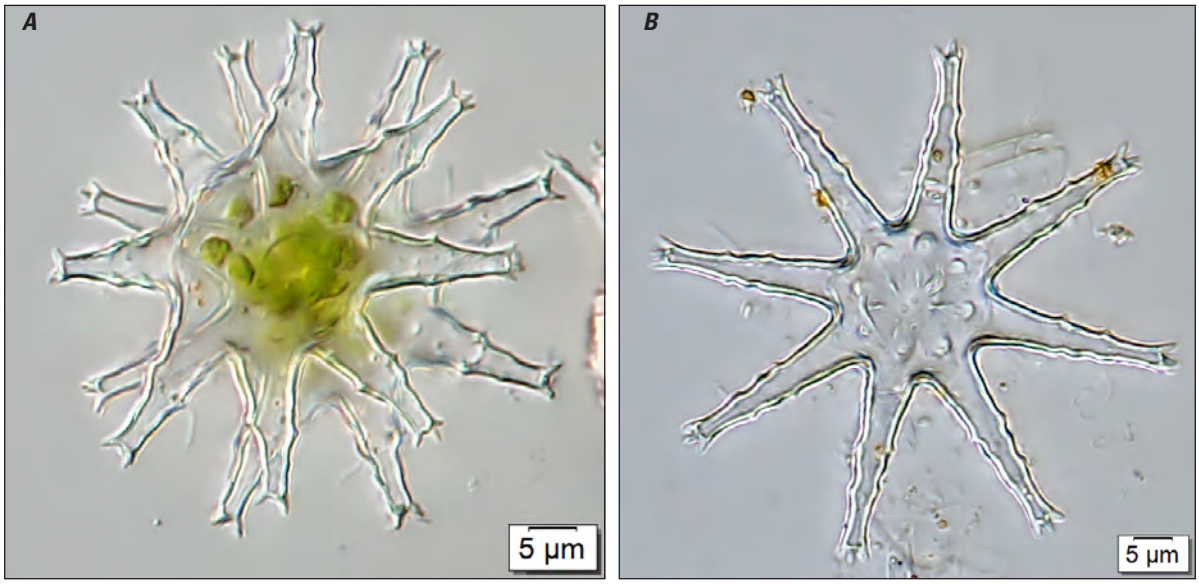


Figure 212. *Staurastrum rotula.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum sebaldi* Reinsch

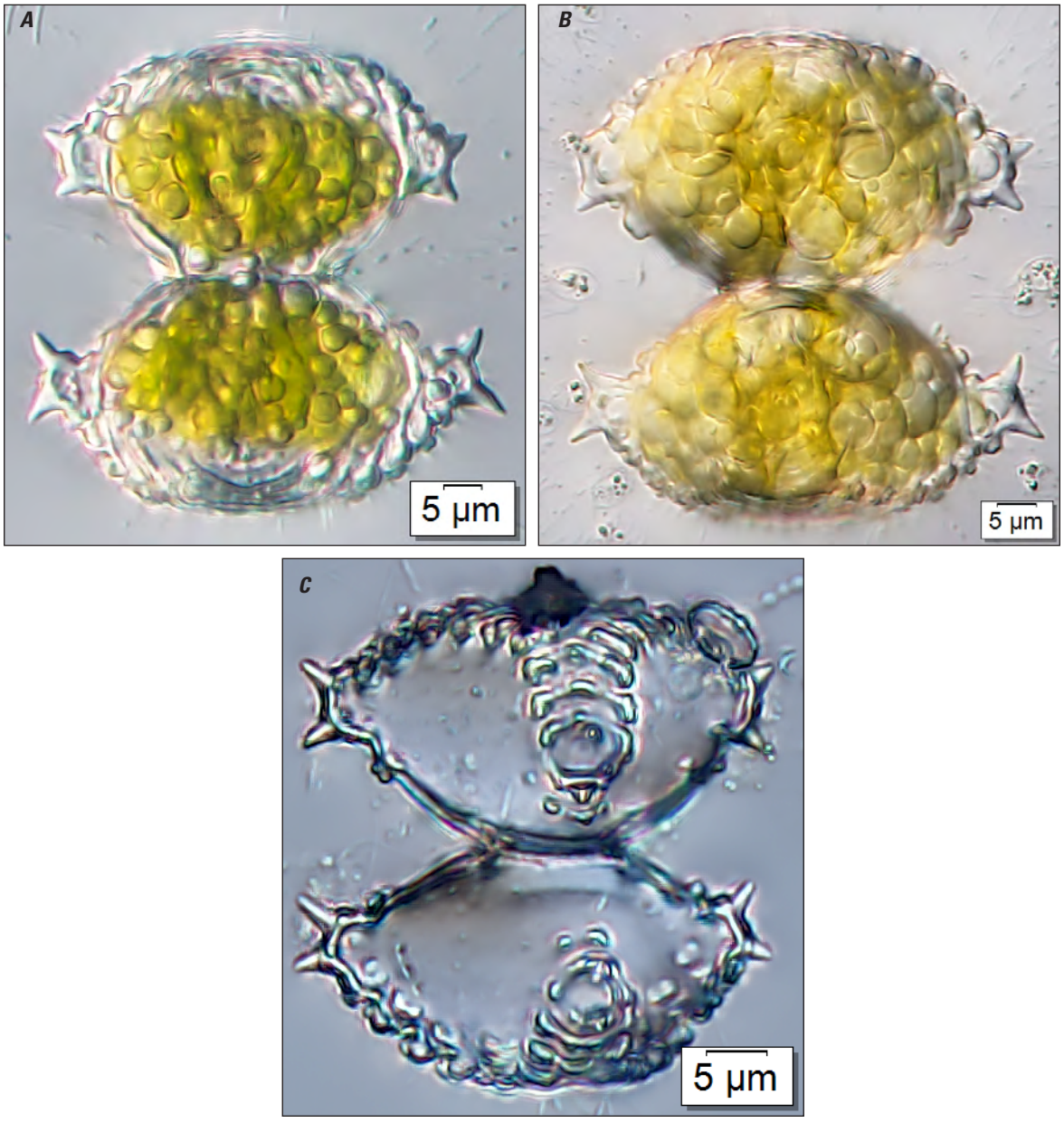


Figure 213. *Staurastrum sebaldi.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum striolatum* (Nägeli) W. Archer

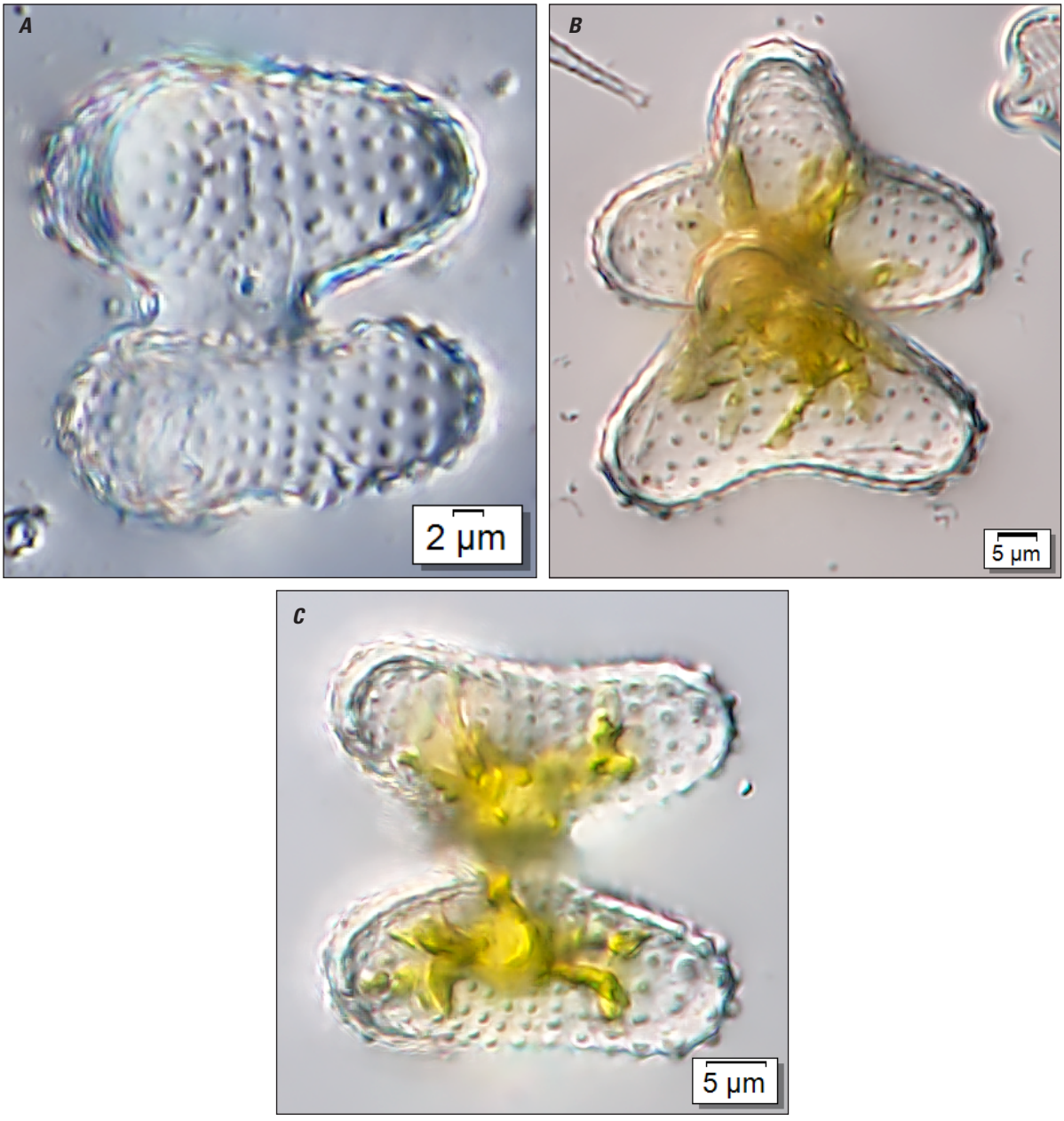


Figure 214. *Staurastrum striolatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum subpygmaeum* var. *spiniferum* A.M. Scott & Grönblad

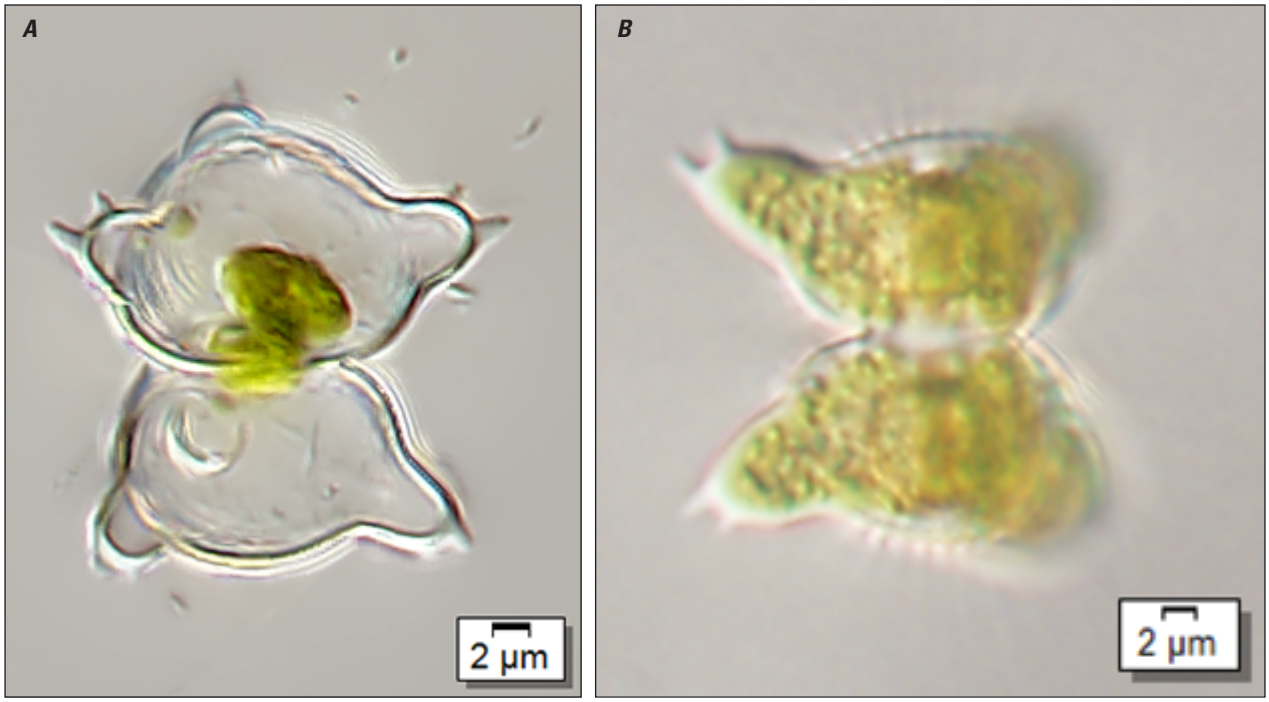


Figure 215. *Staurastrum subpygmaeum* var. *spiniferum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum tetracerum* Ralfs ex Ralfs

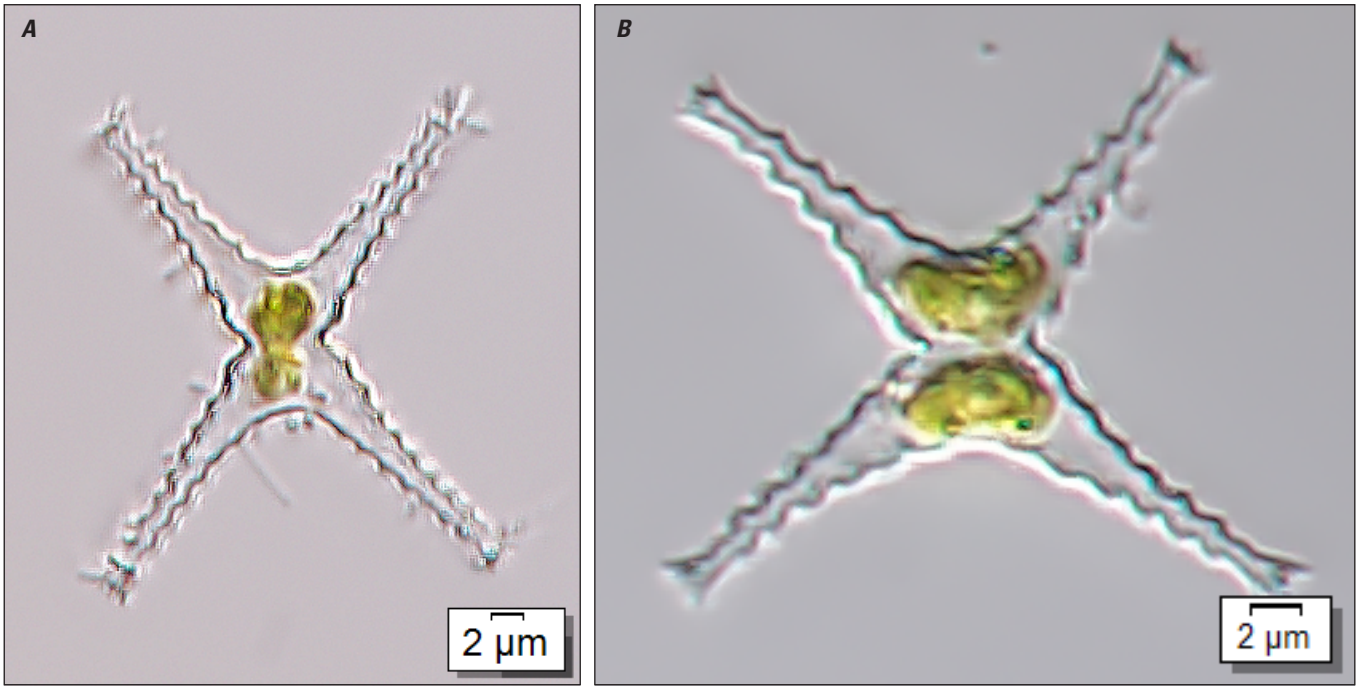


Figure 216. *Staurastrum tetracerum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum tohopekaligense* Wolle

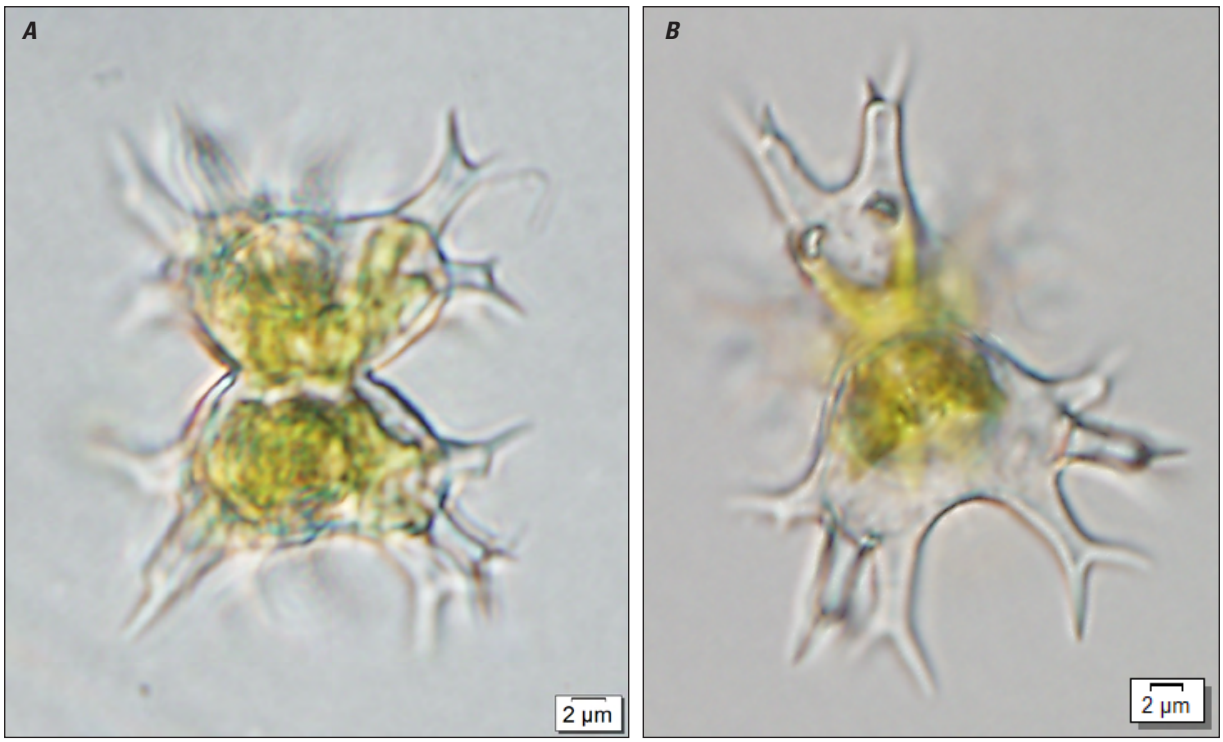


Figure 217. *Staurastrum tohopekaligense.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum trifidum* var. *inflexum* West & West

