

Lone Lake Phytoplankton Summary

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1 Introduction

2 Methods

Sample collection: Planktonic algae samples were collected by Dr. Mark Sytsma on June 12 and 25, July 9 and 23, August 13 and 27 September 10 and 27, and October 15 and 29, 2019. The samples were collected using a 20 μm mesh phytoplankton net that was towed slightly below the lake surface for approximately 3 meters. The concentrated plankton samples were stored in a 250-mL polypropylene bottle and kept cool and away from direct sunlight until the sample could be delivered to the Institute for Watershed Studies (IWS) laboratory in Bellingham Washington. Live, unpreserved samples were brought to the laboratory on June 12, July 9, October 15, and October 29, 2019, and were examined within 48 hr. The remaining samples were preserved in 10% buffered formalin and held until they could be delivered to the IWS laboratory.

Sample processing: Live, unpreserved algae samples were opened and placed in an environmental chamber at 15° C on a 18:6 light/dark cycle until the samples could be processed. Preserved samples were kept at room temperature out of direct sunlight until they could be examined. The live and preserved algae were examined using a Nikon Eclipse 80i with phase contrast and Nomarski (DIC) objectives equipped with a Nikon DS-Fi2 digital camera.

Aliquots from the live algae collected on June 12 and July 9, 2019 were preserved in 2% glutaraldehyde for SEM analysis. The preserved samples were dewatered using sequential dilutions of 10–90% ethanol, dried using a critical point CO₂ evaporator, sputter coated, and examined using a scanning electron microscope.

Sample analysis: The algae in each sample were identified to the lowest practical taxonomic level (taxon) using standard taxonomic literature. Each taxon was assigned a relative abundance rank: rank #1 indicates taxa that were present but not abundant; rank #2 indicates taxa that were common in the sample but were not dominant; rank #3 indicates taxa that dominated the sample and were generally present in all microscopic fields of view. The ranked data from each Lone Lake samples are listed in Table 1. Additional algae data collected by IWS from 2008–2019 were used to supplement the Lone Lake algae species list (Table 2). Digital images for all algal taxa listed in Tables 1–2 are included in Figures 1–60, beginning on page 10.

Table 1: Lone Lake algal abundance in plankton samples collected 12 June - 29 October 2019.

Taxon	Sampling date				
	Jun 12	Jun 25	Jul 9	Jul 23	Aug 13
Chlorophyta (green algae)					
<i>Botryococcus braunii</i>	2	1	1	1	1
<i>Chlamydomonas</i> spp. (including zoospores)	2	0	1	0	0
<i>Chlorococcum minutum</i> ?	0	0	0	0	0
<i>Chlorogonium</i> sp. (epiphytic)	0	1	1	0	0
<i>Coelastrum microporum</i>	0	0	0	0	0
<i>Eudorina elegans</i>	1	3	1	0	0
<i>Korshikoviella michailovskoensis</i> (epizoic)	0	0	1	0	0
<i>Oocystis</i> spp.	2	0	1	2	2
<i>Pediastrum duplex</i>	1	0	1	1	0
<i>Planktosphaeria gelatinosa</i>	0	0	1	1	1
<i>Pseudopediastrum boryanum</i>	1	0	1	0	0
<i>Sphaerocystis schroeteri</i>	1	2	3	2	1
<i>Stylosphaeridium stipitatum</i> (epiphytic)	0	0	1	0	0
<i>Tetraspora lemmermannii</i> ?	1	0	0	0	0
<i>Volvox tertius</i>	1	2	3	1	0
Streptophyta (desmids and related green algae)					
<i>Closterium acutum</i> var. <i>variabile</i>	0	0	0	0	0
<i>Closterium</i> spp.	1	1	1	0	0
<i>Elakatothrix gelatinosa</i>	0	0	0	1	0
<i>Staurastrum pingue</i> var. <i>planctonicum</i>	3	2	3	1	1
<i>Staurastrum cingulum</i>	3	2	2	1	1
Cyanobacteria (blue-green algae)					
<i>Aphanocapsa/Aphanothece</i> spp.	1	1	2	1	1
<i>Dolichospermum crassum</i>	2	1	1	1	1
<i>Dolichospermum</i> spp.	2	2	2	3	2
<i>Gloeotrichia echinulata</i>	2	2	2	2	0
<i>Microcystis aeruginosa</i>	2	1	2	3	3
<i>Microcystis flos-aquae</i> ?	0	0	1	0	1
<i>Microcystis wesenbergii</i>	1	0	1	1	1
<i>Oscillatoria</i> sp.	0	1	1	1	1
<i>Phormidium</i> spp.	1	0	1	0	0
<i>Pseudanabaena</i> spp.	0	0	1	1	3

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Table 1: Lone Lake 2019 algal abundance, continued

Taxon	Sampling date				
	Jun 12	Jun 25	Jul 9	Jul 23	Aug 13
Cyanobacteria (blue-green algae)					
<i>Woronichinia compacta?</i>	0	0	0	0	0
<i>Woronichinia naegeliana</i>	2	1	1	2	3
Other/Bacillariophyta (diatoms)					
<i>Asterionella formosa</i>	3	1	1	1	0
<i>Aulacoseira ambigua</i>	3	2	3	2	2
<i>Eunotia</i> sp.	0	0	0	1	0
<i>Fragilaria capucina</i>	1	0	0	0	0
<i>Fragilaria crotonensis</i>	3	3	3	2	0
<i>Stephanodiscus niagarae</i>	3	1	1	0	1
unk. filamentous diatom	0	0	0	0	0
unk. naviculoid diatom	0	0	0	0	0
Other/Cryptophyta (cryptomonads)					
<i>Cryptomonas</i> spp.	0	0	0	0	0
Other/Euglenophyta (euglenoids)					
<i>Euglena</i> spp.	1	0	1	0	0
<i>Euglena texta</i>	0	1	1	0	0
<i>Trachelomonas hispida</i>	1	0	0	0	0
<i>Trachelomonas volvocinopsis</i>	1	1	2	1	1
Other/Miozoa (dinoflagellates)					
<i>Ceratium hirundinella</i> (including cysts)	0	2	1	0	1
Other/Ochromyxa (golden algae)					
<i>Dinobryon divergens</i>	0	0	2	0	0
<i>Lagynion</i> sp. (epiphytic)	3	0	1	0	0
<i>Mallomonas</i> sp.	0	0	0	0	0
<i>Uroglenopsis americana</i>	0	1	0	0	0

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Table 1: Lone Lake 2019 algal abundance, continued

Taxon	Sampling date				
	Aug 27	Sep 10	Sep 27	Oct 15	Oct 29
Chlorophyta (green algae)					
<i>Botryococcus braunii</i>	1	1	0	0	0
<i>Chlamydomonas</i> spp. (including zoospores)	0	0	0	1	1
<i>Chlorococcum minutum</i> ?	0	0	0	0	1
<i>Chlorogonium</i> sp. (epiphytic)	0	0	0	0	1
<i>Coelastrum microporum</i>	0	1	0	0	0
<i>Eudorina elegans</i>	1	1	2	1	1
<i>Korshikoviella michailovskoensis</i> (epizoic)	0	0	0	0	0
<i>Oocystis</i> spp.	2	1	1	1	1
<i>Pediastrum duplex</i>	0	0	0	0	1
<i>Planktosphaeria gelatinosa</i>	0	0	1	2	2
<i>Pseudopediastrum boryanum</i>	0	0	0	0	1
<i>Sphaerocystis schroeteri</i>	1	1	1	1	1
<i>Stylosphaeridium stipitatum</i> (epiphytic)	0	0	0	0	0
<i>Tetraspora lemmermannii</i> ?	0	0	0	0	0
<i>Volvox tertius</i>	0	0	1	1	1
Streptophyta (desmids and related green algae)					
<i>Closterium acutum</i> var. <i>variabile</i>	0	0	0	0	1
<i>Closterium</i> spp.	0	0	0	0	0
<i>Elakatothrix gelatinosa</i>	0	0	0	0	0
<i>Staurastrum pingue</i> var. <i>planctonicum</i>	1	2	1	1	1
<i>Staurastrum cingulum</i>	1	1	0	0	1
Cyanobacteria (blue-green algae)					
<i>Aphanocapsa/Aphanothece</i> spp.	1	2	2	1	1
<i>Dolichospermum crassum</i>	2	2	1	1	1
<i>Dolichospermum</i> spp.	2	1	1	1	2
<i>Gloeotrichia echinulata</i>	0	0	0	0	0
<i>Microcystis aeruginosa</i>	3	1	2	1	1
<i>Microcystis flos-aquae</i> ?	0	2	1	1	1
<i>Microcystis wesenbergii</i>	3	3	2	1	1
<i>Oscillatoria</i> sp.	1	1	1	0	0
<i>Phormidium</i> spp.	0	0	0	0	0
<i>Pseudanabaena</i> spp	3	0	0	1	0

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Table 1: Lone Lake 2019 algal abundance, continued

Taxon	Sampling date				
	Aug 27	Sep 10	Sep 27	Oct 15	Oct 29
Cyanobacteria (blue-green algae)					
<i>Woronichinia compacta?</i>	0	2	1	1	1
<i>Woronichinia naegeliana</i>	3	3	3	2	1
Other/Bacillariophyta (diatoms)					
<i>Asterionella formosa</i>	0	0	0	0	0
<i>Aulacoseira ambigua</i>	1	1	1	3	3
<i>Eunotia</i> sp.	0	0	0	0	0
<i>Fragilaria capucina</i>	0	0	0	0	0
<i>Fragilaria crotonensis</i>	0	1	1	2	2
<i>Stephanodiscus niagarae</i>	1	1	3	3	3
unk. filamentous diatom	0	0	0	0	1
unk. naviculoid diatom	0	0	0	0	1
Other/Cryptophyta (cryptomonads)					
<i>Cryptomonas</i> spp.	0	0	0	2	2
Other/Euglenophyta (euglenoids)					
<i>Euglena</i> spp.	1	1	1	1	2
<i>Euglena texta</i>	0	0	0	1	2
<i>Trachelomonas hispida</i>	0	0	0	0	0
<i>Trachelomonas volvocinopsis</i>	0	1	0	1	1
Other/Miozoa (dinoflagellates)					
<i>Ceratium hirundinella</i> (including cysts)	1	1	2	1	1
Other/Ochromyxa (golden algae)					
<i>Dinobryon divergens</i>	0	0	0	0	0
<i>Lagynion</i> sp. (epiphytic)	0	0	0	0	3
<i>Mallomonas</i> sp.	0	0	0	1	1
<i>Uroglenopsis americana</i>	0	0	0	0	0

Table 2: Lone Lake algae species list. Species that were collected by IWS (2008–2019) but not found in the 2019 plankton samples are indicated using an asterisk. Taxonomic authority is from Guiry and Guiry (2019).

Taxon	Taxonomic Authority
Chlorophyta (green algae)	
<i>Ankyra judayi</i> *	(G.M.Smith) Fott
<i>Botryococcus braunii</i>	Kützing
<i>Characium ornithocephalum</i> *	A.Braun
<i>Chlamydomonas</i> spp.	Ehrenberg
<i>Chlorococcum minutum</i> ?	R.C.Starr
<i>Chlorogonium</i> sp. (epiphytic)	Ehrenberg
<i>Coelastrum microporum</i>	Nägeli
<i>Eudorina elegans</i>	Ehrenberg
<i>Korshikoviella michailovskoensi</i>	(Elenkin) P.C.Silva
<i>Oedogonium</i> sp.*	Link ex Hirn
<i>Oocystis</i> spp.	Nägeli ex A.Braun
<i>Pediastrum duplex</i>	Meyen
<i>Planktosphaeria gelatinosa</i>	G.M.Smith
<i>Pleodorina californica</i> *	W.R.Shaw
<i>Pseudopediastrum boryanum</i>	(Turpin) E.Hegewald
<i>Sphaerocystis schroeteri</i>	Chodat
<i>Stylosphaeridium stipitatum</i>	(Bachmann) Geitler & Gimesi
<i>Tetraspora lemmermannii</i> ?	Fott
<i>Volvox aureus</i> *	Ehrenberg
<i>Volvox globator</i> *	Linnaeus
<i>Volvox tertius</i>	Art.Meyer
Streptophyta (desmids and related green algae)	
<i>Closterium acutum</i> var. <i>variabile</i>	(Lemmermann) Willi Krieger
<i>Closterium</i> spp.	Nitzsch ex Ralfs
<i>Elakatothrix gelatinosa</i>	Wille
<i>Staurastrum pingue</i> var. <i>planctonicum</i>	(Teiling) Coesel & Meersters
<i>Staurastrum cingulum</i>	West & G.S.West G.M.Smith
Cyanobacteria (blue-green algae)	
<i>Aphanocapsa/Aphanothece</i> spp.	Nägeli/Nägeli
<i>Chroococuss</i> sp.*	Nägeli
<i>Dolichospermum crassum</i>	(Lemmermann) P.Wacklin, L.Hoffmann & J.Komárek

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Table 2: Lone Lake algae species list, continued

Taxon	Taxonomic Authority
Cyanobacteria (blue-green algae)	
<i>Dolichospermum</i> spp.	(Ralfs ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek
<i>Gloeotrichia echinulata</i>	P.G.Richter
<i>Limnoraphis birgei</i> *	(G.M.Smith) J.Komárek, E.Zapomelová, J.Smarda, J.Kopecký, E.Rejmánková, J.Woodhouse, B.A.Neilan & J.Komárková
<i>Microcystis aeruginosa</i>	(Kützing) Kützing
<i>Microcystis flos-aquae</i> ?	(Wittrock) Kirchner
<i>Microcystis wesenbergii</i>	(Komárek) Komárek ex Komárek
<i>Oscillatoria</i> sp.	Vaucher ex Gomont
<i>Phormidium</i> spp.	Kützing ex Gomont
<i>Pseudanabaena mucicola</i> *	(Naumann & Huber-Pestalozzi) Schwabe
<i>Pseudanabaena</i> spp.	Lauterborn
<i>Tolypothrix lanata</i> *	Wartmann ex Bornet & Flahault
<i>Woronichinia compacta</i> ?	(Lemmermann) Komárek & Hindák
<i>Woronichinia naegeliana</i>	(Unger) Elenkin
Other/Bacillariophyta (diatoms)	
<i>Asterionella formosa</i>	Hassall
<i>Aulacoseira ambigua</i>	(Grunow) Simonsen
<i>Eunotia</i> sp.	Ehrenberg
<i>Fragilaria capucina</i>	Desmazières
<i>Fragilaria crotonensis</i>	Kitton
<i>Stephanodiscus niagarae</i>	Ehrenberg
<i>Surirella</i> sp.*	Turpin
unk. filamentous diatom	Karsten
unk. naviculoid diatom	Karsten
Other/Cryptophyta (cryptomonads)	
<i>Cryptomonas</i> spp.	Ehrenberg
Other/Euglenophyta (euglenoids)	
<i>Colacium vesiculosum</i>	Ehrenberg
<i>Euglena</i> spp.	Ehrenberg
<i>Euglena texta</i>	(Dujardin) Hübner

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Table 2: Lone Lake algae species list, continued

Taxon	Taxonomic Authority
Other/Euglenophyta (euglenoids)	
<i>Trachelomonas hispida</i>	(Perty) F.Stein
<i>Trachelomonas volvocinopsis</i>	Svirenko
Other/Miozoa (dinoflagellates)	
<i>Ceratium hirundinella</i>	(O.F.Müller) Dujardin
Other/Ochrophyta (golden algae)	
<i>Dinobryon divergens</i>	O.E.Imhof
<i>Lagynion</i> sp.	Pascher
<i>Mallomonas</i> sp.	Perty
<i>Uroglenopsis americana</i>	(G.N.Calkins) Lemmermann

3 Lone Lake Phytoplankton Images

This section contains high resolution digital images of the common algae collected in plankton samples from Lone Lake during the summer of 2019. All taxonomic identifications were provided by Dr. Robin Matthews and represent my best effort to provide accurate classifications using conventional taxonomic sources and following the nomenclature in AlgaeBase (<http://www.algaebase.org>). All images were photographed by Dr. Matthews using a Nikon Eclipse 80i microscope with phase contrast or Nomarski (DIC) objectives or a scanning electron microscope (SEM). These images may be used for noncommercial purposes under the copyright license described at <http://www.wwu.edu/iws>, with appropriate credit given to the image copyright holder (Dr. Matthews) and Western Washington University. Comments, suggestions, or requests for copies of the digital images may be directed to the Institute for Watershed Studies, Western Washington University, 516 High Street, Bellingham, WA, 98225.

Unless otherwise noted, the images represent algae collected in Lone Lake as part of this project or the IWS Northwest Lakes monitoring project. If high quality images were not available for Lone Lake taxa, representative images were included from other Northwest Washington lakes. The image captions for specimens from live samples list the date when the image was created, which was usually within 48 hr of collection. The captions on SEM images list the date when the sample was processed, with the image creation date stamped at the bottom of the image.

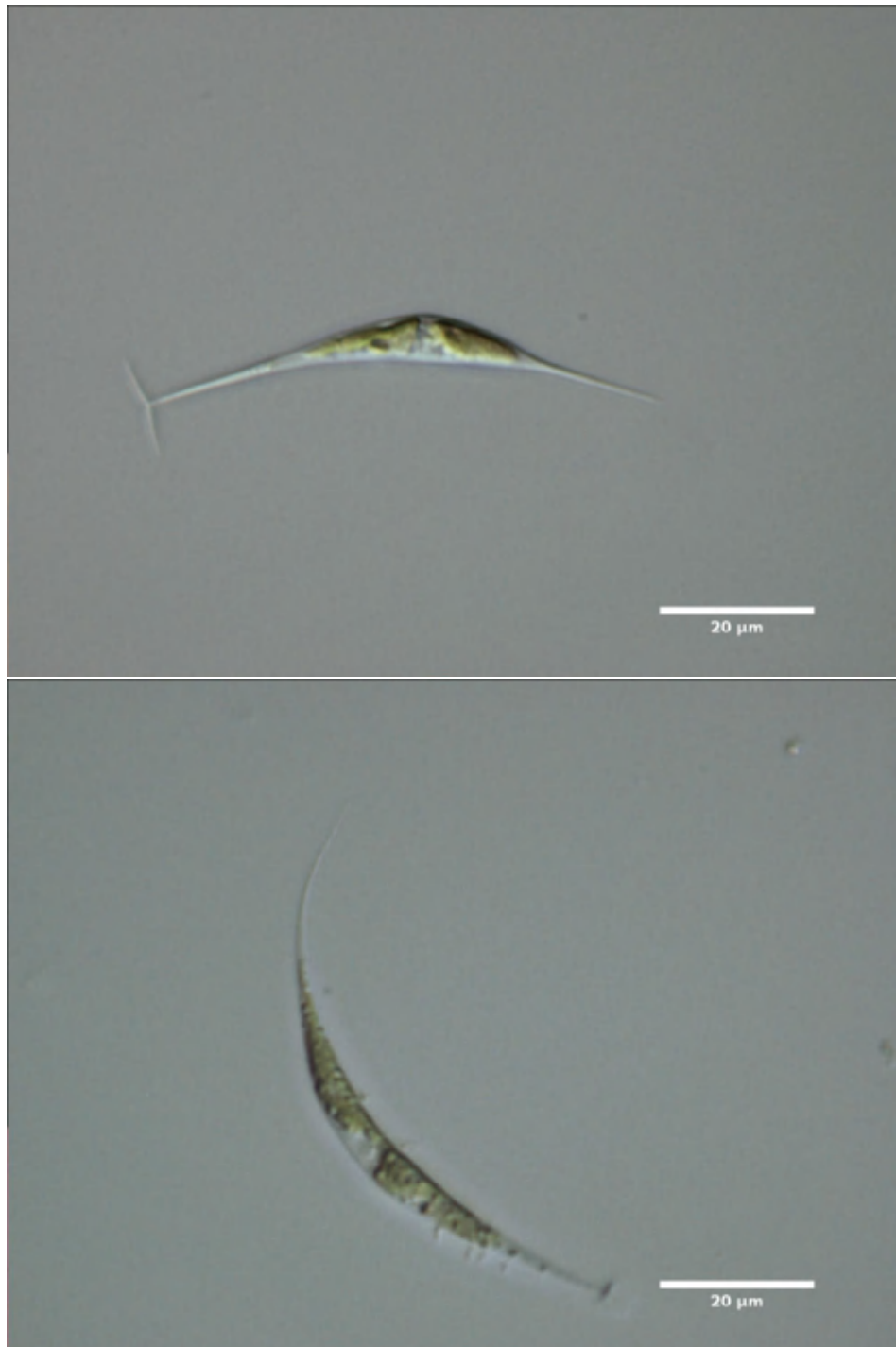


Figure 1: Chlorophyta - upper image: *Ankyra judayi* (600x DIC), September 1, 2008; lower image: *Ankyra judayi* (600x DIC), Cranberry Lake, Island County, July 7, 2010.

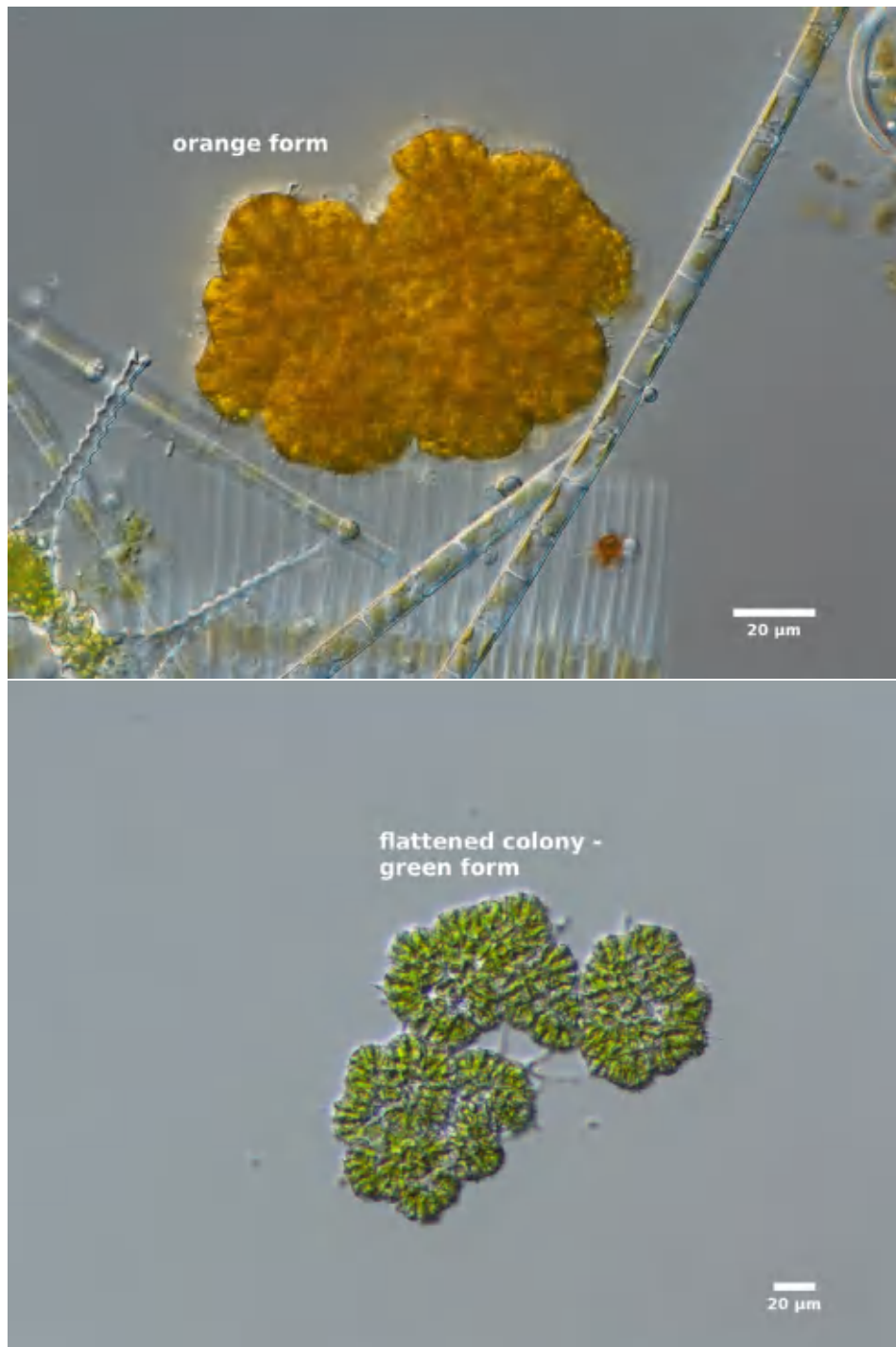


Figure 2: Chlorophyta - upper image: *Botryococcus braunii* (400x DIC), June 12, 2019; lower image: *Botryococcus braunii* (200x DIC), Heart Lake, Skagit County, July 19, 2016.

