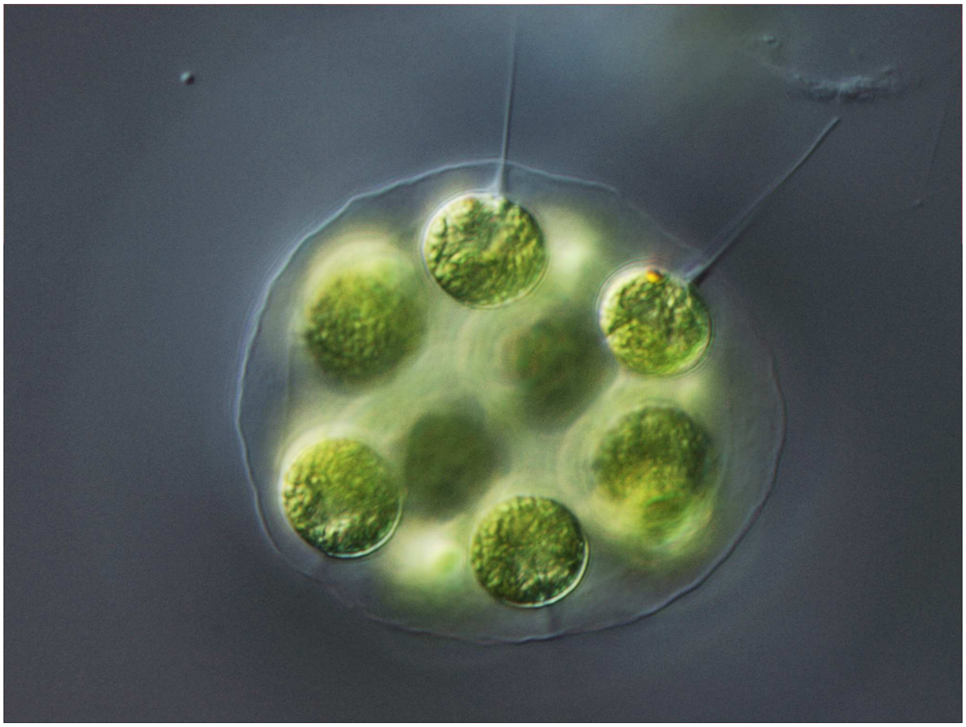

# Lake Padden Monitoring Project
# 2012 Final Report


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# Contents

# 1 Introduction

The Lake Padden monitoring project was initiated in 2011 by the citizens group, People for Lake Padden (P4LP), to provide an intensive water quality study of Lake Padden. Water samples were collected between June and December 2011 by Andrew Majeske, a student intern working with the Institute for Watershed Studies (IWS) and the Nooksack Salmon Enhancement Association (NSEA). The results from this project were summarized by Majeske et al. (2012). The water quality monitoring was funded for a second year by P4LP, which provided funding for IWS student intern Laura Junge. Additional funding was provided by the City of Bellingham to identify the types of algae that were most common in the lake and to test for the presence of microcystin, an algal toxin produced by certain strains of blue-green algae (Cyanobacteria). Although not part of the original funded scope of work, detailed settled algae counts were provided by R. Matthews to supplement the algae and microcystin data collected by L. Junge.

This report covers the water quality data collected from June 2011 through October 2012 and algae data collected May through November 2012. The water quality data are summarized using annotated tables and figures, beginning on page 5; the raw water quality data are included in Appendix A and the quality control results are included in Appendix B. Algal data are summarized in Table 1 and Figures 14–18 (pages 1 and 19–26). Additional algae data are included in Appendix C, which contains algae counts from preserved, whole-water samples (Appendix C.1), a list of the algae present in live samples collected concurrently with the microcystin samples (Appendix C.2), and photographs of the major taxa in the lake (Appendix C.3).

# 2 Methods

## 2.1 Water Quality Samples

The water quality samples were collected from June 2011 through September 2012 at two sites located at opposite ends of the lake from docks extending out from the shoreline (Figure 1). The eastern site was located about 50 m from a small tributary; the western site was about 40 m from the outflow into Padden Creek. The water samples were collected 0.3 m below the lake surface and approximately 30 m from the shoreline. The samples were collected monthly during the winter and every two weeks during the spring and summer.

Water temperature was measured at each site using a calibrated thermometer. Dissolved oxygen samples were collected at each site and processed in the laboratory using the Winkler method (Table A, [age 27). Water samples were collected in an acid washed 1-liter bottle and transported on ice to the laboratory to be processed for pH, conductivity, nitrogen (total, nitrate/nitrite, ammonium), and phosphorus (total and soluble). Chlorophyll samples were collected in a 1-liter opaque bottle and transported on ice to the laboratory.

Depth profiles were collected in August and November 2011 and August 2012 from the deepest area of the lake using a small boat (Figure 1). The depth profiles were constructed using a YSI-meter, calibrated in the field prior to use, to measure temperature and dissolved oxygen. Additional water quality samples were collected in 2011 from 0.3 m and 9 m depths and analyzed for the same parameters listed above, excluding chlorophyll (see Majeske et al. 2012).

All analysis were performed following the analytical methods listed in Table A. The water quality data are included in Appendix A. To ensure quality control, ten percent of water samples were collected in duplicate to estimate variation between samples collected at the same location, depth, and time (field duplicates); ten percent of all laboratory samples were duplicated to estimate analytical variation for samples from the same bottle (lab duplicates). Laboratory blanks, matrix spikes, and laboratory control/check samples were included with all analytical runs to estimate background noise and recovery of known concentrations of each analyte. The quality control results are listed in Appendix B. The IWS laboratory is accredited by the Department of Ecology. For additional information, contact Dr. Robin Matthews, Director or Ms. Joan Vandersypen, Laboratory Supervisor.

## Algae Samples

Algae and microcystin samples were collected every two weeks during June and July 2012, and weekly from August through November 2012 at the western water quality site (outlet), near the off-lease dog park, and from the main swimming beach area (Figure 1, page 6).

The microcystin samples were collected in 125-mL glass bottles with Teflon© lids and transported to the laboratory on ice. The samples were stored at 4° C and analyzed within 1 week. Microcystin levels were measured using a Quanitiplate Kit for Microcystins (Cat. No. EP022) made by EnviroLogix in Portland, Maine. This kit has a quantitation range from 0.16 to 2.5 $\mu$g/L. This method is a competitive Enzyme-Linked ImmunoSorbent Assay (ELISA) that selects for the microcystin toxin. As recommended by the manufacturer, all samples were analyzed in duplicate and the average was entered into the data set (EnviroLogix, 2010).

Concentrated, unpreserved (live) algae samples were collected concurrently using a 20 $\mu$m mesh plankton net. The live algae samples were used to determine which types of algae were dominant at the time the microcystin samples were collected. Unconcentrated algae samples were collected at various near-shore locations to provide a general taxonomic record of the algal diversity in the lake. The unconcentrated algae samples were preserved using Lugol's iodine solution and counted using the settling chamber method (Table A).

# 3 References

APHA, 2012. Standard Methods for the Examination of Water and Wastewater, 22st Edition. American Public Health Association, American Water Works Association, and Water Environment Federation, Washington D. C.

Carlson, R E. and J. Simpson. 1996. A Coordinator's Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

DOH. 2008. Washington State Recreational Guidance for Microcystins (Provisional) and Anatoxin-a (Interim/Provisional). DOH 334-177, Washington State Department of Health, Division of Environmental Health, Olympia, WA.

EnviroLogix. 2010. QuantiPlate Kit for Microcystins, Catalog Number EP 022, Rev. 07–01–10, 500 Riverside Industrial Parkway, Portland, ME.EnviroLogix

Majeske, A., R. Matthews, B. Gross, and D. Roberts. 2012. Lake Padden Water Quality Monitoring Project June–December 2011 Final Report. Undergraduate project report submitted to the People for Lake Padden by the Institute for Watershed Studies, Huxley College of the Environment, Western Washington University, Bellingham WA.

# 4 Annotated Figures and Tables

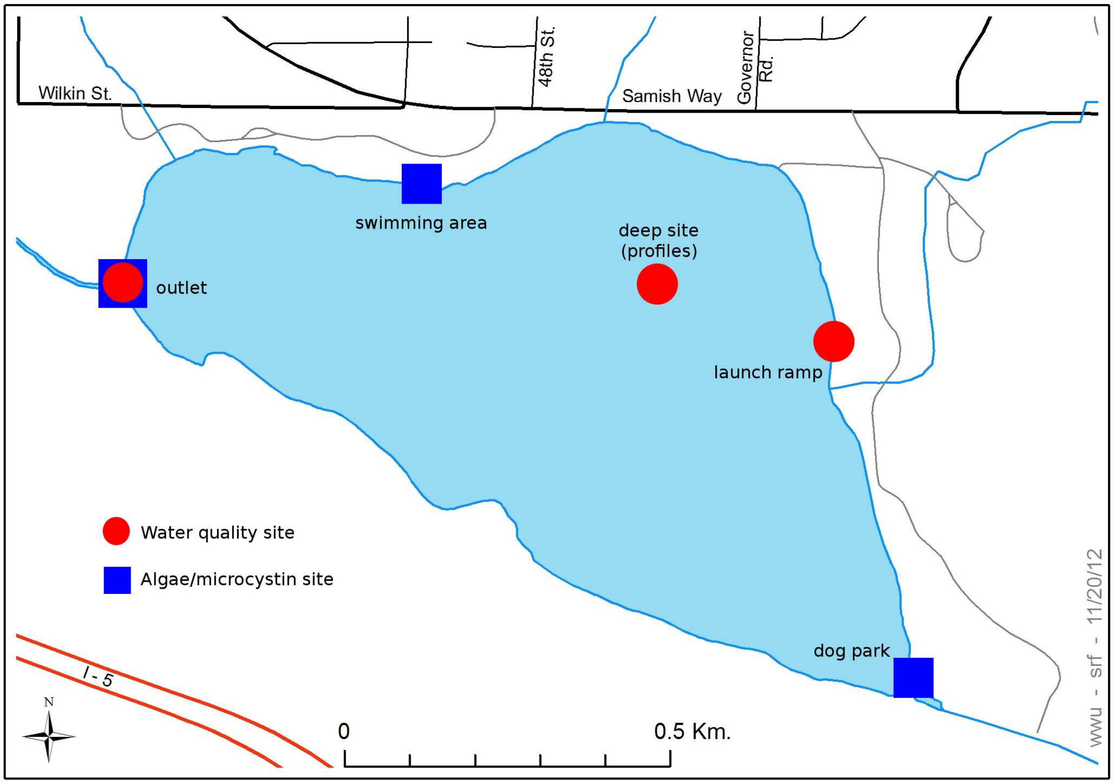



Figure 1: Lake Padden 2011–2012 water quality and algae sampling sites. Base map created by S. Freelan, GIS Specialist, Huxley College of the Environment, Western Washington University, WA.