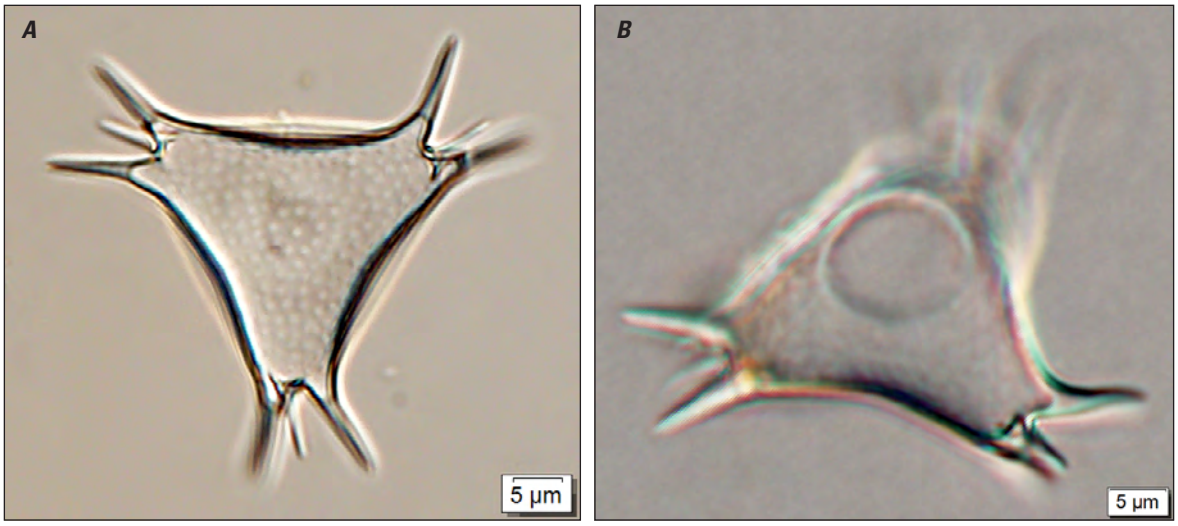


Figure 218. *Staurastrum trifidum* var. *inflexum*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum turgescens* var. *sparsigranulatum* Scott & Grönblad

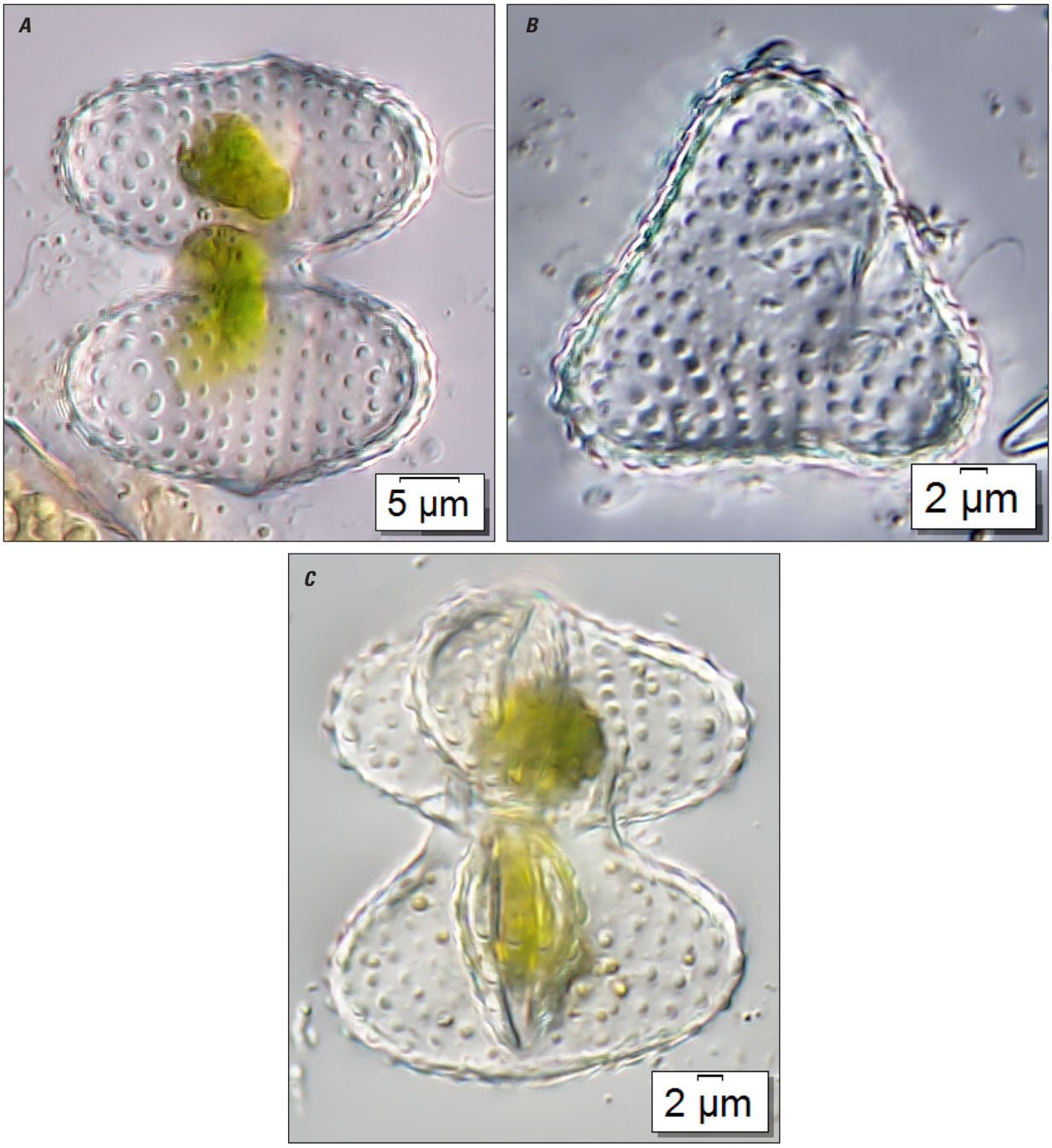


Figure 219. *Staurastrum turgescens* var. *sparsigranulatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum vestitum* Ralfs

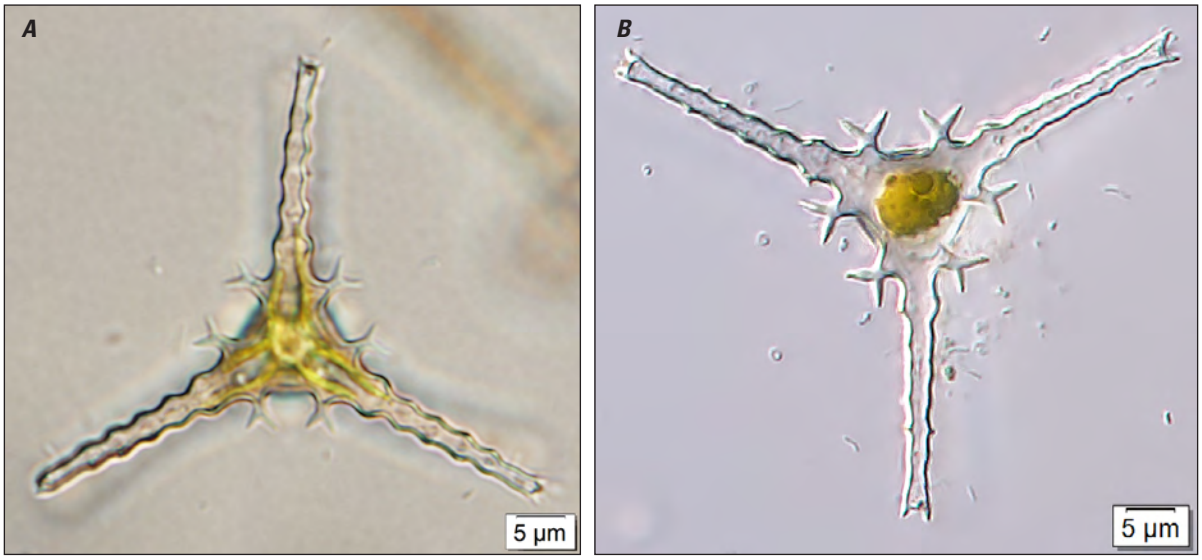


Figure 220. *Staurastrum vestitum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

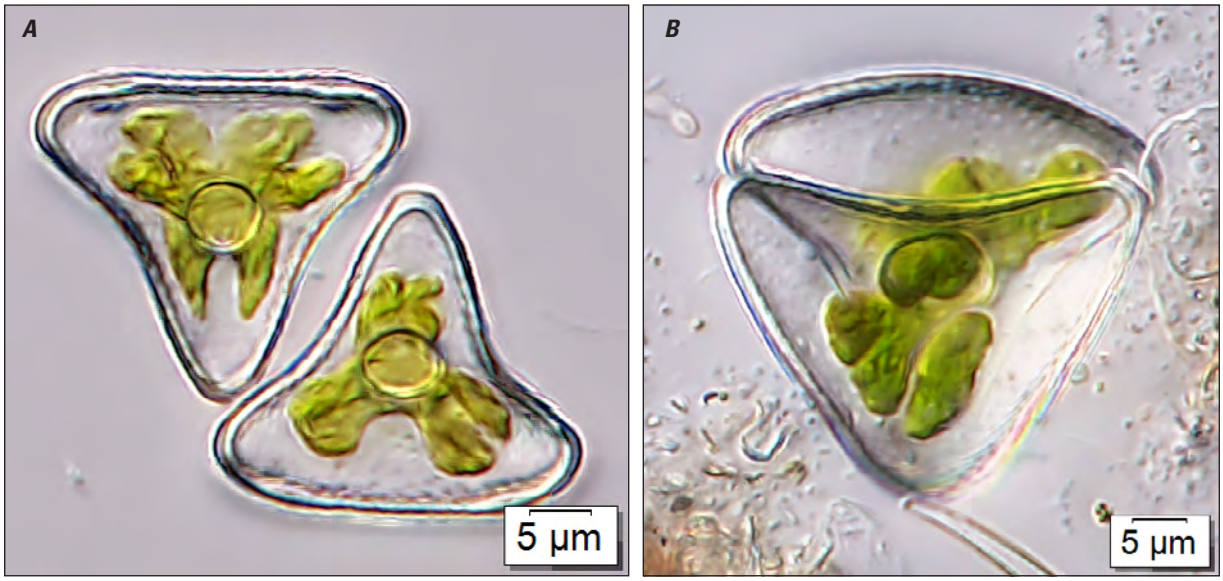


Figure 221. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

Figure 222. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

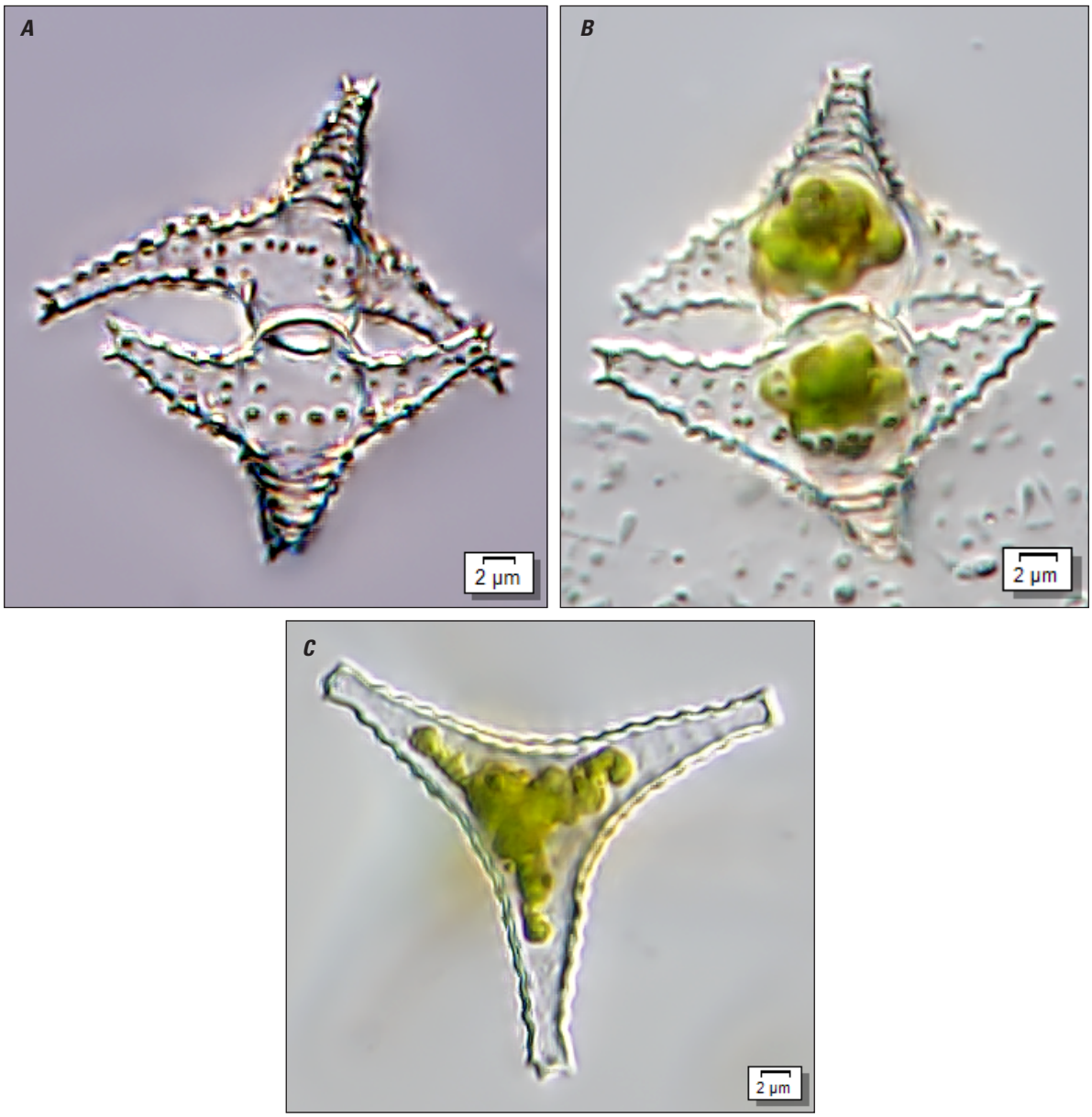


Figure 223. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

Figure 224. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

Figure 225. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

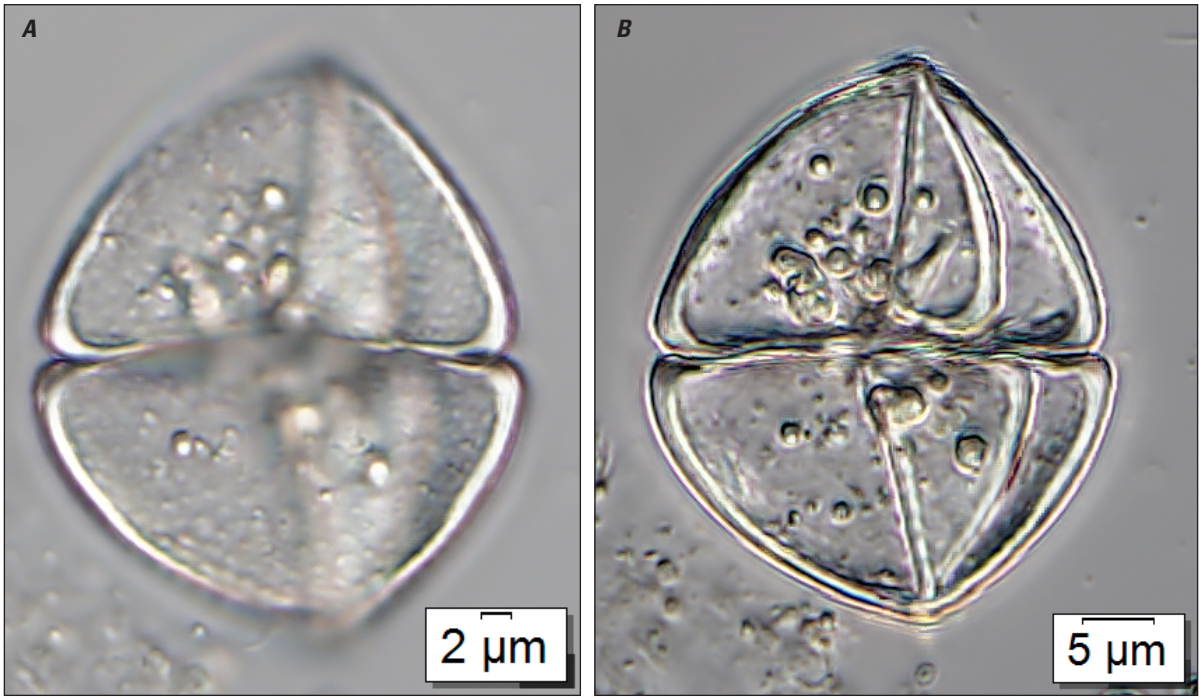


Figure 226. *Staurastrum* sp.

Order Desmidiales

Family Desmidiaceae

Genus *Staurastrum*

Species *Staurastrum* sp.