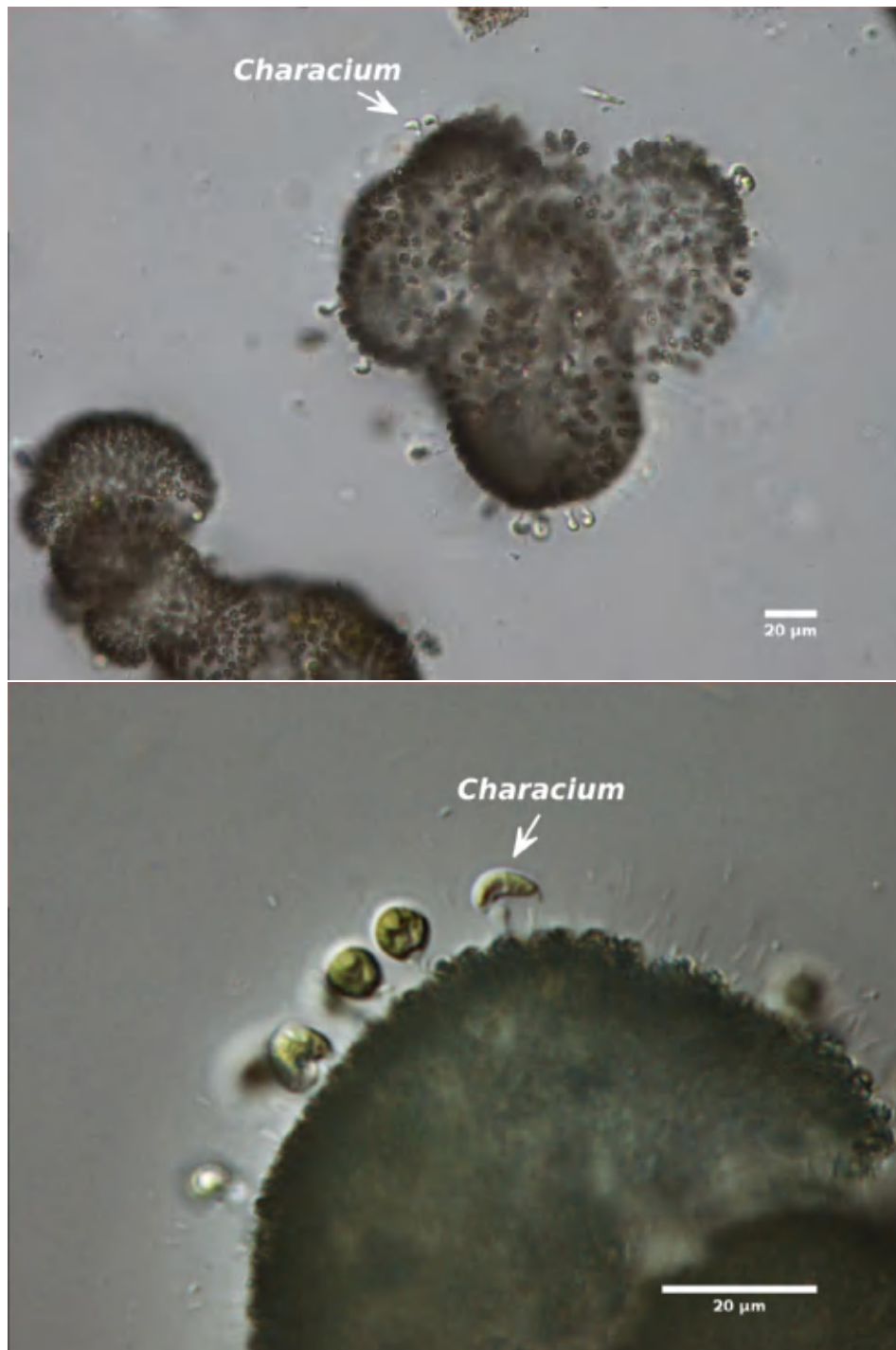


Figure 3: Chlorophyta - upper image: *Characium ornithocephalum* (200x DIC), September 30, 2009; lower image: *Characium ornithocephalum* (600x DIC), September 30, 2009.

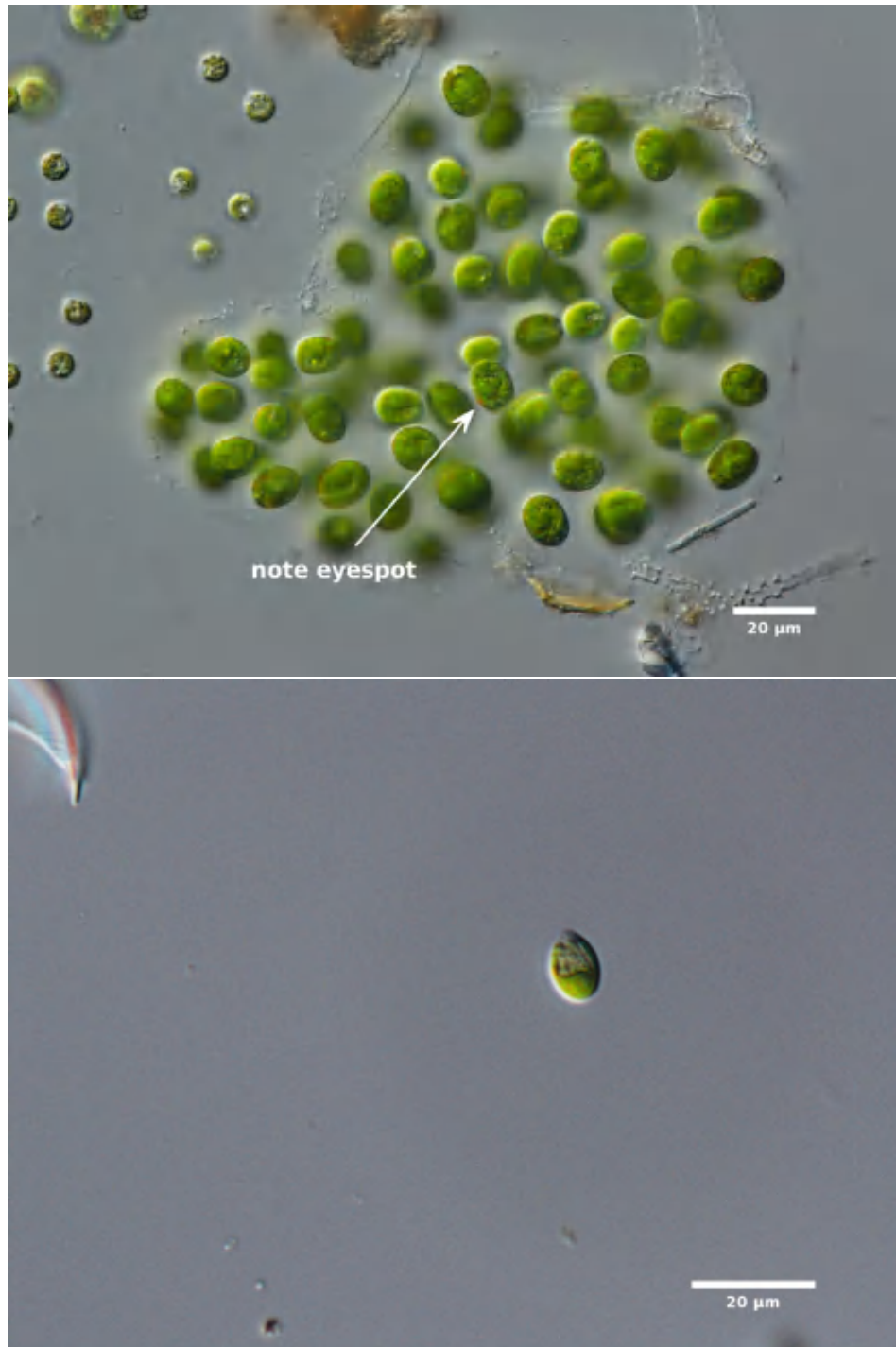


Figure 4: Chlorophyta - upper image: *Chlamydomonas* zoospores (400x DIC), July 9, 2019; lower image: *Chlamydomonas* vegetative cell (600x DIC), October 15, 2019.

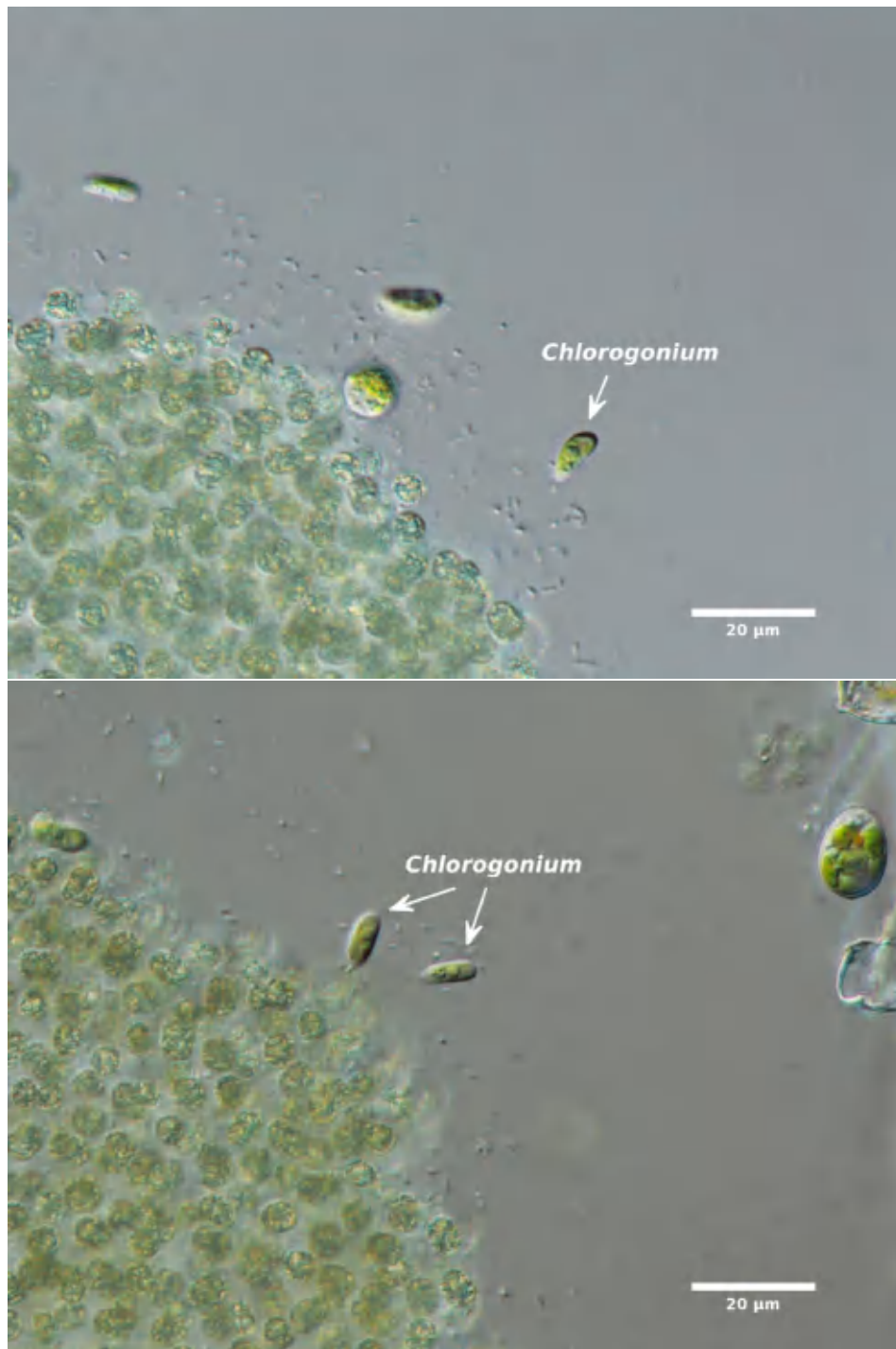


Figure 5: Chlorophyta - upper image: *Chlorogonium* (600x DIC), July 9, 2019; lower image: *Chlorogonium* (600x DIC), July 9, 2019.



Figure 6: Chlorophyta - upper/lower images: *Chlorococcum minutum*? (600x DIC), October 29, 2019.

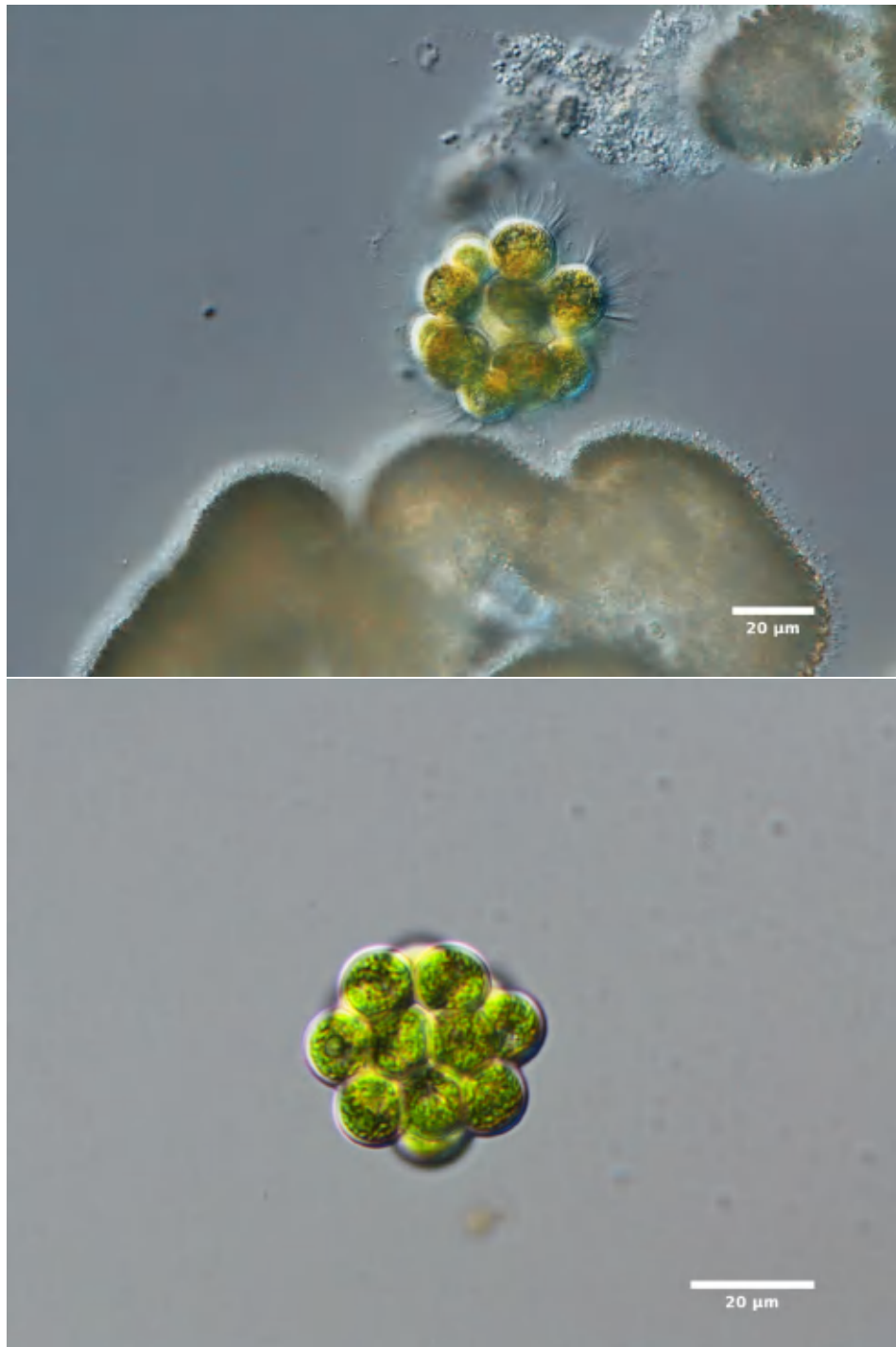


Figure 7: Chlorophyta - upper image: *Coelastrum microporum* (400x DIC), October 17, 2019; lower image: *Coelastrum microporum* (600x DIC), Heart Lake, Skagit County, June 26, 2016.



Figure 8: Chlorophyta - upper/lower images: *Eudorina elegans* (600x DIC), October 17, 2019.



Figure 9: Chlorophyta - upper image: *Korshikoviella michailovskoensis* (600x DIC), July 9, 2019; lower image: *Korshikoviella michailovskoensis* (400x DIC), Heart Lake, Skagit County, July 13, 2018.

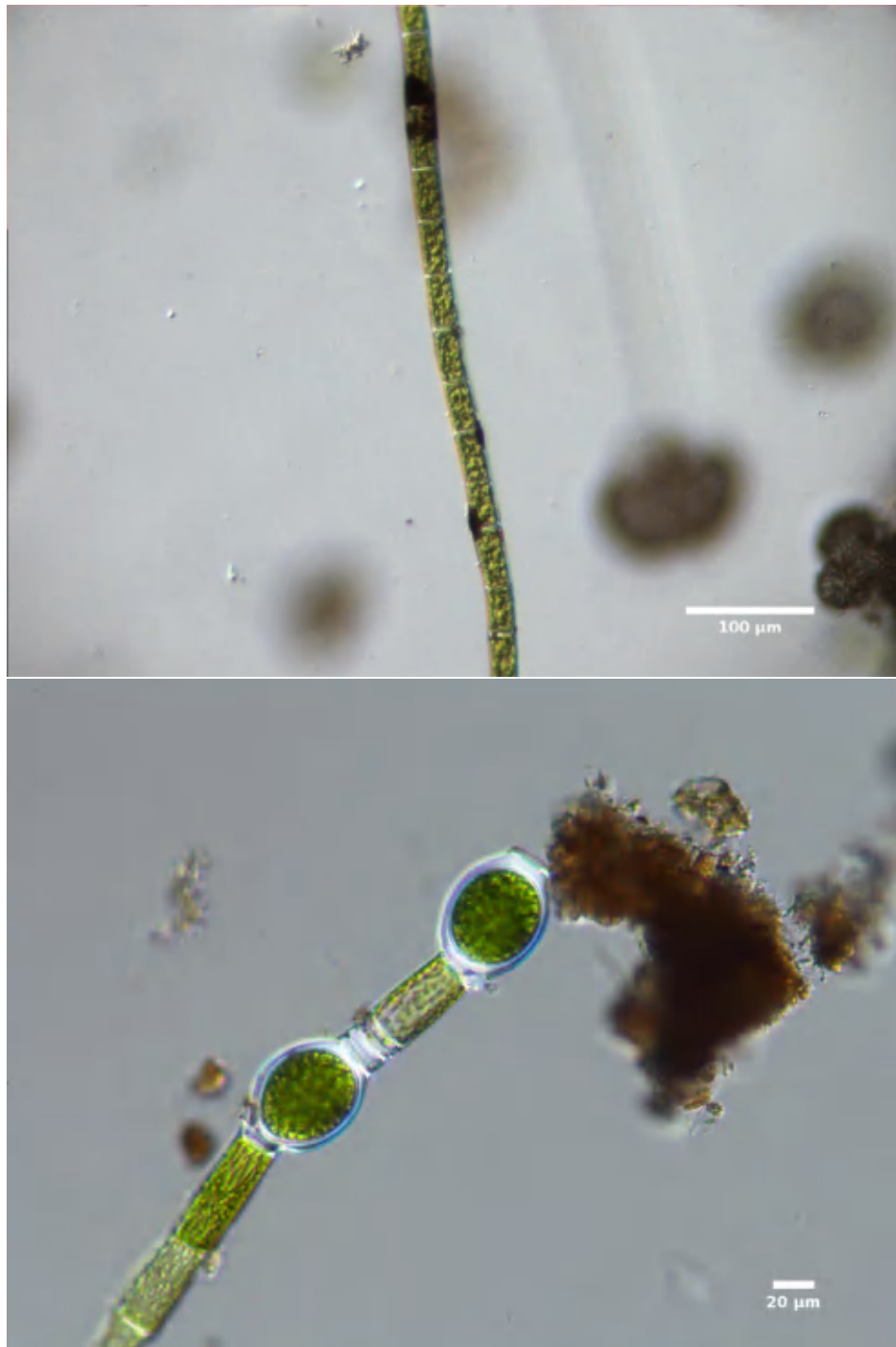


Figure 10: Chlorophyta - upper image: *Oedogonium* (100x DIC), September 30, 2009; lower image: *Oedogonium* (200x DIC), small pond near Fairhaven Park, Whatcom County, May 20, 2015.

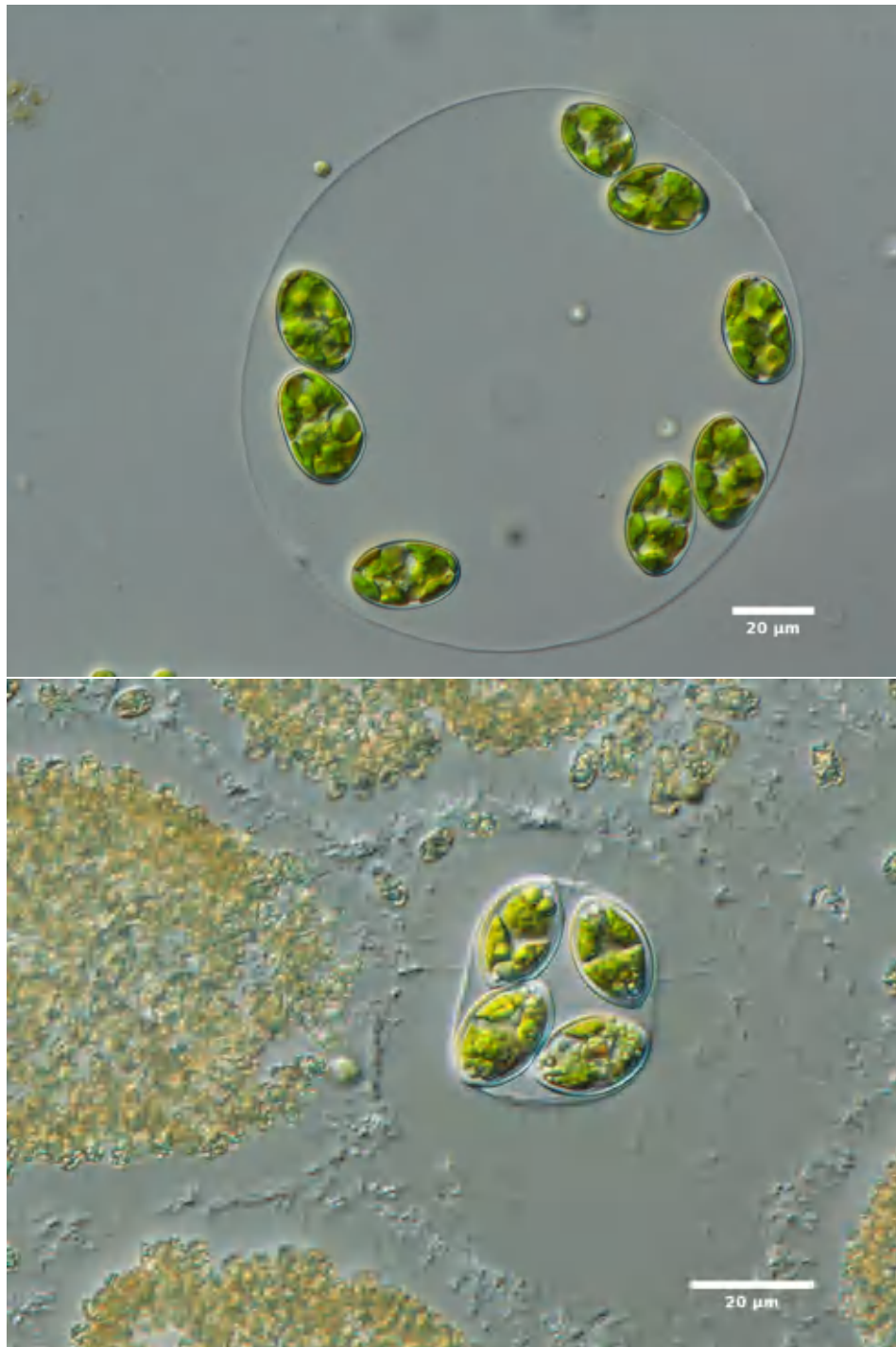


Figure 11: Chlorophyta - upper image: *Oocystis* (400x DIC), July 9, 2019; lower image: *Oocystis* (600x DIC), June 13, 2019. Note the different cell sizes that indicated there are at least two species of *Oocystis* present in Lone Lake.

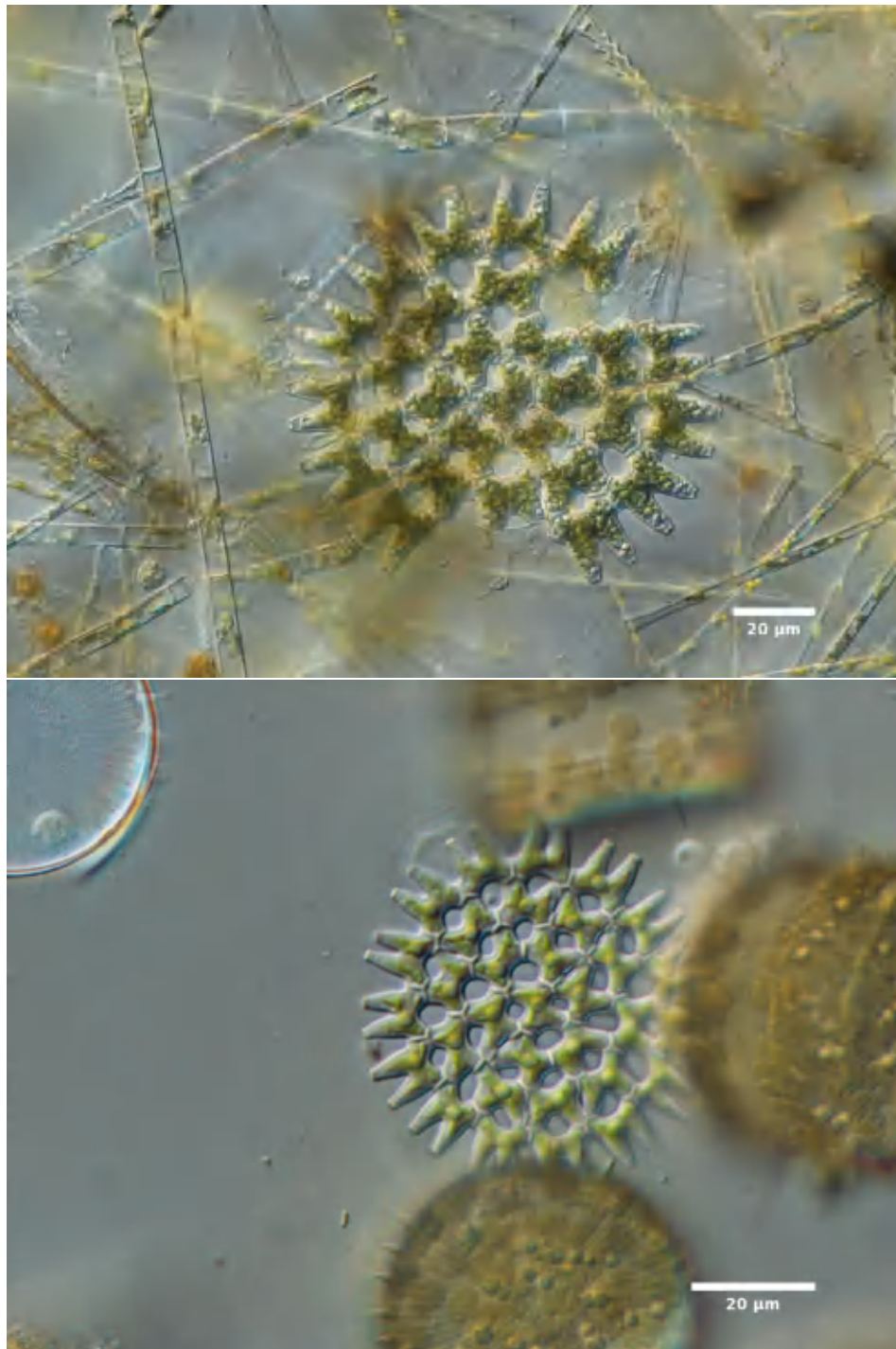


Figure 12: Chlorophyta - upper image: *Pediastrum duplex* (400x DIC), June 13, 2019; lower image: *Pediastrum duplex* (600x DIC), October 29, 2019.