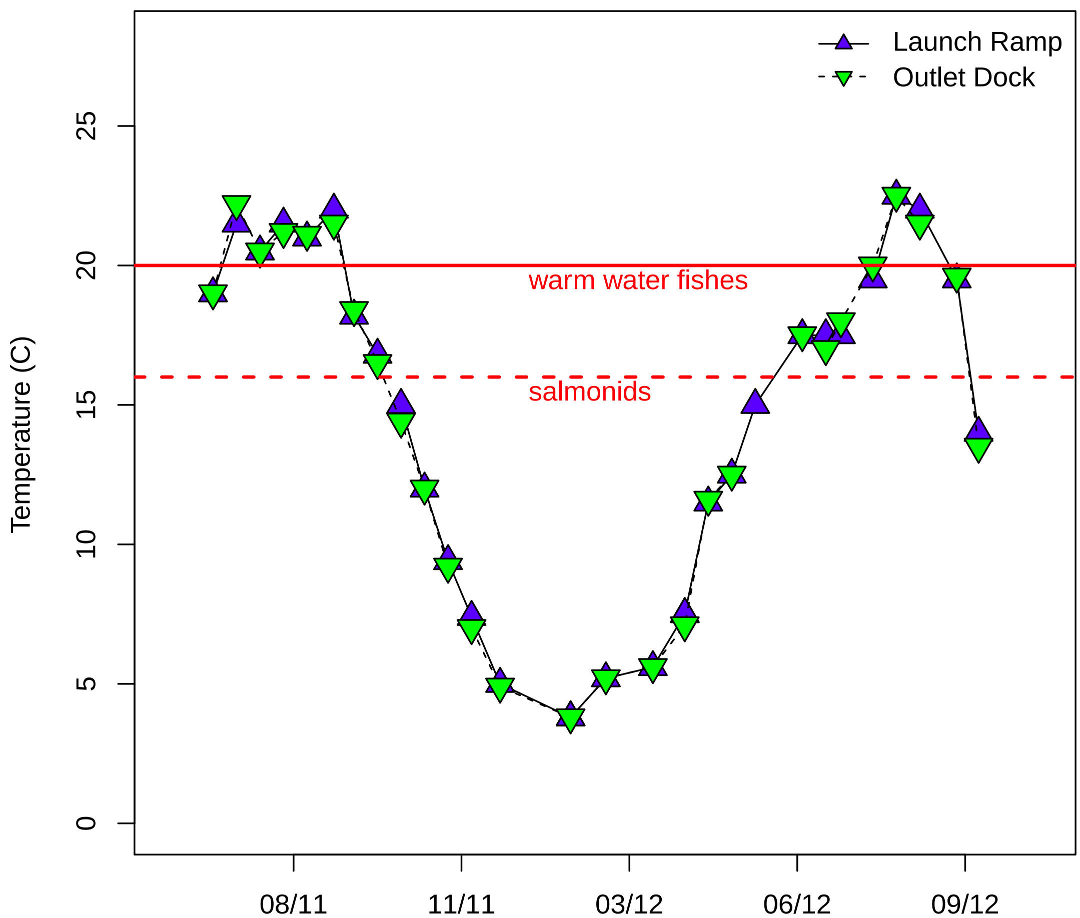



Figure 2: Lake Padden 2011–2012 water temperature results. Water temperature followed typical seasonal patterns, with warmer temperatures during summer and cooler temperatures during winter. Based on the surface water standards in WAC 173–201A–200, the near-shore water temperatures exceeded the maximum level required for providing summer habitat for salmonids (- - -) and for rearing indigenous warm-water fishes (—). Water temperatures might be cooler in the other regions of the lake, but the depth profiles showed that summer water temperatures exceeded 20°C in portions of the water column (Figure 4, page 9).

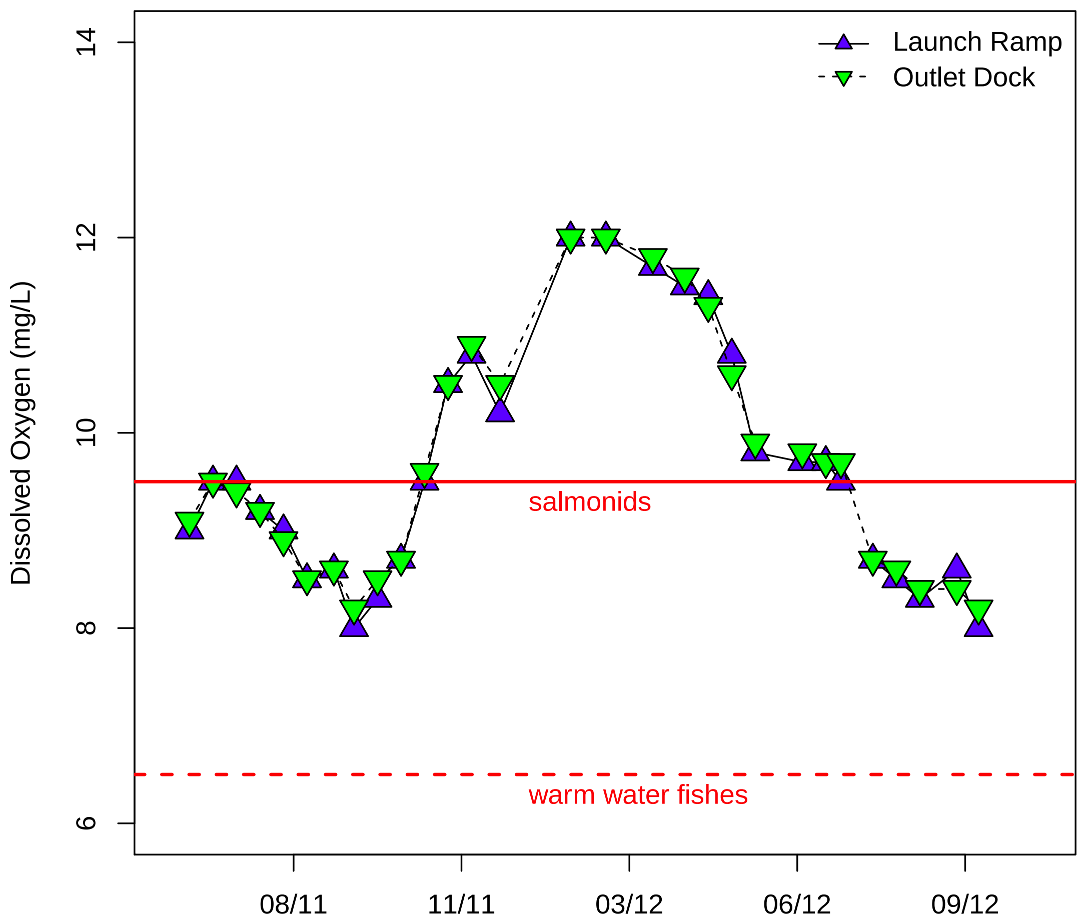



Figure 3: Lake Padden 2011–2012 dissolved oxygen results. Dissolved oxygen concentrations were generally above 8 mg/L, with lower concentrations during the summer and higher concentrations during the winter (cold water holds more oxygen than warm water). Based on the surface water standards in WAC 173–201A–200, the near-shore dissolved oxygen concentrations were lower than the minimum level required for providing summer habitat for salmonids (- - -), but were above the minimum level required for rearing indigenous warm-water fishes (—). The depth profiles showed that summer dissolved oxygen levels were too low near the bottom of the lake to provide suitable fish habitat (Figure 4, page 9).