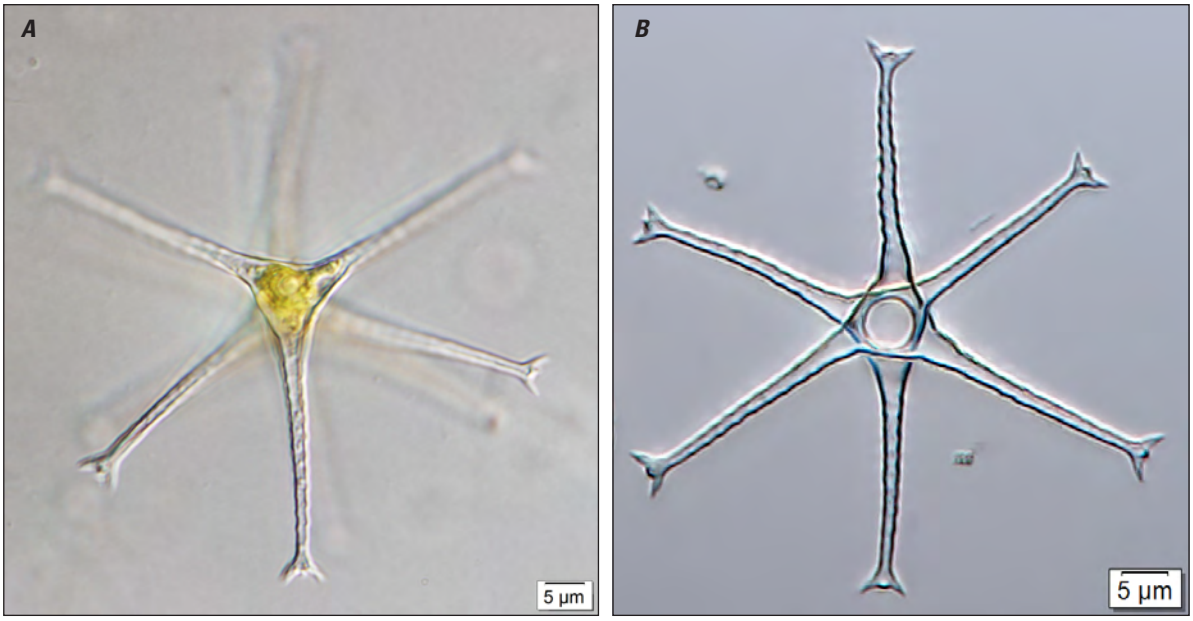


Figure 227. *Staurastrum* sp.

Staurodesmus Teiling

Cells are usually deeply constricted and vary in shape. Each angle of the semicell has a single spine, the key characteristic separating this genus from *Staurastrum*. The surface of the cell wall can have fine pores or granules. The chloroplast is axial and extends to each angle of the cell.

Twelve *Staurodesmus* taxa were identified in samples from the refuge (figs. 228–239). Only one, *Staurodesmus convergens* var. *laportei*, was found at the west perimeter site.

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus convergens* Ehrenberg ex Ralfs

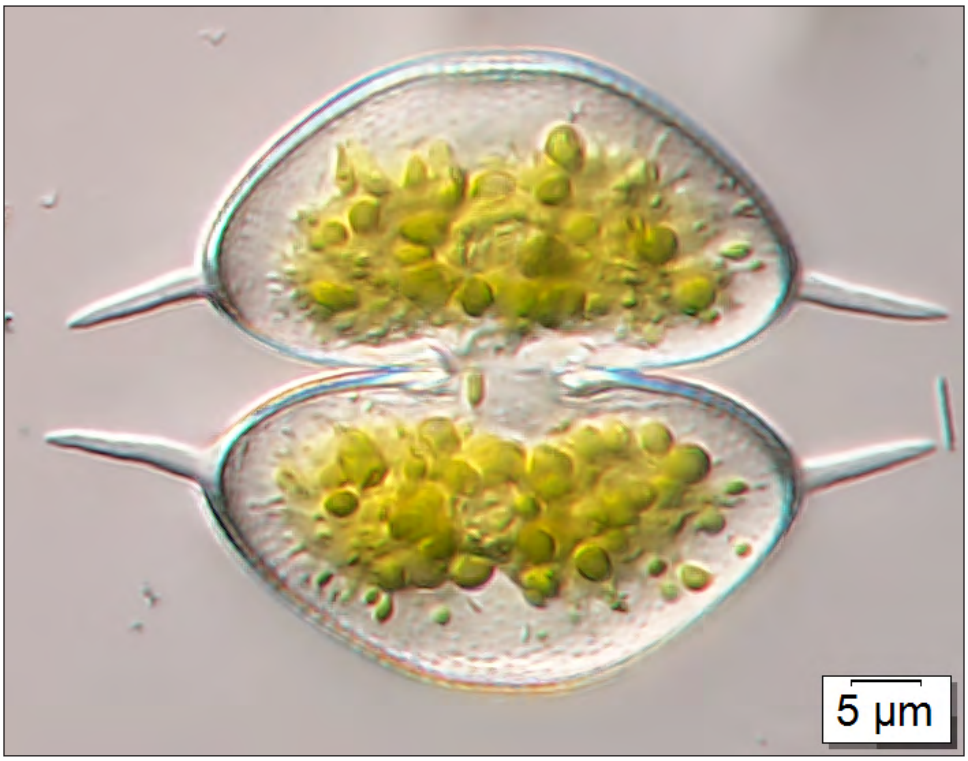


Figure 228. *Staurodesmus convergens.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus cuspidatus* (Brébisson) Teiling

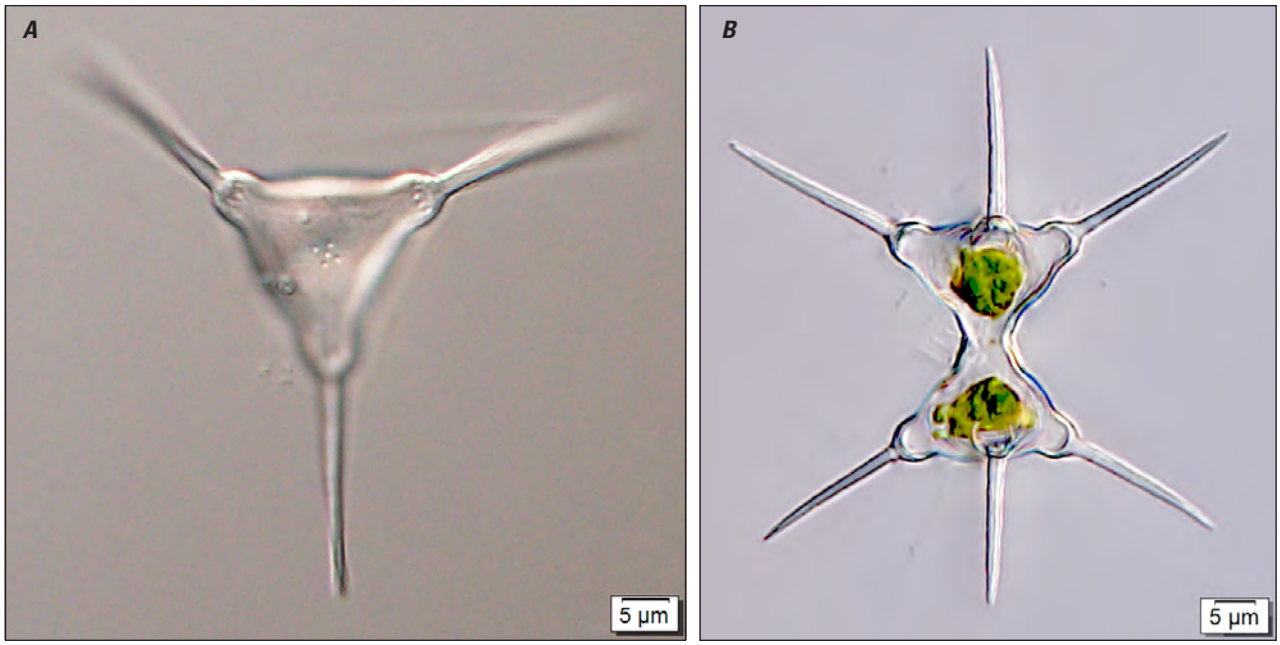


Figure 229. *Staurodesmus cuspidatus.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus cuspidatus* var. *curvatus* (West) Teiling

Figure 230. *Staurodesmus cuspidatus* var. *curvatus*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus dejectus* (Brébisson) Teiling

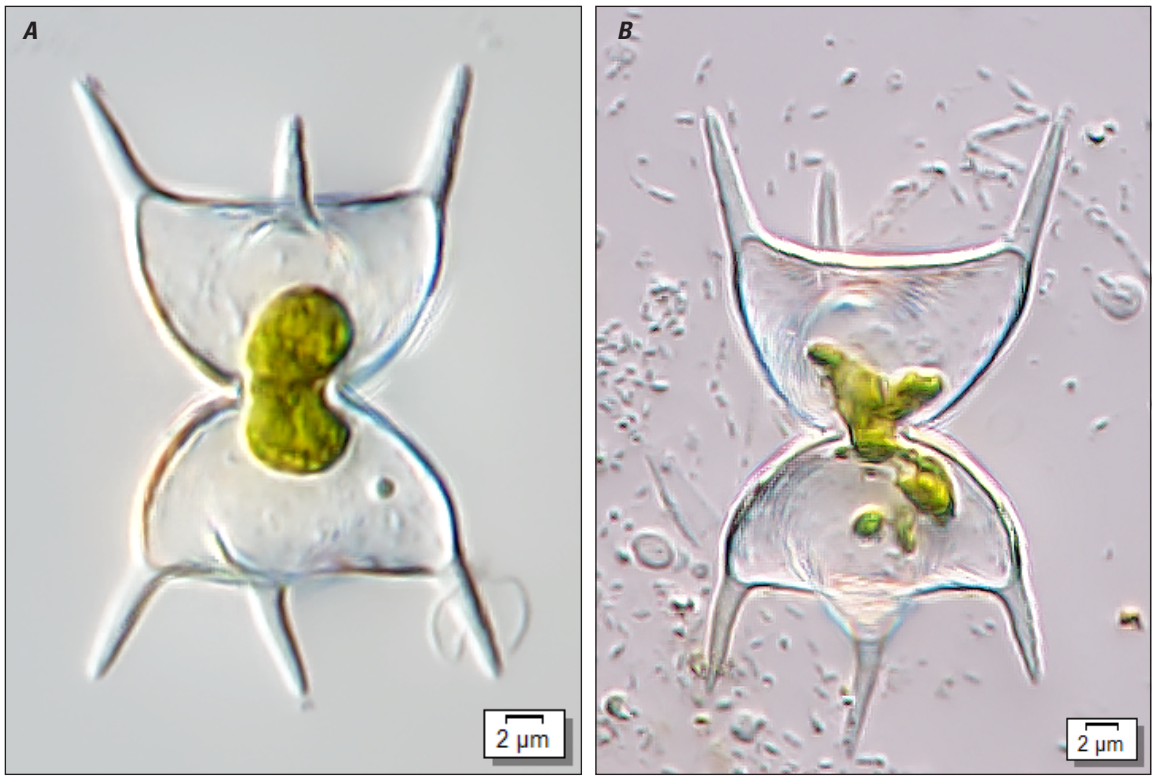


Figure 231. *Staurodesmus dejectus*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus dickiei* (Ralfs) S. Lillieroth

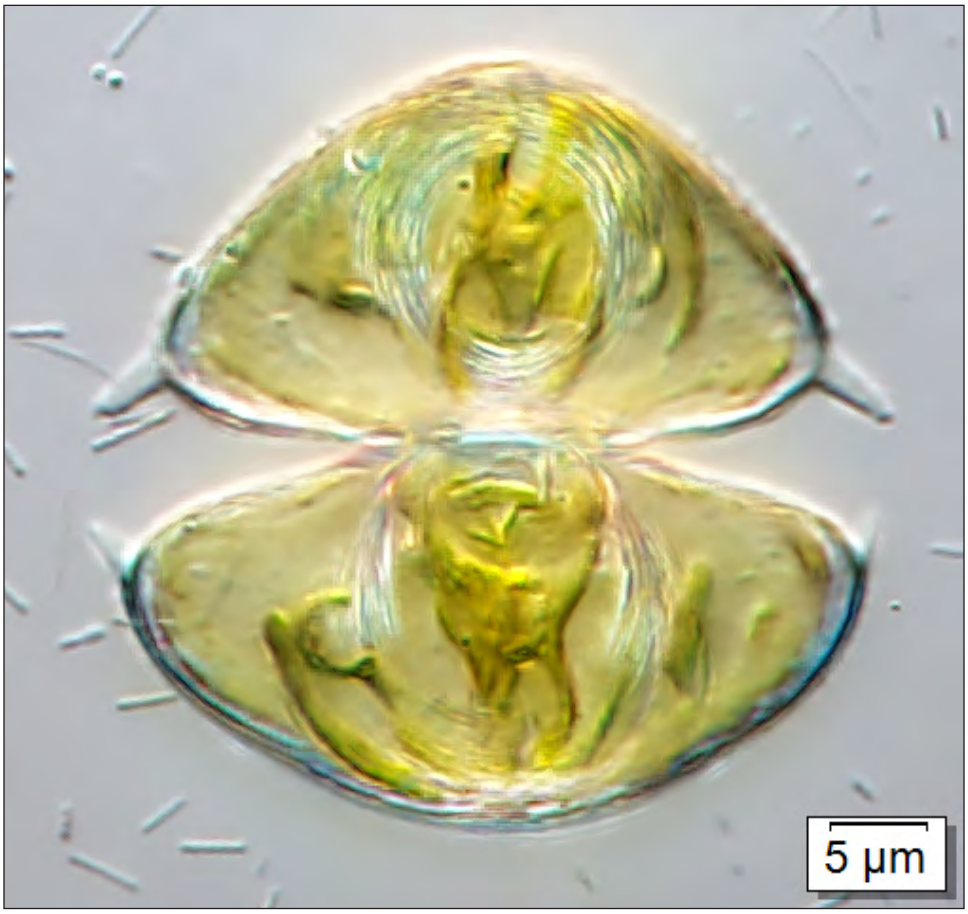


Figure 232. *Staurodesmus dickiei.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus glaber* (Ralfs) Teiling

Figure 233. *Staurodesmus glaber.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus maximus* (Borge) Teiling

Figure 234. *Staurodesmus maximus.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus octocornis* (Ehrenberg ex Ralfs) Stastny, Skaloud & Neustupa

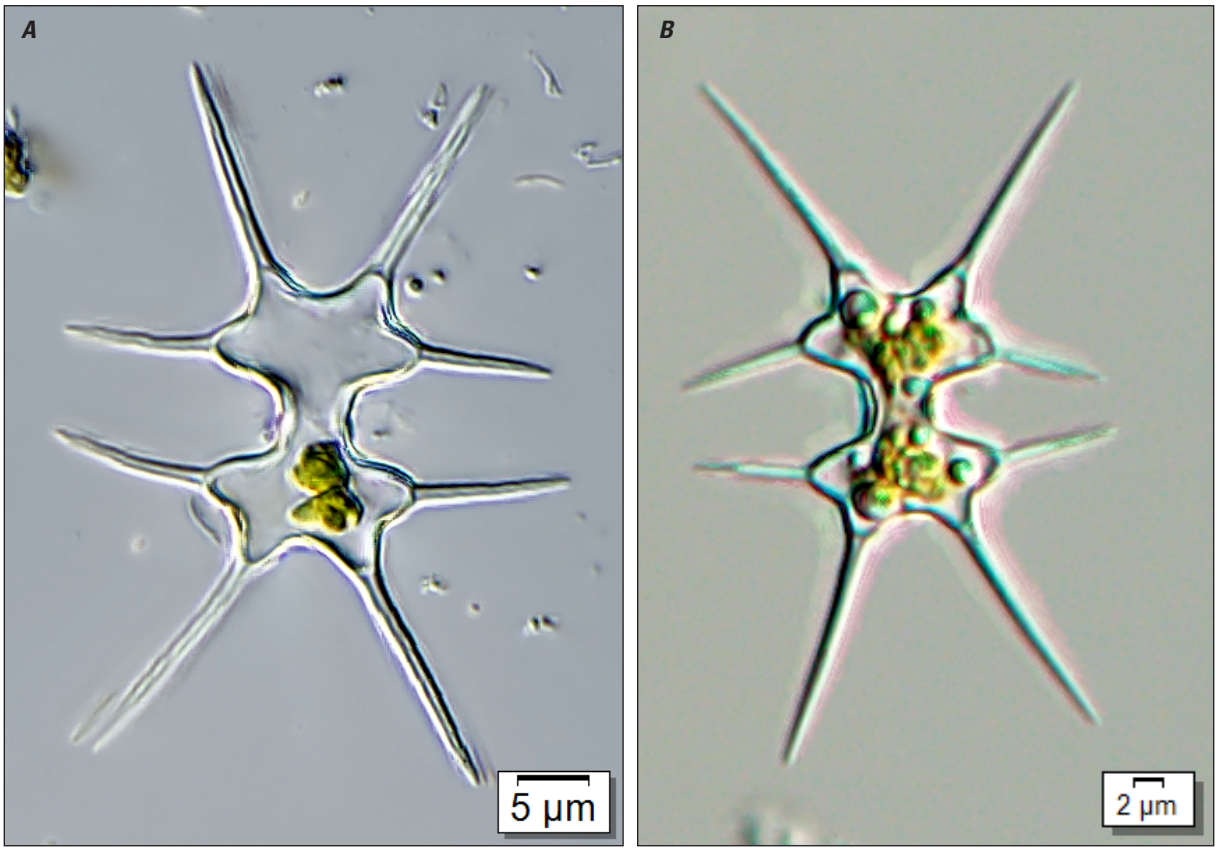


Figure 235. *Staurodesmus octocornis.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus* cf. *omearae* (W. Archer) Teiling

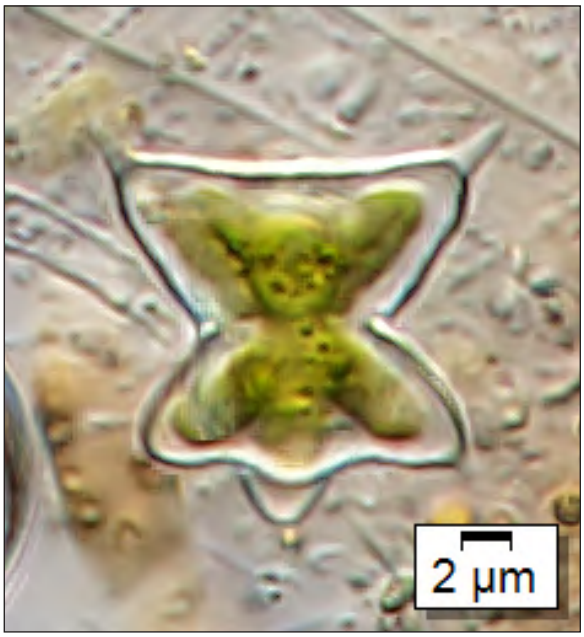


Figure 236. *Staurodesmus* cf. *o'mearii*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus pachyrhynchus* (Nordstedt) Teiling

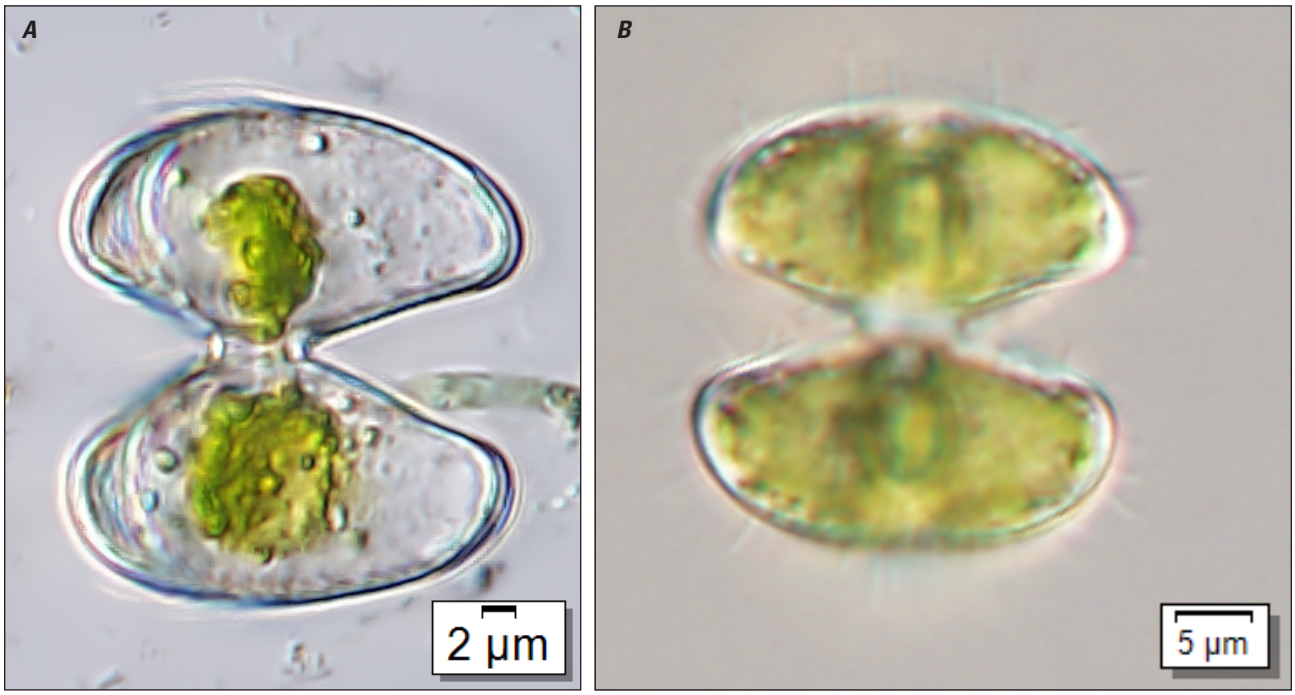


Figure 237. *Staurodesmus pachyrhynchus*.