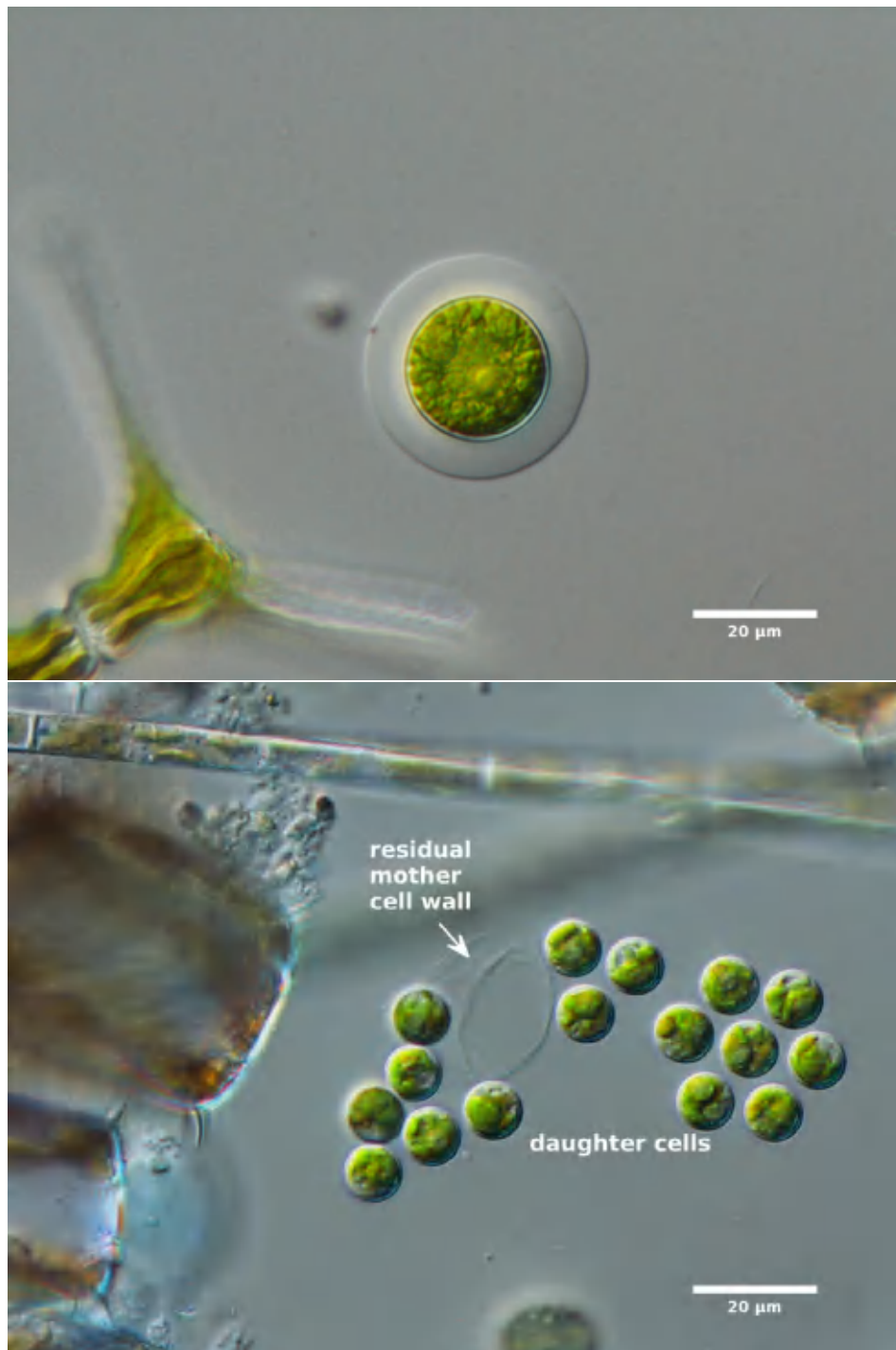


Figure 13: Chlorophyta - upper image: *Planktosphaeria gelatinosa* mother cell (600x DIC), July 9, 2019; lower image: *Planktosphaeria gelatinosa* daughter cells (600x DIC), October 15, 2019.

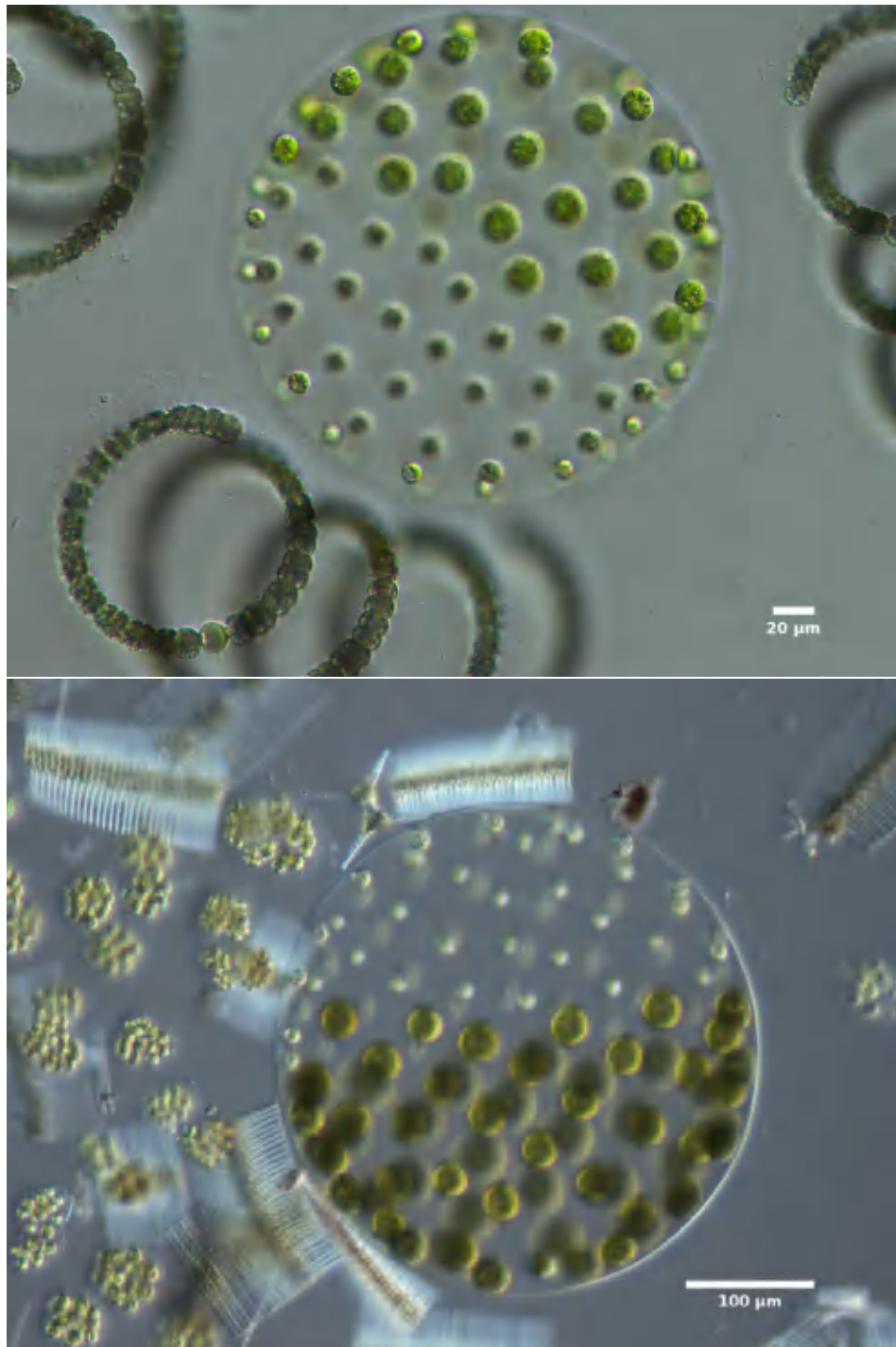


Figure 14: Chlorophyta - upper image: *Pleodorina californica* (200x DIC), August 4, 2014; lower image: *Pleodorina californica* (100x DIC), July 22, 2013.

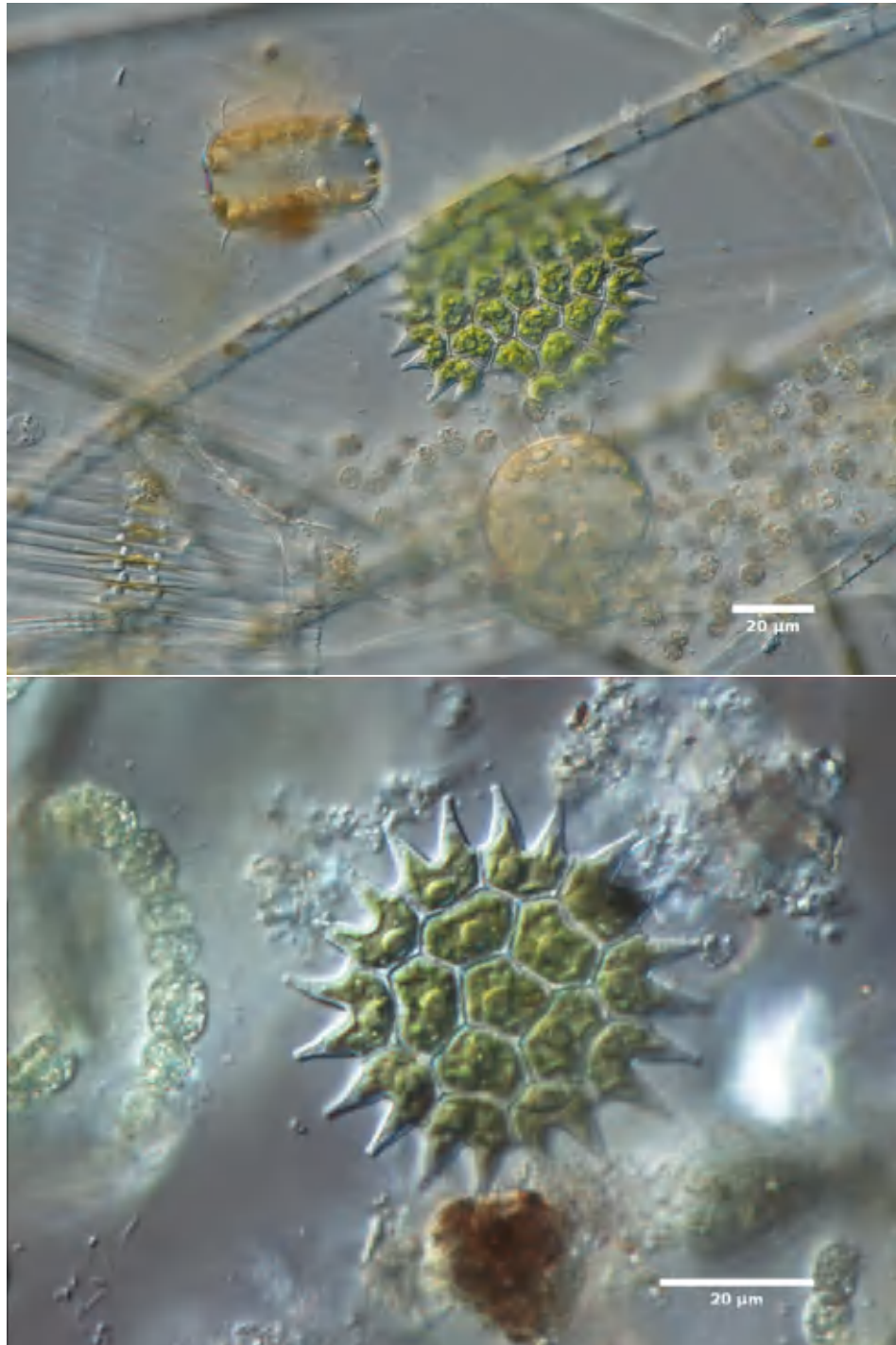


Figure 15: Chlorophyta - upper image: *Pseudopediastrum boryanum* (400x DIC), June 13, 2019; lower image: *Pseudopediastrum boryanum* (600x DIC), Wisser Lake, Whatcom County, August 19, 2009.

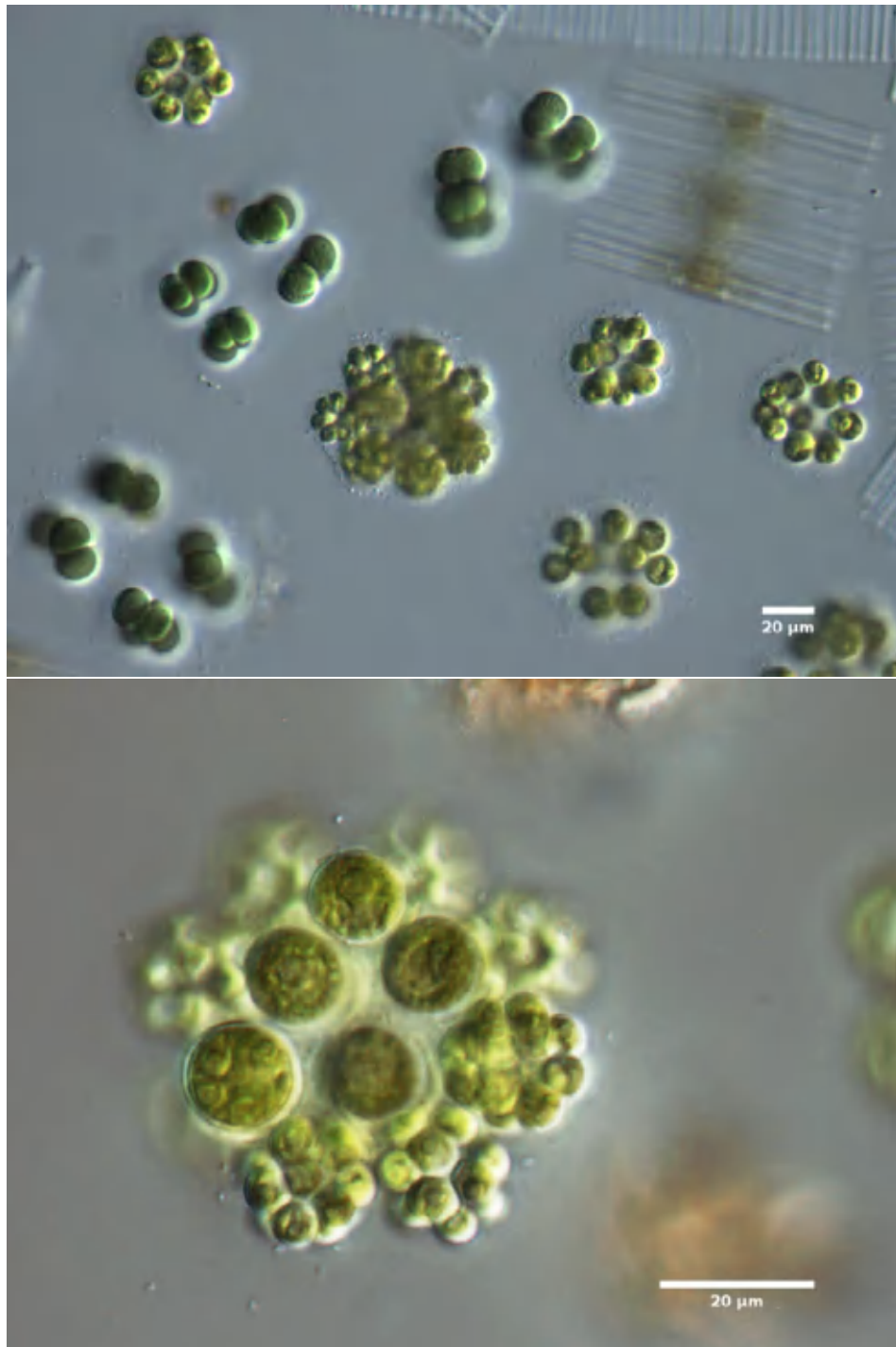


Figure 16: Chlorophyta - upper image: *Sphaerocystis schroeteri* (200x DIC), July 22, 2013; lower image: *Sphaerocystis schroeteri* (600x DIC), July 22, 2013.

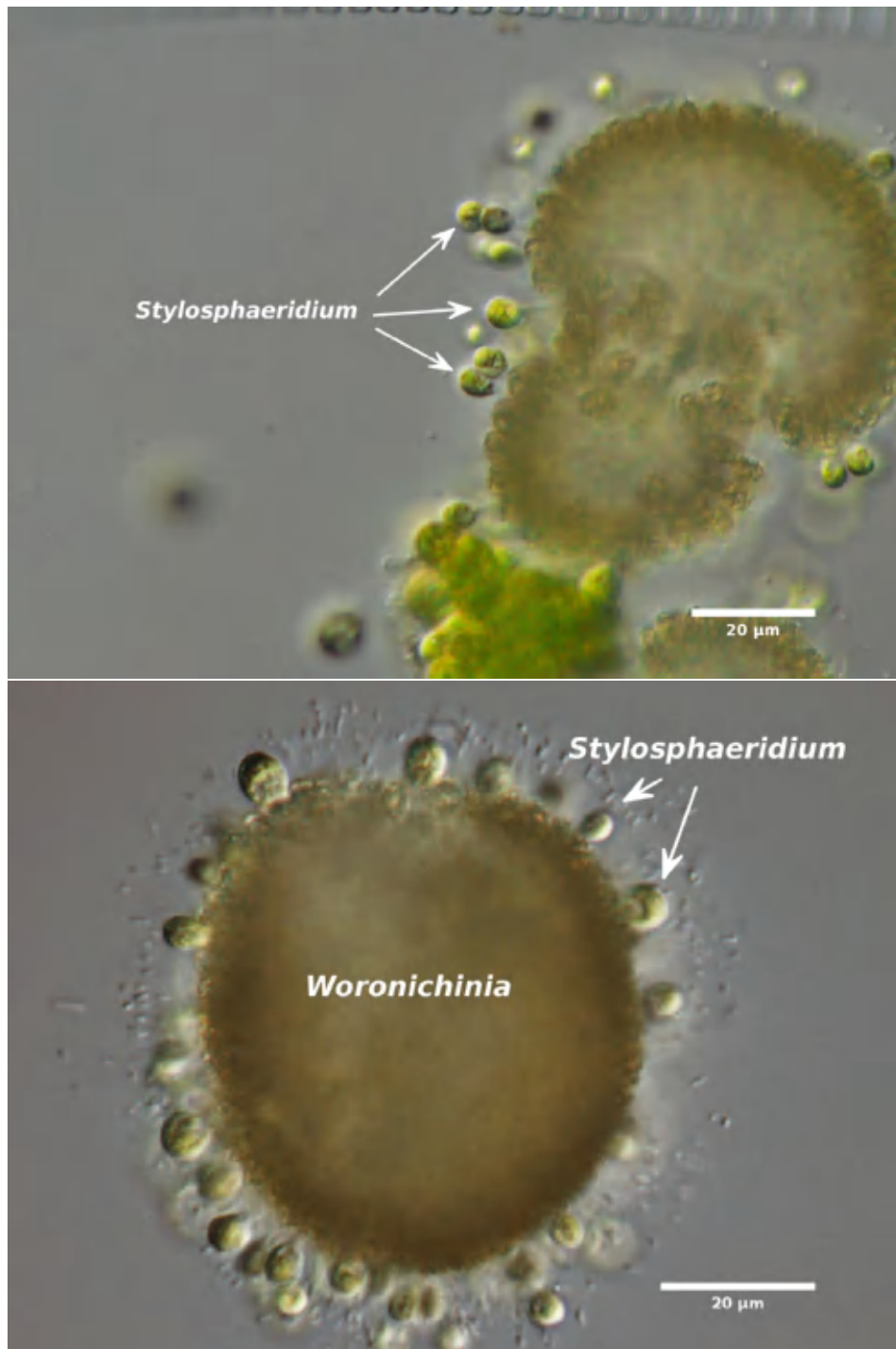


Figure 17: Chlorophyta - upper image: *Stylosphaeridium stipitatum* epiphyte on *Woronichinia* (600x DIC), July 9, 2019; lower image: *Stylosphaeridium stipitatum* epiphyte on *Woronichinia* (600x DIC), Lake Ketchum, Snohomish County, July 15, 2013.

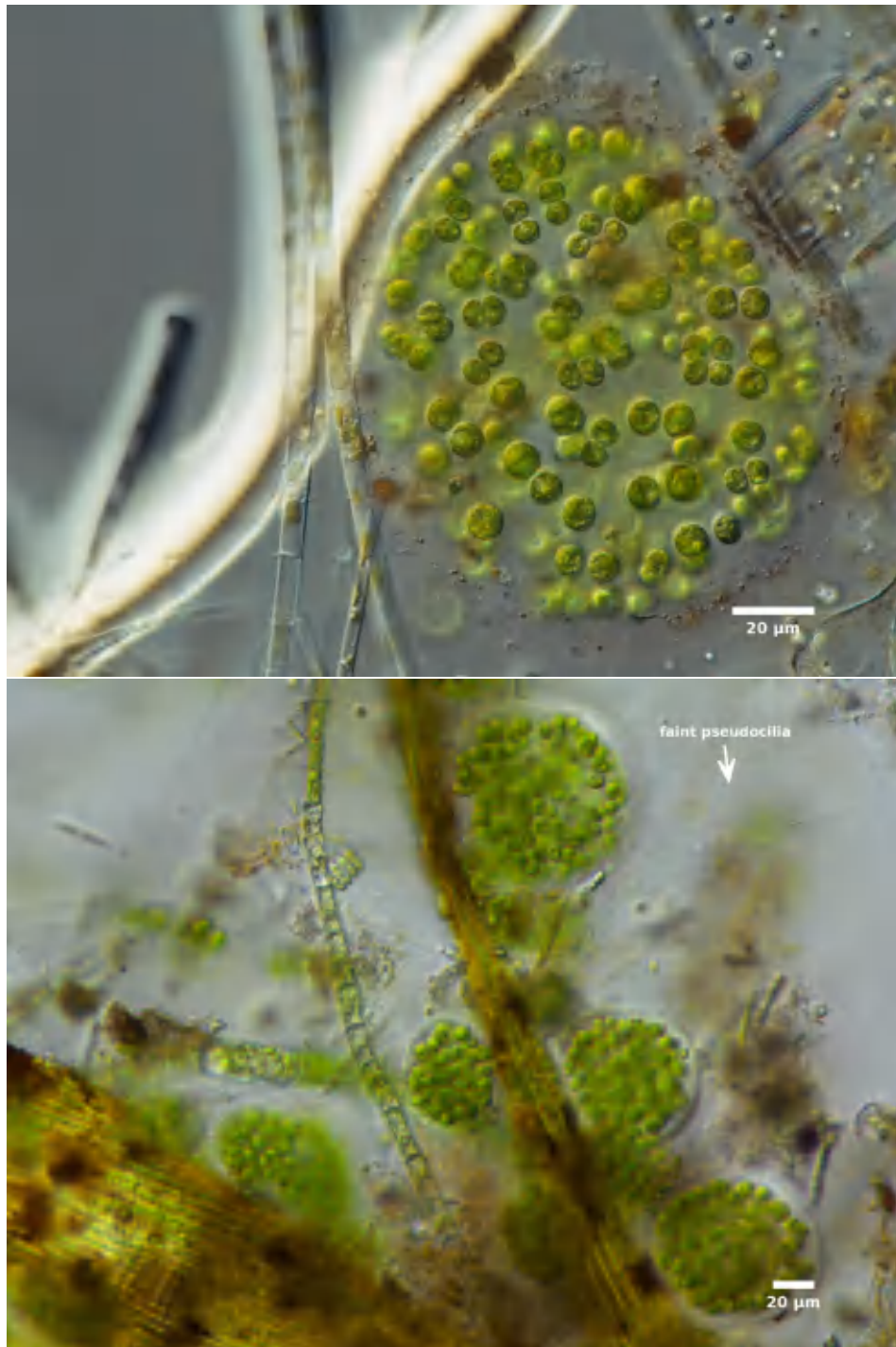


Figure 18: Chlorophyta - upper image: *Tetraspora lemmermannii*? (400x DIC), June 12, 2019; lower image: *Tetraspora lemmermannii*? (200x DIC), small pond near Fairhaven Park, Whatcom County, April 13, 2015.