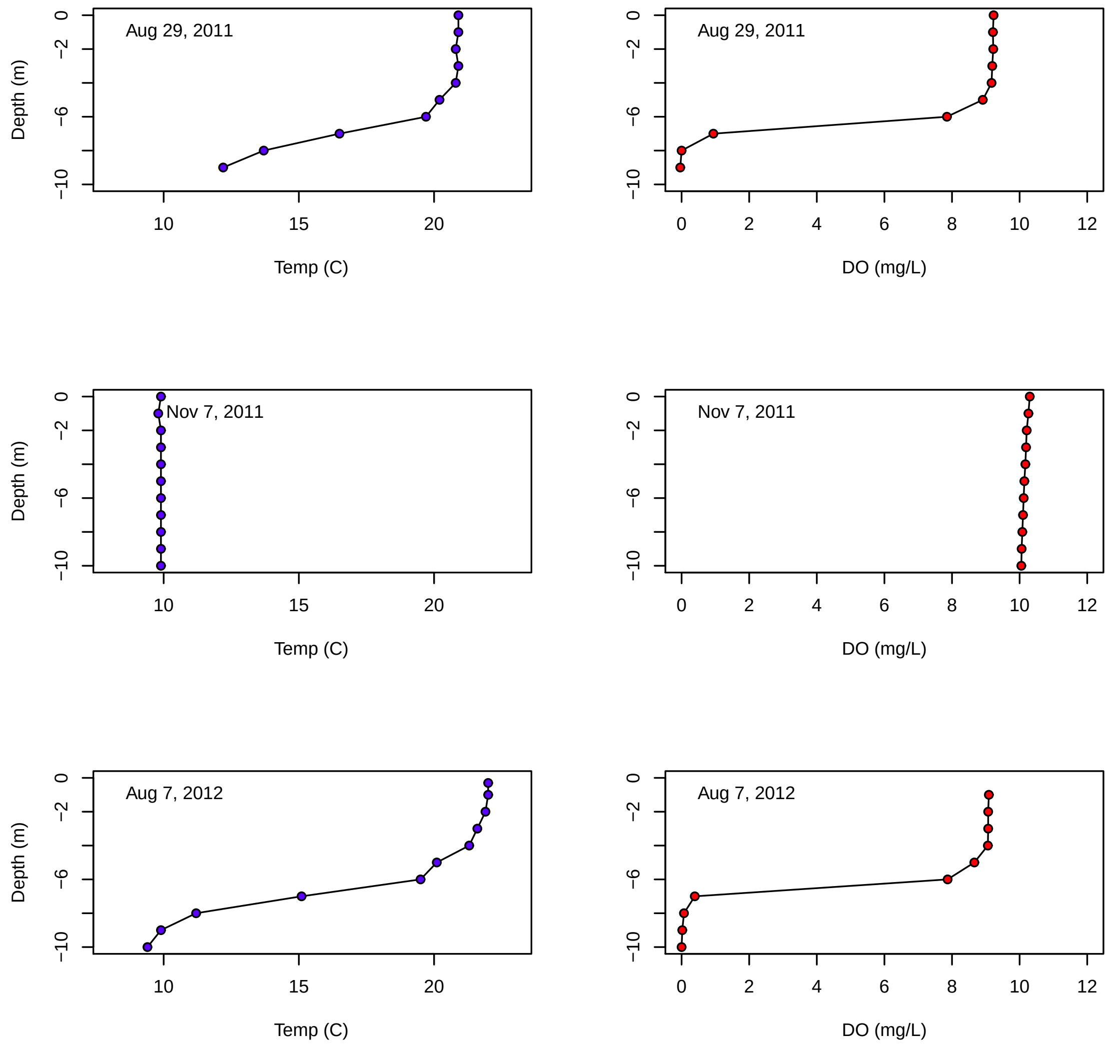



Figure 4: Lake Padden 2011–2012 temperature and dissolved oxygen profiles. Lake Padden stratifies during the summer due to density differences between the warm, less dense surface water (*epilimnion*) and colder, denser bottom water (*hypolimnion*). The epilimnion and hypolimnion remain separated until the lake cools in the fall, when the entire water column mixes. When stratified, the bottom of the lake is isolated from the atmosphere; if the water column contains large amounts of organic material, bacteria and other microorganisms can use up the hypolimnion dissolved oxygen, causing the lake to become *anoxic*. Anoxia has many unpleasant features (e.g., loss of fish habitat) and causes plant nutrients (e.g., phosphorus) to become more readily available to algae. The oxygen profiles show that Lake Padden becomes anoxic during summer stratification.

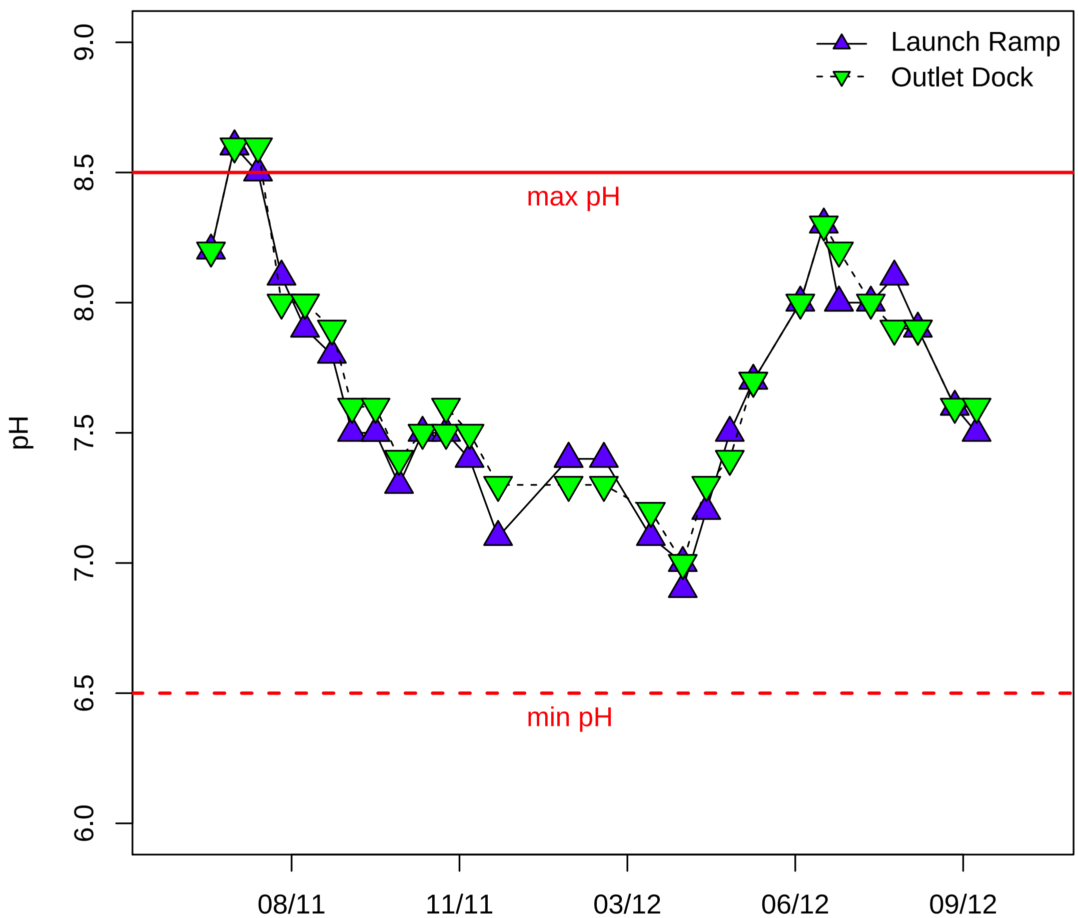



Figure 5: Lake Padden 2011–2012 pH results. The pH in water is determined by the concentrations of $H^+$ ions. During photosynthesis, algae remove dissolved $CO_2$, which can temporally raise pH by reducing the concentration of dissolved carbonic acid, which is formed when $CO_2$ reacts with water: $H_2O + CO_2 \leftrightarrow H_2CO_3$ (carbonic acid). The influence of photosynthesis is illustrated by the Lake Padden pH values, which were higher in the summer compared to fall and winter. Except in July 2011, the pH values of Lake Padden fell within the range needed to sustain salmonid and indigenous warm-water fishes (WAC 173–201A–200).

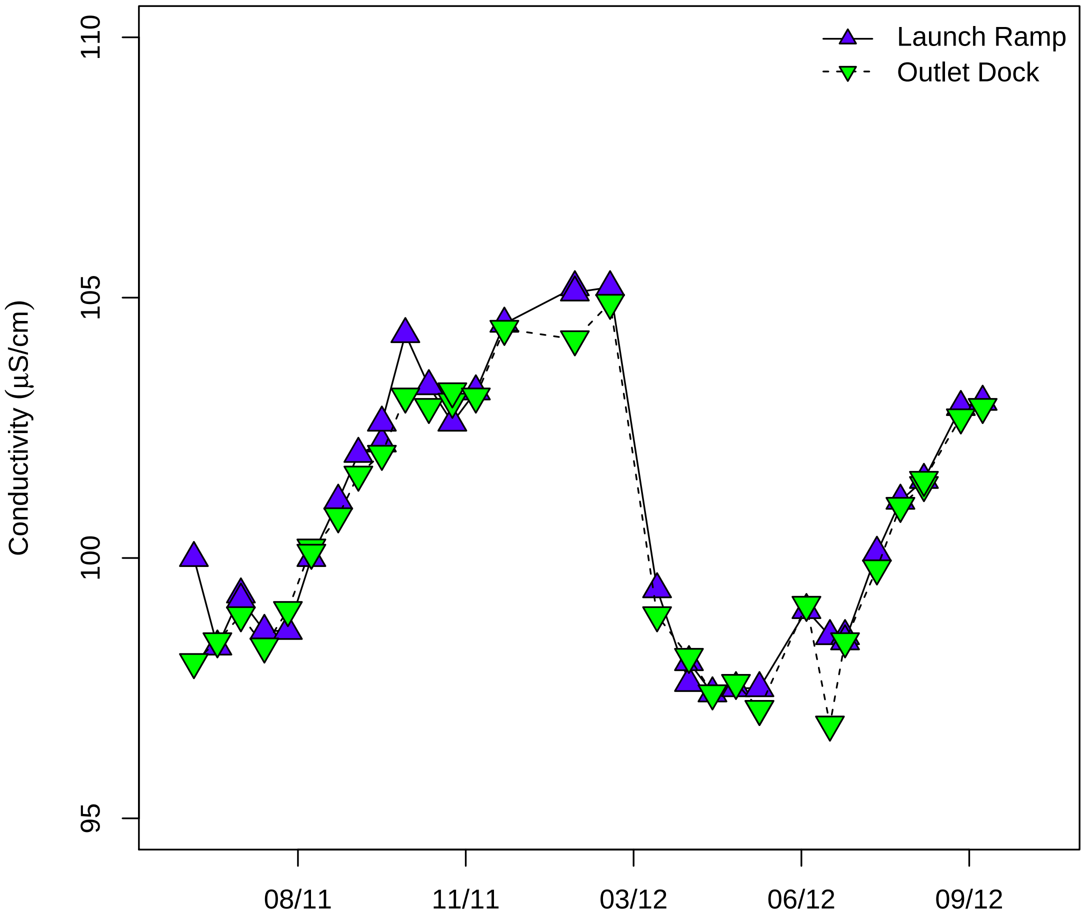



Figure 6: Lake Padden 2011–2012 specific conductance (conductivity) results. Conductivity is influenced by the type and amount of dissolved ions in the water. The soil type and land use in the watershed influence the amount of dissolved ions entering the lake via surface runoff and groundwater. Biological activity and chemical interactions determine whether dissolved ions remain in the water column. The conductivity values in Lake Padden were consistently low (≤105 $\mu$S/cm), but increased slightly during late summer and fall. Conductivity can be influenced by in-lake factors such as decomposition, but the most likely factor is precipitation. Heavy rainfall usually lowers conductivity by diluting the concentration of dissolved ions; however, rain events may also increase conductivity by transporting dissolved ions from the watershed into the lake.