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus pachyrhynchus* var. *pseudopachyrhnchum* (Wolle) Teiling

Figure 238. *Staurodesmus pachyrhynchus* var. *pseudopachyrhnchum.*

Order Desmidiales

Family Desmidiaceae

Genus *Staurodesmus*

Species *Staurodesmus subulatus* (Kützing) Croasdale

Figure 239. *Staurodesmus subulatus.*

Teilingia Bourrelly

Cells of this genus form filaments. They are distinguished from *Spondylosium* cells by small granules at the apex of the cell and may not appear attached along the entire apex where two cells met (fig. 240). The cells are typically small with axial chloroplasts.

Two taxa, *Teilingia granulata* and *Teilingia quadrispinata* f. *evoluta*, were identified in samples from the refuge (figs. 241–242). Both taxa were only found at the east interior, west interior, and east transition sites.

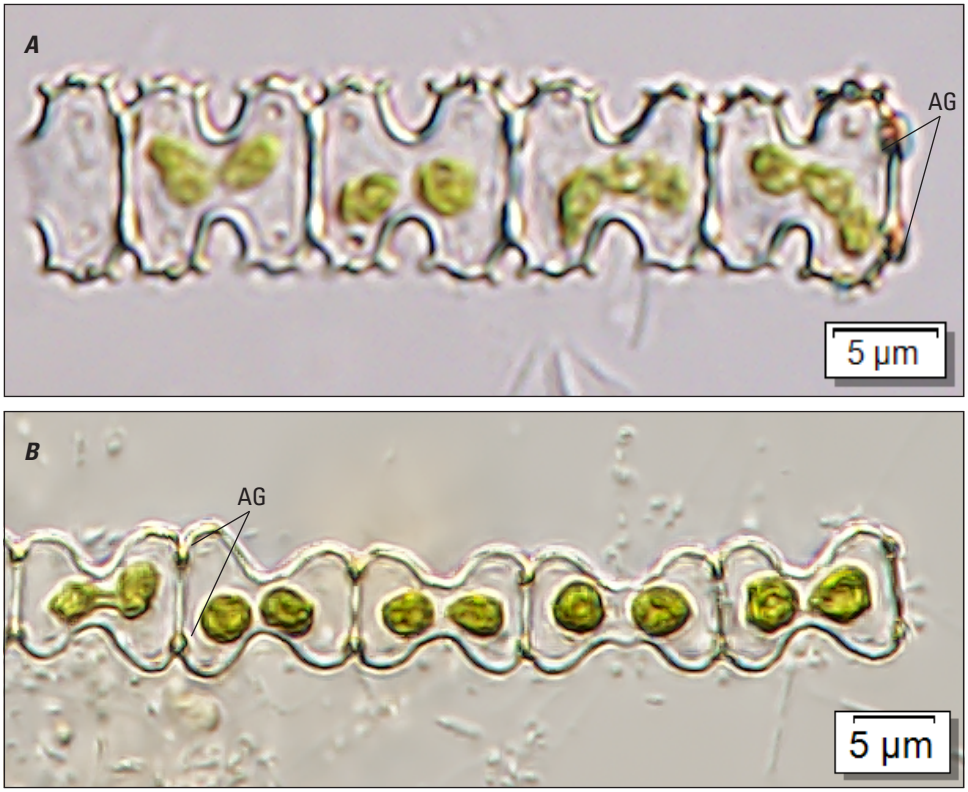


Figure 240. *A, Teilingia quadrispinata* f. *evoluta* and *B, Teilingia granulata* both have apical granules (AG) which can be seen in both images.

Order Desmidiales

Family Desmidiaceae

Genus *Teilingia*

Species *Teilingia granulata* (J. Roy & Bisset) Bourrelly

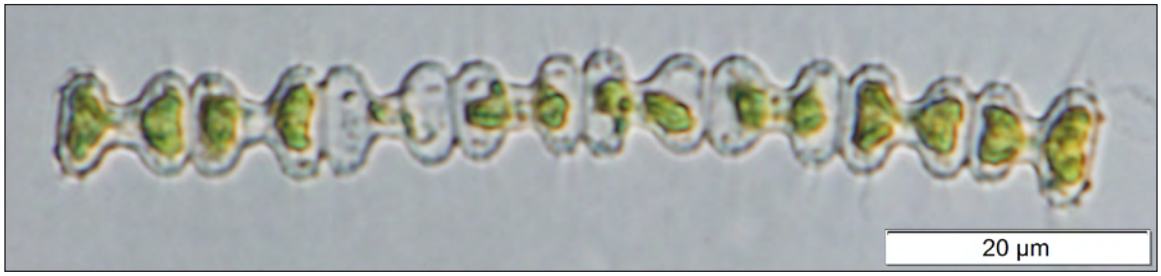


Figure 241. *Teilingia granulata.*

Order Desmidiales

Family Desmidiaceae

Genus *Teilingia*

Species *Teilingia quadrispinata* f. *evoluta* (Scott & Grönblad) Croasdale

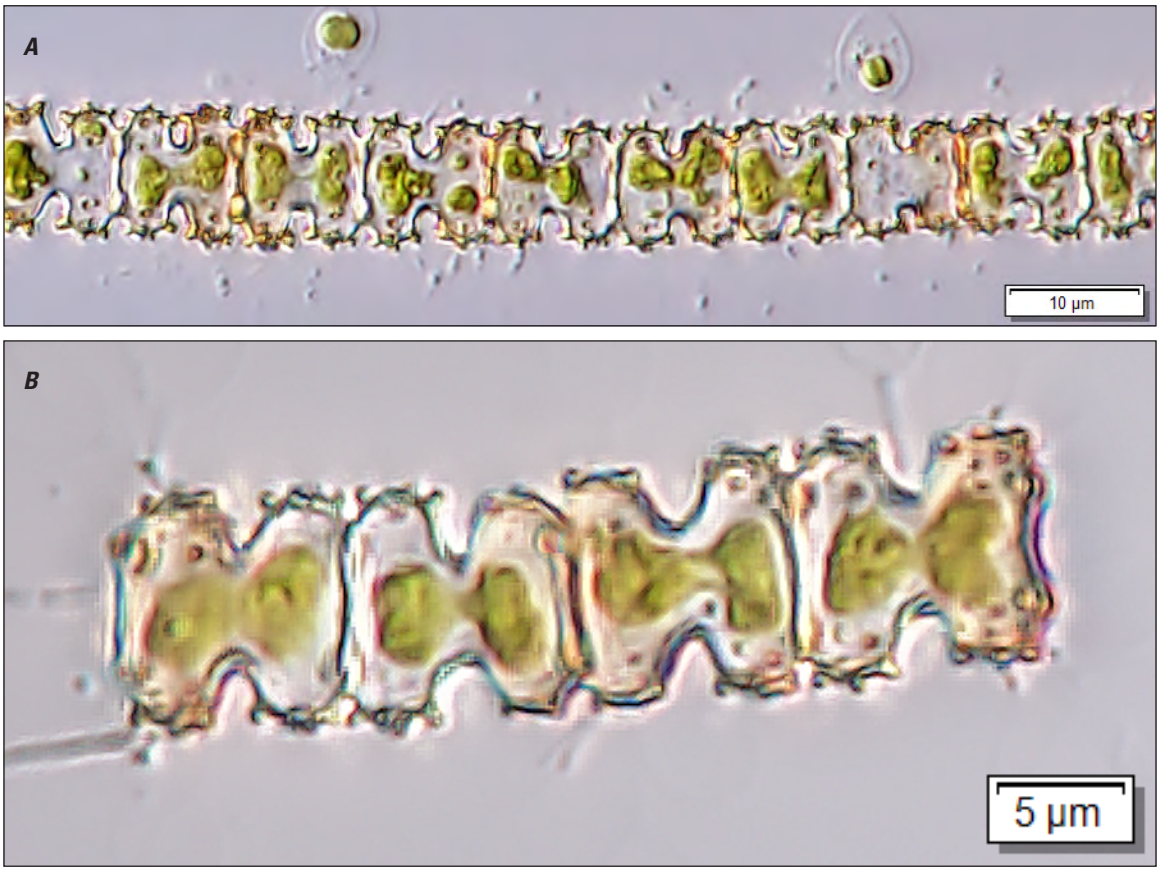


Figure 242. *Teilingia quadrispinata* f. *evoluta*.

Tetmemorus Ralfs ex Ralfs

Cells are cylindrical with an apical incision. Pores are often visible on the cell's surface (fig. 243) and can be evenly distributed or arranged in lines across the cell.

Two species of this genus, *Tetmemorus brebissonii* and *Tetmemorus granulatus*, were identified in samples from the refuge (figs. 244–245). Both species were only found at the east and west interior sites.

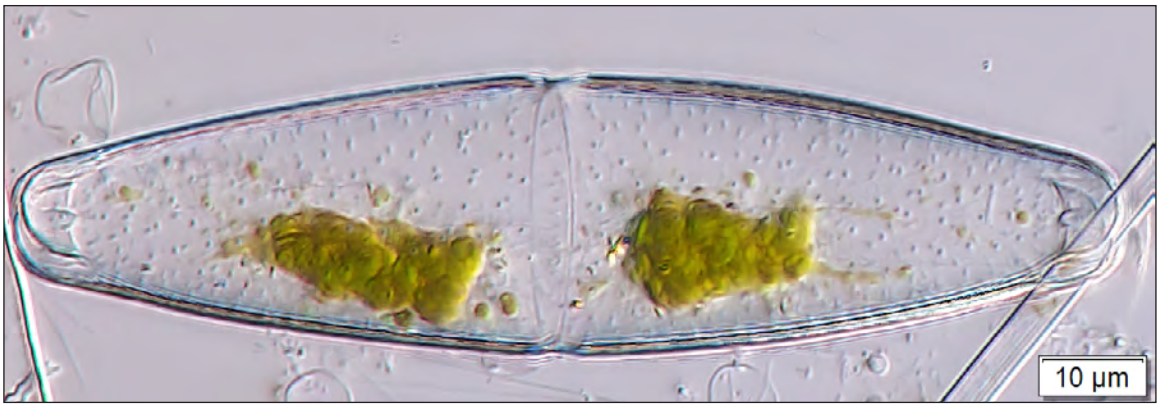


Figure 243. *Tetmemorus granulatus* has a deeply incised apex and a cell wall covered with fine pores.

Order Desmidiales

Family Desmidiaceae

Genus *Tetmemorus*

Species *Tetmemorus brebissonii* (Menegh.) Ralfs

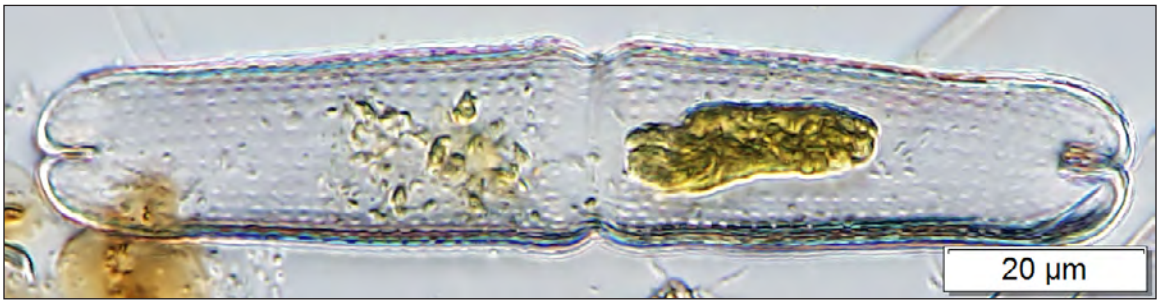


Figure 244. *Tetmemorus brebbisonii.*

Order Desmidiales

Family Desmidiaceae

Genus *Tetmemorus*

Species *Tetmemorus granulatus* Brébisson ex Ralfs

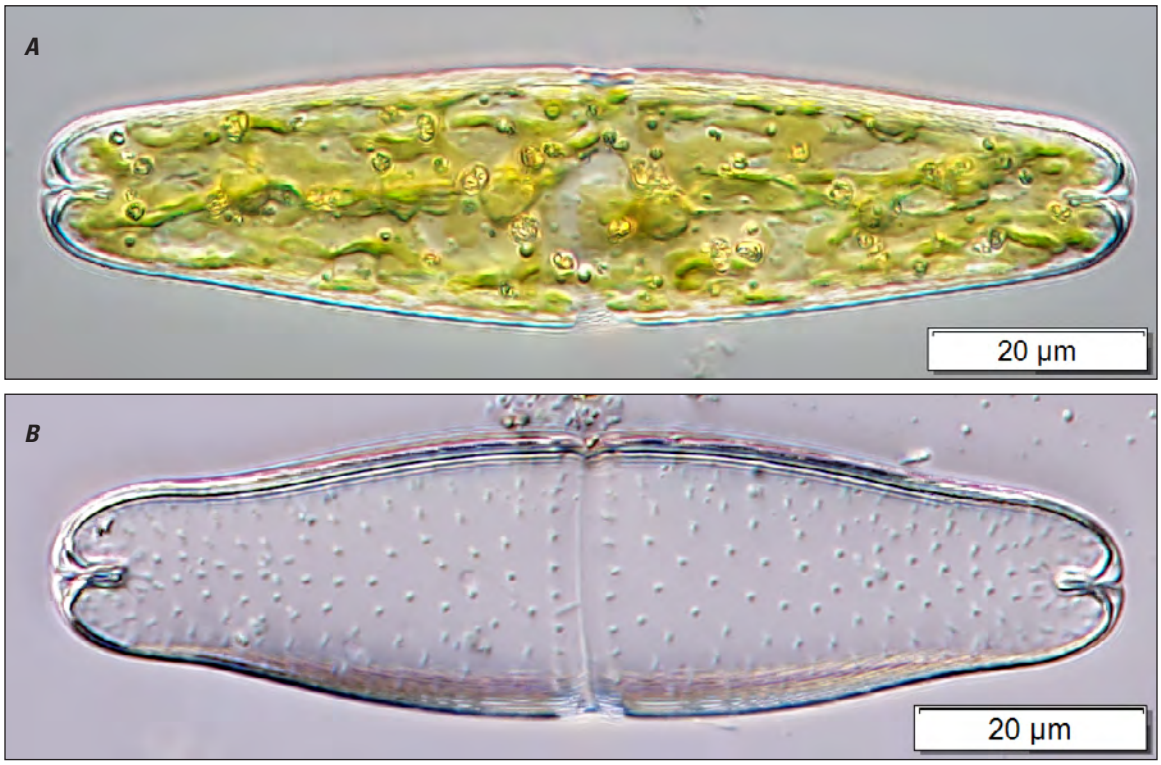


Figure 245. *Tetmemorus granulatus*.

Triploceras (Bailey ex Ralfs) Bailey

Cells are solitary, with two polar lobes tipped with spines at the apex. The cells have very little incision in the midregion and are slightly tapered. The cell has whorls of processes that are tipped with spines or teeth.

Two species and three taxa of this genus were identified in samples from the refuge (figs. 246–248). This genus was found at all sites except the west perimeter site.

Order Desmidiales

Family Desmidiaceae

Genus *Triploceras*

Species *Triploceras gracile* Bailey

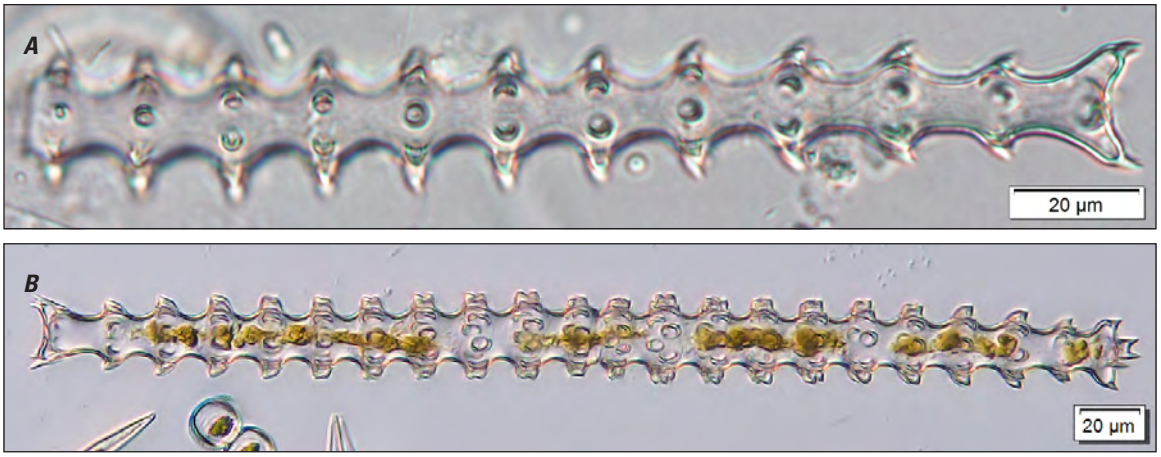


Figure 246. *Triploceras gracile*.