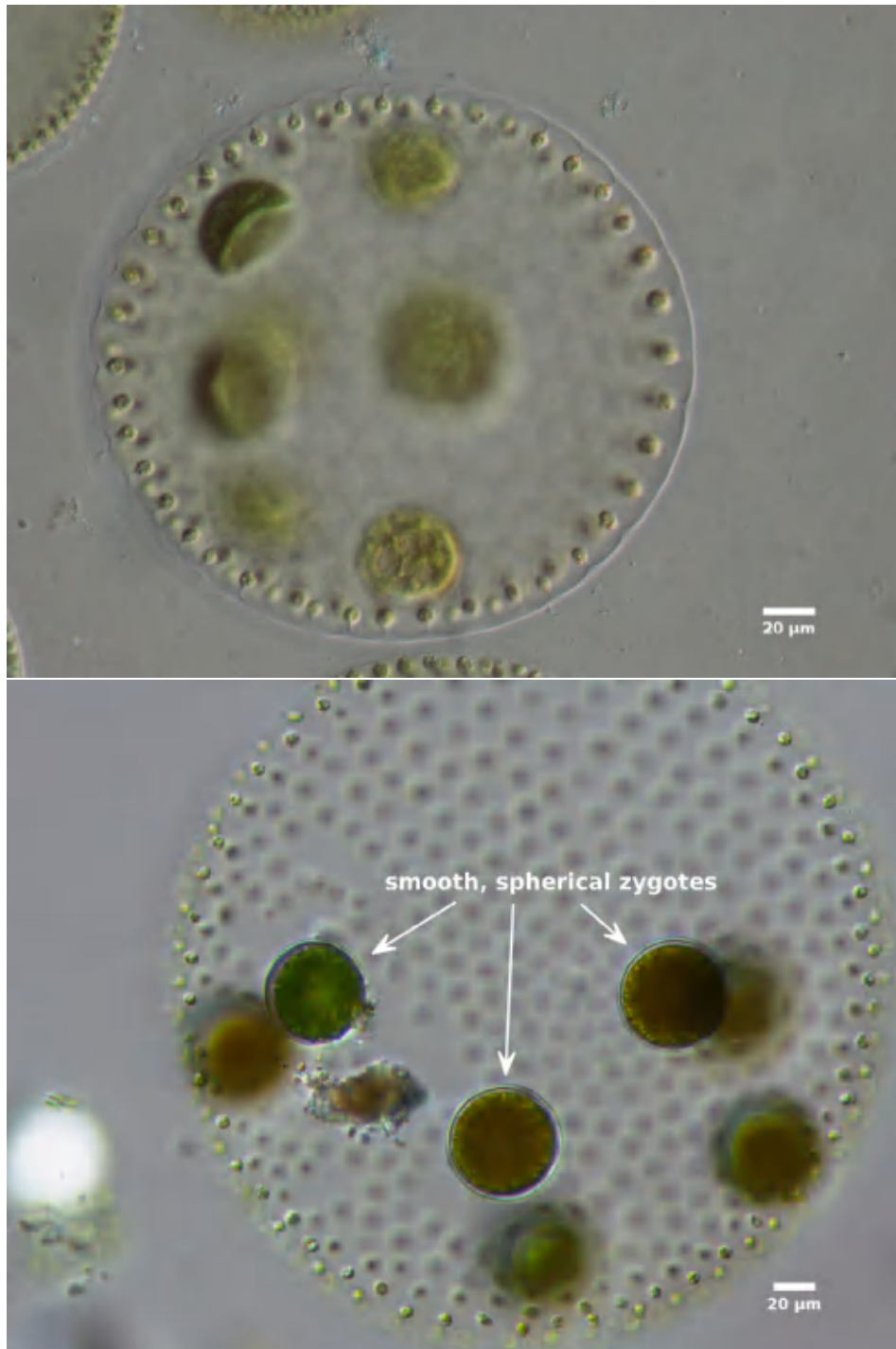


Figure 19: Chlorophyta - upper image: *Volvox aureus* (600x DIC), July 23, 2013; lower image: *Volvox aureus* zygotes (600x DIC), Myrtle Lake, Snohomish County, September 17, 2014.

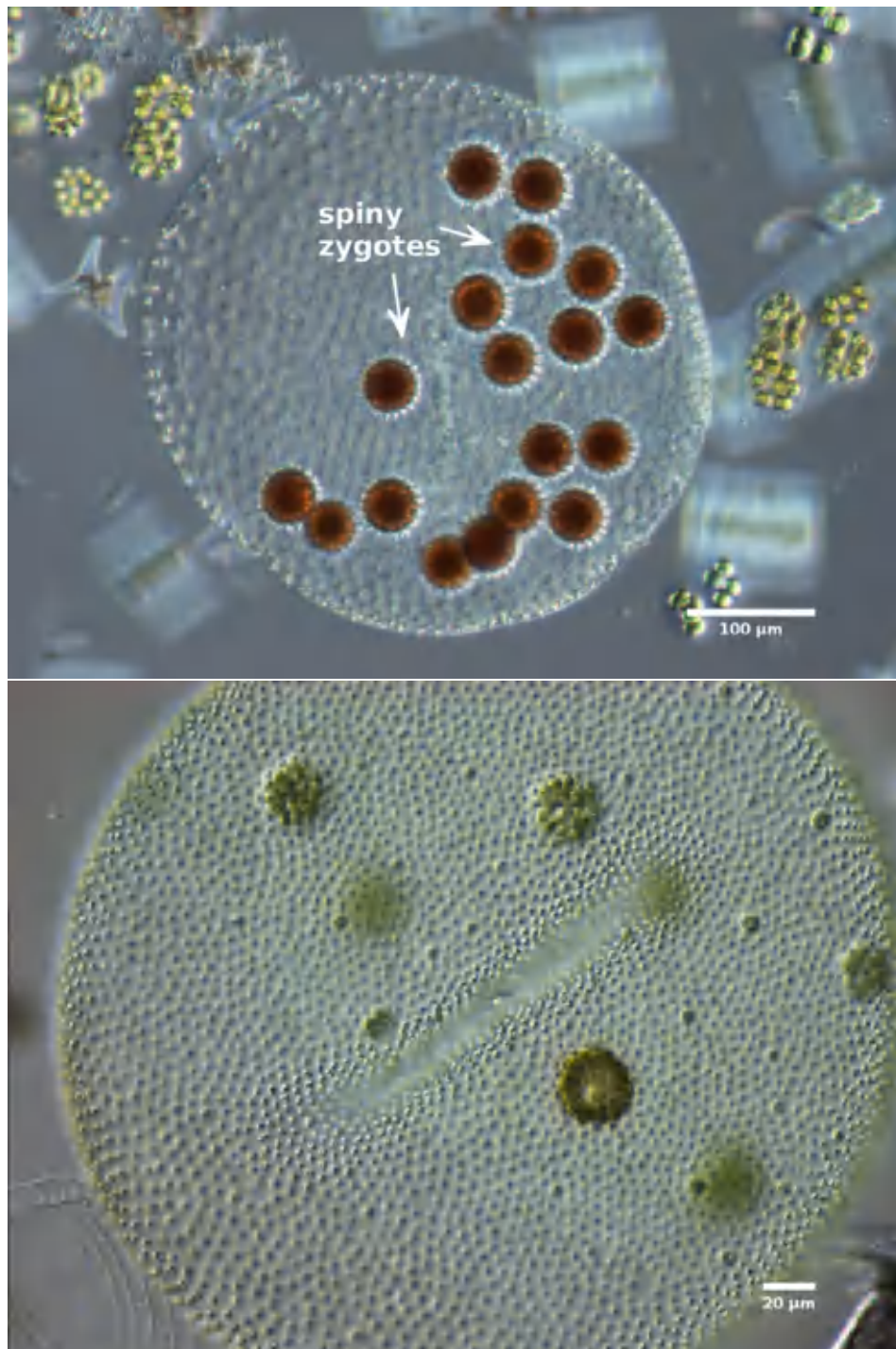


Figure 20: Chlorophyta - upper image: *Volvox globator* zygotes (100x DIC), July 22, 2013; lower image: *Volvox globator* (200x DIC), Vogler Lake, Skagit County, September 9, 2009.

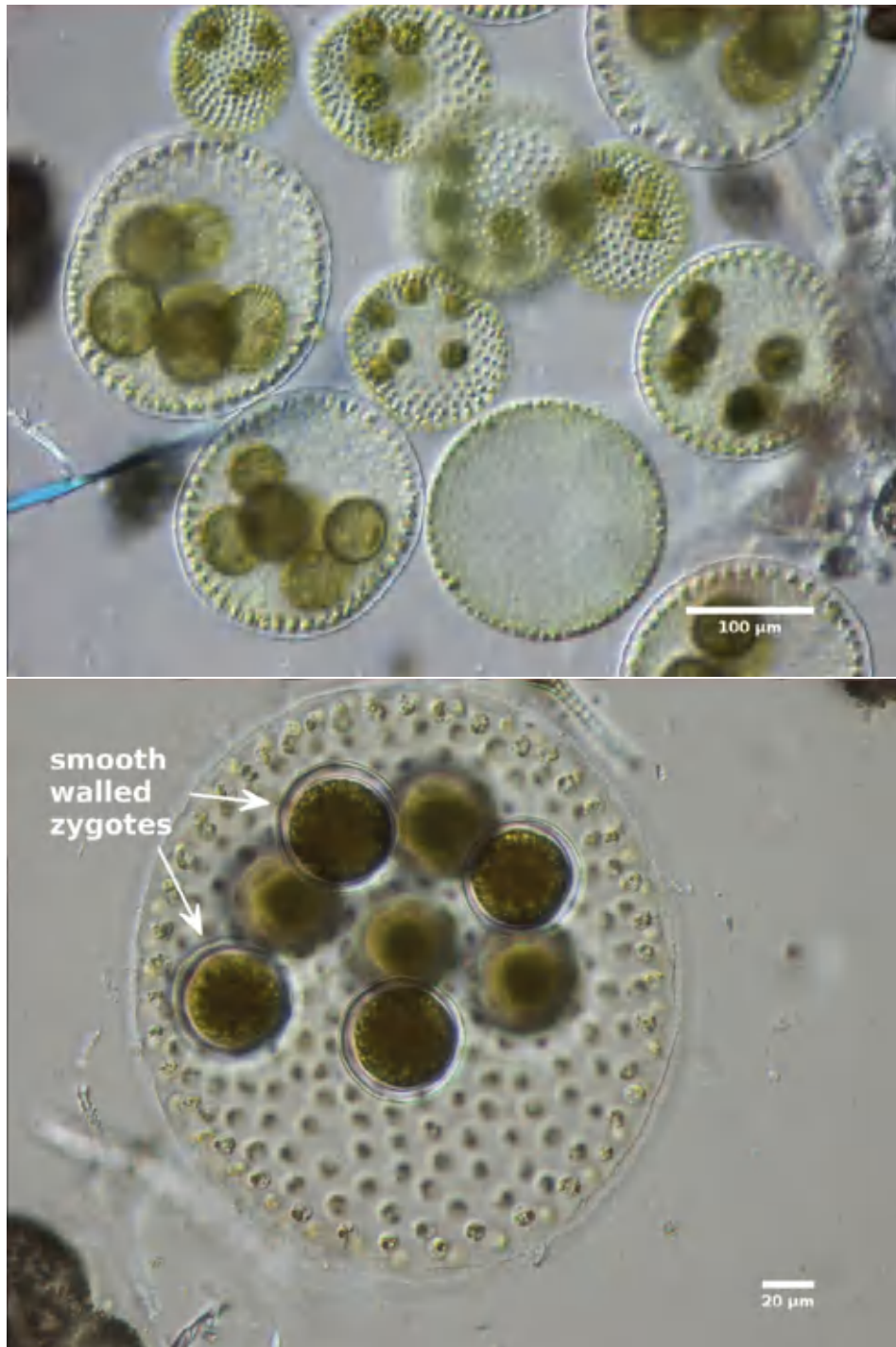


Figure 21: Chlorophyta - upper image: *Volvox tertius* bloom (100x DIC), October 1, 2009; lower image: *Volvox tertius* zygotes (200x DIC), October 1, 2009.



Figure 22: Chlorophyta/Streptophyta (desmid) - upper image: *Closterium acutum* var. *variable* (400x DIC), July 9, 2019 ; lower image: *Closterium acutum* var. *variable* (400x DIC), October 29, 2019.



Figure 23: Chlorophyta/Streptophyta (desmid) - upper image: *Closterium* (200x DIC), July 9, 2019; lower image: *Closterium* (400x DIC), June 12, 2019.

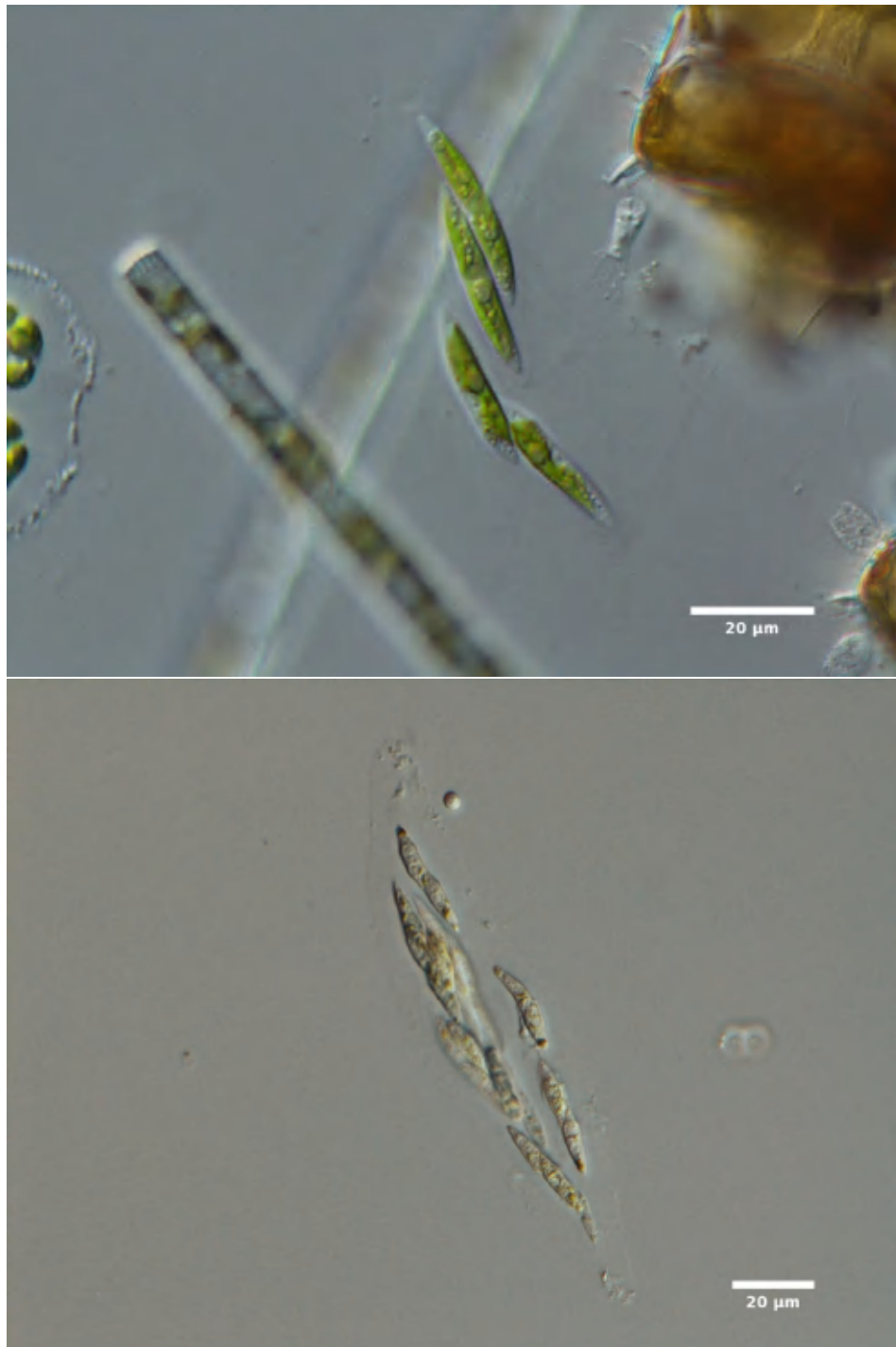


Figure 24: Chlorophyta/Streptophyta - upper image: *Elakatothrix gelatinosa* (600x DIC), October 29, 2019; lower image: *Elakatothrix gelatinosa* (400x DIC), October 2, 2019.

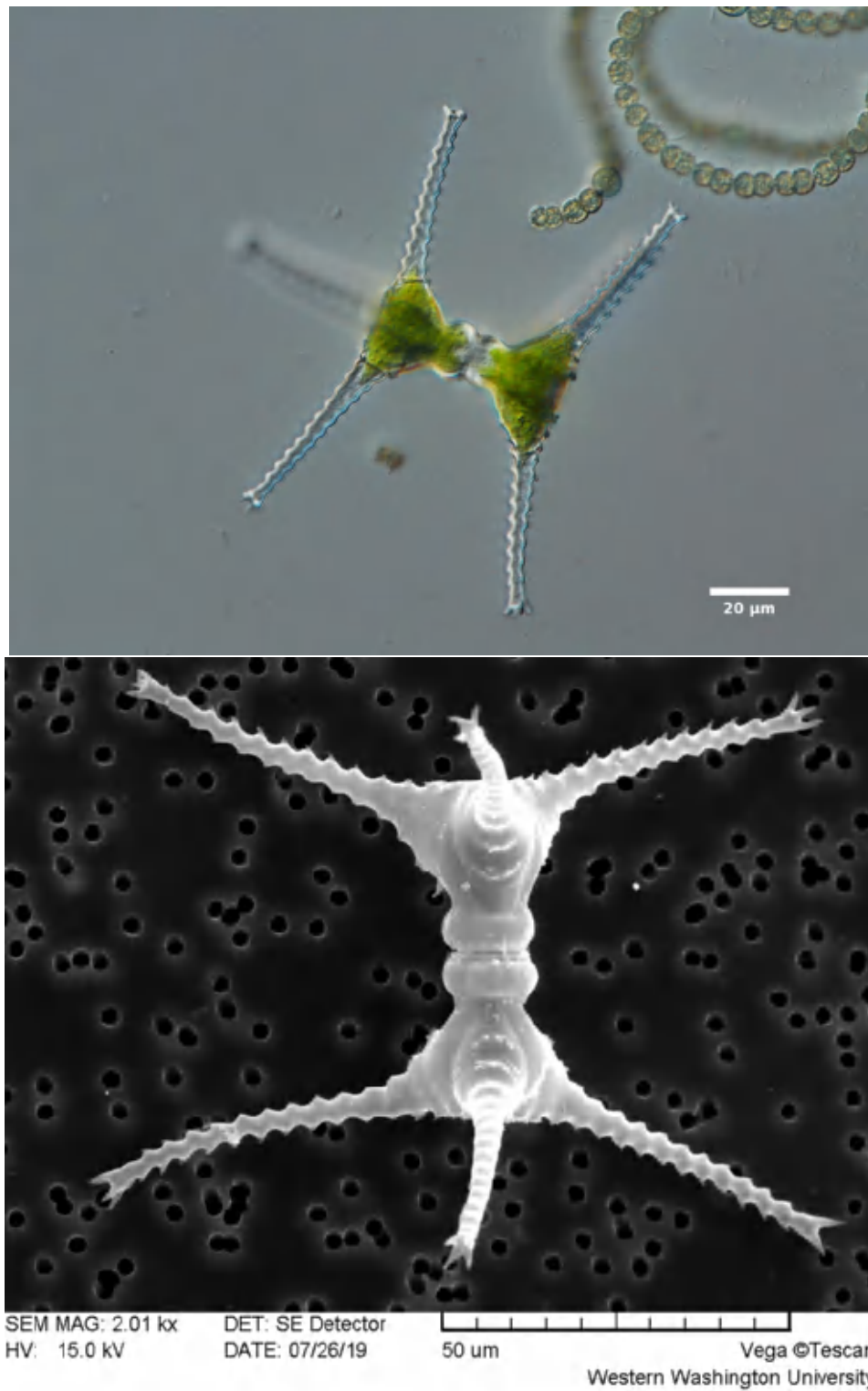


Figure 25: Chlorophyta/Streptophyta (desmid)- upper image: *Staurastrum pingue* var. *planctonicum* (400x DIC), July 9, 2019; lower image: *Staurastrum pingue* var. *planctonicum* (SEM), June 12, 2019.

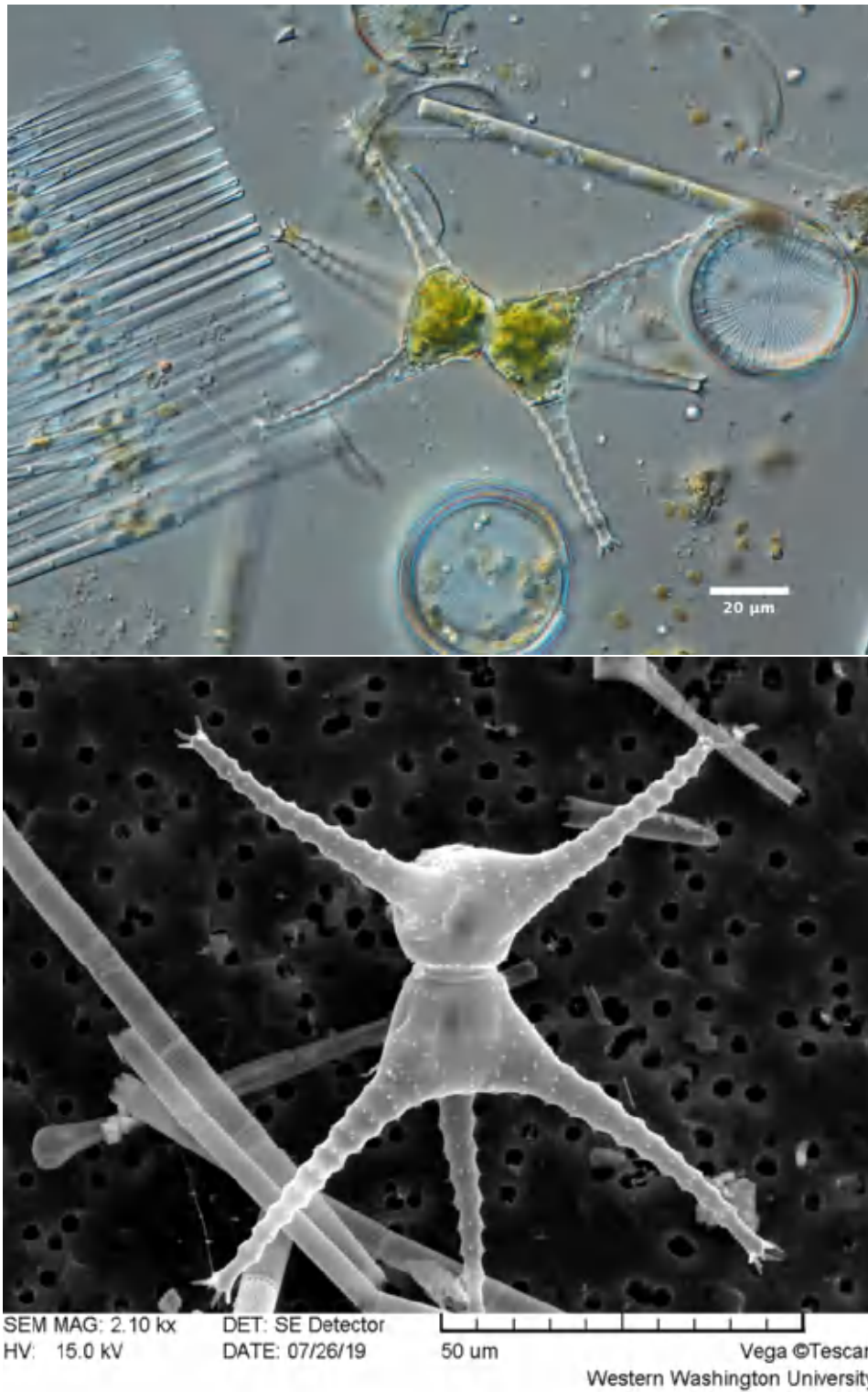


Figure 26: Chlorophyta/Streptophyta (desmid) - upper image: *Staurastrum cingulum* (400x DIC), June 13, 2019; lower image: *Staurastrum cingulum* (SEM), June 13, 2019.