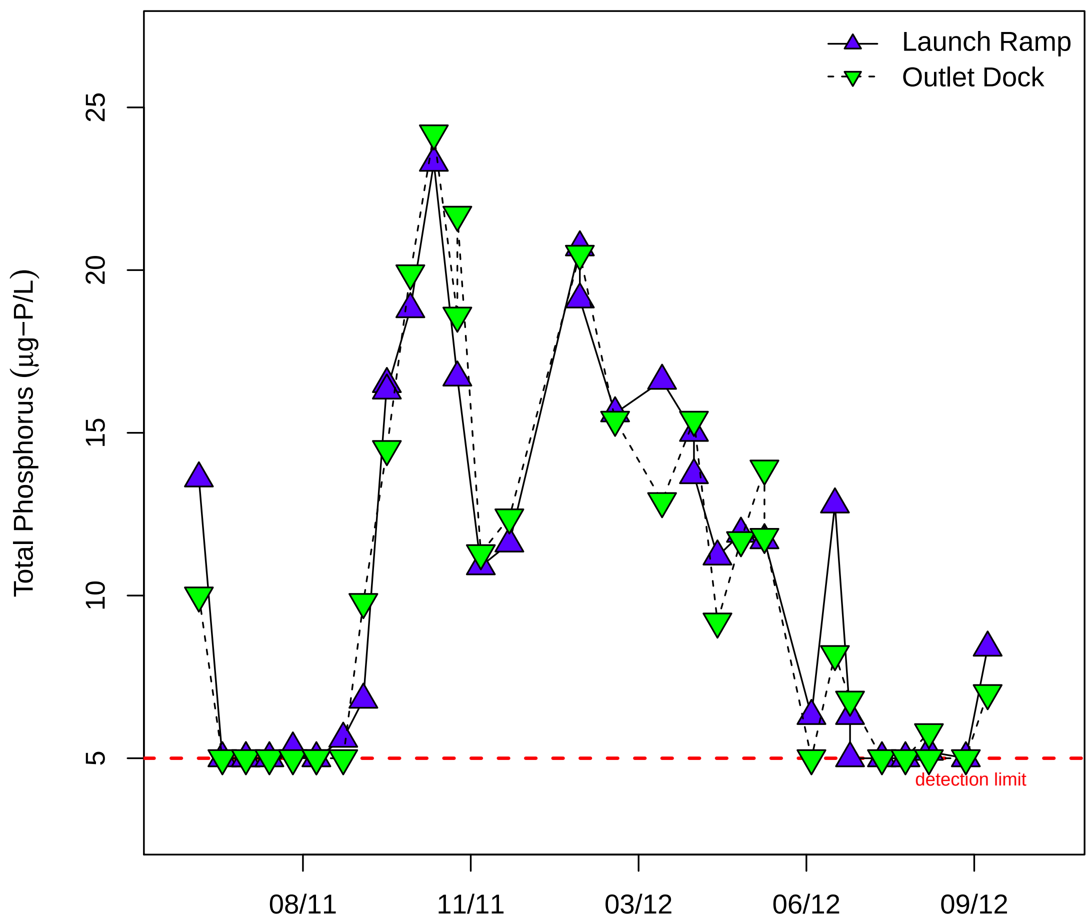



Figure 7: Lake Padden 2011–2012 total phosphorus results. Total phosphorus includes phosphorus bound in organic matter (algae and other microbiota) and dissolved or soluble phosphate. Phosphorus is usually the nutrient that limits the amount of algae in a lake. The Lake Padden total phosphorus values occasionally exceeded the 20 $\mu$g-P/L action level described in WAC 173–201A–230. Lakes with total phosphorus values above the action level do not necessarily pose a threat to human health or aquatic life, but may be associated with high chlorophyll concentrations and algae blooms. Total phosphorus levels were highest during late fall and winter due to destratification and mixing, and lowest during the summer due to algal uptake. Approximately 30% of the samples were below the analytical detection limit (5 $\mu$g-P/L).

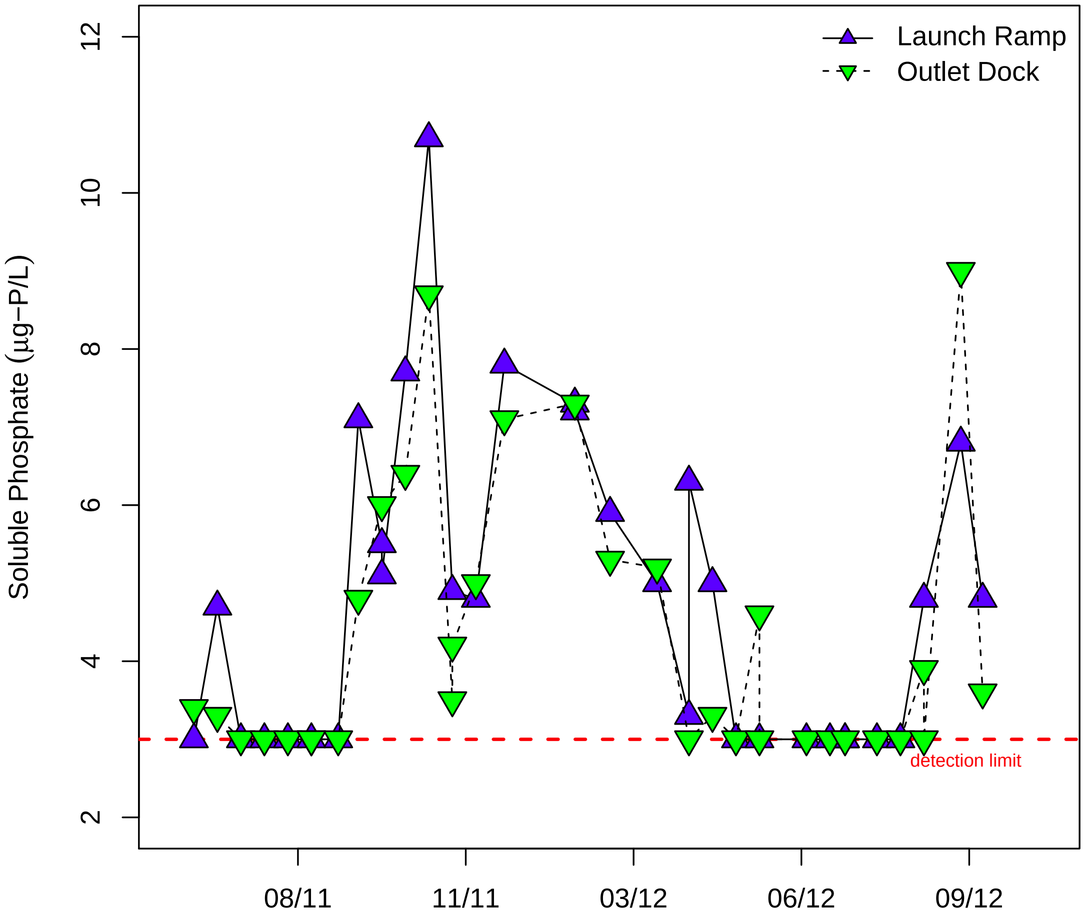



Figure 8: Lake Padden 2011–2012 soluble phosphate results. Soluble phosphate is the soluble inorganic portion of total phosphorus, and is readily available to algae and other microbiota. Soluble phosphate concentrations are usually low in the water column due to rapid uptake by biota. The soluble phosphate levels were highest during late fall and winter due to destratification and mixing, and lowest during the summer due to algal uptake. Approximately 40% of the samples were below the analytical detection limit (3 $\mu$g-P/L).