Order Desmidiales

Family Desmidiaceae

Genus *Triploceras*

Species *Triploceras gracile* var. *bispinatum* Taylor

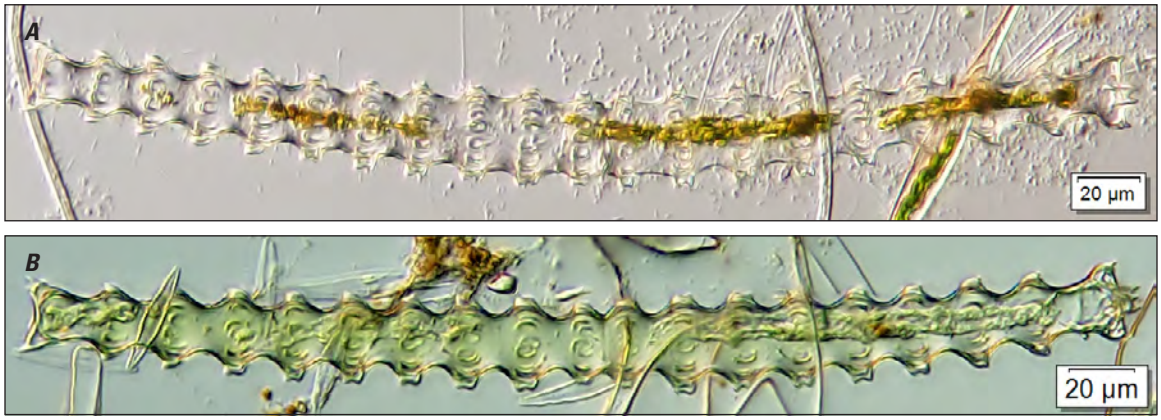


Figure 247. *Triploceras gracile* var. *bispinatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Triploceras*

Species *Triploceras verticillatum* (Bailey) Bailey

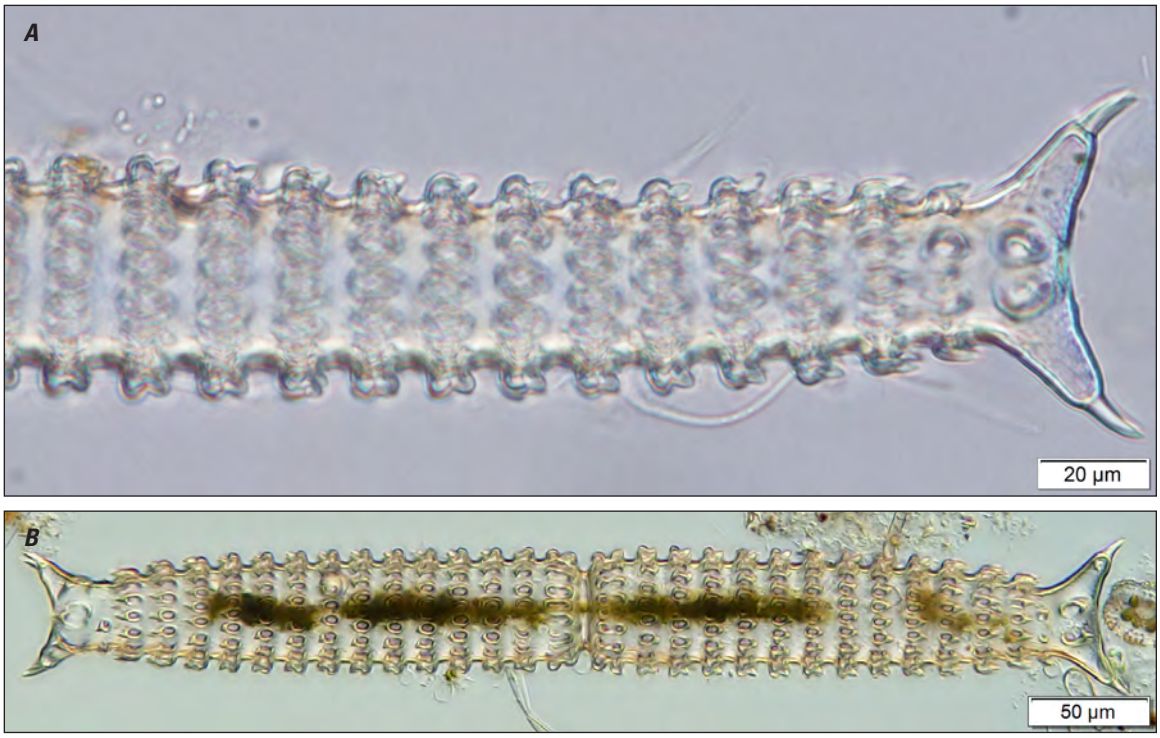


Figure 248. *Triploceras verticillatum.*

Xanthidium Ehrenberg ex Ralfs

Cells are solitary and deeply constricted. Each angle of the cell has two spines (fig. 249). The cell wall is often thickened in the midregion and can sometimes be ornamented with granules, spines, or verrucae in this region.

Eight taxa from this genus were identified, as well as one that could only be identified to the genus (figs. 250–257). In the refuge, these cells were commonly found at the east and west interior sites and very rarely found at the west perimeter site.

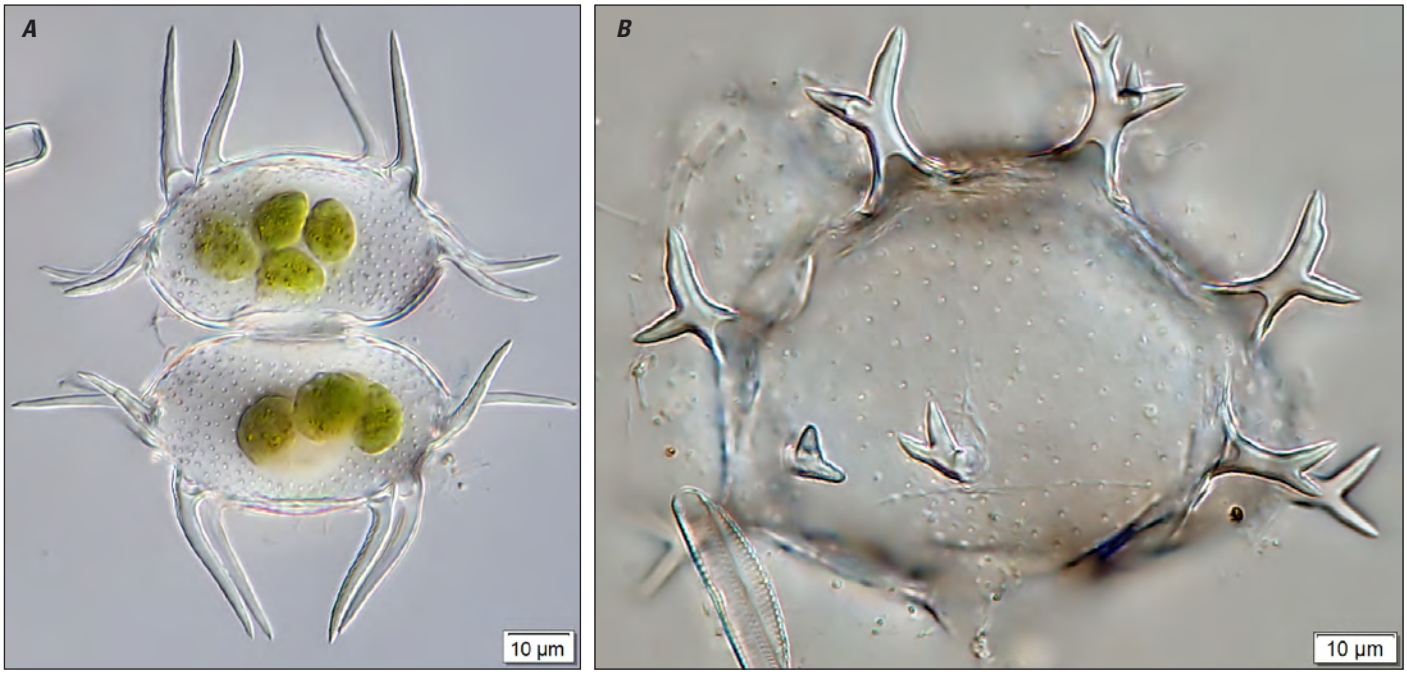


Figure 249. *A*, *Xanthidium antilopaeum* var. *incrassatum* has a thickened midregion devoid of the fine pores that cover the rest of the cell wall. *Xanthidium antilopaeum* is an incredibly variable species, and three taxa of this species were found in the refuge. *B*, *Xanthidium armatum* cells can have a central area containing bifurcate teeth or spines.

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium antilopaeum* Kützing

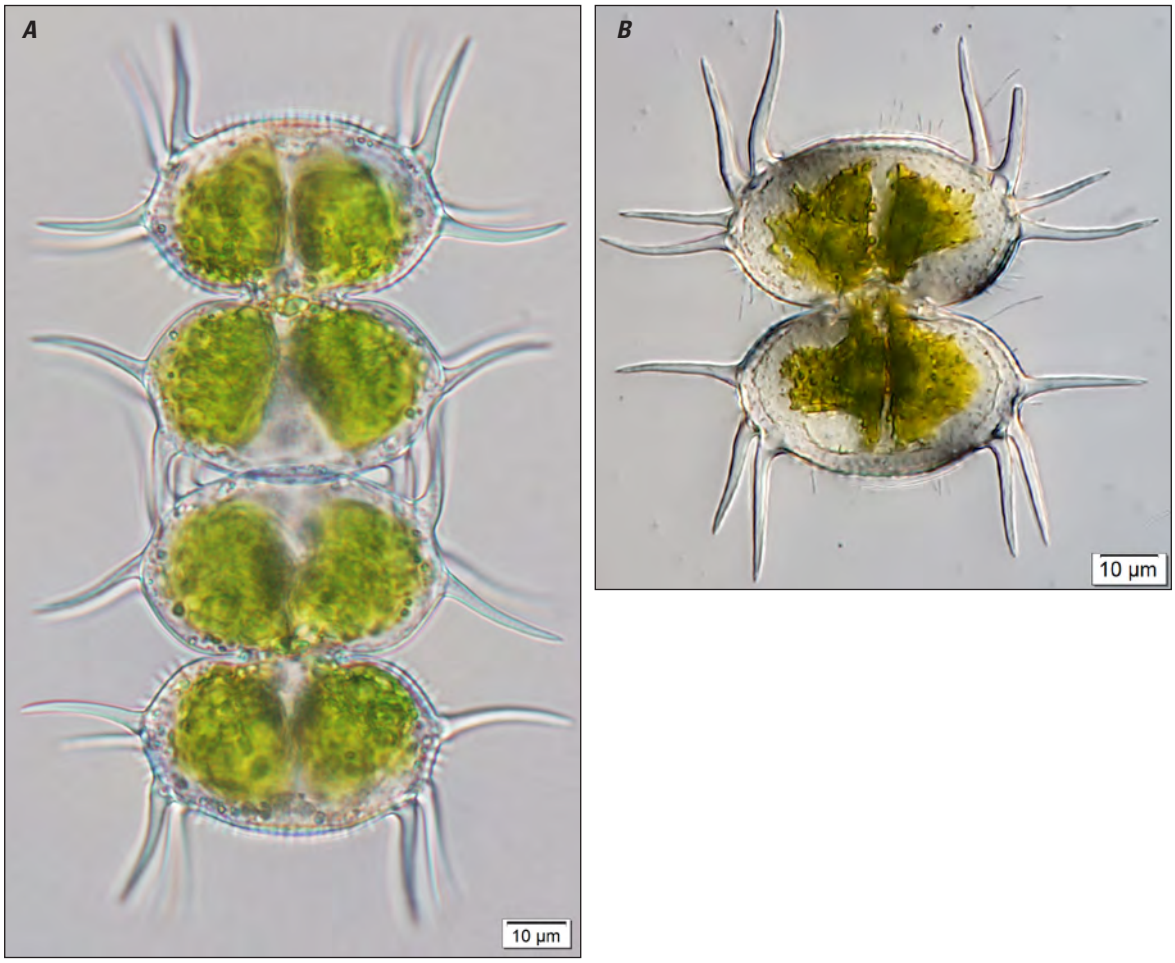


Figure 250. *Xanthidium antilopaeum.*

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium antilopaeum* var. *incrassatum* (Grönblad) Förster

Figure 251. *Xanthidium antilopaeum* var. *incrassatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium antilopaeum* var. *polymazum* Nordstedt

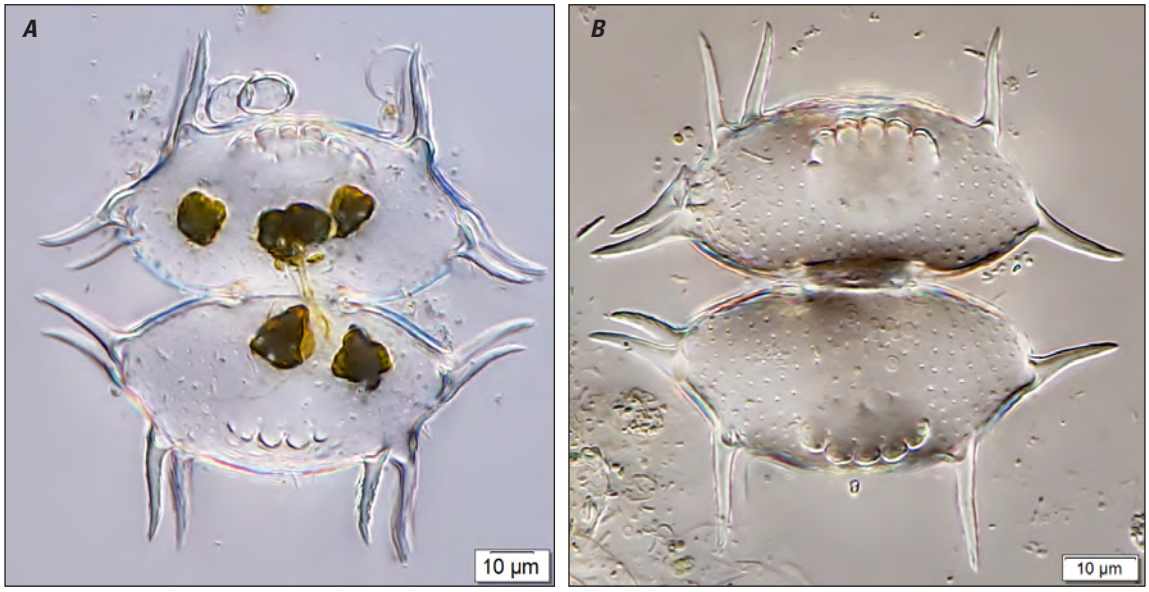


Figure 252. *Xanthidium antilopaeum* var. *polymazum*.

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium armatum* Brébisson ex Ralfs

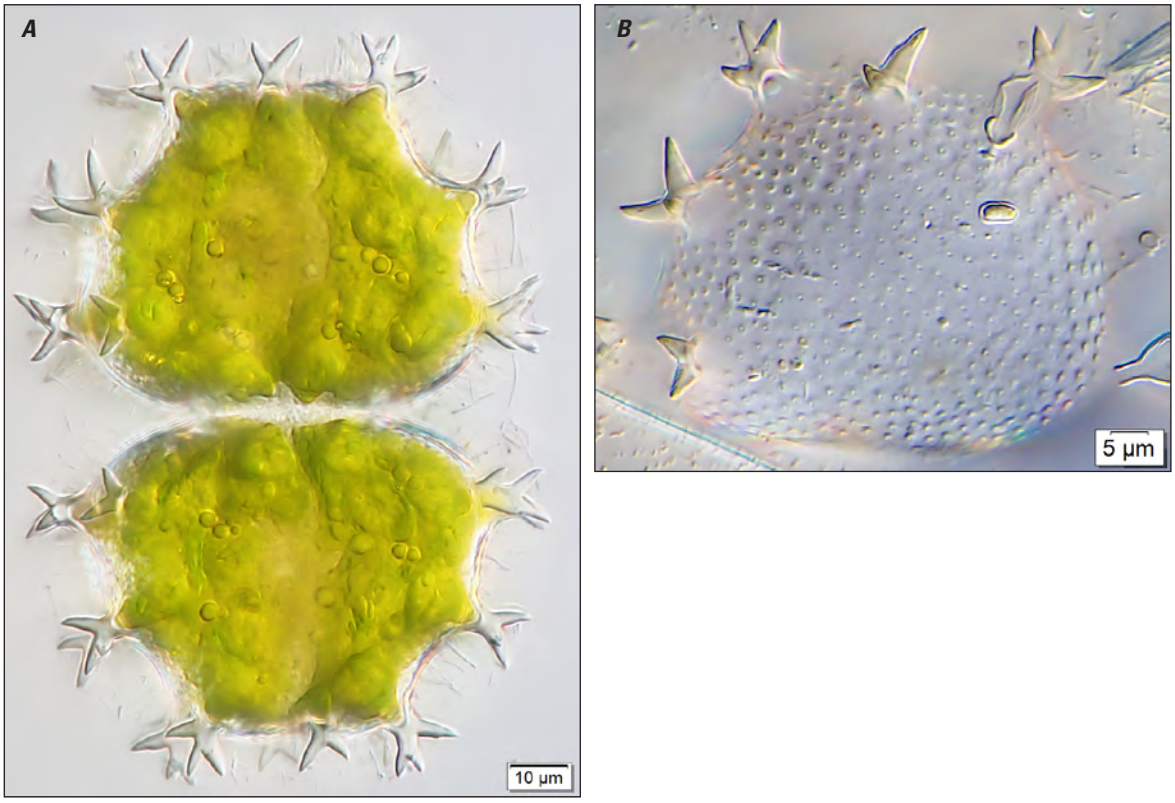


Figure 253. *Xanthidium armatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium concinnum* Archer