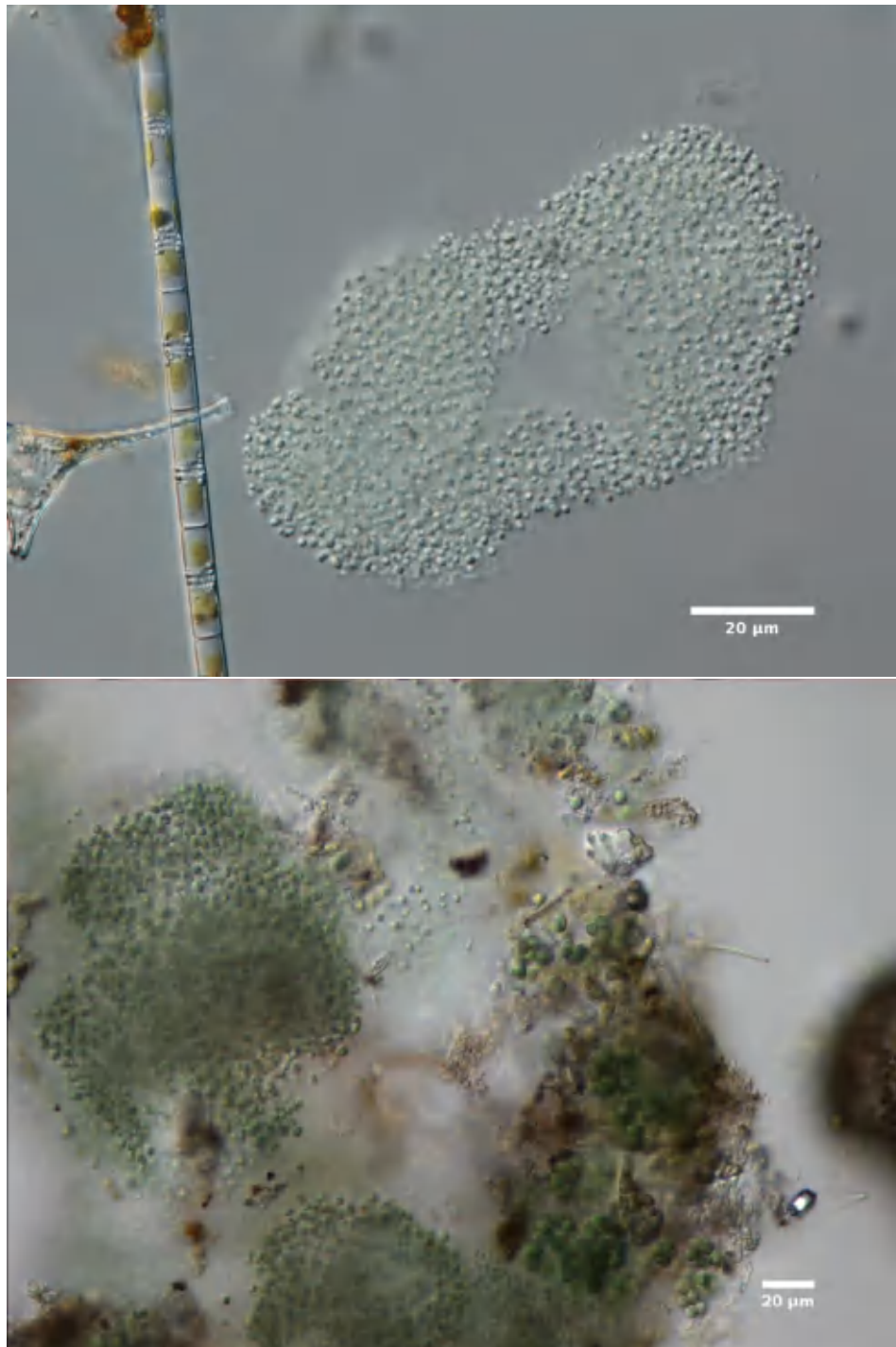


Figure 27: Cyanobacteria - upper image: *Aphanocapsa* (600x DIC), June 12, 2019; lower image: *Aphanocapsa* and *Aphanothece* (200x DIC), September 30, 2009.

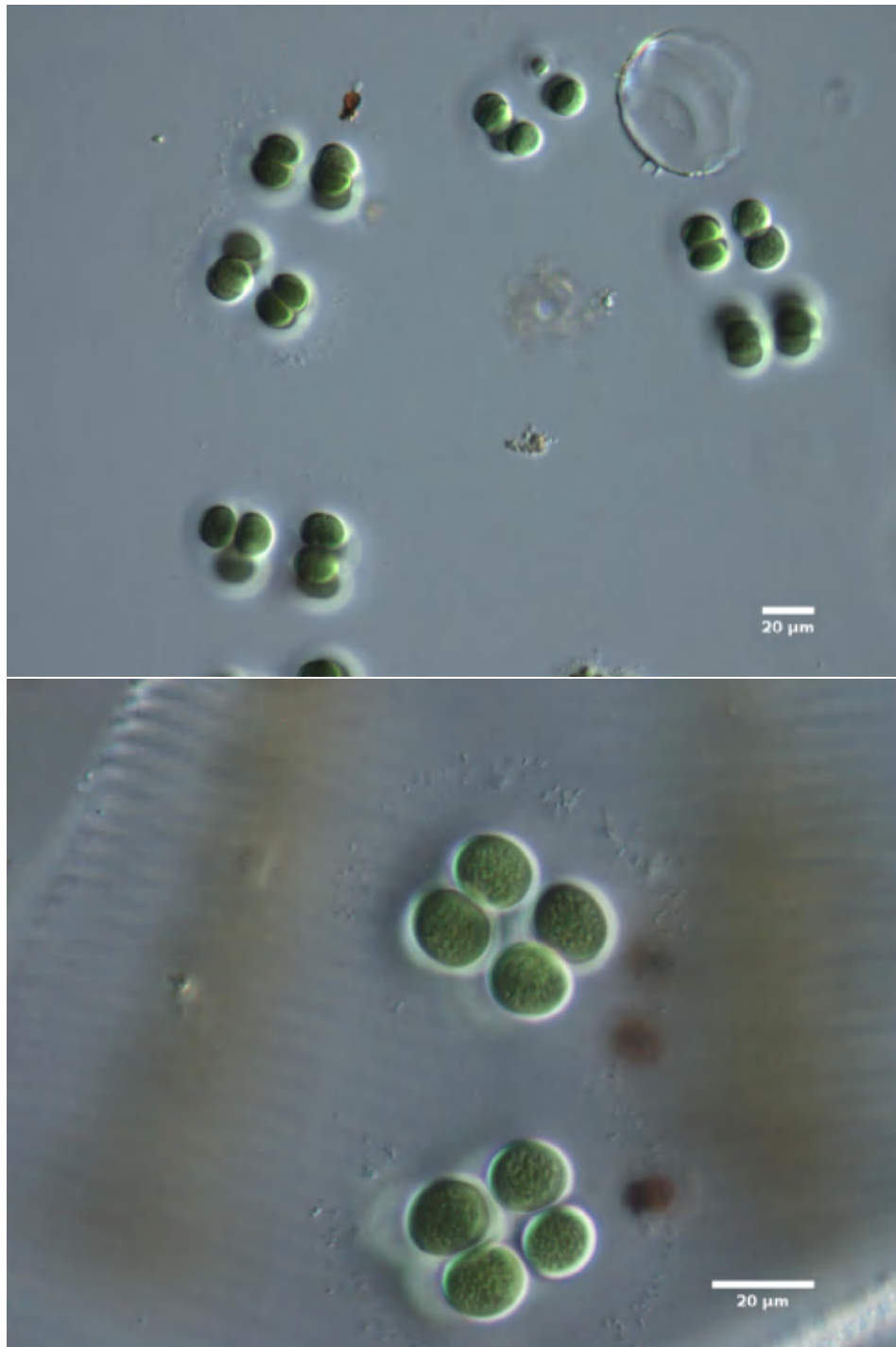


Figure 28: Cyanobacteria - upper images: *Chroococcus* (200x DIC), July 22, 2013; lower image: *Chroococcus* (400x DIC), July 22, 2013.

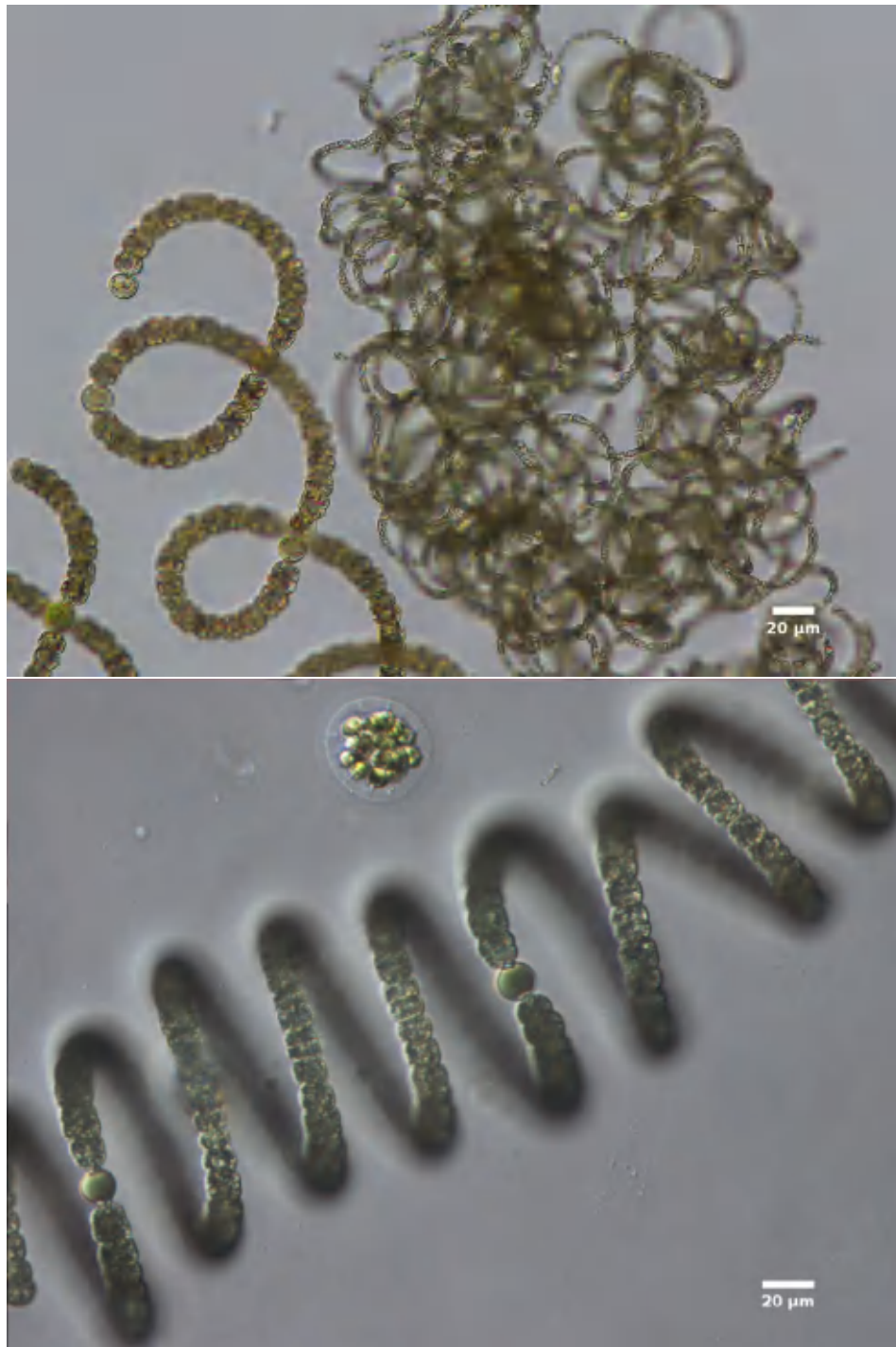


Figure 29: Cyanobacteria - upper images: Two species of *Dolichospermum* (200x DIC), August 2, 2017; lower image: *Dolichospermum crassum* (200x DIC), August 25, 2009.



Figure 30: Cyanobacteria - upper images: *Gloeotrichia echinulata* colonies (100x DIC), June 13, 2019; lower image: *Gloeotrichia echinulata* trichomes (200x DIC), June 13, 2019.

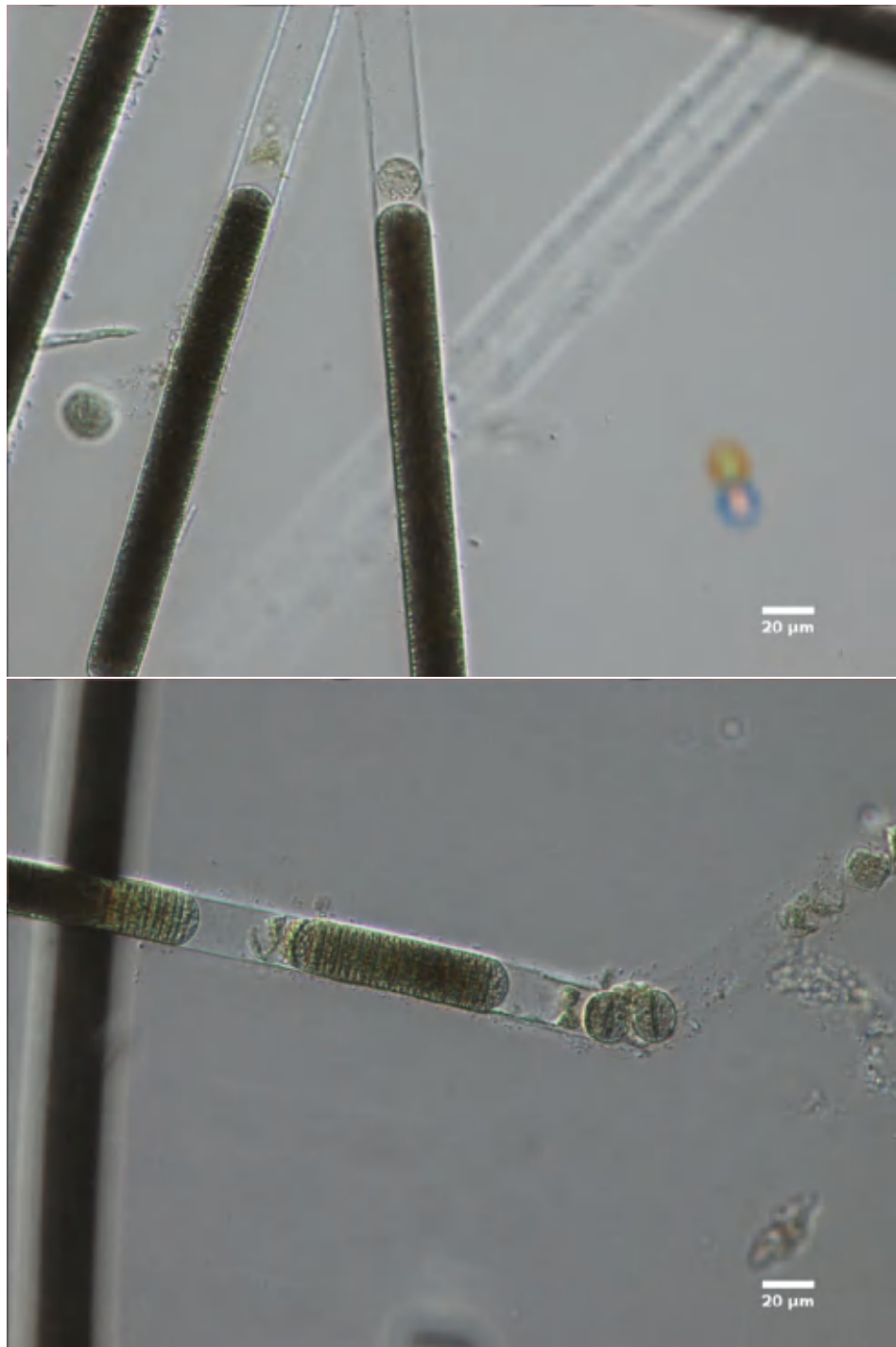


Figure 31: Cyanobacteria - upper/lower images: *Limnoraphis birgei* (200x DIC), August 28, 2008. Note presence of sheath surrounding trichome.

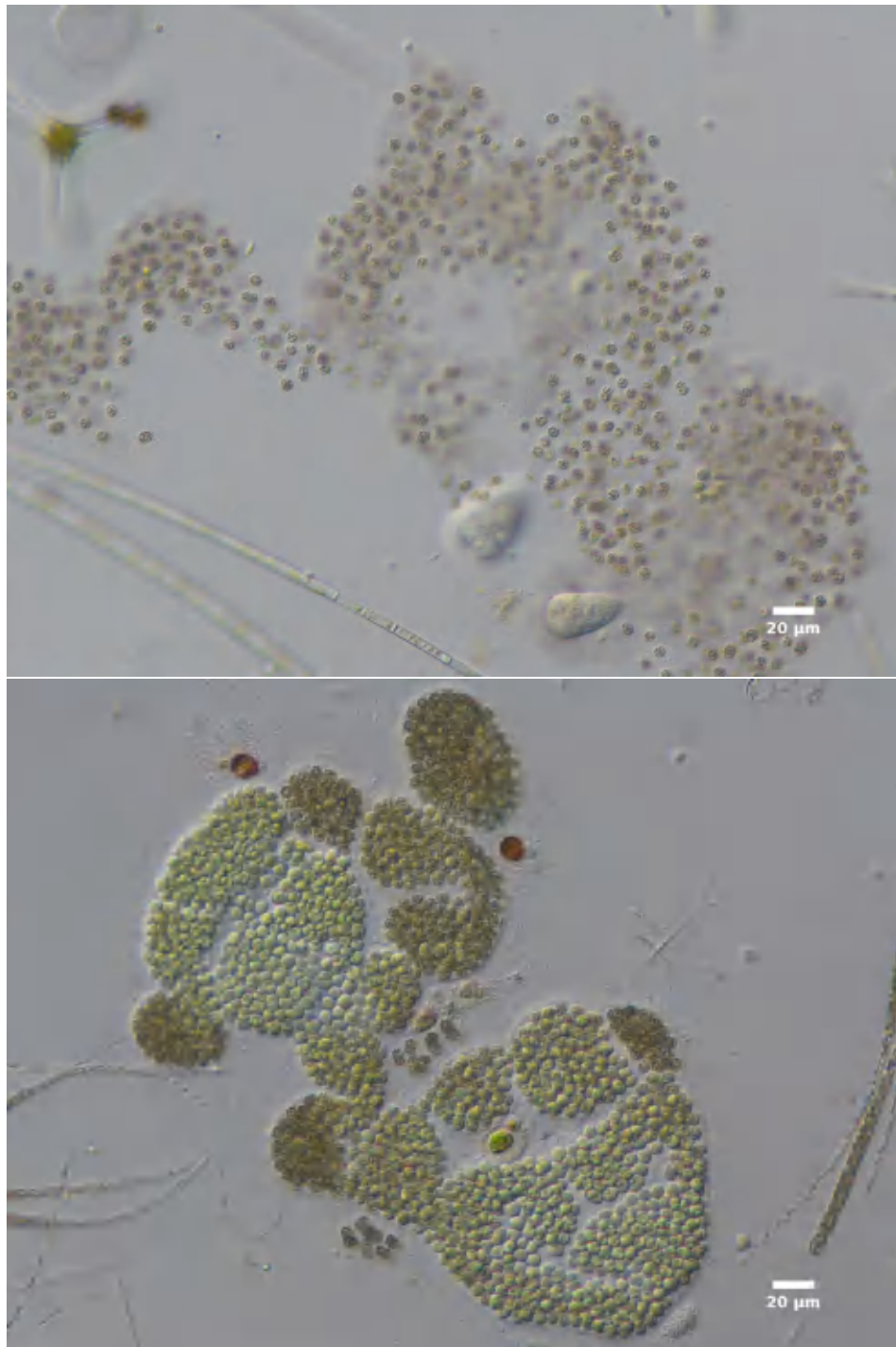


Figure 32: Cyanobacteria - upper image: *Microcystis aeruginosa* (200x DIC), June 12, 2019; lower image: Decomposing *Microcystis aeruginosa* colony (200x DIC), June 13, 2019.

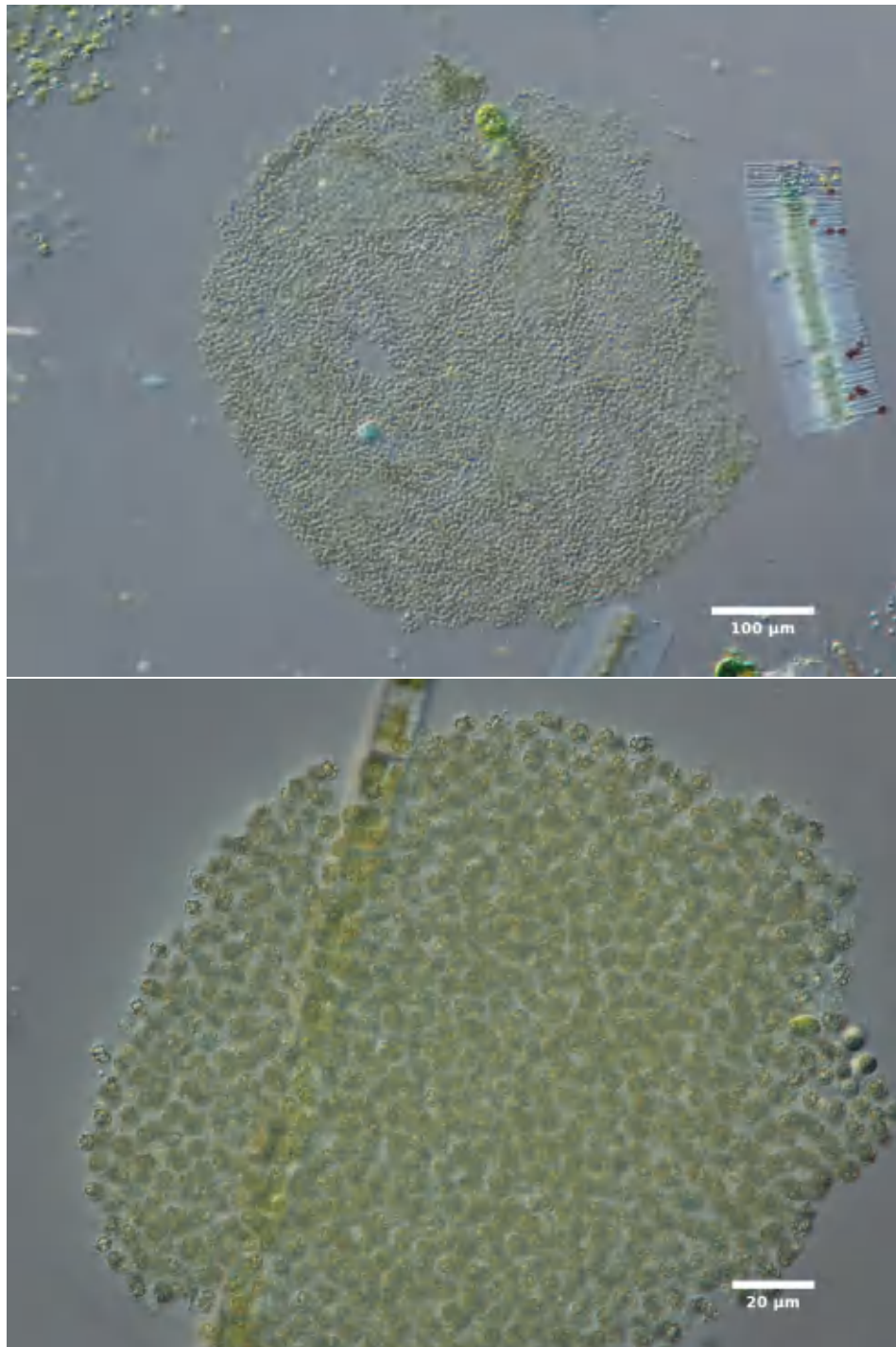


Figure 33: Cyanobacteria - upper image: *Microcystis flos-aquae*? (100x DIC), July 9, 2019; lower image: *Microcystis flos-aquae*? (400x DIC), July 9, 2019. Note tiny, densely arranged cells in spherical colony.

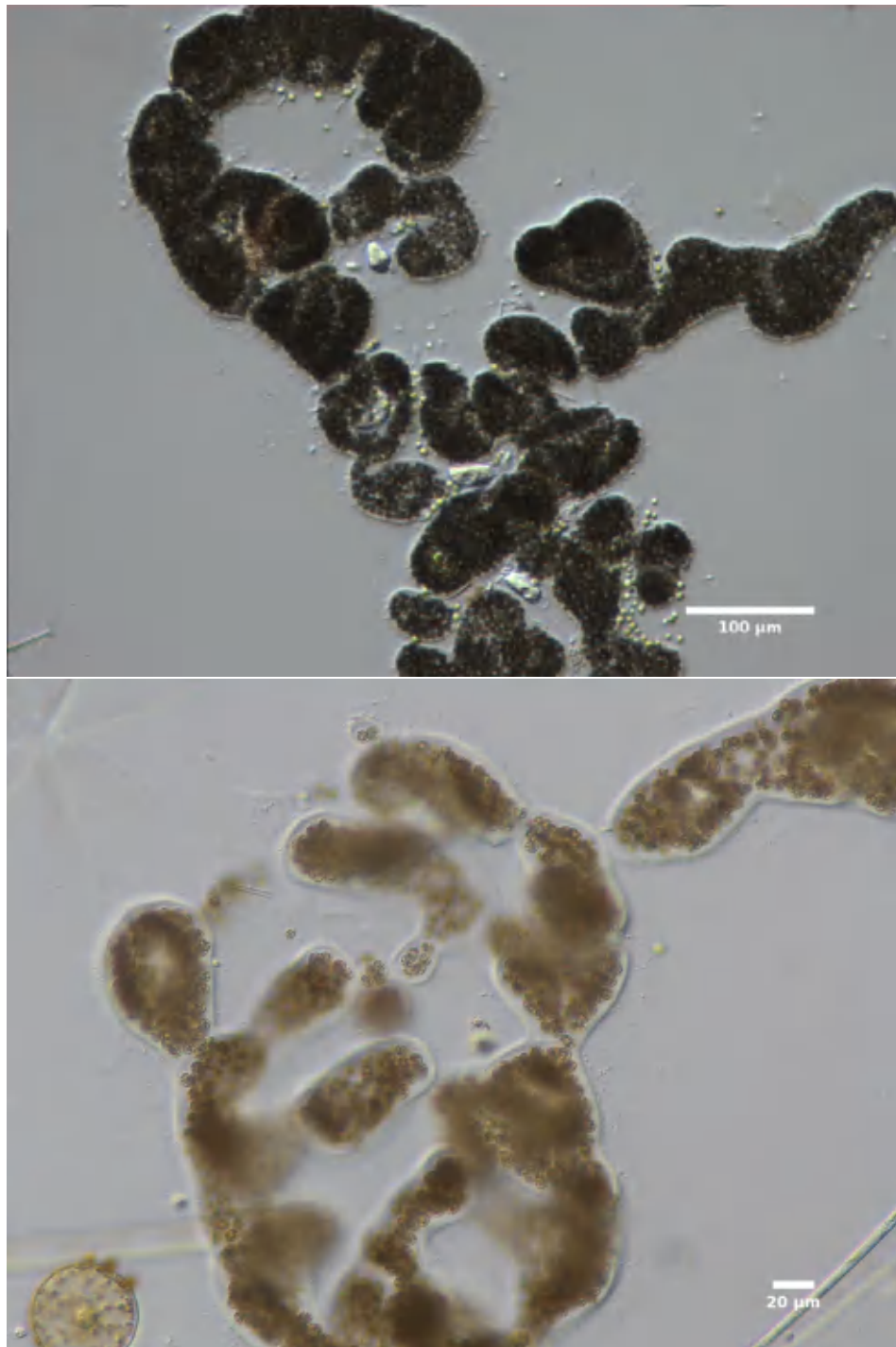


Figure 34: Cyanobacteria - upper image: *Microcystis wesenbergii* (100x DIC), July 19, 2011; lower image: *Microcystis wesenbergii* (200x DIC), June 12, 2019.