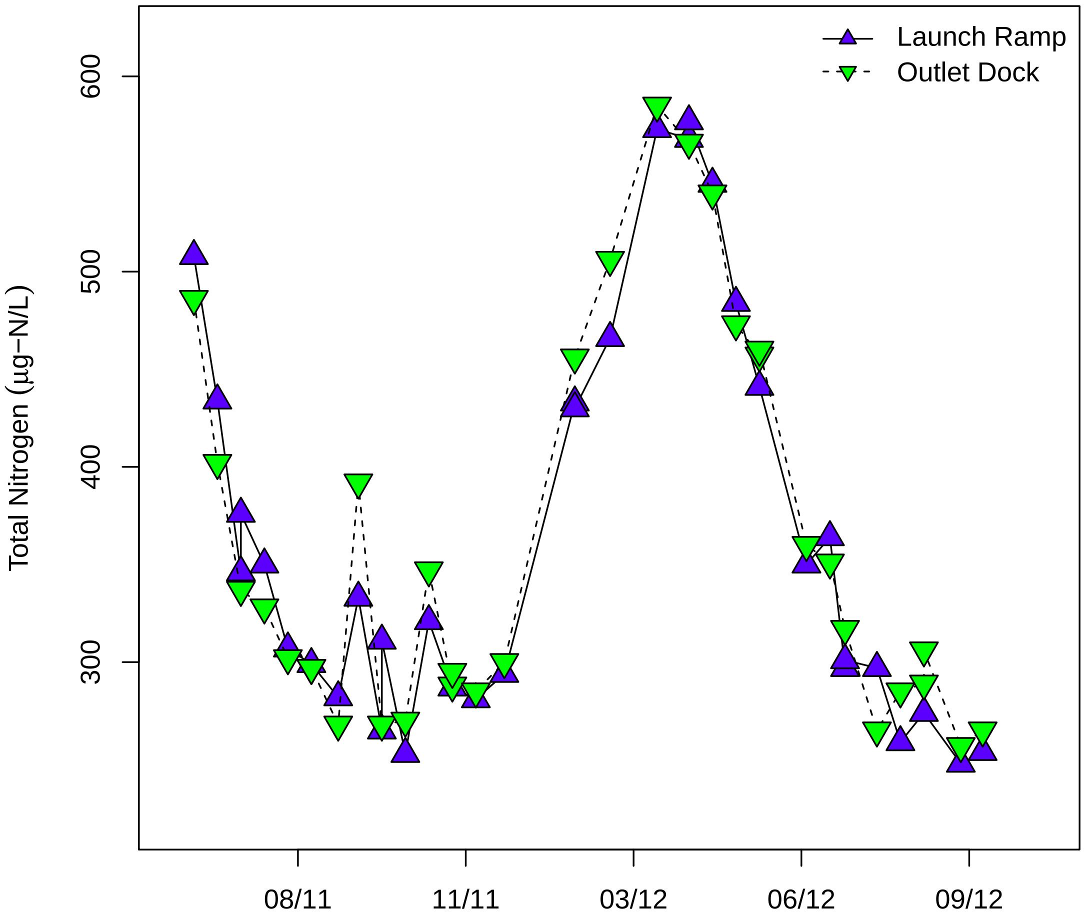



Figure 9: Lake Padden 2011-2012 total nitrogen results. Total nitrogen includes nitrogen bound in organic matter (algae and other microbiota) and dissolved inorganic nitrogen (nitrate, nitrite, and ammonium). In the winter, much of the total nitrogen in the water column will be in the form of nitrate. During the summer, however, algae take up dissolved inorganic nitrogen. This can cause the total nitrogen levels to decrease, or the inorganic nitrogen fractions may be replaced by organic nitrogen from algae and decomposing biota. Lake Padden had its highest total nitrogen concentrations during the winter and spring, with very low levels during the summer. This follows the seasonal patterns seen in the nitrate/nitrite concentrations (Figure 10, page 15). None of the samples were below the analytical detection limit (10 $\mu$g-N/L).

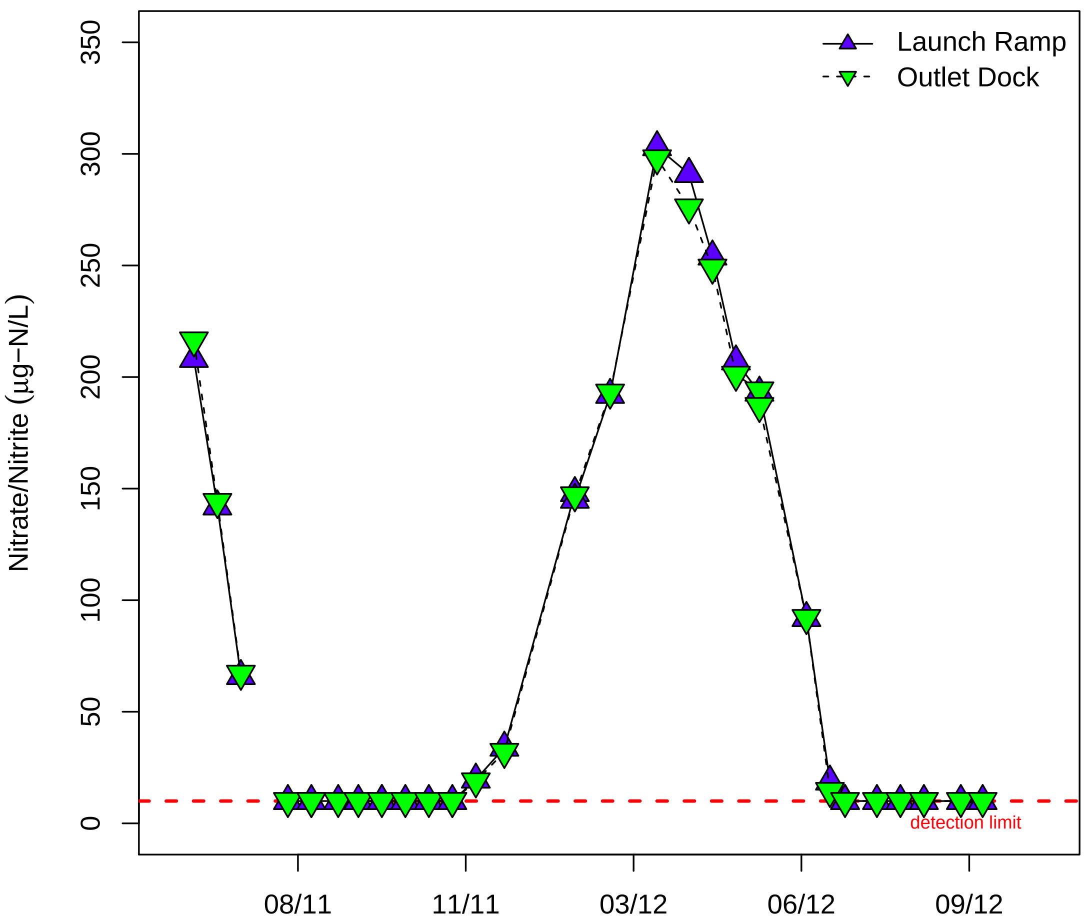



Figure 10: Lake Padden 2011–2012 nitrate/nitrite results. Nitrate/nitrite ($NO_3/NO_2$) were measured together because nitrite concentrations are usually negligible. Nitrate/nitrite is often the major component of dissolved inorganic nitrogen, which also includes ammonium ($NH_4$). Dissolved inorganic nitrogen is an important nutrient for most algae. When dissolved inorganic nitrogen concentrations are low, conditions favor cyanobacteria or blue-green algae because cyanobacteria can use dissolved $N_2$, which is replenished from the atmosphere. During the summer and fall, Lake Padden nitrate/nitrite levels were very low, indicating cyanobacteria blooms are likely to occur. Cyanobacteria blooms can be a nuisance, sometimes producing foul odors and even toxins. Approximately 50% of the samples were below the analytical detection limit (10 $\mu$g-N/L).

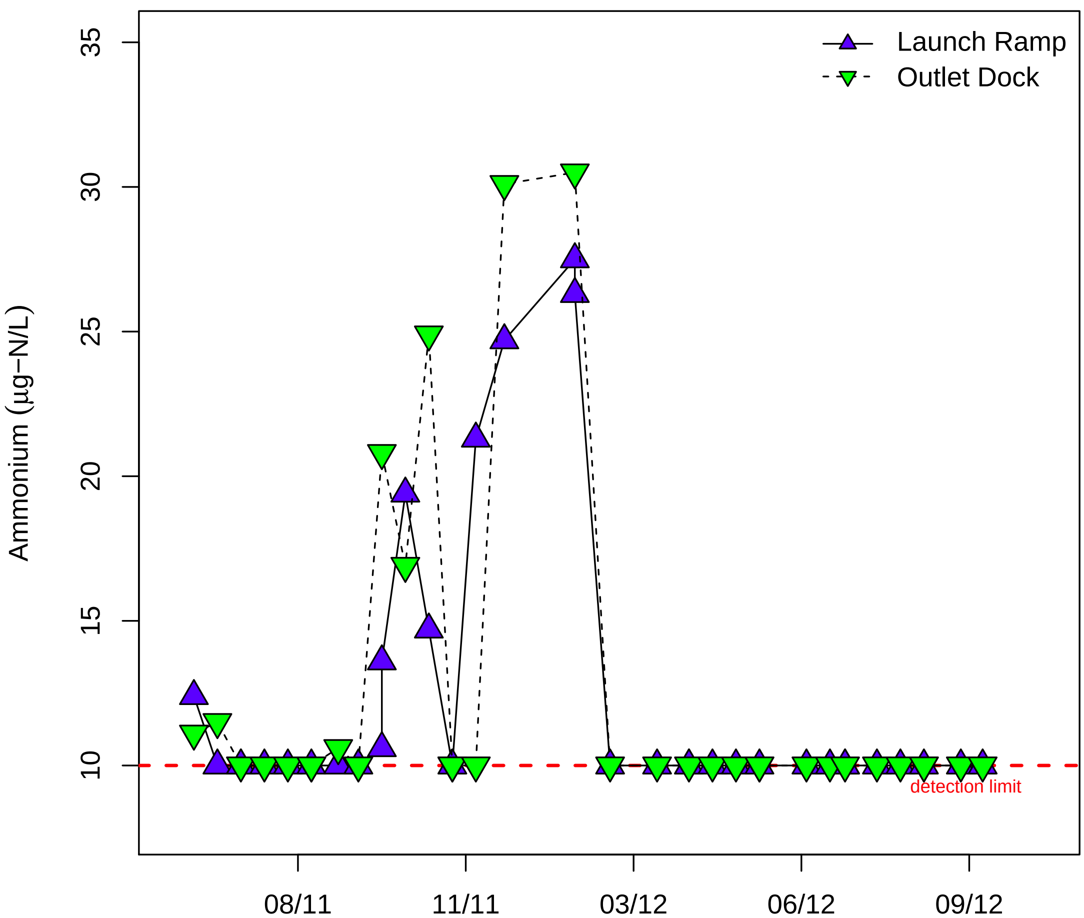



Figure 11: Lake Padden 2011–2012 ammonium results. Ammonium concentrations are usually very low in oxygenated water and are typically associated with anaerobic conditions at the bottom of the lake. In Lake Padden, ammonium levels were near or below the IWS analytical detection limit in summer but elevated during the fall and winter. The ammonium probably originates from the anoxic hypolimnion and lake sediments, and is introduced into the water column when the lake destratifies (see the discussion of anoxia and destratification in the caption for Figure 4, page 9). Approximately 75% of the samples were below the analytical detection limit (10 $\mu$g-N/L).