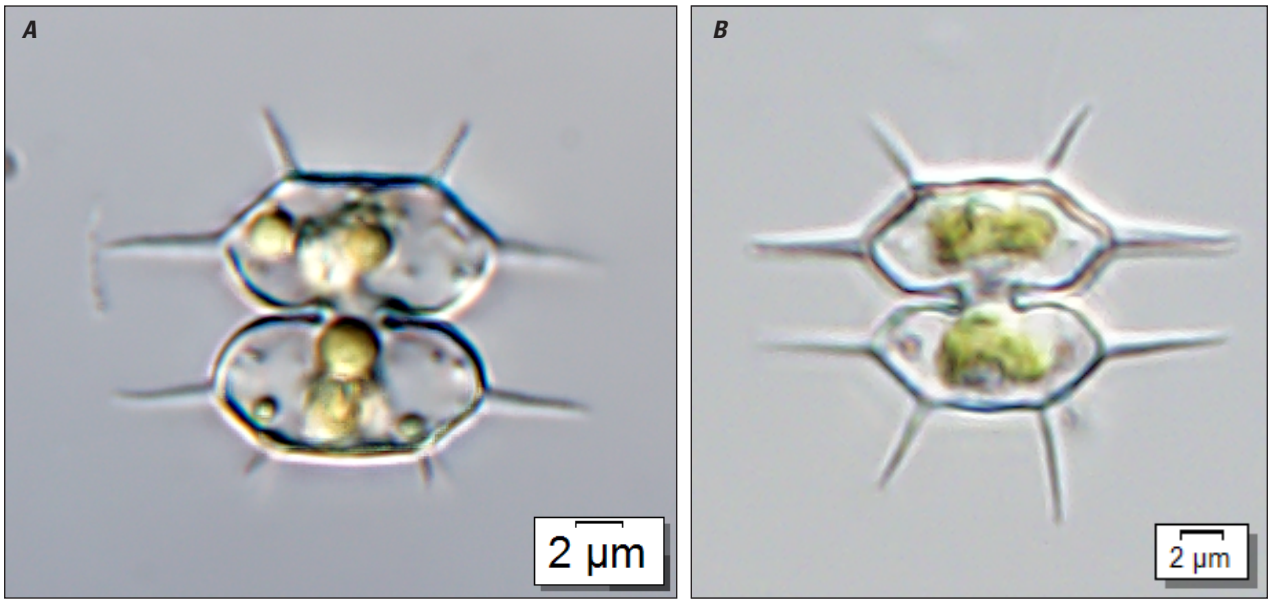


Figure 254. *Xanthidium concinnum.*

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium cristatum* var. *scrobiculatum* A.M. Scott & Grönblad

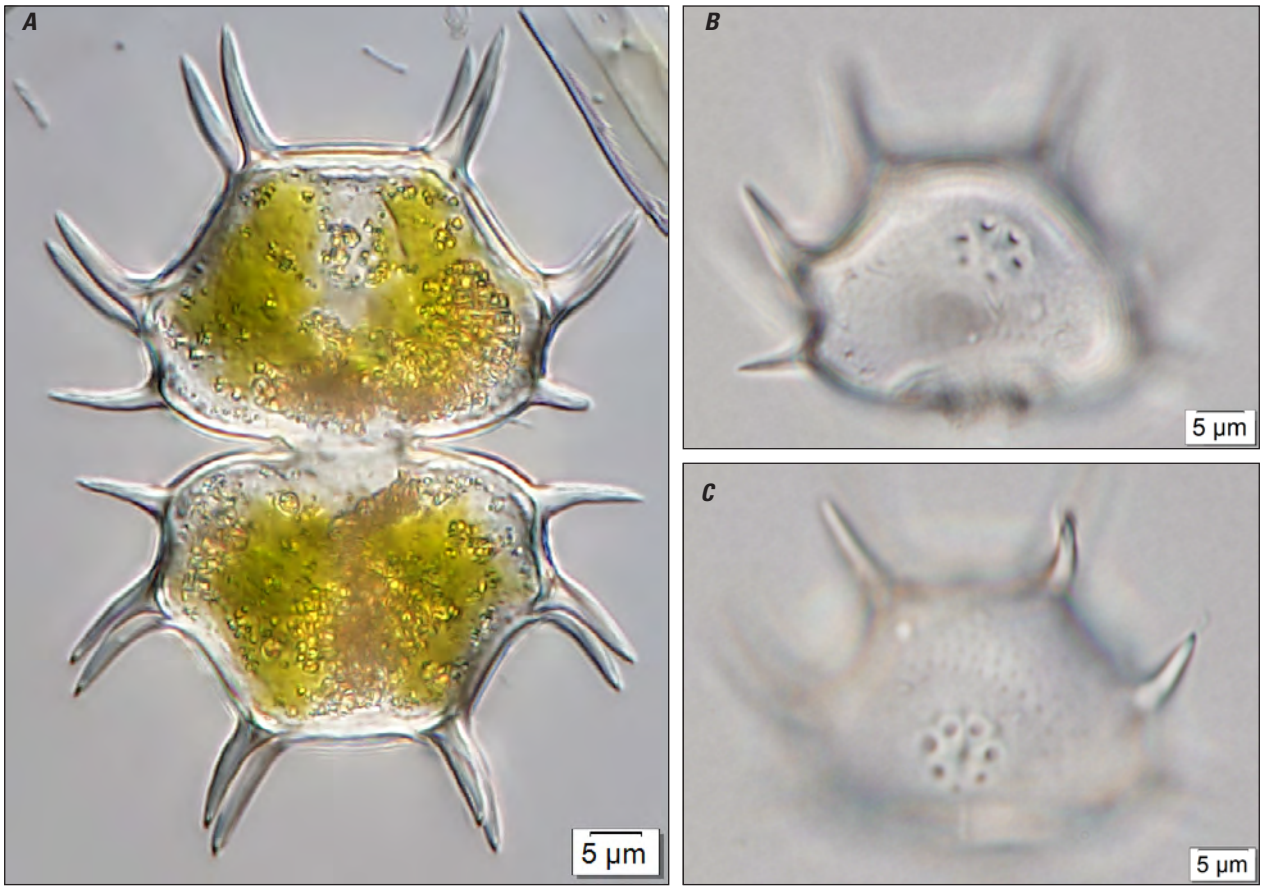


Figure 255. *Xanthidium cristatum* var. *scrobiculatum*.

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium smithii* W. Archer

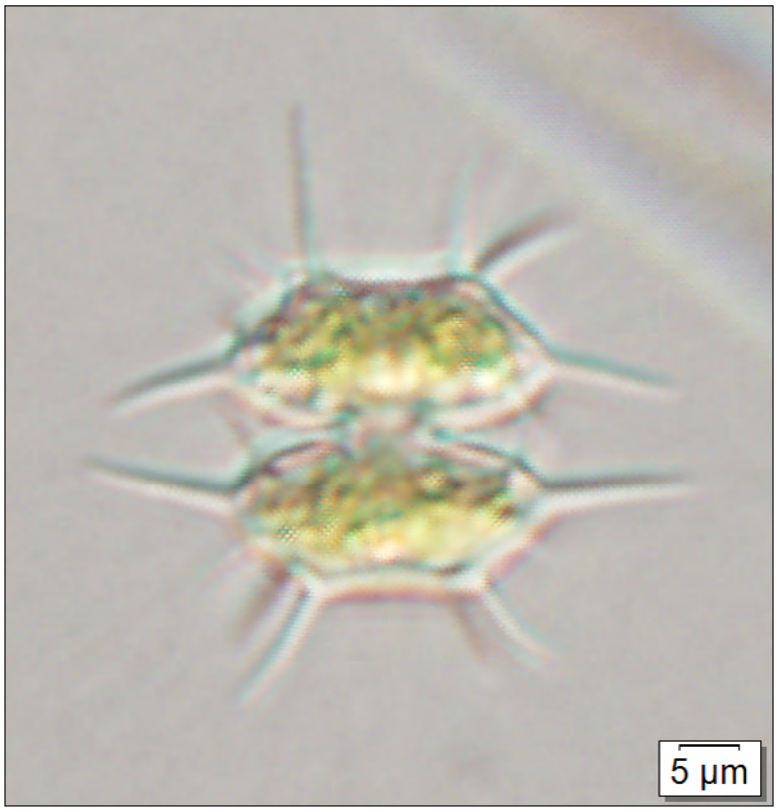


Figure 256. *Xanthidium smithii.*

Order Desmidiales

Family Desmidiaceae

Genus *Xanthidium*

Species *Xanthidium wewahitchkense* Scott & Grönblad

Figure 257. *Xanthidium wewahitchkense*.

Gonatozygon De Bary

Cells can be solitary or in filaments (fig. 258). The cell is always cylindric, though the apices may vary in shape. The cell wall can be smooth or covered with granules or spines. One chloroplast is in each semicell, and it can vary in shape among species.

Three species of *Gonatozygon* were identified in samples from the refuge (figs. 259–261). Of these, *Gonatozygon monotaenium* was common and tended to form filaments of two or more cells. *Gonatozygon brebissonii* was only found as solitary cells and only at the east interior and east transition sites. *Gonatozygon aculeatum* was very rare and only found at the east interior site.

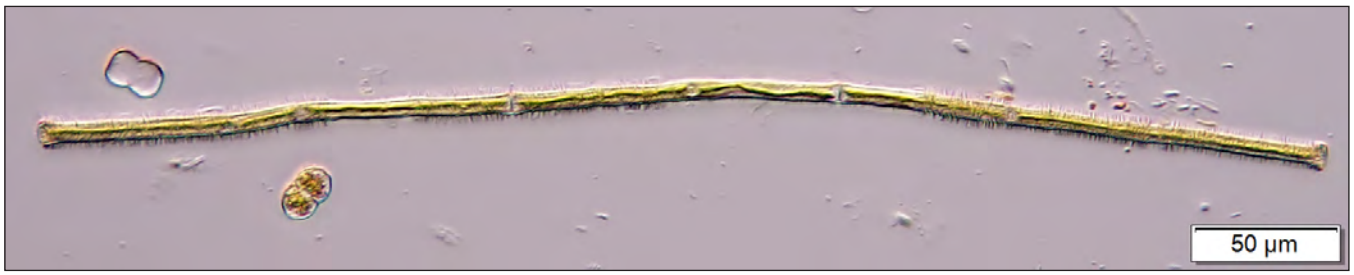


Figure 258. This *Gonatozygon monotaenium* filament is made up of three cells, connected at the apices.

Order Desmidiales

Family Desmidiaceae

Genus *Gonatozygon*

Species *Gonatozygon aculeatum* W.N. Hastings

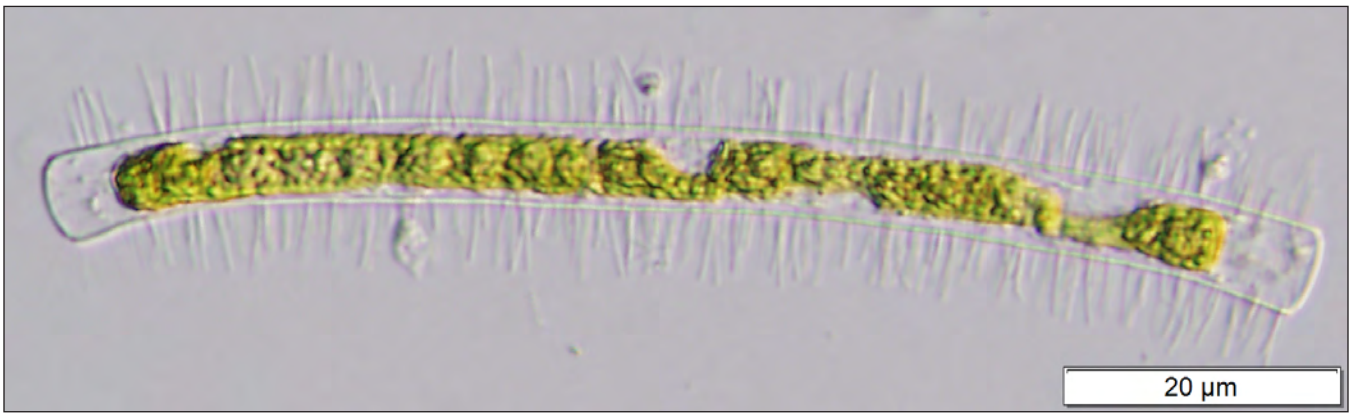


Figure 259. *Gonatozygon aculeatum.*

Order Desmidiales

Family Desmidiaceae

Genus *Gonatozygon*

Species *Gonatozygon brebissonii* De Bary

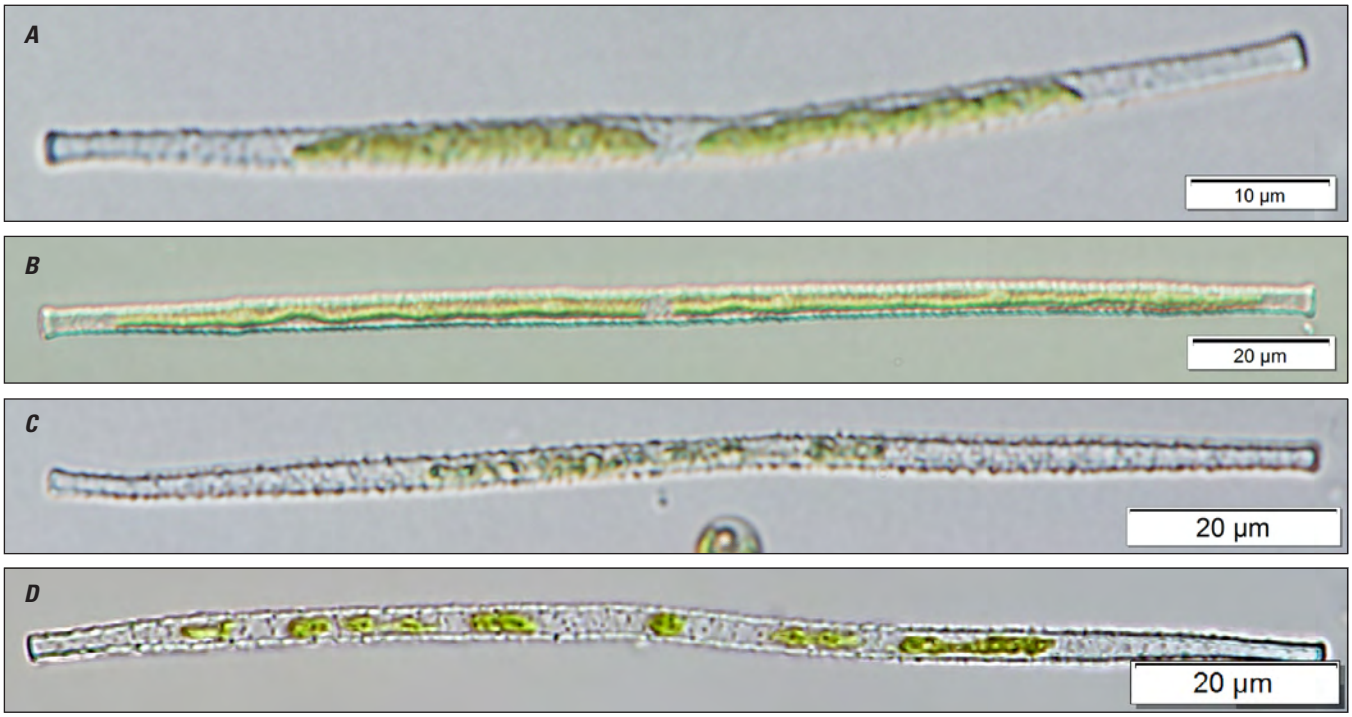


Figure 260. *Gonatozygon brebissonii.*

Order Desmidiales

Family Desmidiaceae

Genus *Gonatozygon*

Species *Gonatozygon monotaenium* De Bary

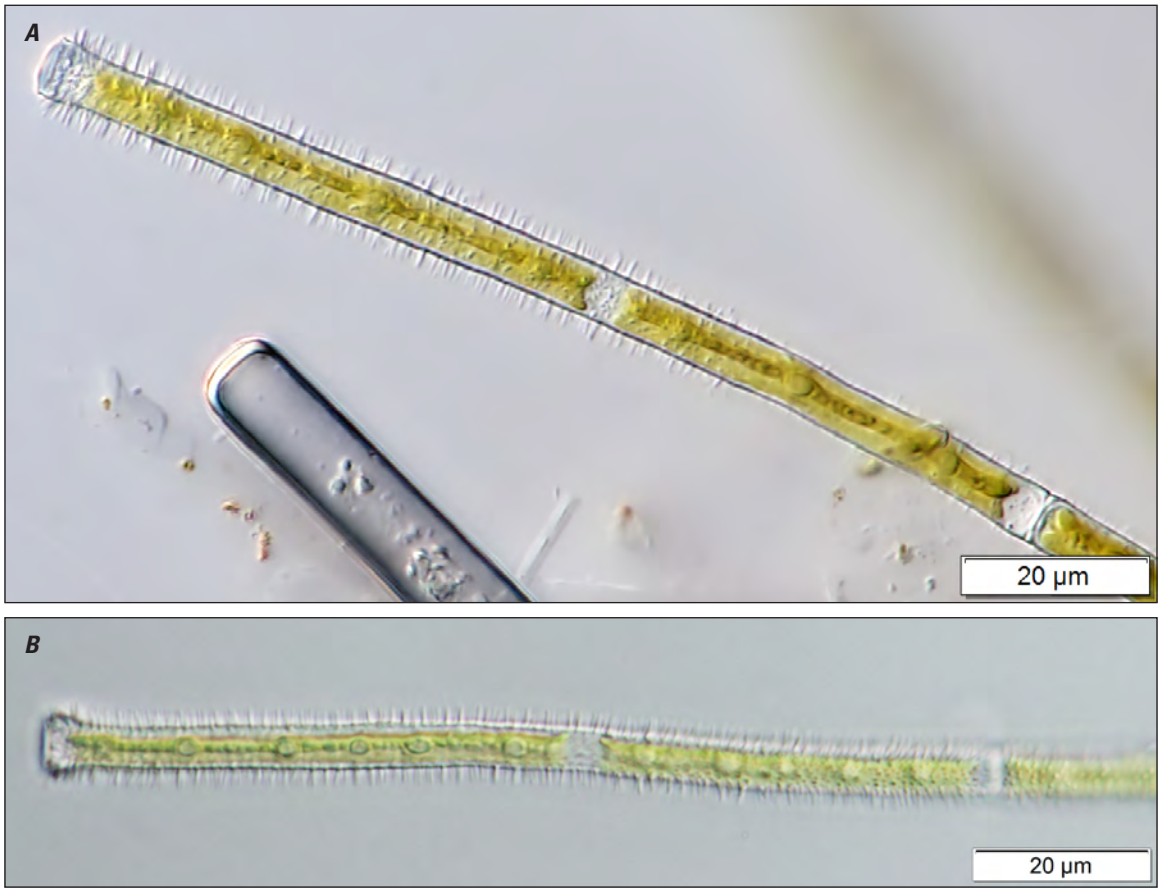


Figure 261. *Gonatozygon monotaenium.*

Penium Brébisson ex Ralfs

Cells are solitary and cylindrical. The cells have no distinct isthmus (fig. 262*A*) and can have girdle bands (fig. 262*B*). The cell is often ornamented and can appear brown from iron deposits. One chloroplast is in each semicell, and it is typically axial.