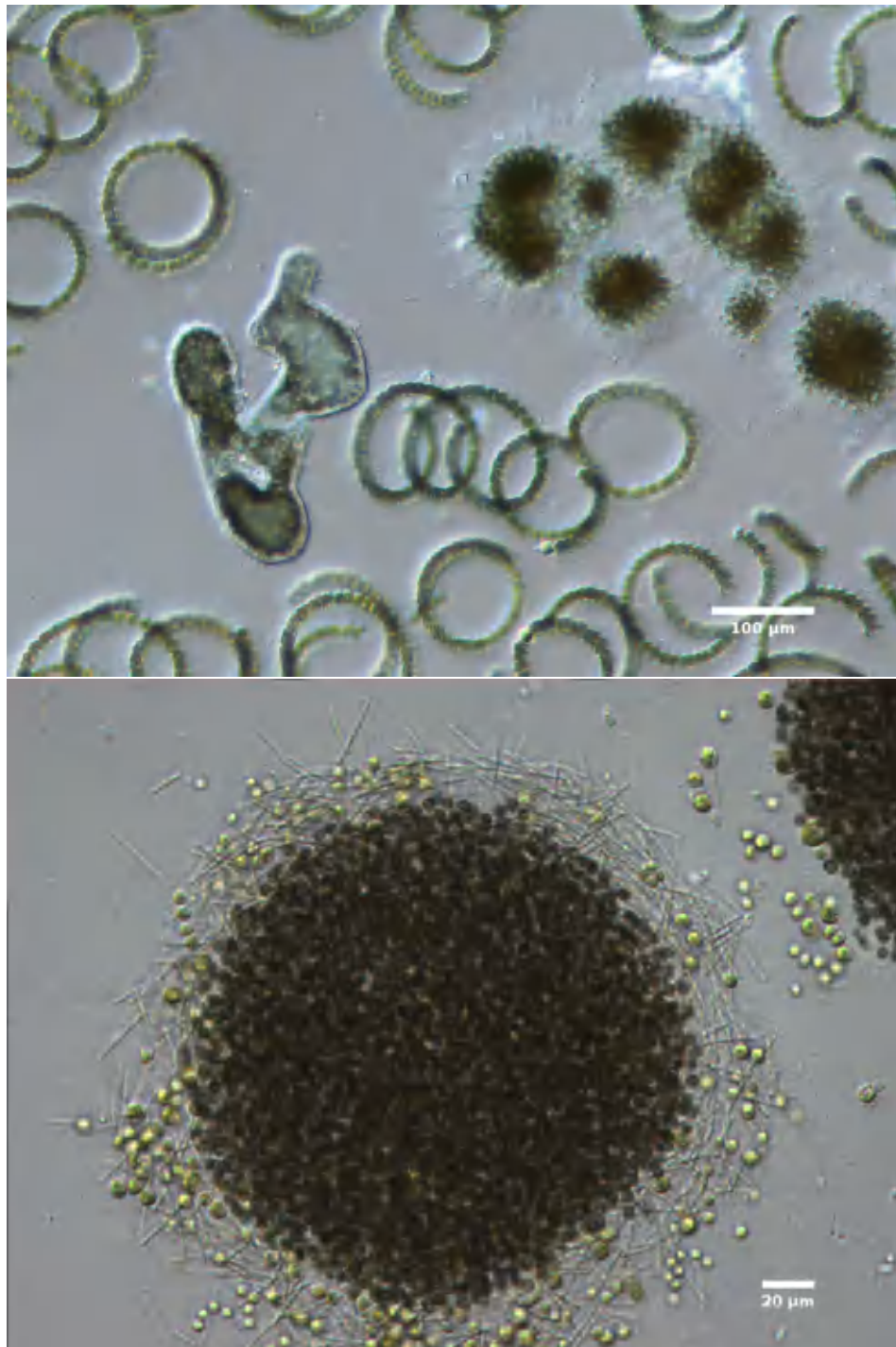


Figure 35: Cyanobacteria - upper image: *Microcystis aeruginosa* and *Microcystis wesenbergii* (100x DIC), August 4, 2014; lower image: *Microcystis* epiphytes - *Pseudanabaena* and inactive *Chlamydomonas* (200x DIC), July 19, 2011.

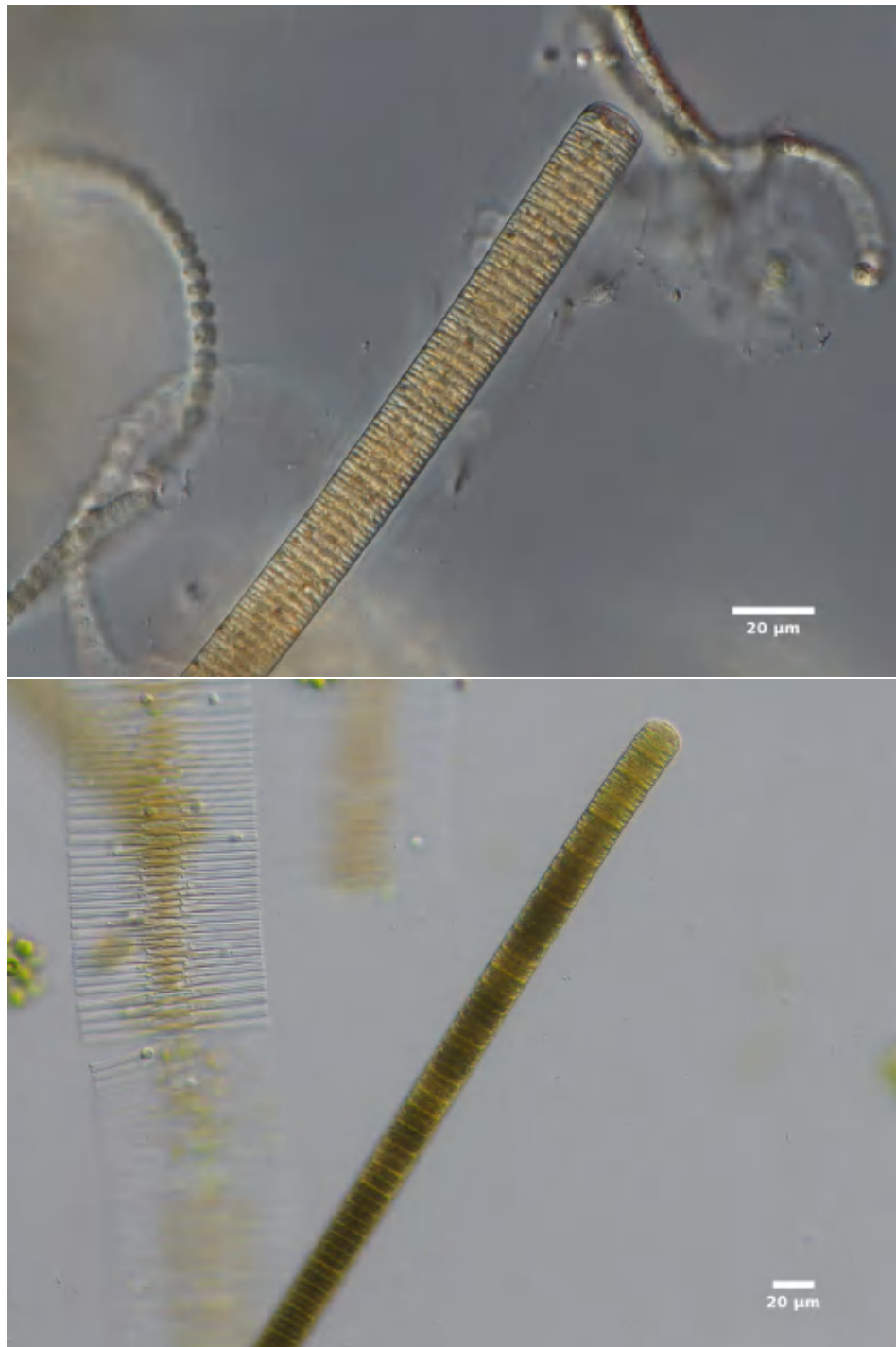


Figure 36: Cyanobacteria - upper image: *Oscillatoria* (400x DIC), October 2, 2019; lower image: *Oscillatoria* (200x DIC), July 9, 2019. Note absence of sheath surrounding trichome.



Figure 37: Cyanobacteria - upper image: *Phormidium* (200x DIC), September 30, 2009; lower image: *Phormidium* (200x DIC), June 12, 2019.



Figure 38: Cyanobacteria - upper image: *Pseudanabaena mucicola* surrounding *Microcystis aeruginosa* (200x DIC), August 4, 2014; lower image: *Pseudanabaena mucicola* (600x DIC), August 4, 2014.

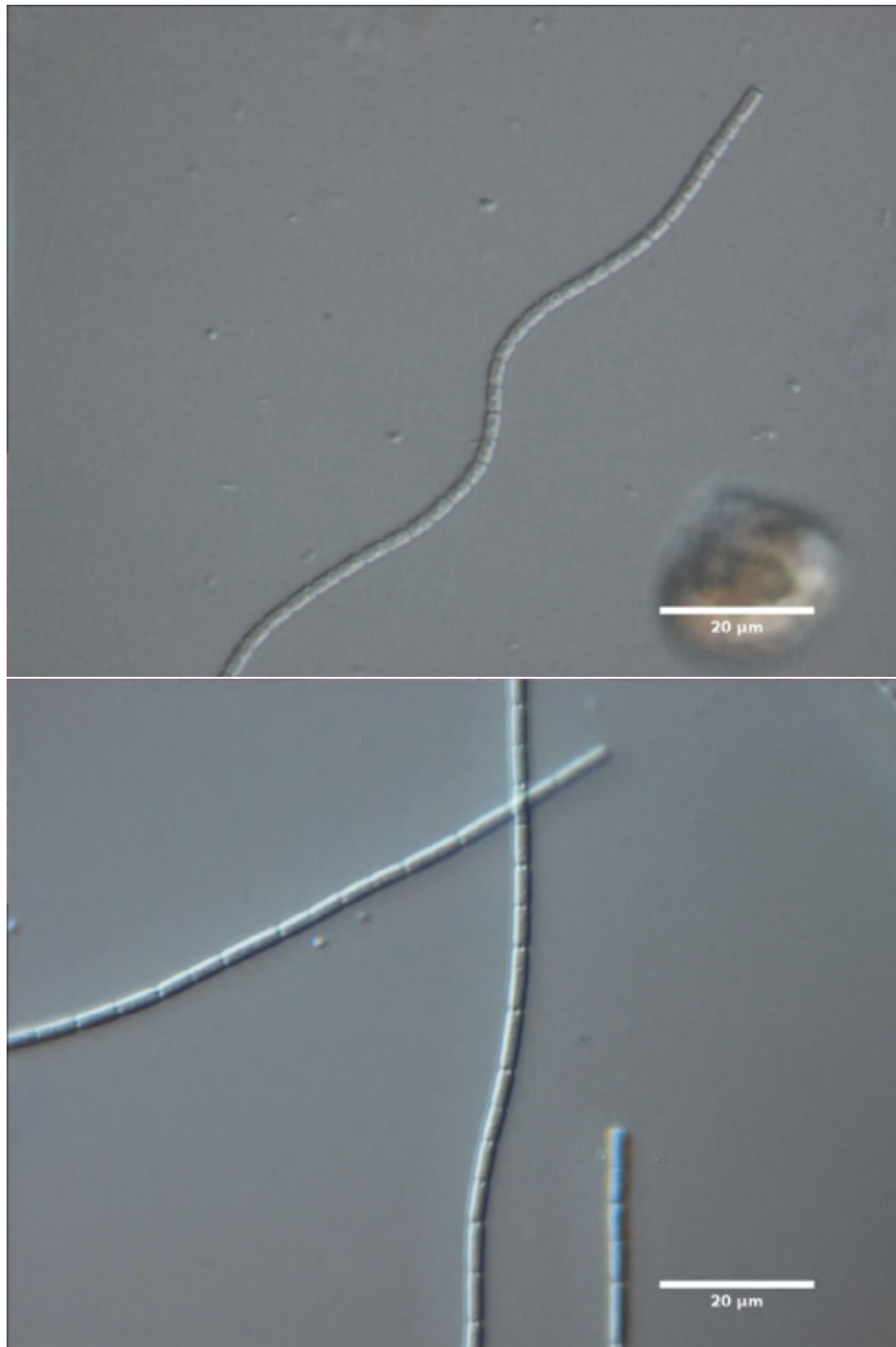


Figure 39: Cyanobacteria - upper image: *Pseudanabaena* (600x DIC), Lake Whatcom, Whatcom County, October 12, 2010; lower image: *Pseudanabaena* (600x DIC), Lake Fazon, Whatcom County, September 23, 2008.



Figure 40: Cyanobacteria - upper image: *Tolypothrix lanata* (200x DIC), September 30, 2009; lower image: *Tolypothrix lanata* (600x DIC), Tennant Lake, Whatcom County, June 22, 2017.

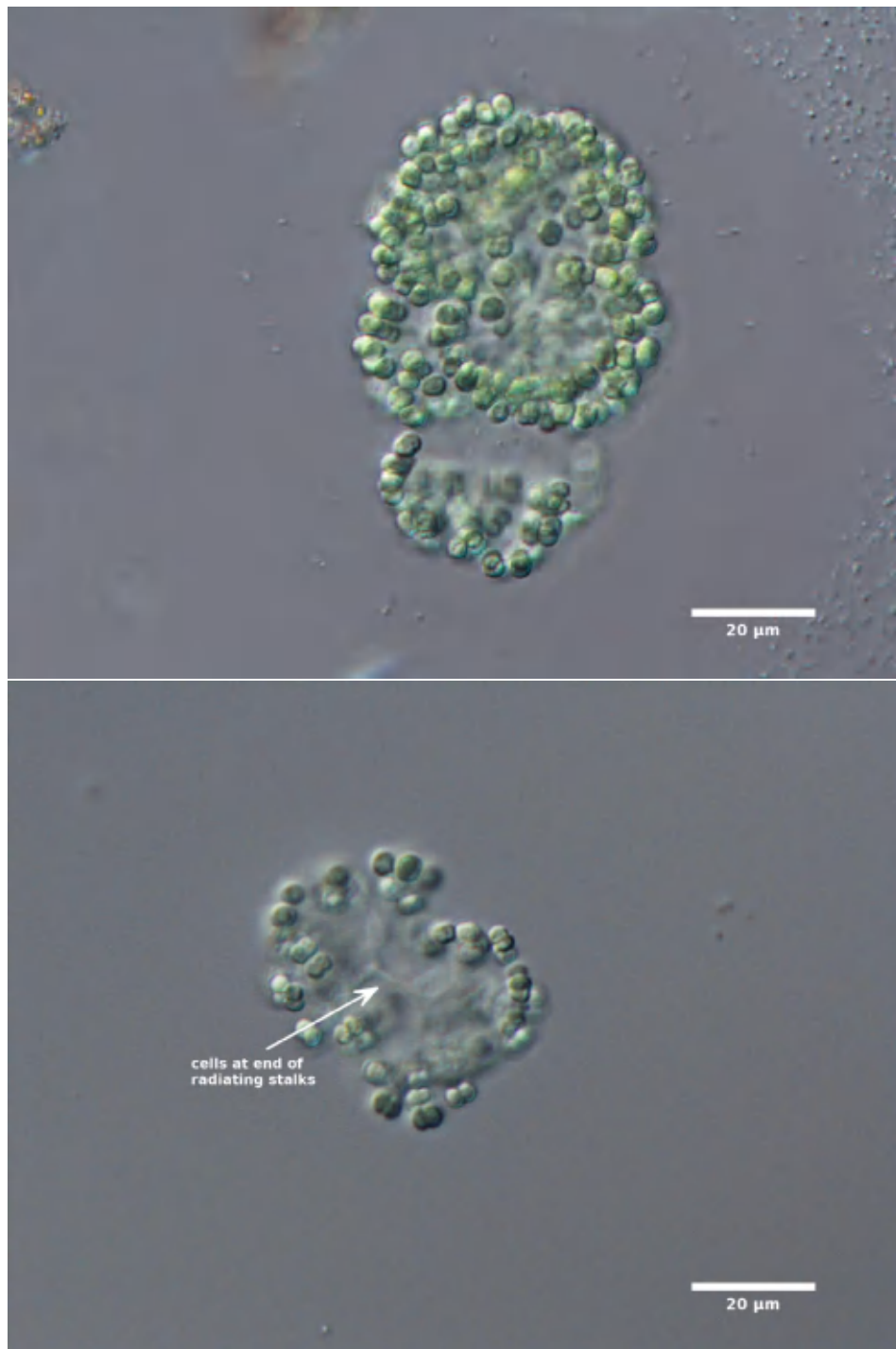


Figure 41: Cyanobacteria - upper image: *Woronichinia compacta*? (600x DIC), October 15, 2019; lower image: *Woronichinia compacta*? (600x DIC), October 29, 2019. Identification is based on presence of thick, radiating mucilage strands, these strands are absent in *Coelosphaerium* and are thinner in *Snowella*.

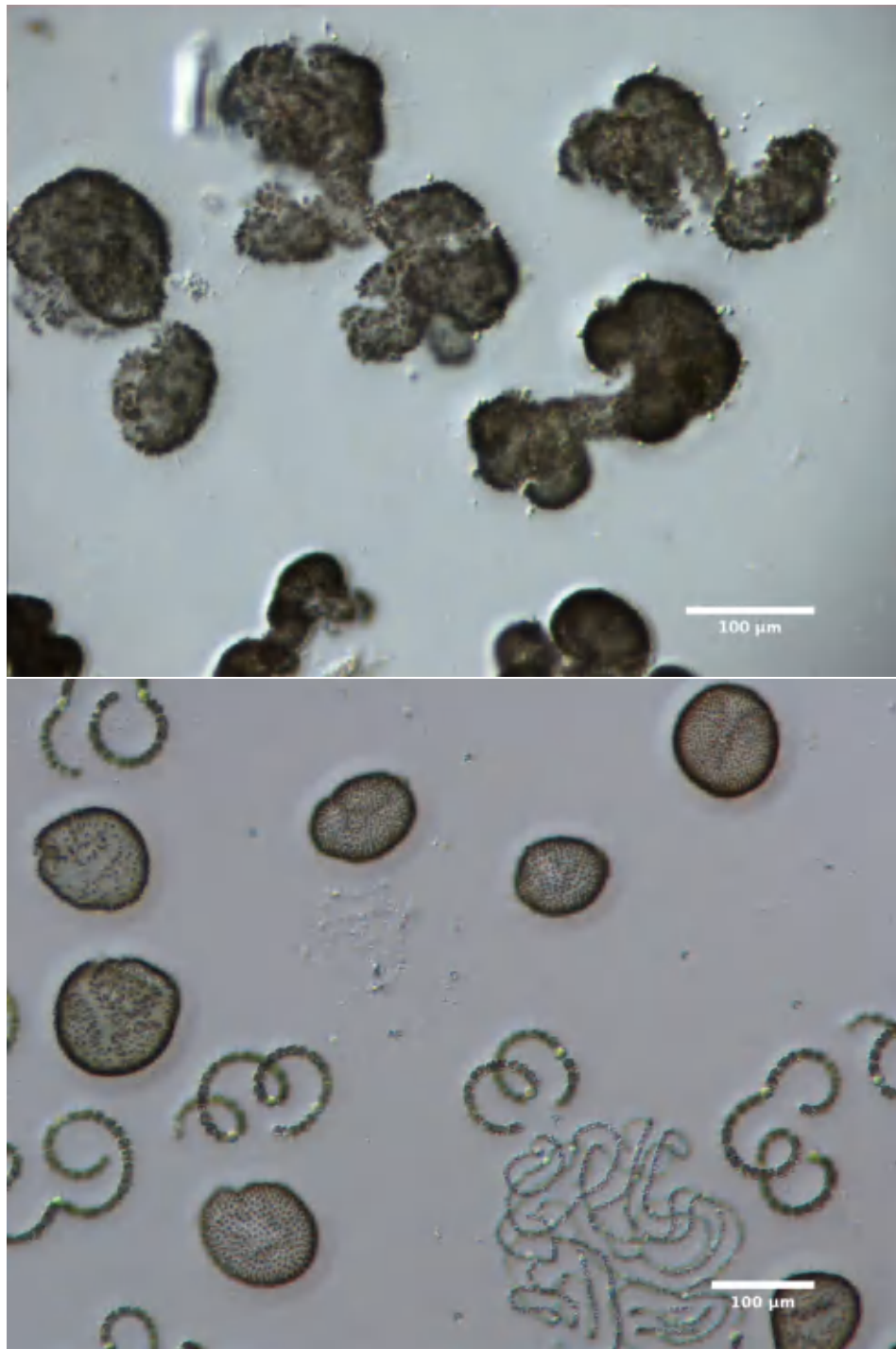


Figure 42: Cyanobacteria - upper image: *Woronichinia naegeliana* (100x DIC), September 30, 2009; lower image: *Woronichinia naegeliana* (100x DIC), Heart Lake, Skagit County, May 12, 2016.

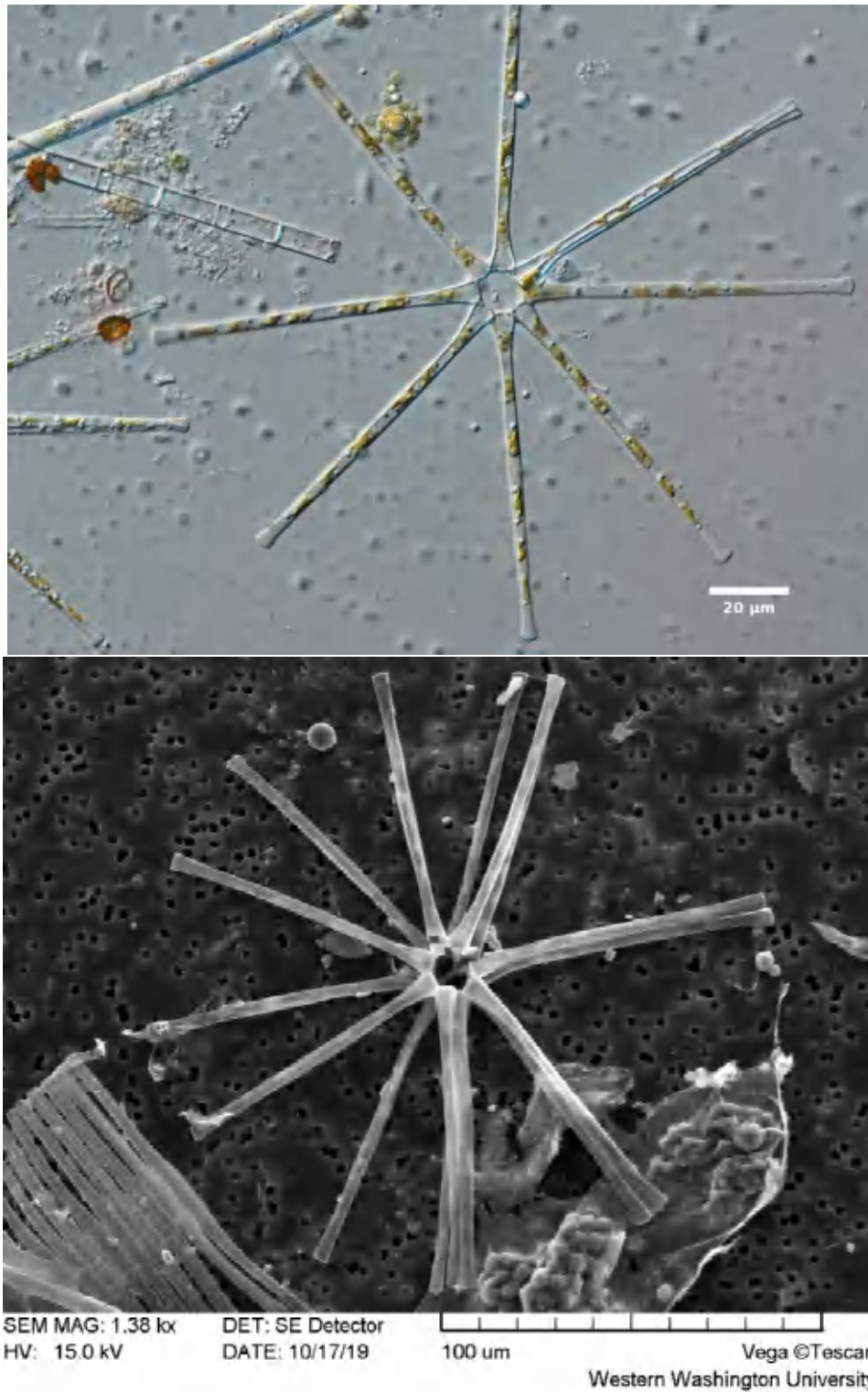


Figure 43: Other/Bacillariophyta - upper image: *Asterionella formosa* (SEM), July 9, 2019; lower image: *Asterionella formosa* (400x DIC), June 13, 2019.