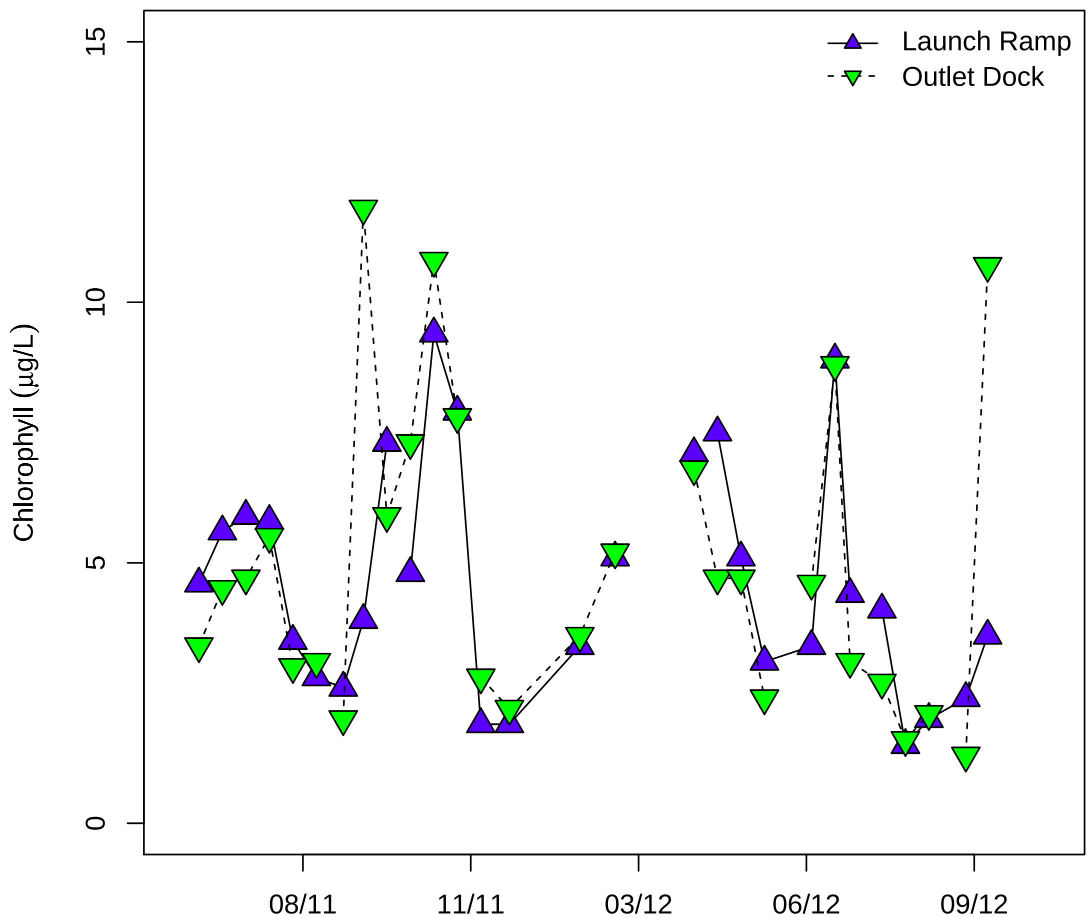
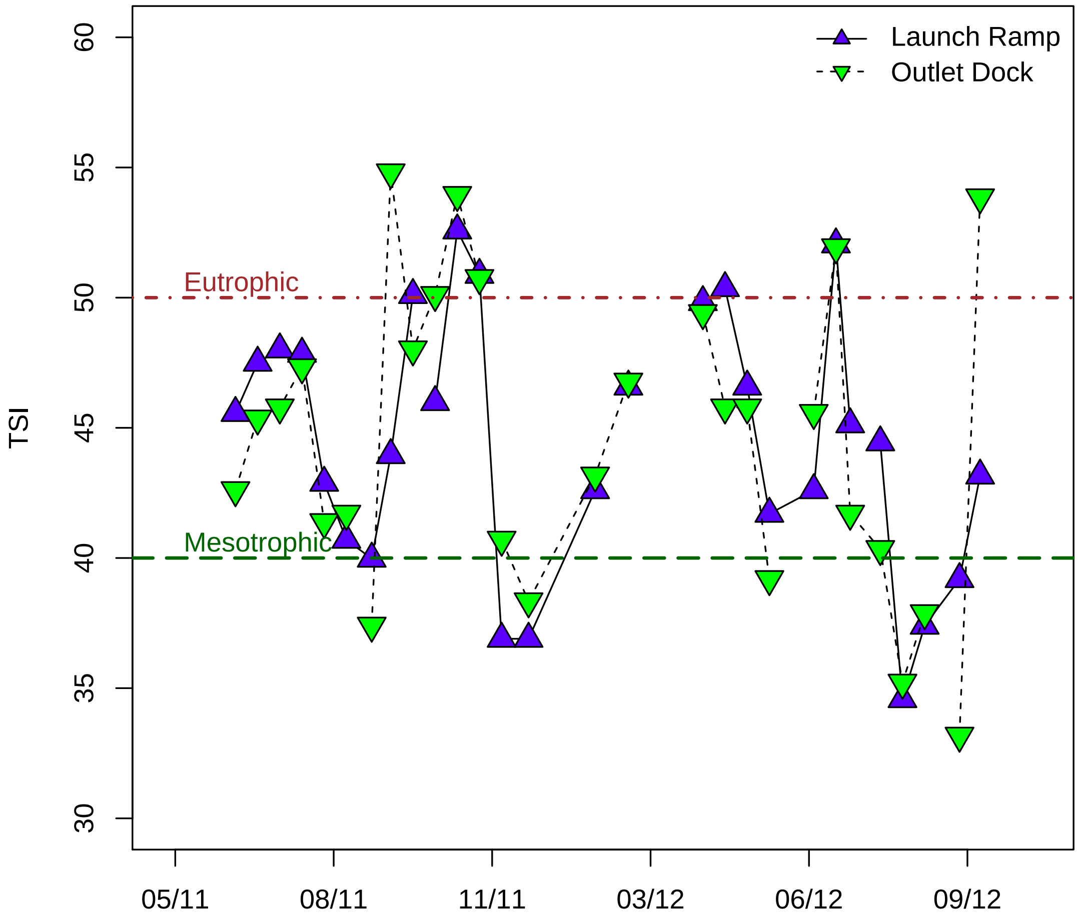
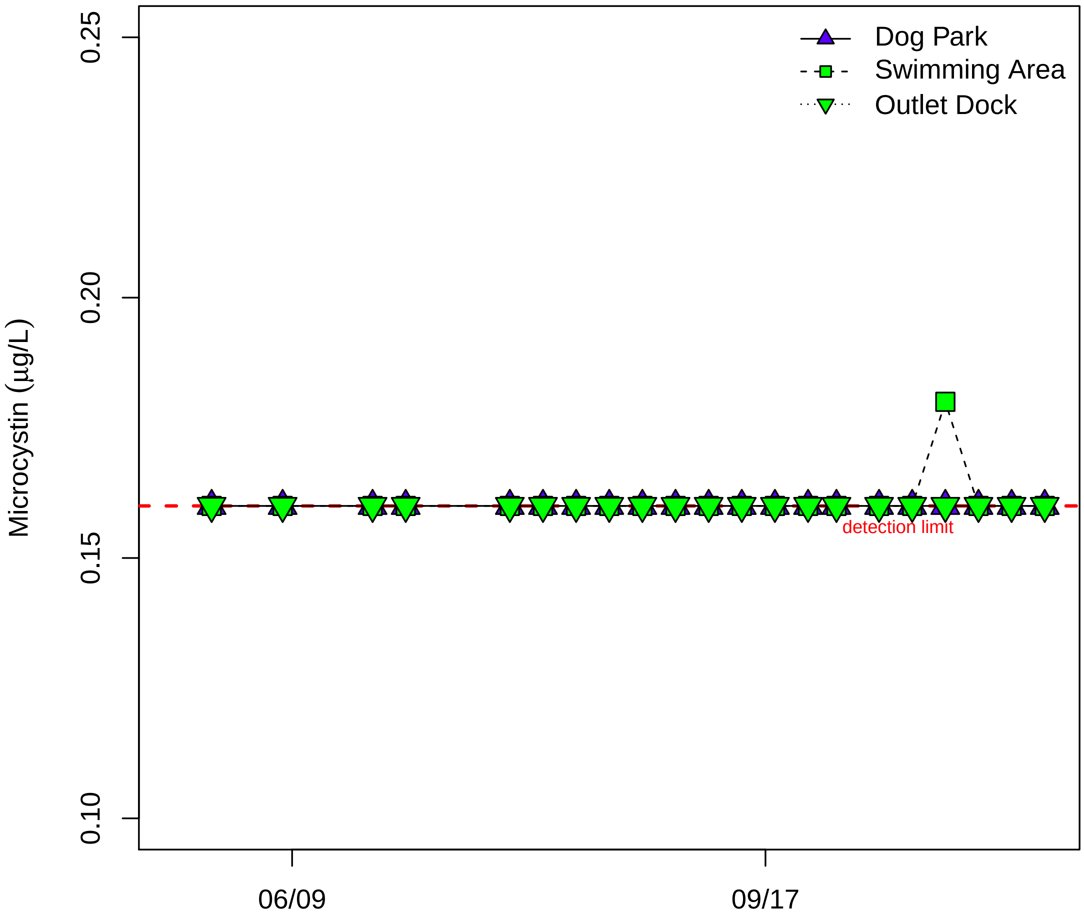