Three different species of *Penium* were identified in samples from the refuge (figs. 263–265). All the species were rare and typically found at the east interior site.

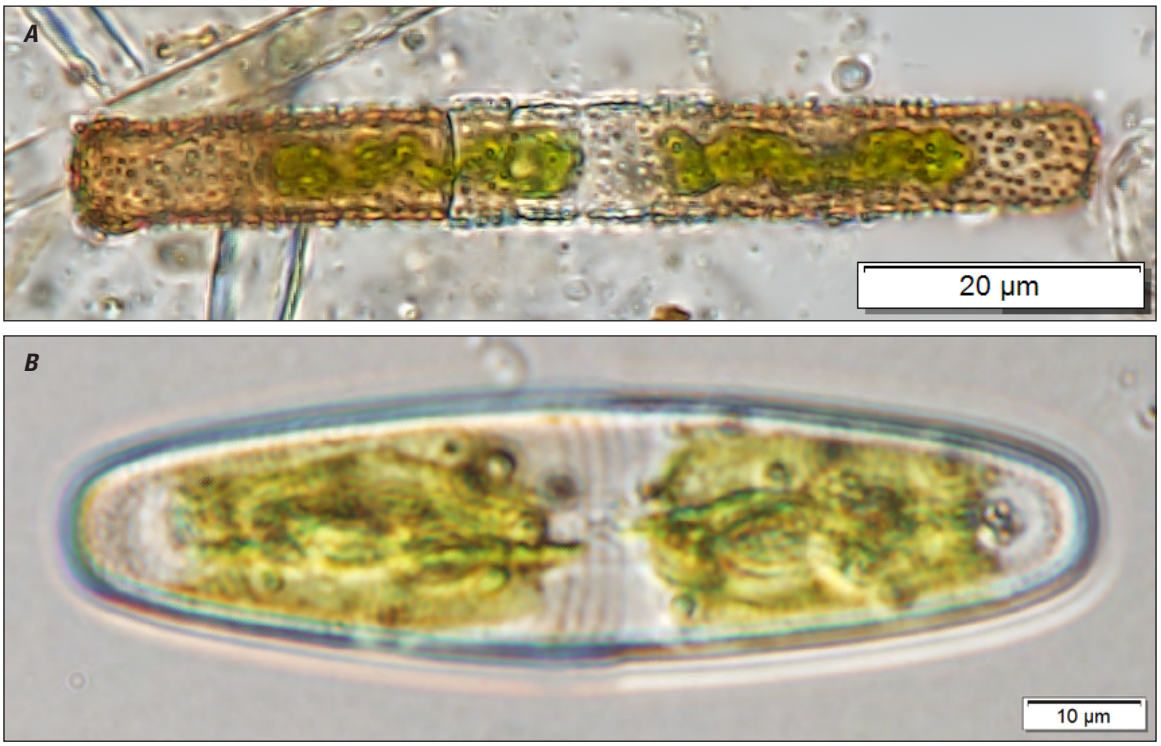


Figure 262. *A*, This *Penium exiguum* cell has iron deposits that make the cell wall appear brown. *B*, Girdle cells and a punctate cell wall are visible in this *Penium* cf. *didymocarpum* cell.

Order Desmidiales

Family Peniaceae

Genus *Penium*

Species *Penium* cf. *didymocarpum* Lundell

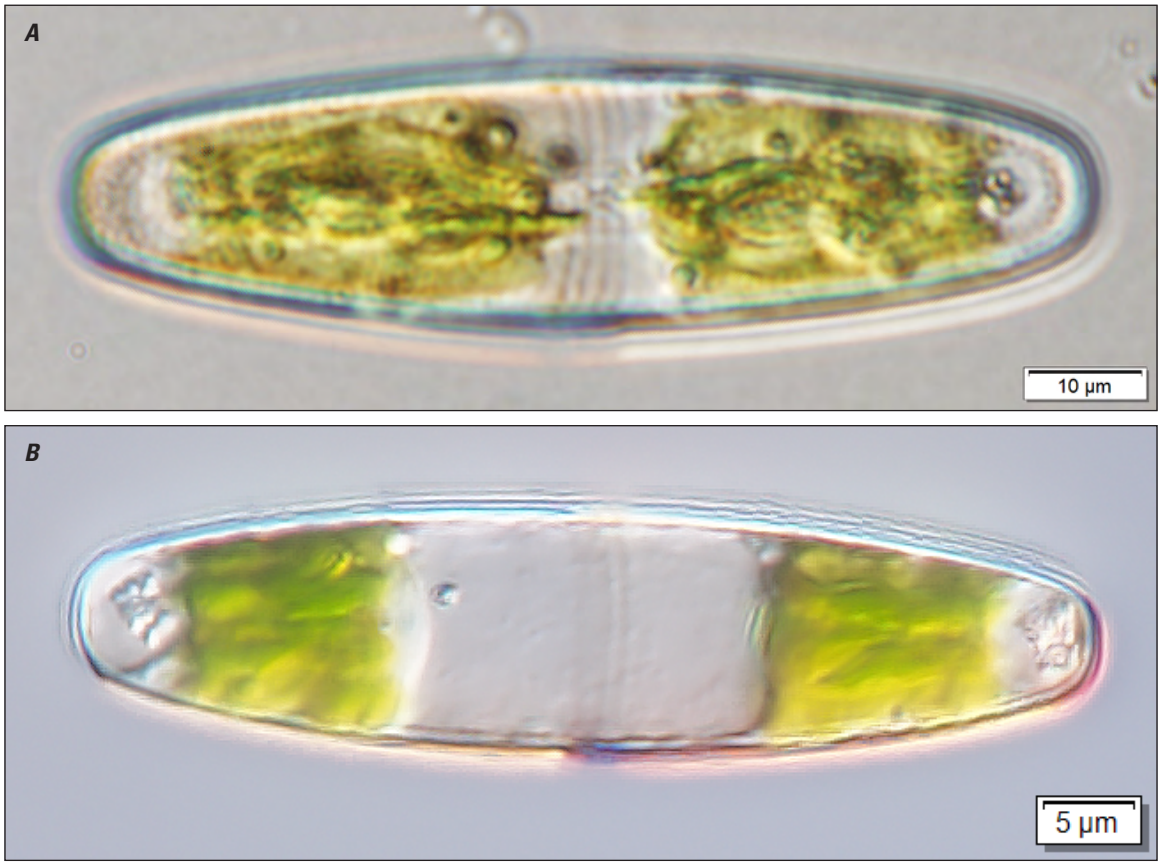


Figure 263. *Penium* cf. *didymocarpum*.

Order Desmidiales

Family Peniaceae

Genus *Penium*

Species *Penium exiguum* West

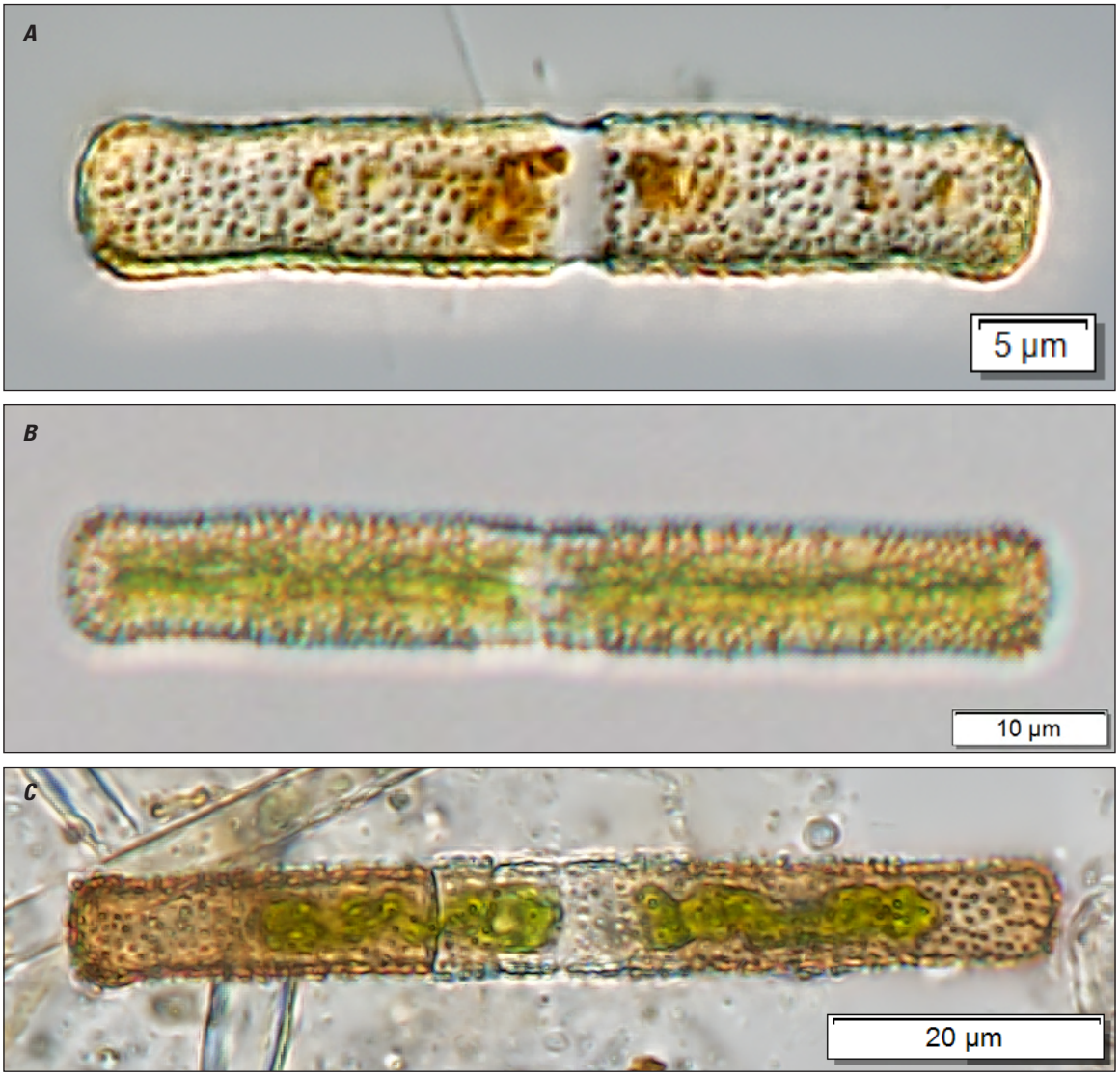


Figure 264. *Penium exiguum.*

Order Desmidiales

Family Peniaceae

Genus *Penium*

Species *Penium* cf. *margaritaceum* Brébisson

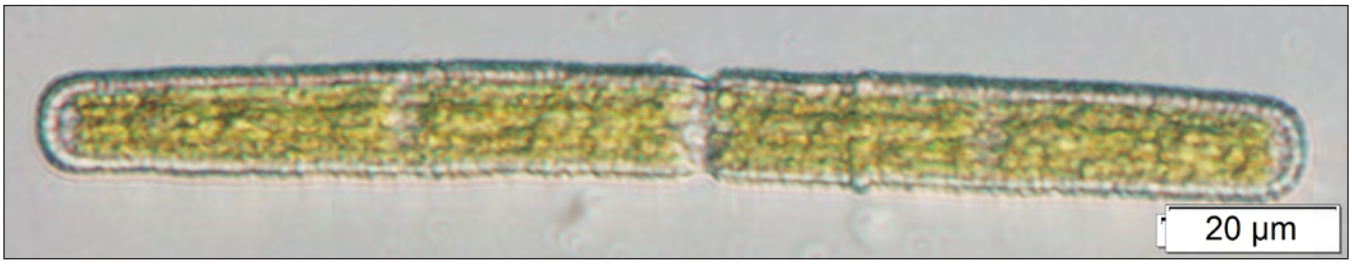


Figure 265. *Penium* cf. *margaritaceum*.

Cylindrocystis Meneghini ex De Bary

Cells are solitary and cylindric. The cell is not constricted, and the cell wall is smooth. Each cell has one to two stellate or asteroid chloroplasts (fig. 266). Reproductive characteristics are often required to identify species.

Based on the vegetative characteristics of the cells, three distinct *Cylindrocystis* taxa were identified in the samples (figs. 267–269). These cells were only found at the east interior, west interior, and east transition sites of the refuge and were not common at any of these sites.

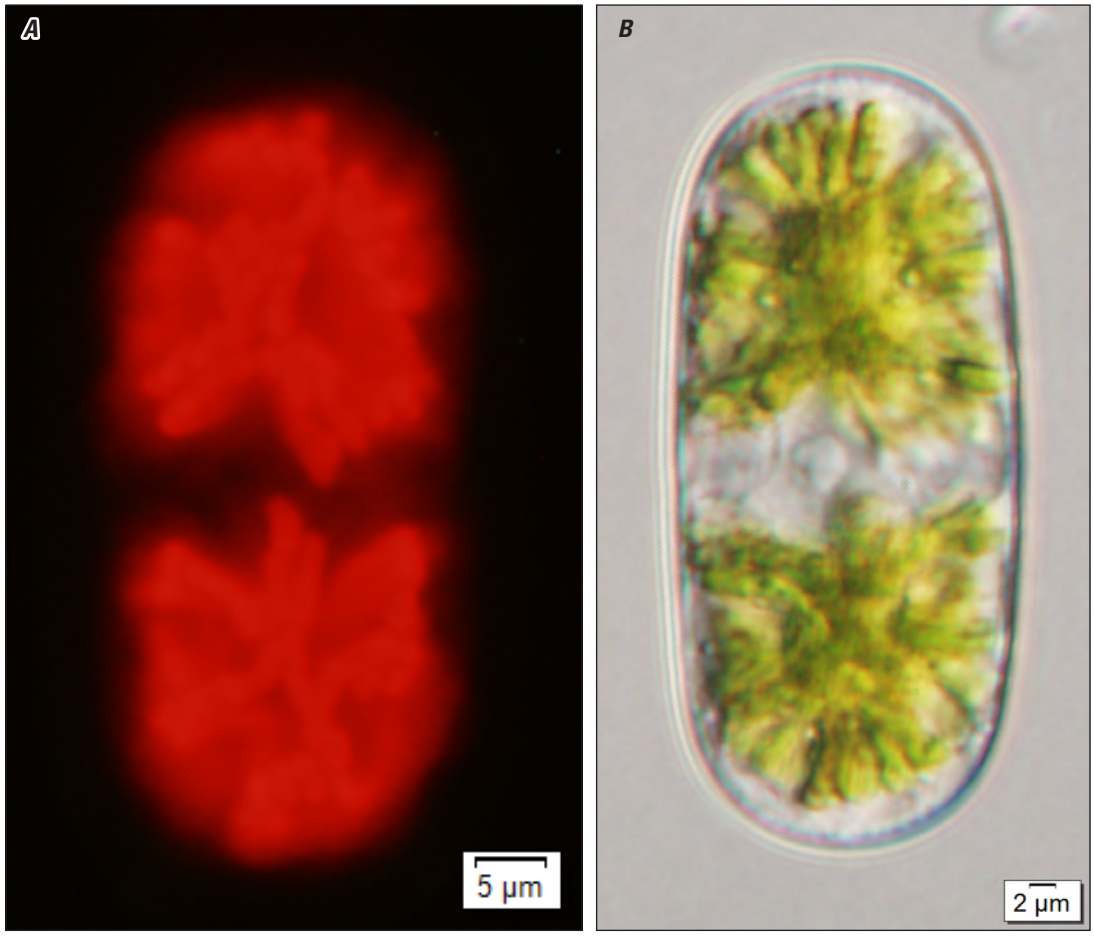


Figure 266. *A*, A wide-green image of *Cylindrocystis* sp. shows the stellate shape of the chloroplast inside the cell. *B*, A light microscopy image of the same cell.

Order Zygnematales

Family Mesotaeniaceae

Genus *Cylindrocystis*

Species *Cylindrocystis* sp.

Figure 267. *Cylindrocystis* sp.

Order Zygnematales

Family Mesotaeniaceae

Genus *Cylindrocystis*

Species *Cylindrocystis* sp.

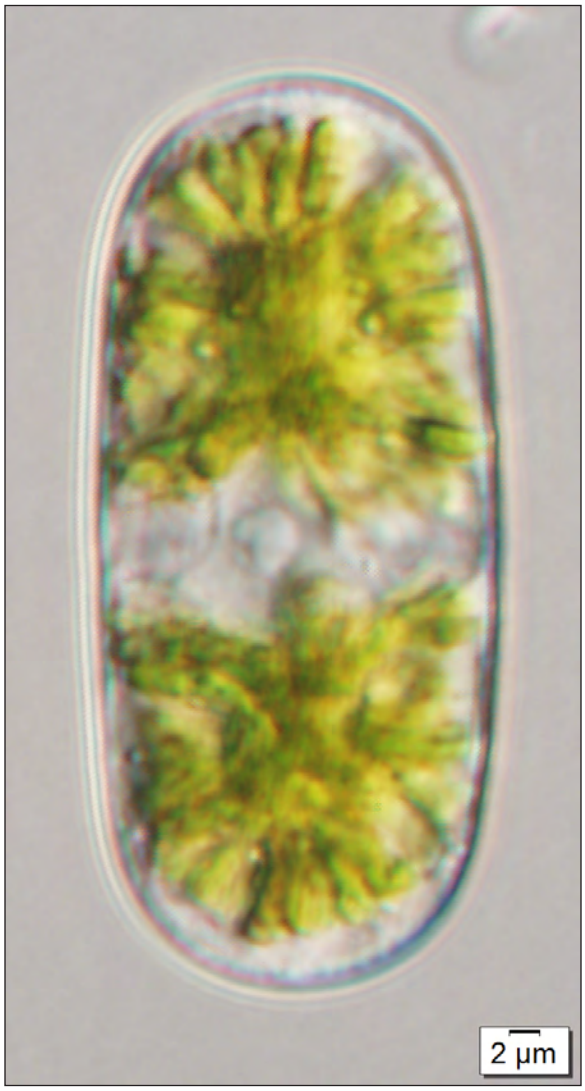


Figure 268. *Cylindrocystis* sp.

Order Zygnematales

Family Mesotaeniaceae

Genus *Cylindrocystis*

Species *Cylindrocystis* sp.