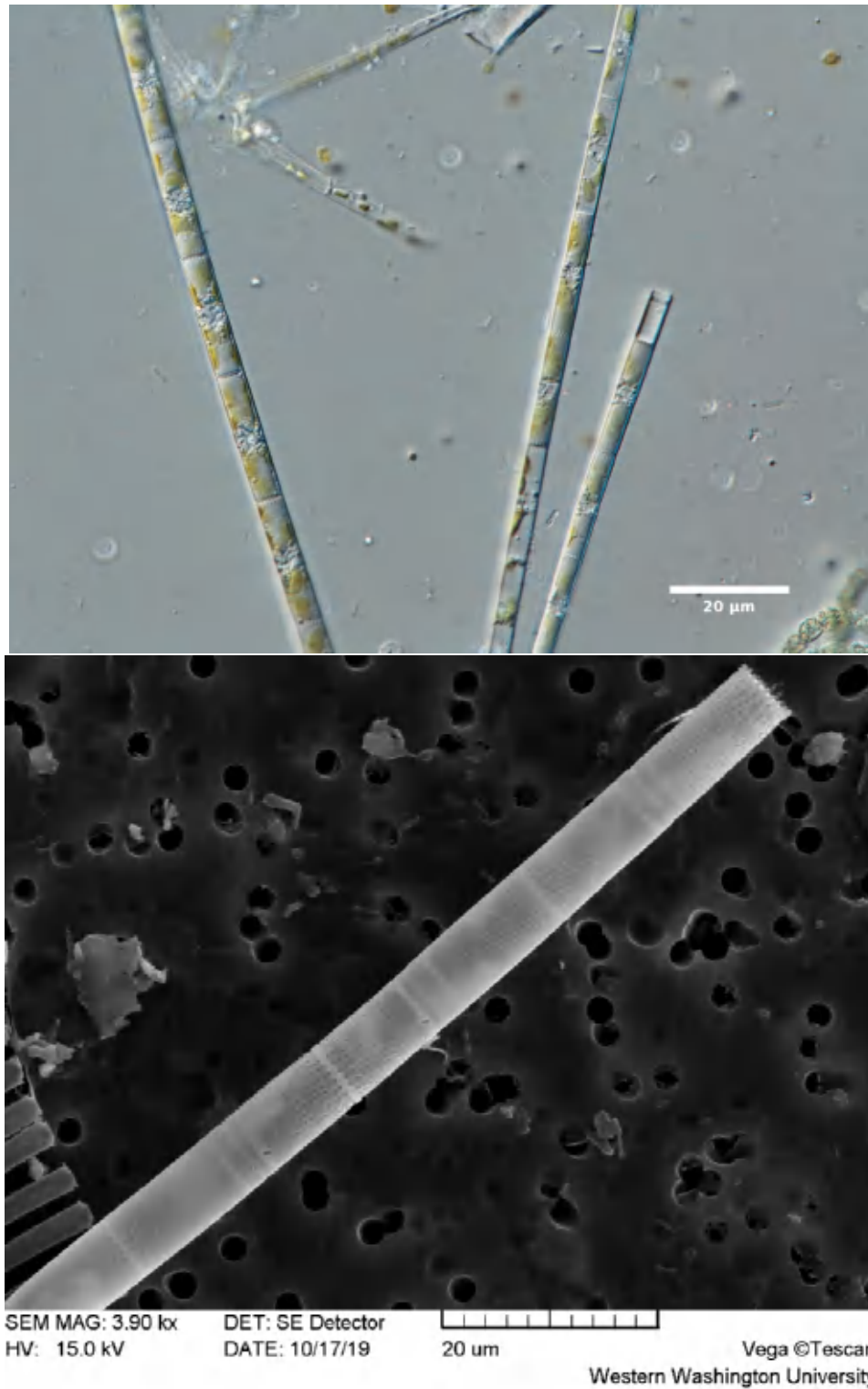


Figure 44: Other/Bacillariophyta - upper image: *Aulacoseira ambigua* (SEM), July 9, 2019; lower image: *Aulacoseira ambigua* (600x DIC), June 13, 2019.



Figure 45: Other/Bacillariophyta - upper/lower images: *Eunotia* (600s DIC), October 2, 2019.

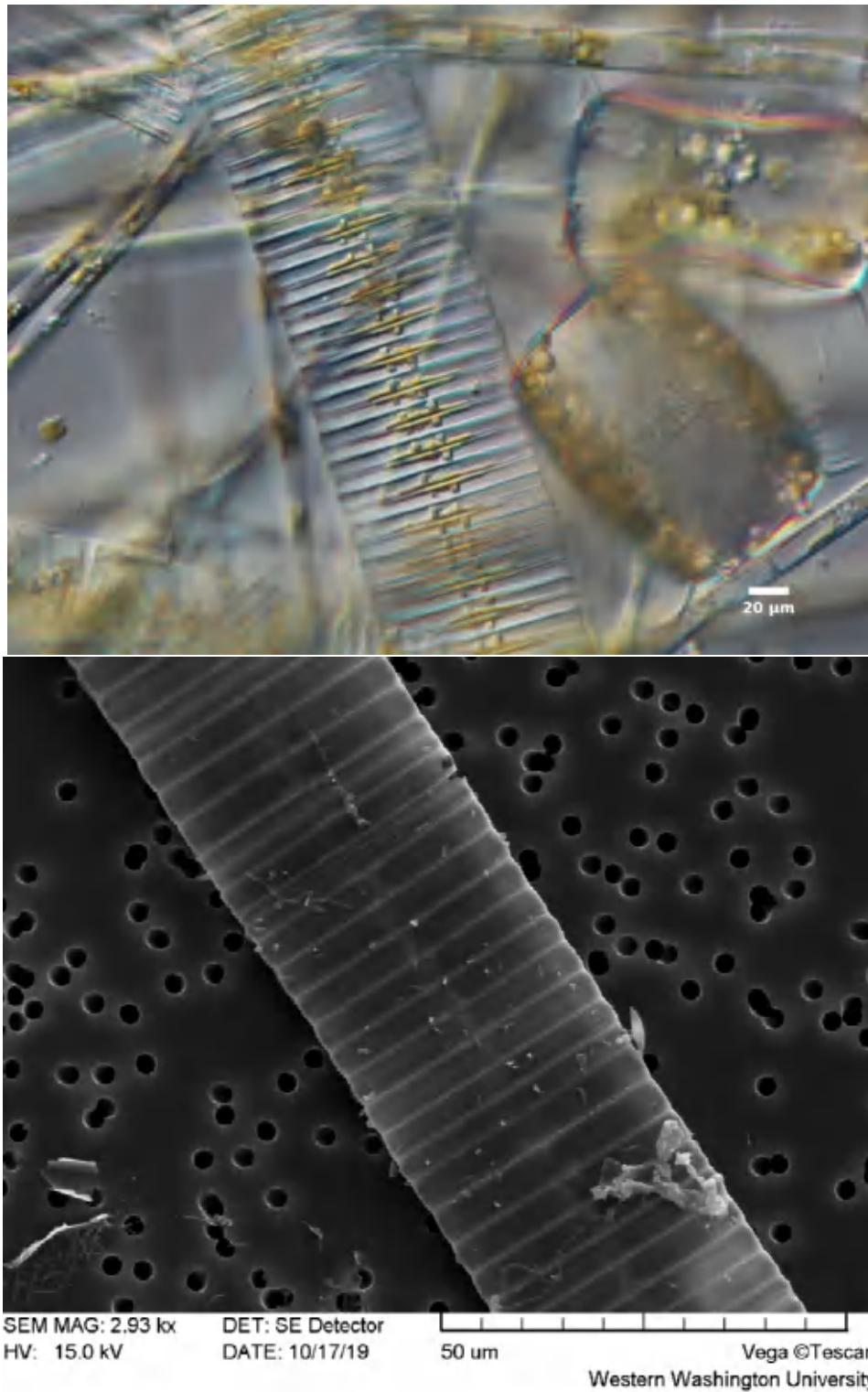


Figure 46: Other/Bacillariophyta - upper image: *Fragilaria capucina* (SEM), July 9, 2019; lower image: *Fragilaria capucina* (200x DIC), June 13, 2019.

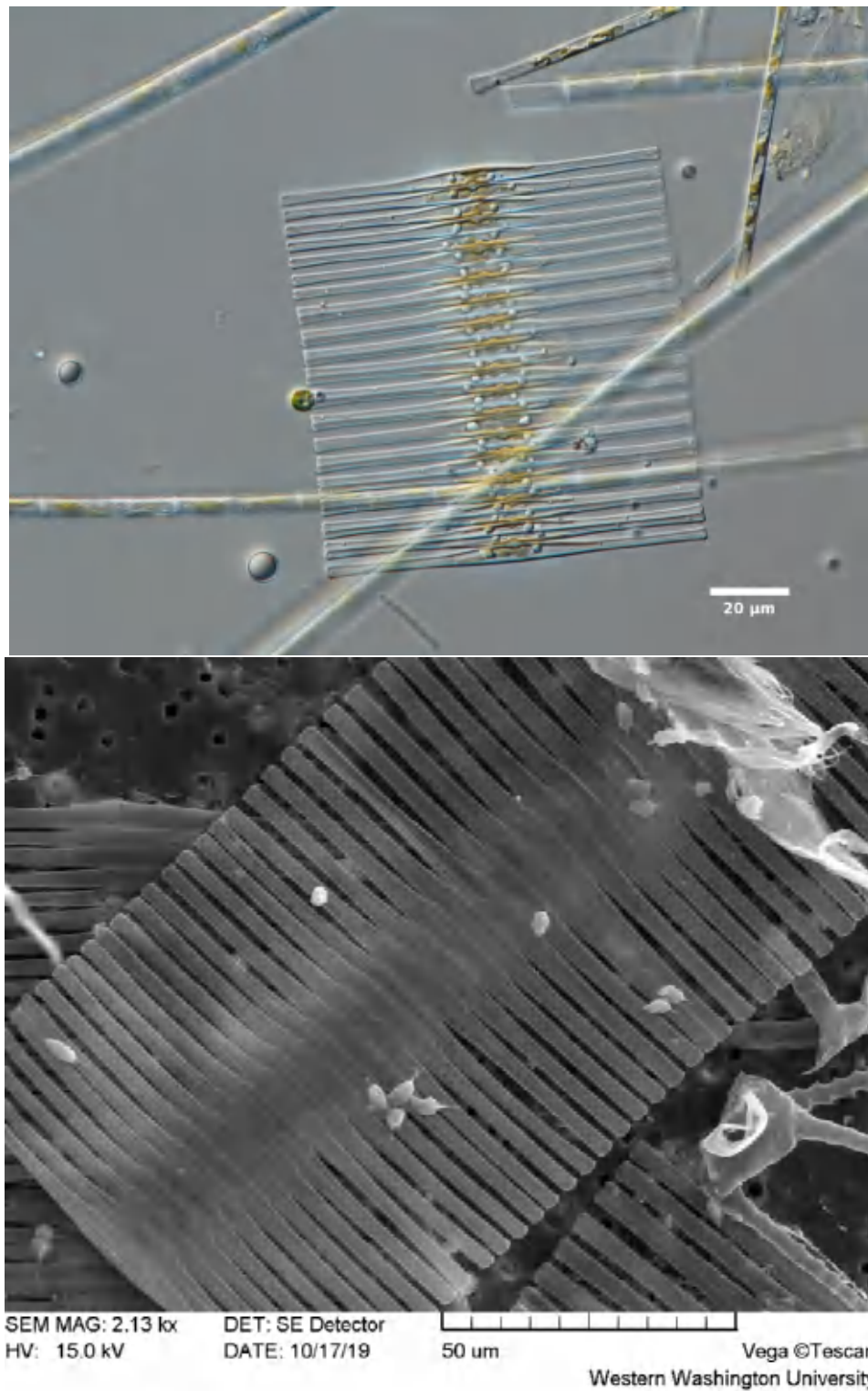


Figure 47: Other/Bacillariophyta - upper image: *Fragilaria crotonensis* (SEM), July 9, 2019; lower image: *Fragilaria crotonensis* (200x DIC), June 12, 2019.

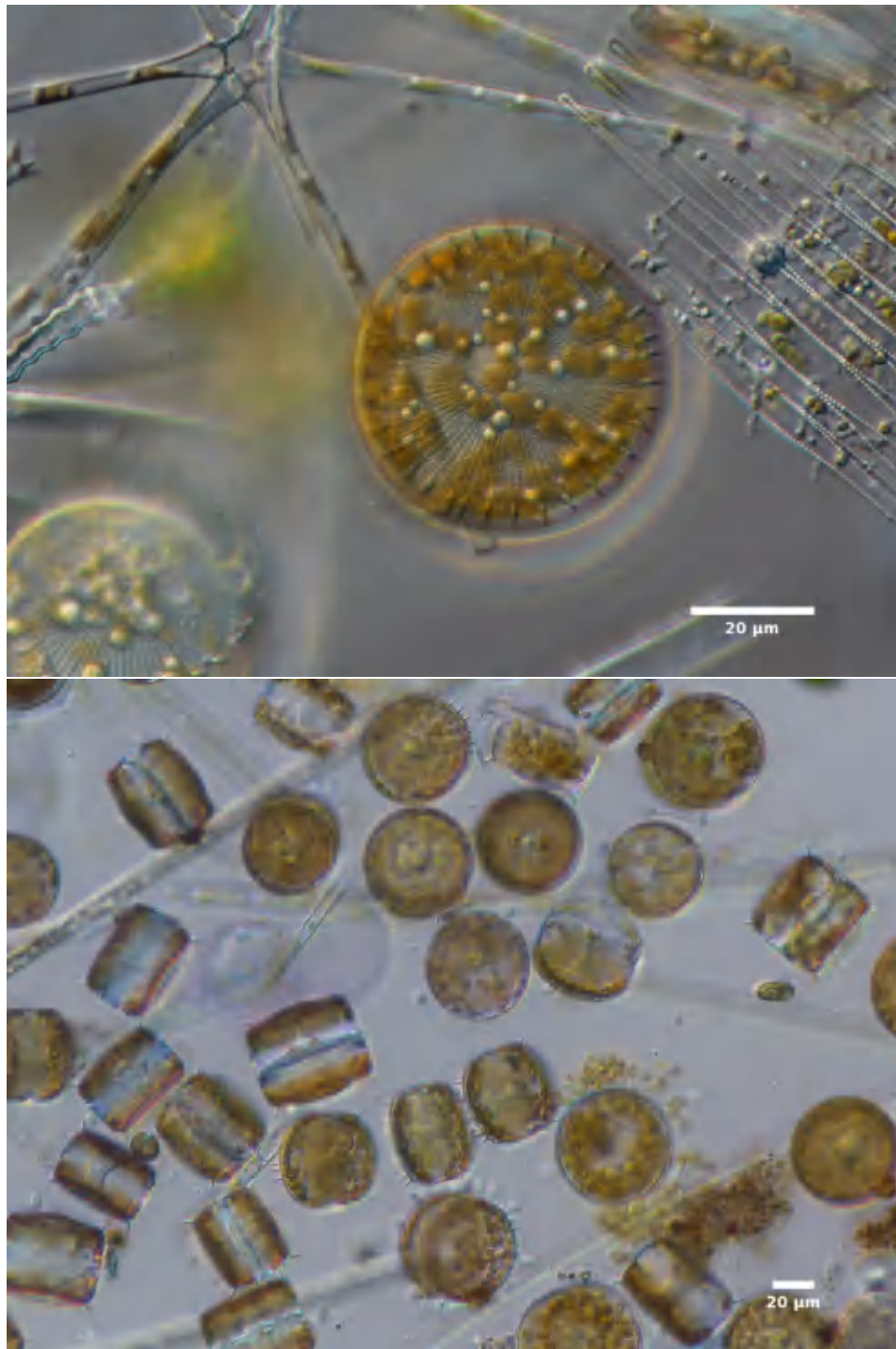


Figure 48: Other/Bacillariophyta - upper image: *Stephanodiscus niagarae* (600x DIC), June 13, 2019; lower image: *Stephanodiscus niagarae* bloom (200x DIC), October 15, 2019.



Figure 49: Other/Bacillariophyta - upper image: *Surirella* (400x DIC), September 30, 2009; lower image: *Surirella* (200x DIC), September 30, 2009.

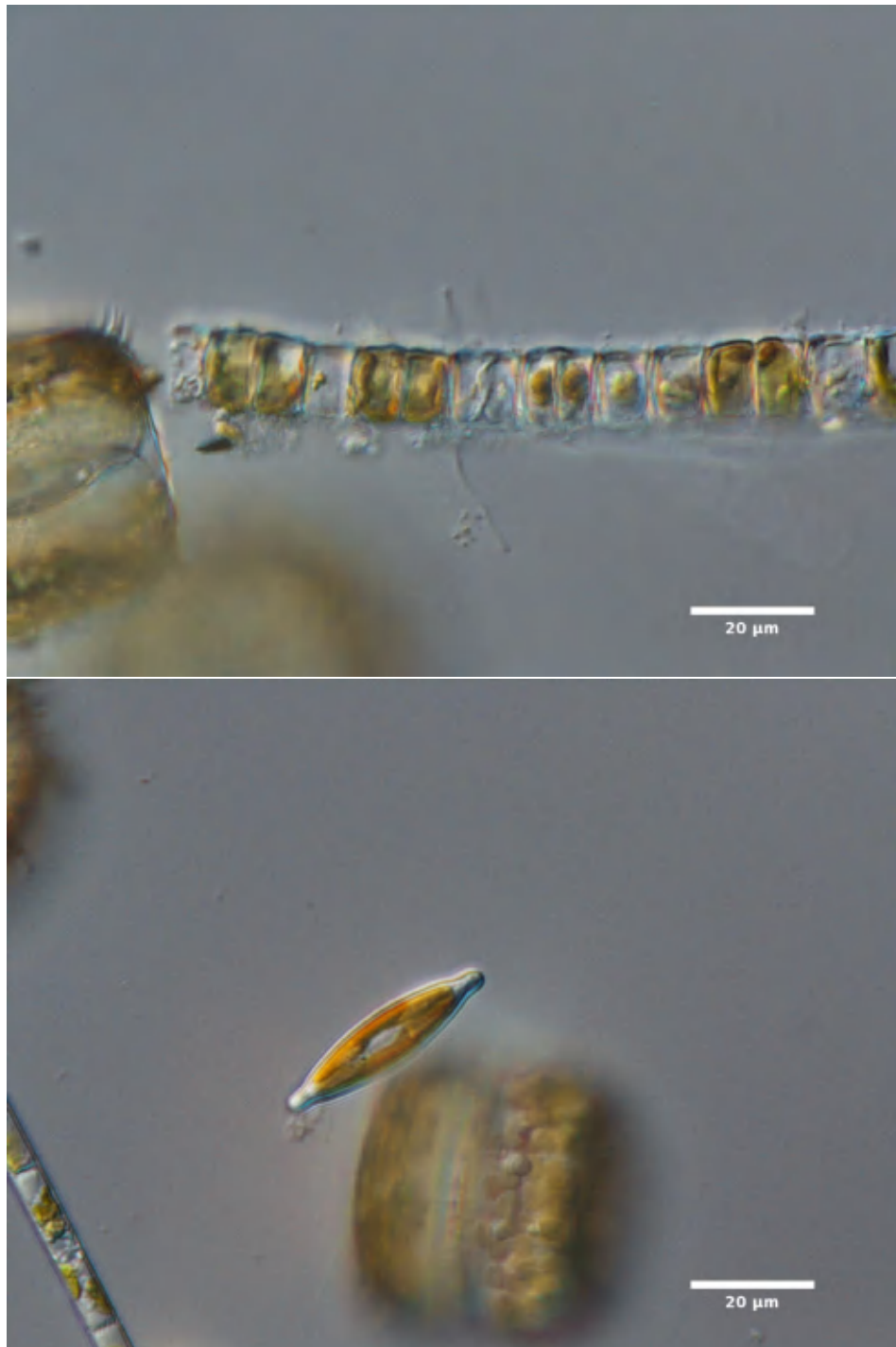


Figure 50: Other/Bacillariophyta - upper/lower images: unknown filamentous and naviculoid diatoms (600x DIC), October 22, 2019.

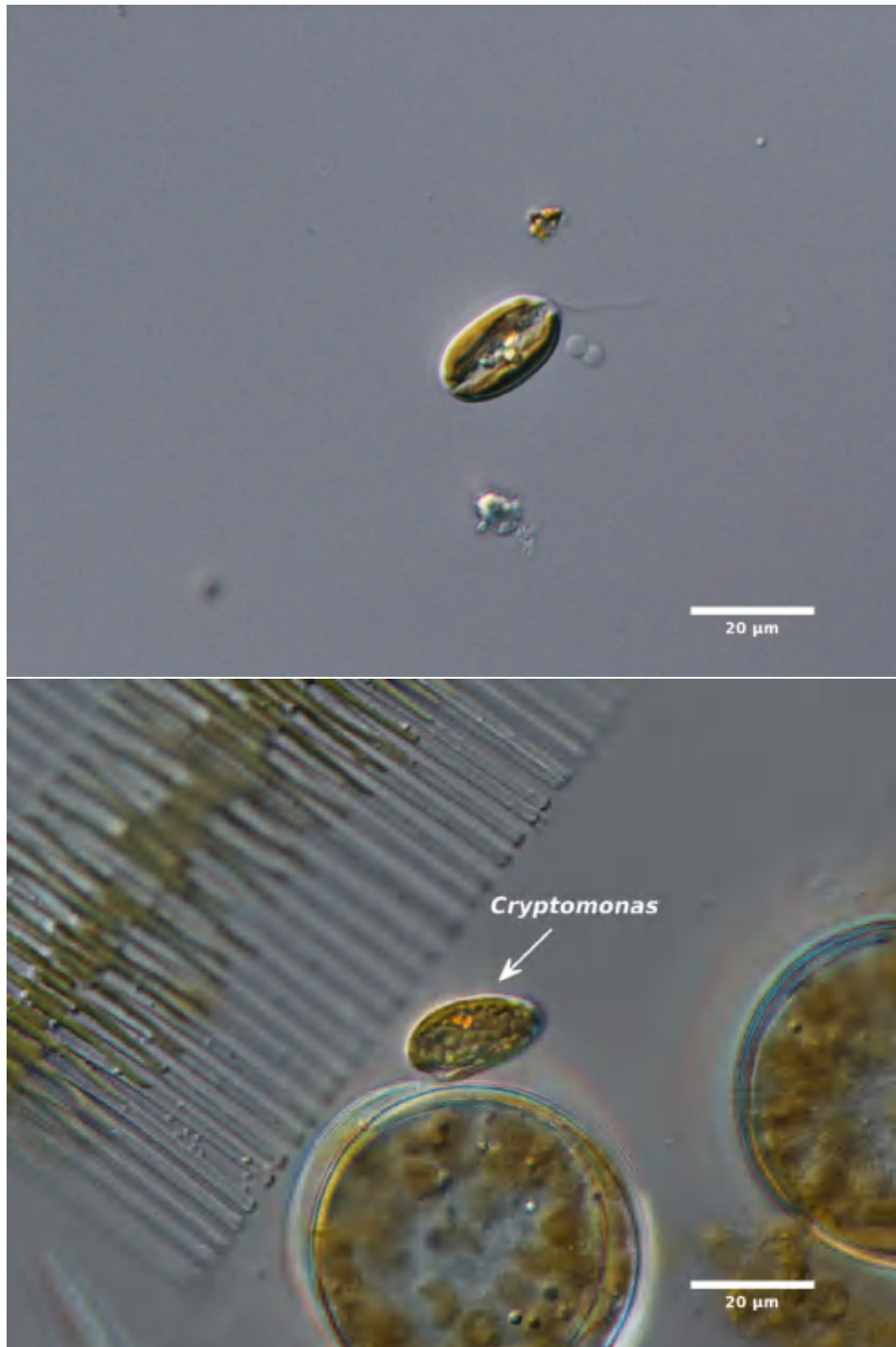


Figure 51: Other/Cryptophyta - upper/lower images: *Cryptomonas* (600x DIC), October 15, 2019.

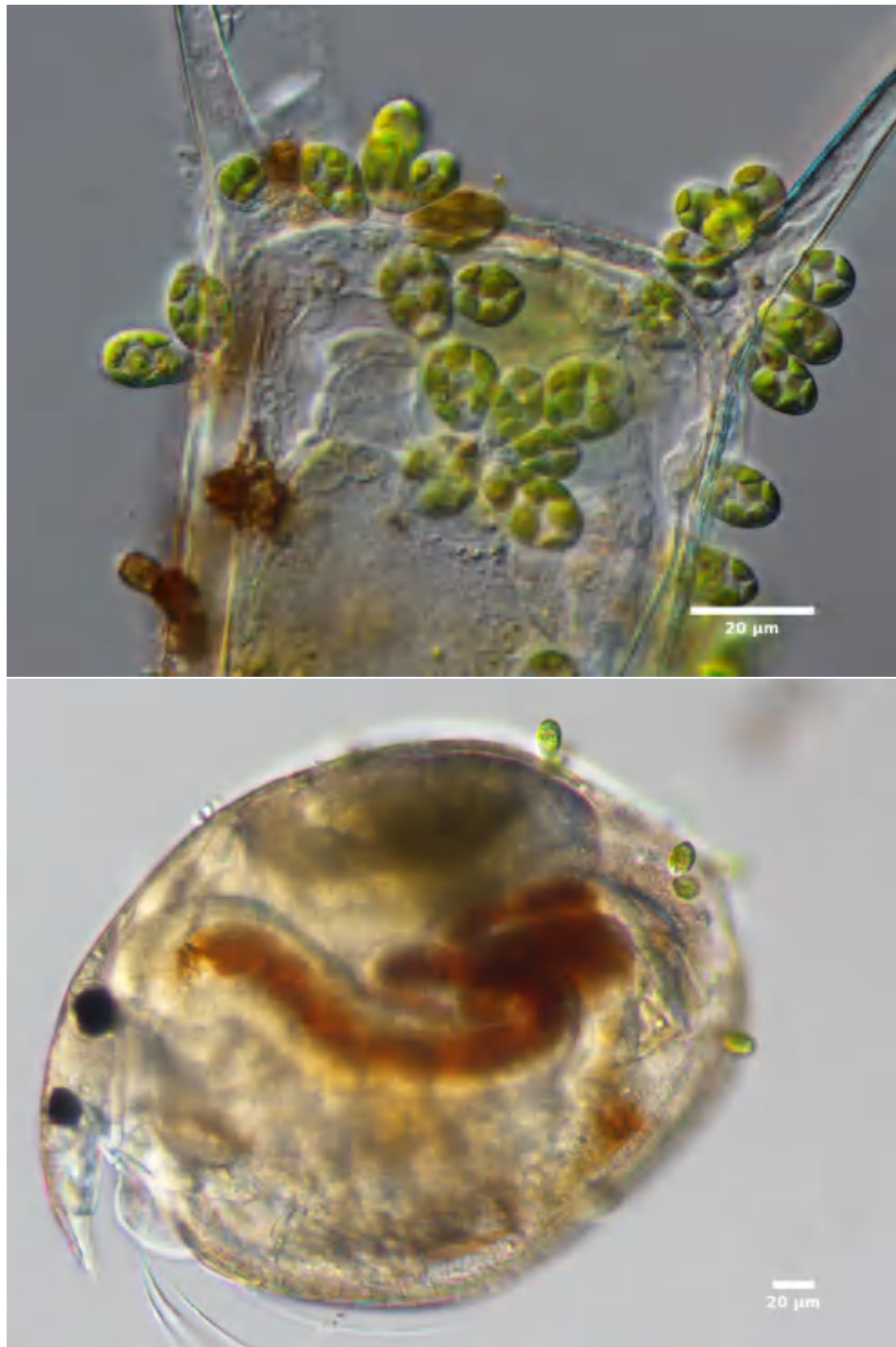


Figure 52: Other/Euglenophyta - upper image: *Colacium vesiculosum* 600x DIC, July 9, 2019; lower image: *Colacium vesiculosum* (200x DIC), Tennant Lake, Whatcom County, April 2, 2015.