Figure 12: Lake Padden 2011–2012 chlorophyll results. Chlorophyll is the primary photosynthetic pigment in algae and is the best single indicator of the amount of algae present. Lake Padden has periodic chlorophyll peaks throughout most of the year, with the highest peaks occurring during summer and fall. The late summer and fall chlorophyll peaks occurred when the dissolved inorganic nitrogen concentrations were very low (Figures 10 and 11, pages 15), which means that these peaks were most likely blooms of cyanobacteria.




$$TSI_{chl} = 9.81 \times \ln(Chl, \mu g/L) + 30.6$$

Figure 13: Carlson's Trophic State Index for Lake Padden, 2011–2012. Carlson's Trophic State Index is a tool used to classify the trophic state of lake based on the chlorophyll concentrations during peak algal growth (generally late summer and early fall). Lakes with low concentrations of chlorophyll are biologically unproductive or oligotrophic ($TSI_{chl} < 30$); lakes that have high chlorophyll concentrations are biologically productive or eutrophic ($TSI_{chl} > 50$); lakes that fall between these concentrations are moderately productive or mesotrophic ($TSI_{chl}$ 40–50) or oligomesotrophic ($TSI_{chl}$ 30–40). The median $TSI_{chl}$ was 45 (mesotrophic), but some of the summer and fall values were in the eutrophic range.




| Location | Date | Microcystin | Major Algae (Table 1) |
|---|---|---|---|
| Swimming area | Sept 5 | 0.16 $\mu$g/L | *Anabaena*, diatoms |
| | Oct 25 | 0.18 $\mu$g/L | *Aphanizomenon*, *Anabaena* |
| | Nov 1 | 0.16 $\mu$g/L | diatoms, *Aphanizomenon* |
| Lake outlet | Nov 8 | 0.16 $\mu$g/L | diatoms, *Anabaena* |

Figure 14: Lake Padden 2012 microcystin results. Microcystin is a type of liver toxin produced by some species of cyanobacteria, including *Anabaena* and *Microcystis*, both of which are common in Lake Padden. Not all species of cyanobacteria produce toxins, and even within the species that can produce toxins, some strains do not appear to be able to produce toxins. Even among the toxin-producing strains, the algae may not produce toxins, or the levels may be too low to detect. The Lake Padden microcystin levels were $<$0.16 $\mu$g/L (analytical detection limit) except the samples listed above. All samples were were $<$6 $\mu$g/L, which is the provisional limit for swimming areas (DOH, 2008).

Table 1: Dominant and sub-dominant algae collected at the microcystin sampling sites using a 20 $\mu$m plankton net. Dominant algae were defined as the most common species present in the sample; sub-dominant algae were listed when other common species were observed in the sample. See Appendix C.2, beginning on page 39, for a complete list of algae present in these samples.

| | Outlet | Dog Park | Beach |
|---|---|---|---|
| May 23 | | | |
| Dominant | *Dinobryon*, diatoms | *Dinobryon*, diatoms | *Dinobryon*, diatoms |
| Sub-dominant | na | na | na |
| June 7 | | | |
| Dominant | diatoms | diatoms | diatoms |
| Sub-dominant | *Anabaena*, *Volvox* | na | na |
| June 26 | | | |
| Dominant | *Aphanocapsa*, *Aphanothece*, diatoms | *Aphanocapsa*, *Aphanothece*, diatoms | diatoms |
| July 3 | | | |
| Dominant | diatoms | diatoms | diatoms |
| Sub-dominant | *Aphanocapsa*, *Aphanothece* | *Aphanocapsa*, *Aphanothece* | *Aphanocapsa*, *Aphanothece* |
| July 25 | | | |
| Dominant | diatoms | diatoms | diatoms |
| Sub-dominant | *Anabaena* | *Aphanocapsa*, *Aphanothece* | single cell greens |
| August 1 | | | |
| Dominant | diatoms | diatoms | diatoms |
| Sub-dominant | *Aphanocapsa*, *Aphanothece* | *Aphanocapsa*, *Aphanothece* | *Aphanocapsa*, *Aphanothece* |

*continued on next page*

Table 1: Dominant algae at the microcystin sites, continued

| | Outlet | Dog Park | Beach |
|---|---|---|---|
| August 8 | | | |
| Dominant | diatoms | *Dinobryon* | *Dinobryon* |
| Sub-dominant | *Aphanocapsa*, *Aphanothece* | diatoms | diatoms |
| August 15 | | | |
| Dominant | *Anabaena* | diatoms | diatoms |
| Sub-dominant | *Botryococcus* | *Anabaena* | *Anabaena*, *Botryococcus* |
| August 22 | | | |
| Dominant | diatoms | *Aphanizomenon* | diatoms |
| Sub-dominant | single cell greens | diatoms | *Aphanizomenon* |
| August 29 | | | |
| Dominant | *Aphanizomenon* | *Aphanizomenon* | *Aphanizomenon* |
| Sub-dominant | diatoms | na | na |
| September 5 | | | |
| Dominant | *Anabaena*, diatoms | diatoms | *Anabaena* |
| Sub-dominant | na | *Anabaena* | diatoms |
| September 12 | | | |
| Dominant | *Anabaena* | *Anabaena* | *Anabaena* |
| Sub-dominant | *Ceratium* | diatoms | *Ceratium* |
| September 19 | | | |
| Dominant | *Ceratium* | *Anabaena* | *Anabaena* |
| Sub-dominant | *Anabaena* | single cell greens | *Ceratium* |
| September 26 | | | |
| Dominant | *Anabaena* | *Anabaena* | *Anabaena* |
| Sub-dominant | na | na | diatoms |

*continued on next page*

Table 1: Dominant algae at the microcystin sites, continued

| | Outlet | Dog Park | Beach |
|---|---|---|---|
| October 2 | | | |
| Dominant | *Anabaena* | *Anabaena* | *Anabaena* |
| Sub-dominant | *Mallomonas* | na | na |
| October 11 | | | |
| Dominant | *Anabaena* | *Anabaena* | *Anabaena* |
| Sub-dominant | diatoms | diatoms | diatoms, fil. greens |
| October 18 | | | |
| Dominant | *Anabaena* | diatoms | *Anabaena* |
| Sub-dominant | diatoms | *Anabaena*, *Aphanizomenon* | *Aphanizomenon* |
| October 25 | | | |
| Dominant | *Anabaena* | *Anabaena* | *Aphanizomenon* |
| Sub-dominant | diatoms | *Aphanizomenon* | *Anabaena* |
| November 1 | | | |
| Dominant | diatoms | diatoms | diatoms |
| Sub-dominant | fil. greens | fil. greens, *Synura* | fil. greens, *Aphanizomenon* |
| November 8 | | | |
| Dominant | diatoms | *Anabaena* | fil. greens |
| Sub-dominant | *Aphanizomenon*, fil. greens | fil. greens | *Aphanizomenon*, diatoms |
| November 15 | | | |
| Dominant | *Aphanizomenon* | *Aphanizomenon* | *Aphanizomenon* |
| Sub-dominant | *Anabaena*, *Woronichinia* | diatoms, fil. greens | *Anabaena*, *Woronichinia* |