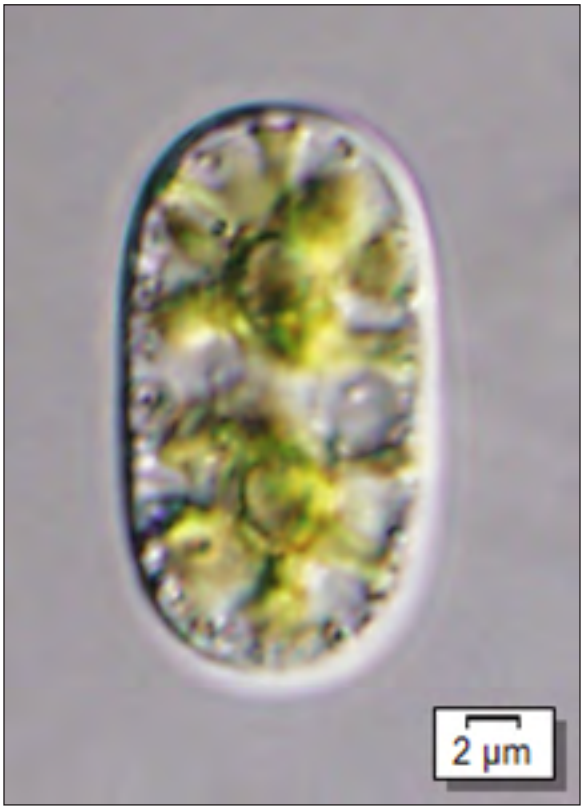


Figure 269. *Cylindrocystis* sp.

Spirotaenia Brébisson ex Ralfs

Cells are elongate and solitary and vary in size and shape. The cell wall is smooth and unconstricted. A single twisting parietal chloroplast extends the entire length of the cell and makes at least one turn.

Only one species, *Spirotaenia minuta*, was identified in samples from the refuge (fig. 270). This species was exceedingly rare and was only found in two samples: one from the east interior site and one from the west transition site.

Order Zygnematales

Family Mesotaeniaceae

Genus *Spirotaenia*

Species *Spirotaenia minuta* Thuret

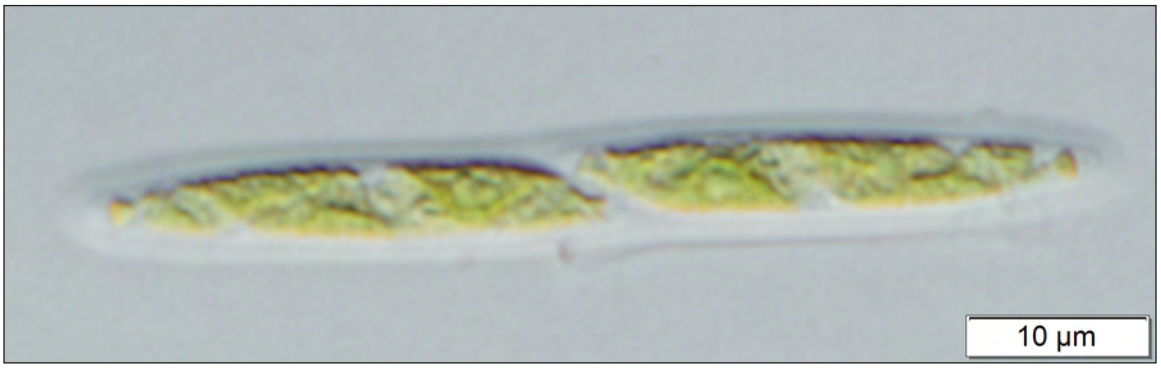


Figure 270. *Spirotaenia minuta*.

Tortitaenia Brook

Cells are solitary and taper to the apices. The cell wall is smooth and unconstricted. In each cell, a single axial chloroplast with twisted ridges runs along the length of the cell.

Only one species, *Tortitaenia obscura*, was identified in samples from the refuge (fig. 271). This species was very rare and was only found at the east interior and west transition sites.

Order Zygnematales

Family Mesotaeniaceae

Genus *Tortitaenia*

Species *Tortitaenia obscura* (Ralfs) Brook

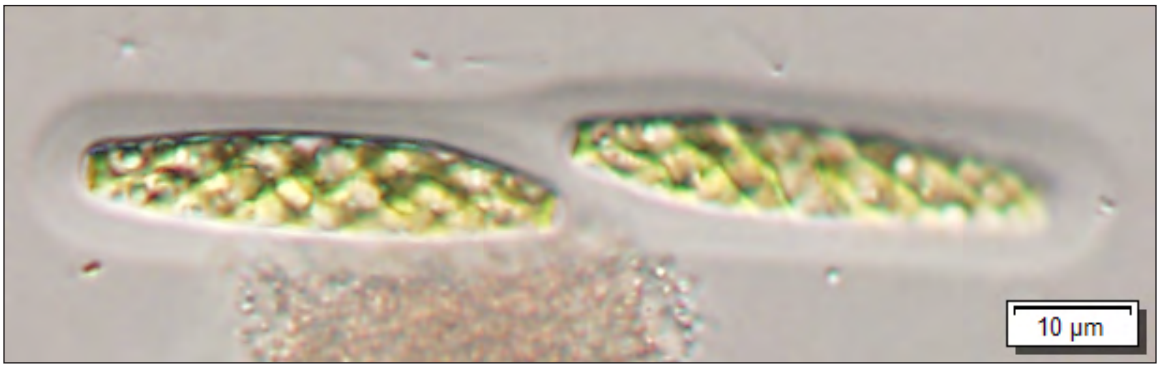


Figure 271. *Tortitaenia obscura* (2 cells).

Netrium (Nägeli) Itzigsohn & Rothe

Cells are straight and at least two times longer than broad. The cell wall is smooth and the midregion is not constricted. One stellate chloroplast is in each semicell.

Three species from this genus were identified in samples from the refuge (figs. 272–274). *Netrium digitus* was the most common species of the three and was found often at the east interior, west interior, and east transition sites. *Netrium lamellosum* and *Netrium oblongum* var. *cylindricum* were rare and only found at the east interior site.

Order Zygnematales

Family Mesotaeniaceae

Genus *Netrium*

Species *Netrium digitus* (Brébisson ex Ralfs) Itzigsohn & Rothe

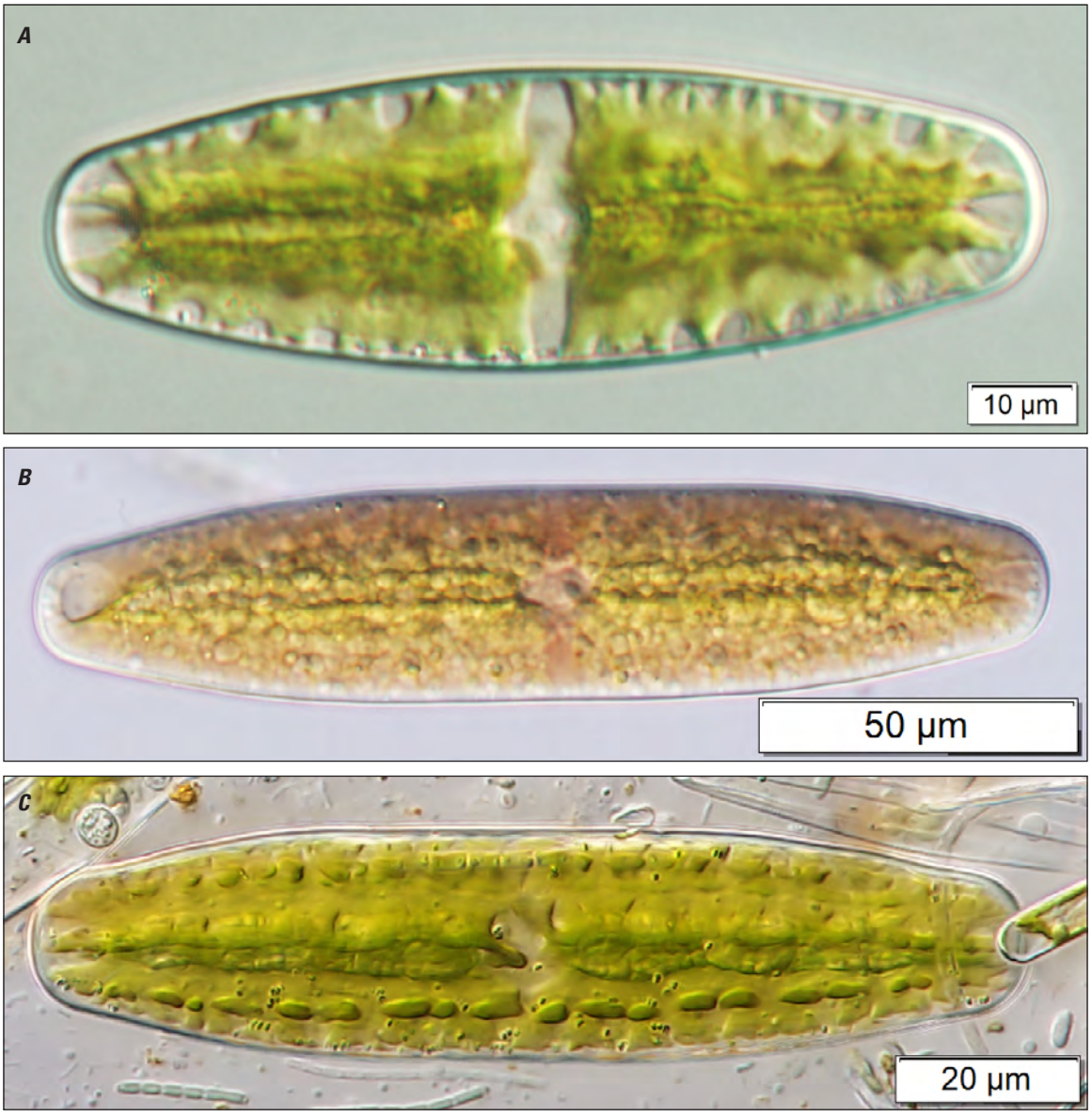


Figure 272. *Netrium digitus.*

Order Zygnematales

Family Mesotaeniaceae

Genus *Netrium*

Species *Netrium lamellosum* (Brébisson) Lütkemüller

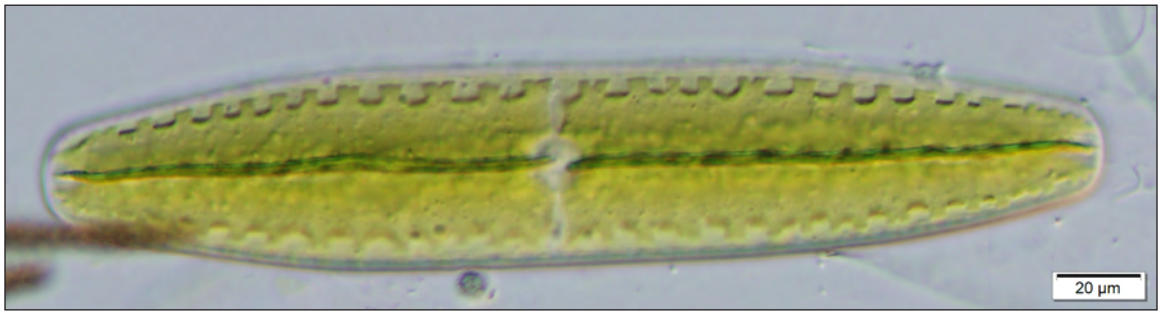


Figure 273. *Netrium lamellosum.*

Order Zygnematales

Family Mesotaeniaceae

Genus *Netrium*

Species *Netrium oblongum* var. *cylindricum* West & West

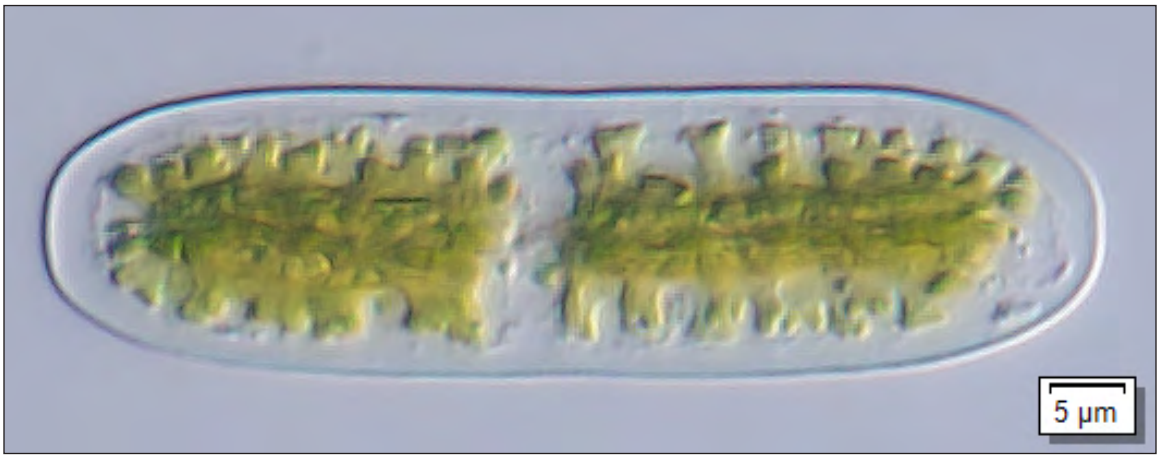


Figure 274. *Netrium oblongum* var. *cylindricum*.

References

Brook, A.J., 1981, The biology of desmids: Berkeley, University of California Press, 276 p.

Brook, A.J., and Williamson, D.B., 2010, A monograph on some British desmids: London, The Ray Society, The Natural History Museum, 364 p.

Browder, J.A., Gleason, P.J., and Swift, D.R., 1991, Periphyton in the Everglades: Spatial variation, environmental correlates, and ecological implications, *in* Davis, S.M., and Ogden, J.C., eds., Proceedings of Everglades Symposium, Key Largo, Fla., 1989, 76 p., accessed May 6, 2019, at http://www.mwaldon.com/Loxahatchee/GrayLiterature/Browder-et-al-1991.pdf.

Chen, C., Meselhe, E., and Waldon, M., 2012, Assessment of mineral concentration impacts from pumped stormwater on an Everglades wetland, Florida, USA—Using a spatially-explicit model: Journal of Hydrology, v. 452–453, p. 25–39.

Coesel, P.F.M., and Meesters, K.J., 2007, Desmids of the Lowlands—Mesotaeniaceae and Desmidiaceae of the European Lowlands: Zeist, the Netherlands, KNNV Publishing, 351 p.

Coesel, P.F.M., and Meesters, K.J., 2013, European flora of the desmid genera Staurastrum and Staurodesmus: Zeist, the Netherlands, KNNV Publishing, 357 p.

Croasdale, H.T., and Flint, E.A., 1986, Flora of New Zealand desmids, volume I: Wellington, Government Printing Office, 133 p.

Croasdale, H.T., and Flint, E.A., 1988, Flora of New Zealand desmids, volume II: Christchurch, The Caxton Press, 147 p.

Croasdale, H.T., Flint, E.A., and Racine, M.M., 1994, Flora of New Zealand desmids, volume III: Lincoln, Canterbury, New Zealand, Menaaki Whenua Press, 218 p.

Gleason, P.J., and Spackman, W., 1974, Calcareous periphyton and water chemistry in the Everglades, *in* Gleason, P.J., ed., Environments of South Florida—Past and present, memoir 2: Coral Gables, Fla., Miami Geological Society, p. 225–248.

Hall, J.D., and McCourt, R.M., Conjugating green algae including desmids, *in* Wehr, J.D., Sheath, R.G., and Kociolek, J.P., Freshwater algae of North America: AP Press, p. 429–457.

Miller, R.L., and McPherson, B.F., 2008, Water quality in the Arthur R. Marshall Loxahatchee National Wildlife Refuge—Trends and spatial characteristics of selected constituents, 1974–2004: U.S. Geological Survey Scientific Investigations Report 2007–5277, 34 p.

Newman, S., Grace, J.B., and Koebel, J.W., 1996, Effects of nutrients and hydroperiod on Typha, Cladium, and Eleocharis—Implications for Everglades restoration: Ecological Applications, v. 6, no. 3, p. 774–783.

Prescott, G.W., Bicudo, C.E.M., and Croasdale, H.T., 1983, A synopsis of North American desmids. Part II. Desmidiaceae: Placodermae. Section 5: Lincoln, University of Nebraska Press, 117 p.

Prescott, G.W., Bicudo, C.E.M., and Vinyard, W.C., 1982, A synopsis of North American desmids. Part II. Desmidiaceae: Placodermae. Section 4: Lincoln, University of Nebraska Press, 700 p.

Prescott, G.W., Croasdale, H.T., and Vinyard, W.C., 1972, North American flora. Desmidiales: Part I: Saccodermae, Mesotaeniaceae: Bronx, N.Y., The New York Botanical Garden, 84 p.

Prescott, G.W., Croasdale, H.T., and Vinyard, W.C., 1975, A synopsis of North American desmids. Part II. Desmidiaceae: Placodermae, Section 1: Lincoln, University of Nebraska Press, 275 p.

Prescott, G.W., Croasdale, H.T., and Vinyard, W.C., 1977, A synopsis of North American desmids. Part II. Desmidiaceae: Placodermae, Section 2: Lincoln, University of Nebraska Press, 413 p.

Prescott, G.W., Croasdale, H.T., Vinyard, W.C., and Bicudo, C.E.M., 1981, A synopsis of North American desmids. Part II. Desmidiaceae: Placodermae, Section 3: Lincoln, University of Nebraska Press, 720 p.

Rosen, B.H., and Mareš, Jan, 2016, Catalog of microscopic organisms of the Everglades, Part 1—The cyanobacteria: U.S. Geological Survey Open-File Report 2016–1114, 108 p., accessed May 6, 2019, at http://dx.doi.org/10.3133/ofr20161114.

Schumacher, G.J., 1960, Further notes on the occurrence of desmids in *Utricularia* bladders: Castanea, v. 25, no. 1, p. 62–65, accessed May 6, 2019, at http://www.jstor.org/stable/4031626.

Swift, D.R., and Nicholas, R.B., 1987, Periphyton and water quality relationships in the Everglades Water Conservation Areas, 1978–1982: West Palm Beach, Fla., South Florida Water Management District, DRE-233.

U.S. Fish and Wildlife Service, 2018, Arthur R. Marshall Loxahatchee National Wildlife Refuge, accessed December 10, 2018, at https://www.fws.gov/refuges/profiles/History.cfm?ID=41560.

Director, Wetland and Aquatic Research Center
U.S. Geological Survey
7920 NW 71st St.
Gainesville, Florida 32653

For additional information, visit
https://www.usgs.gov/centers/wetland-and-aquatic-research-center-warc

Publishing support provided by
Lafayette Publishing Service Center

ISSN 2328031X (print)
ISSN 2328-0328 (online)
https://doi.org/10.3133/sir20195074