Figure 53: Other/Euglenophyta - upper image: *Euglena* 400x DIC, June 13, 2019; lower image: *Euglena* (600x DIC), October 15, 2019.

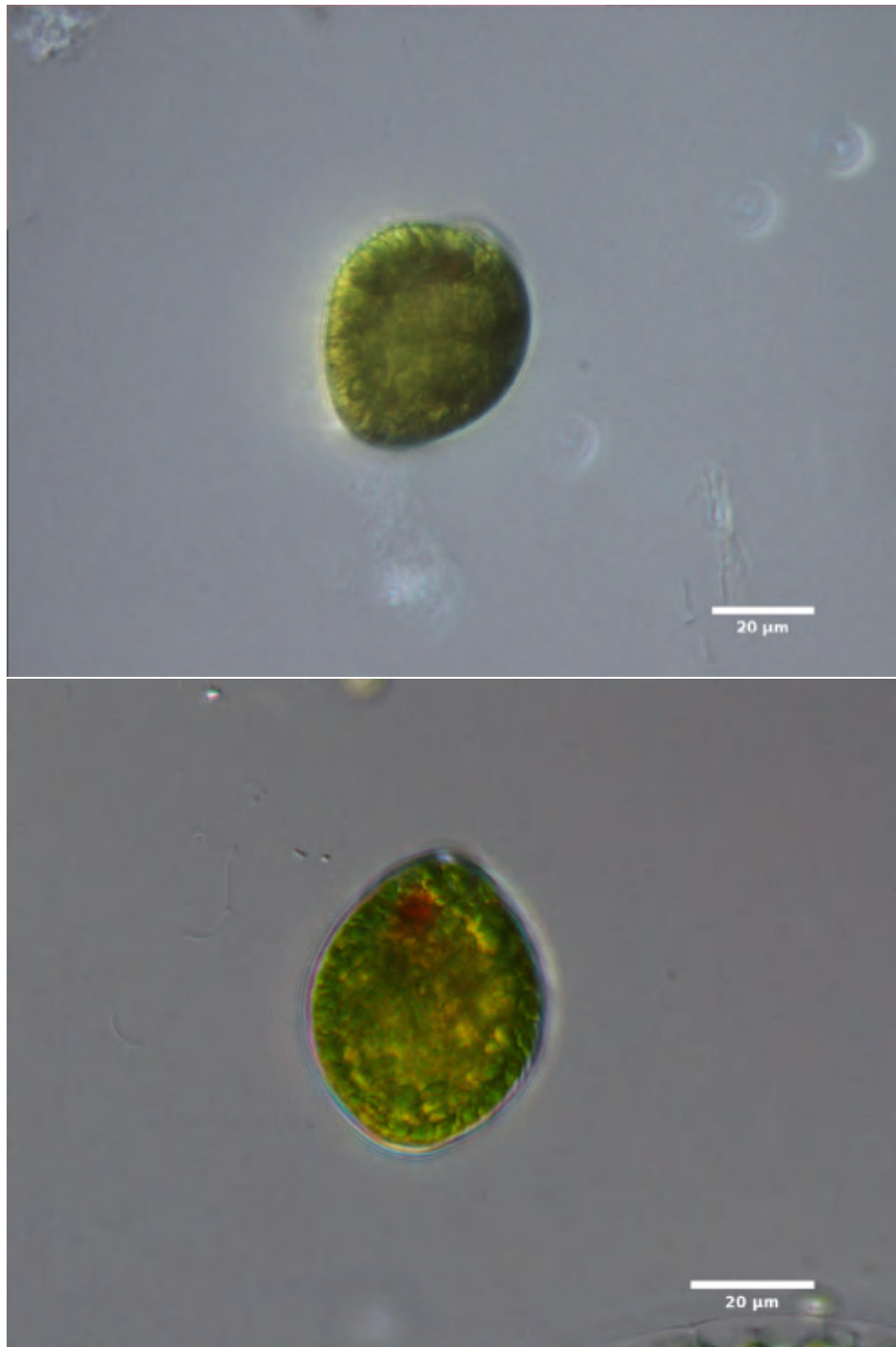


Figure 54: Other/Euglenophyta - upper image: *Euglena texta* (400x DIC), August 25, 2009; lower image: *Euglena texta* (600x DIC), July 9, 2019.

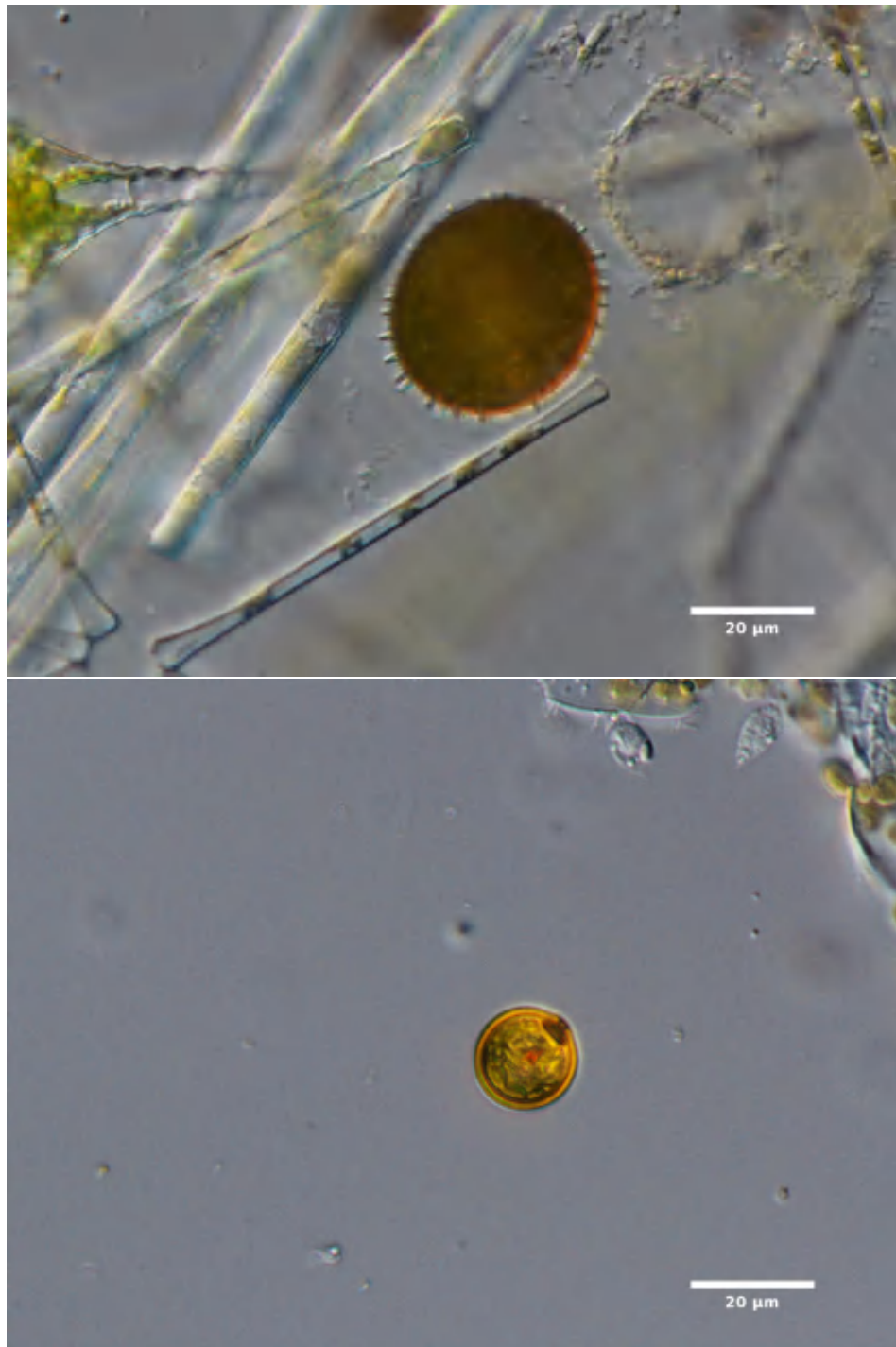


Figure 55: Other/Euglenophyta - upper image: *Trachelomonas hispida* (600x DIC), June 13, 2019; lower image: *Trachelomonas volvocinopsis* (600x DIC), October 15, 2019.



Figure 56: Other/Miozoa - upper image: *Ceratium hirundinella*; (200x DIC), September 30, 2009; lower image: *Ceratium hirundinella* zygote (400x DIC), July 9, 2019.

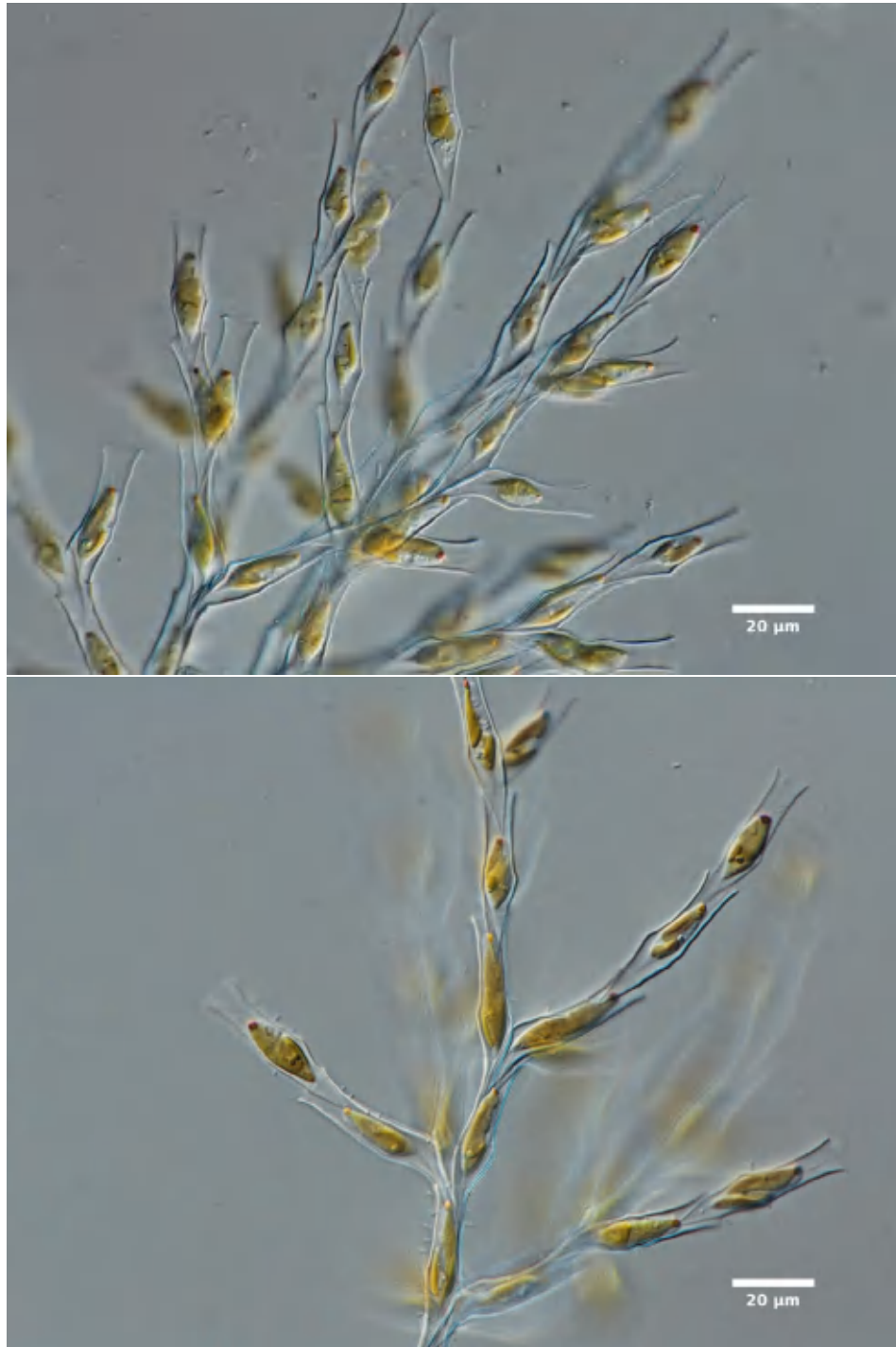


Figure 57: Other/Ochrophyta - upper image: *Dinobryon divergens* (400x DIC), July 9, 2019; lower image: *Dinobryon divergens* (400x DIC), July 9, 2019.

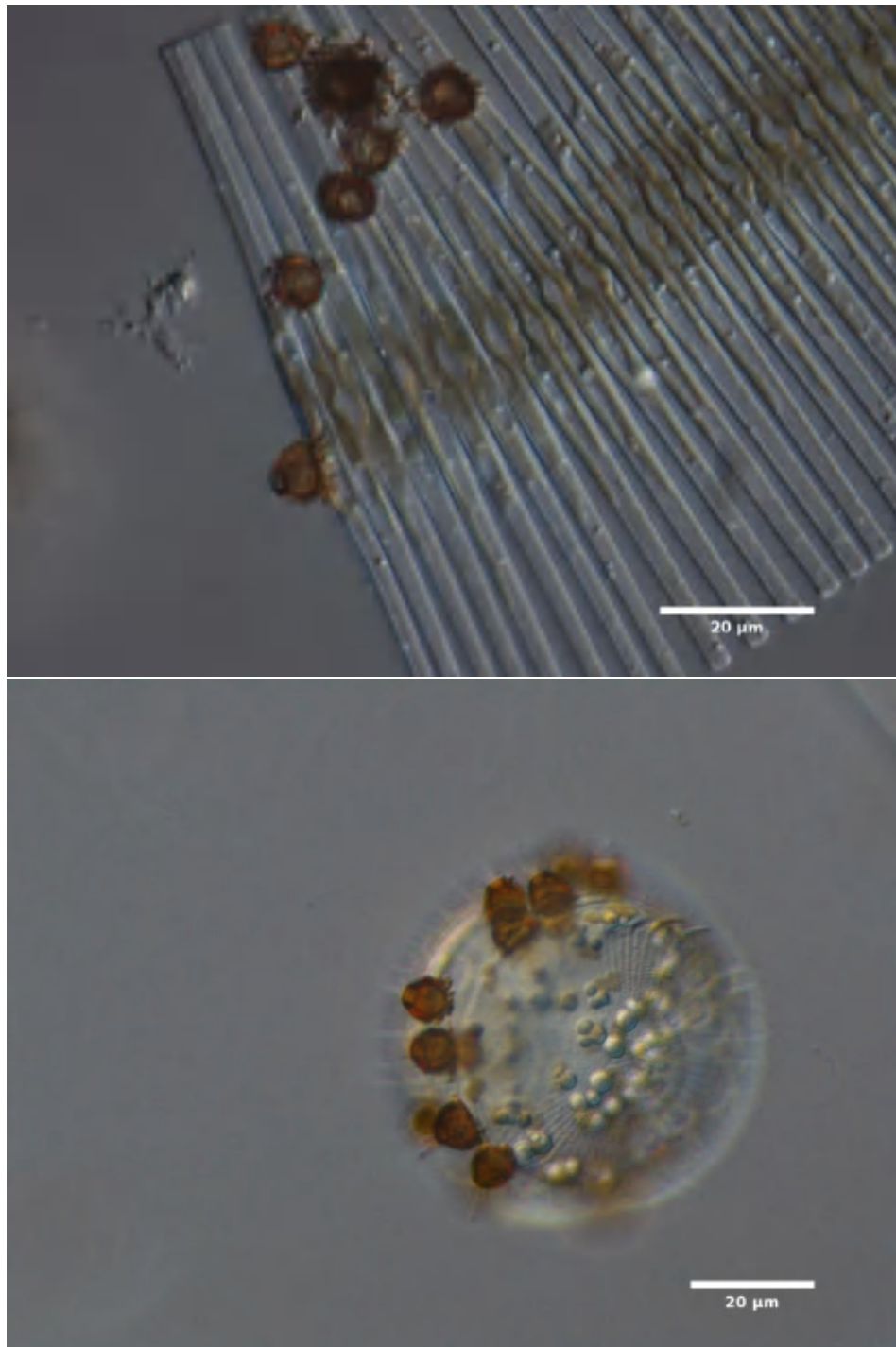


Figure 58: Other/Ochrophyta - upper image: *Lagynion* (600x DIC), July 22, 2013; lower image: *Lagynion* (600x DIC), June 12, 2019.

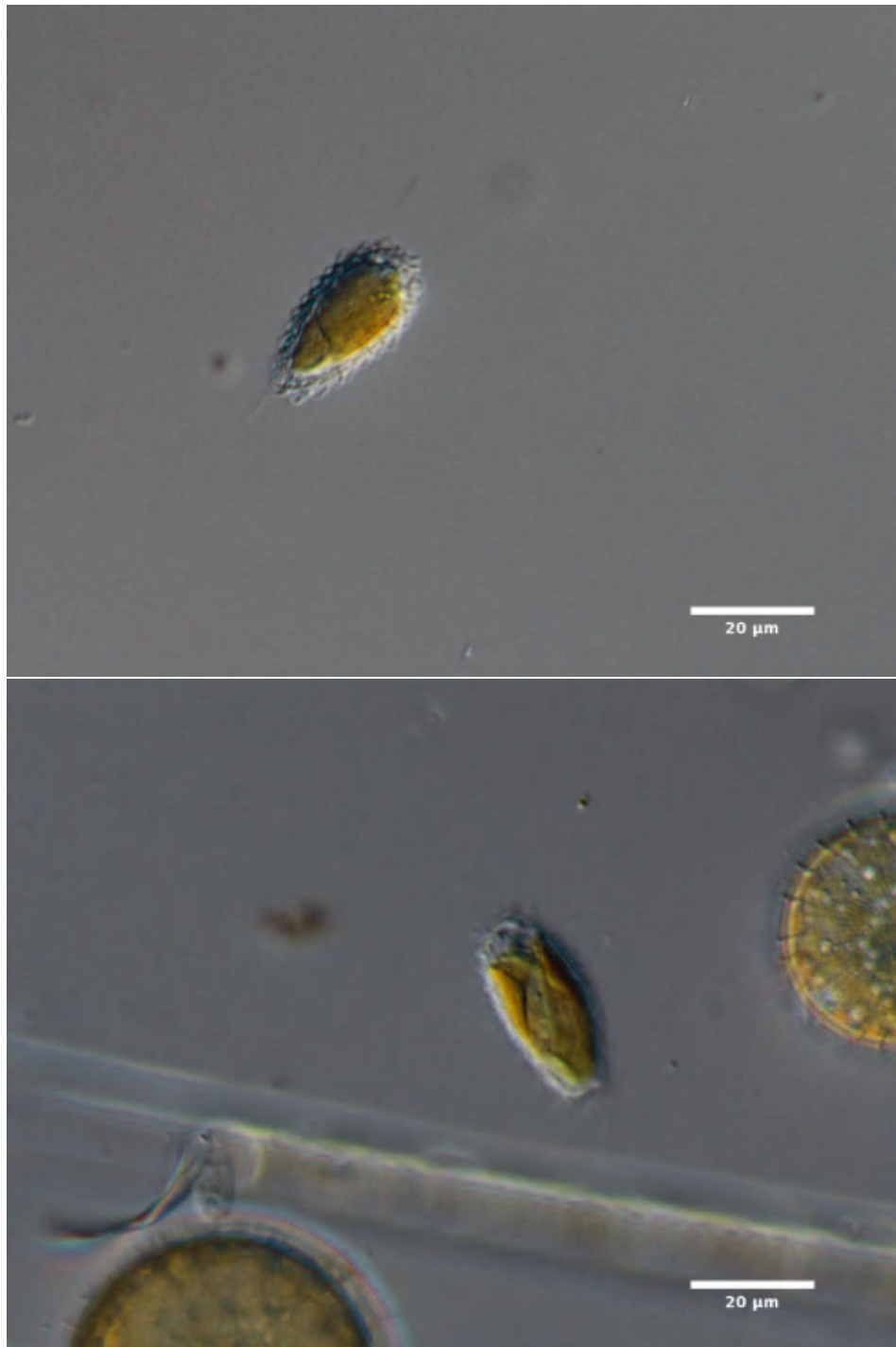


Figure 59: Other/Ochrophyta - upper image: *Mallomonas* (600x DIC), October 15, 2019; lower image: *Mallomonas* (600x DIC), October 29, 2019.

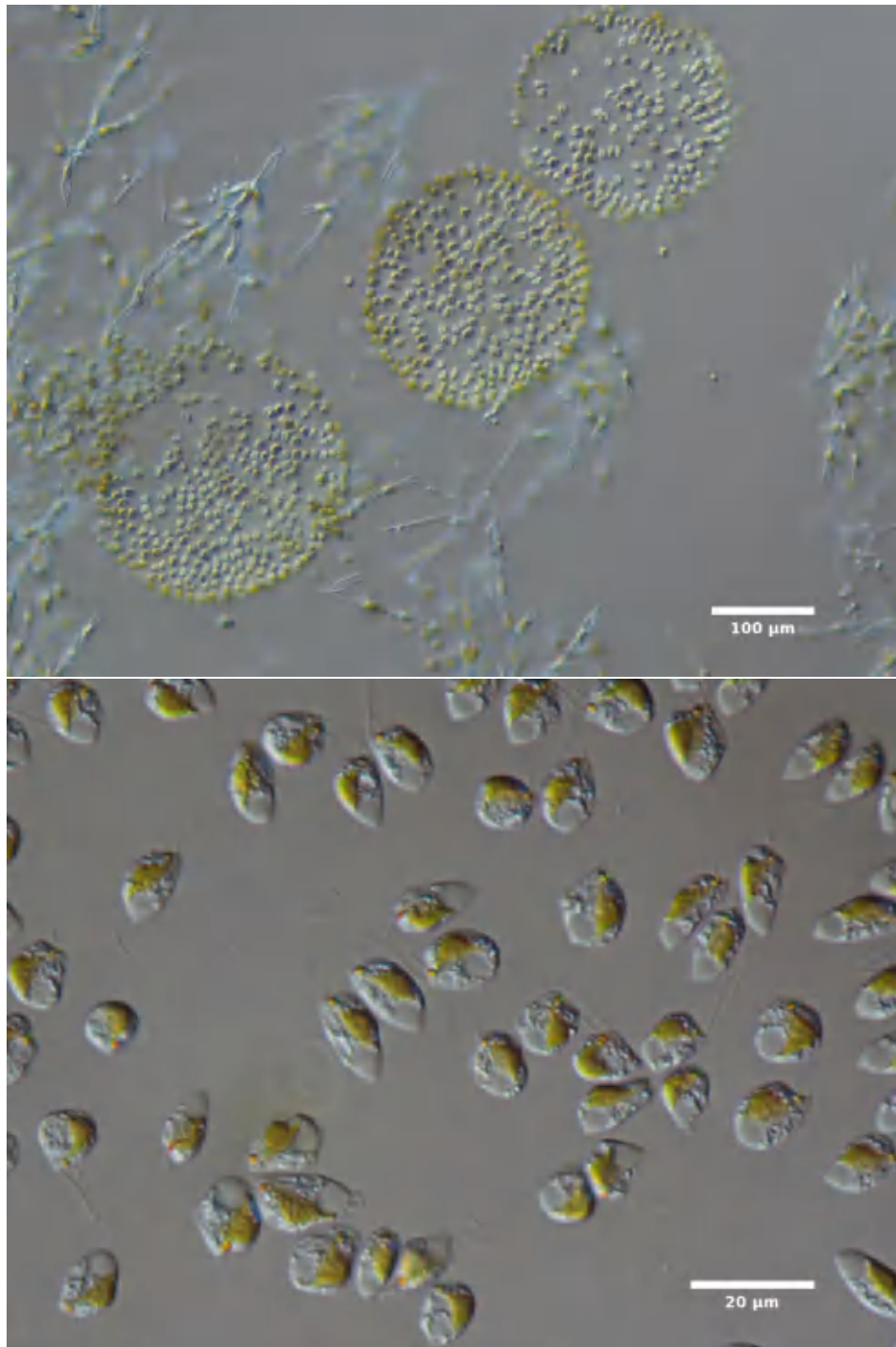


Figure 60: Other/Ochrophyta - upper image: *Uroglenopsis americana* (100x DIC), Toad Lake, Whatcom County, April 10, 2015; lower image: *Uroglenopsis americana* (600x DIC), Toad Lake, Whatcom County, April 10, 2015.