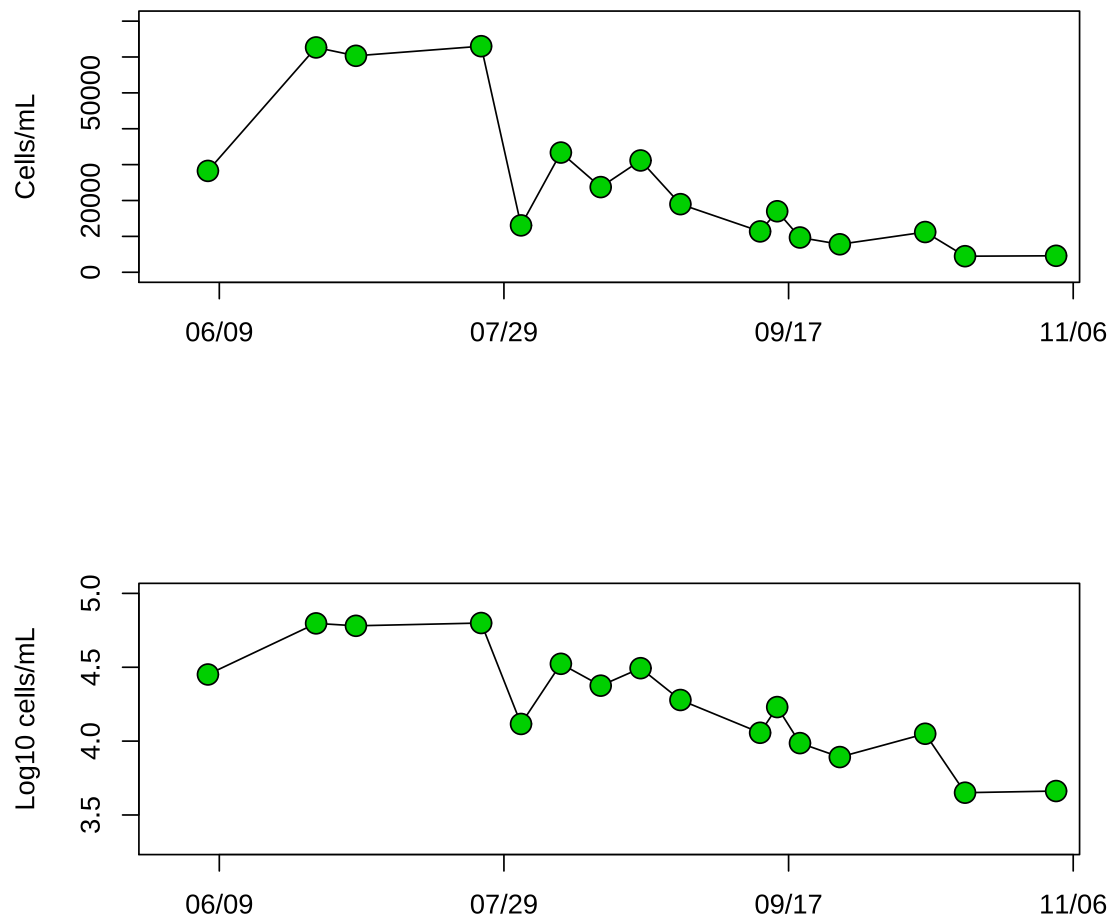



Figure 15: Lake Padden 2012 settled algae counts. The simplest way to estimate algal density in a lake is to measure chlorophyll concentrations in the water column (see Figure 12, page 17). But chlorophyll doesn't show what kinds of algae are present or give an estimate of the number of cells in the sample. Algae can be counted and identified by collecting a sample using a plankton net (see Table 1, page 20; Appendix C.2), but this method underestimates the density of small algae. The traditional method involves preserving an unconcentrated water sample using Lugol's iodine solution, allowing the algae to settle slowly into a counting chamber, then counting the individual cells under high magnification. This figure shows the total number of algae cells in Lake Padden samples collected between May and November 2012. Algae counts are usually presented using a $\log_{10}$ scale because of the large range.

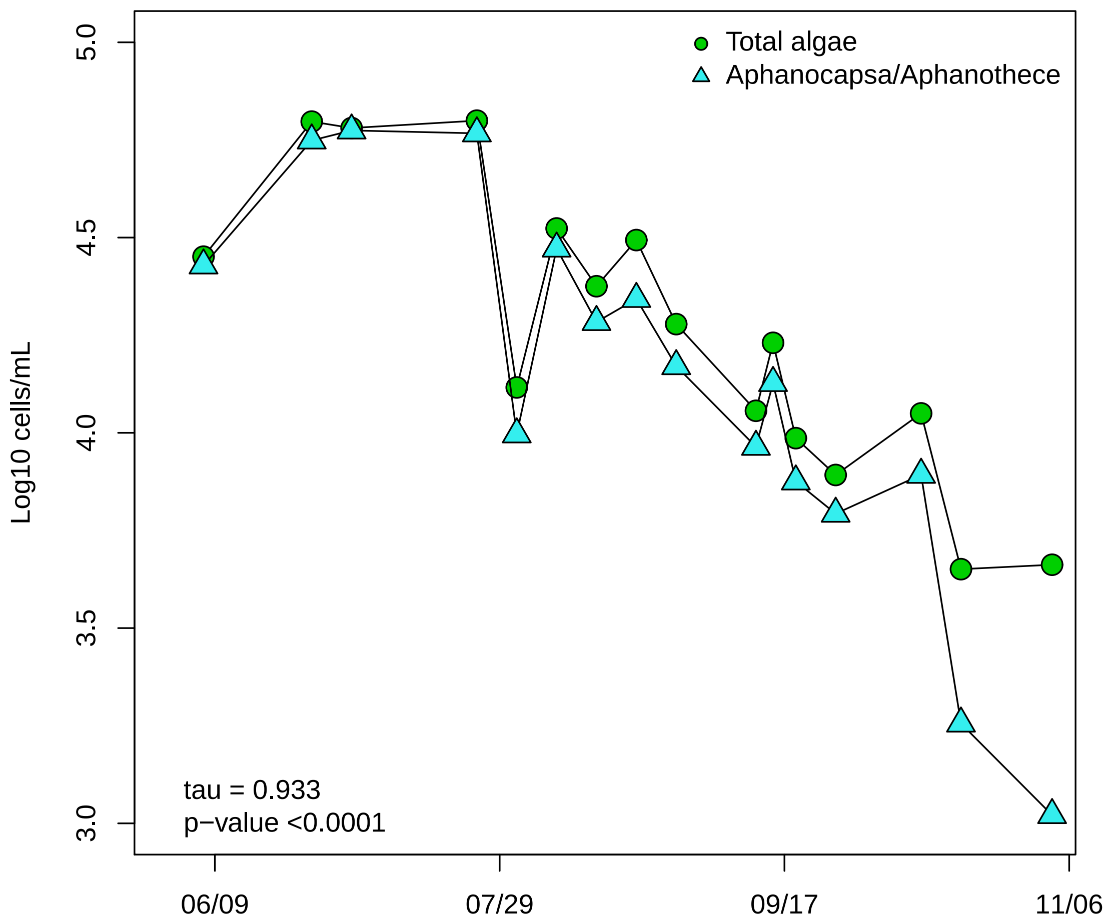



Figure 16: Lake Padden *Aphanocapsa*/*Aphanothece* counts. *Aphanocapsa* and *Aphanothece* are common (nontoxic) cyanobacteria (blue-green algae) that form dense colonies containing hundreds to thousands of tiny, nearly indistinguishable cells. Because the cells are so tiny, even large numbers of cells may not cause an increase in biomass measurements like chlorophyll. In Lake Padden, *Aphanocapsa* and *Aphanothece* dominated the algae cell count throughout most of the summer. As a result, the total counts were highly correlated with *Aphanocapsa*/*Aphanothece* (Kendall's $\tau$ correlation coefficient = 0.933; p-value $\leq$0.0001). While this is an interesting feature, it isn't the only algae pattern that we want to examine. In order to look at the remaining algal patterns, the data in Figures 17–18, (pages 25–26) do not include *Aphanocapsa* and *Aphanothece*.

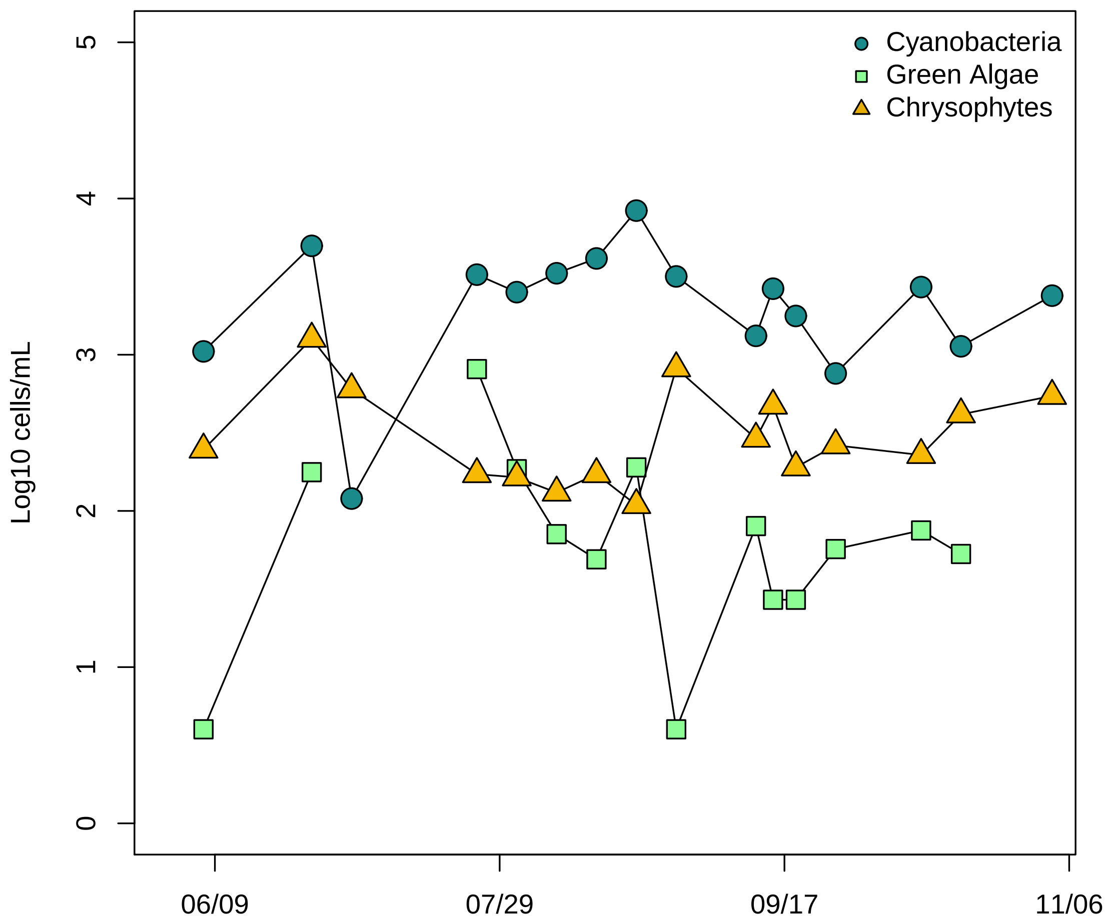



Figure 17: Lake Padden 2012 settled algae counts for cyanobacteria (excluding *Aphanocapsa*/*Aphanothece*), green algae, and chrysophytes. Even without *Aphanocapsa*/*Aphanothece* counts, the Lake Padden algal populations were usually dominated by cyanobacteria. The most common taxa, after *Aphanocapsa*/*Aphanothece* were *Anabaena*, *Aphanizomenon*, and *Snowella* (Appendix C.1). The second most abundant group were chrysophytes, dominated by *Dinobryon*, *Epipyxis*, *Gloeobotrys*, *Mallomonas*, and many different types of diatoms. Green algae usually had lower cell counts than the other groups. The most common green taxa were *Botryococcus*, *Eudorina*, and *Sphaerocystis*. Note that the cell count in the above figure is presented using a $\log_{10}$ scale.

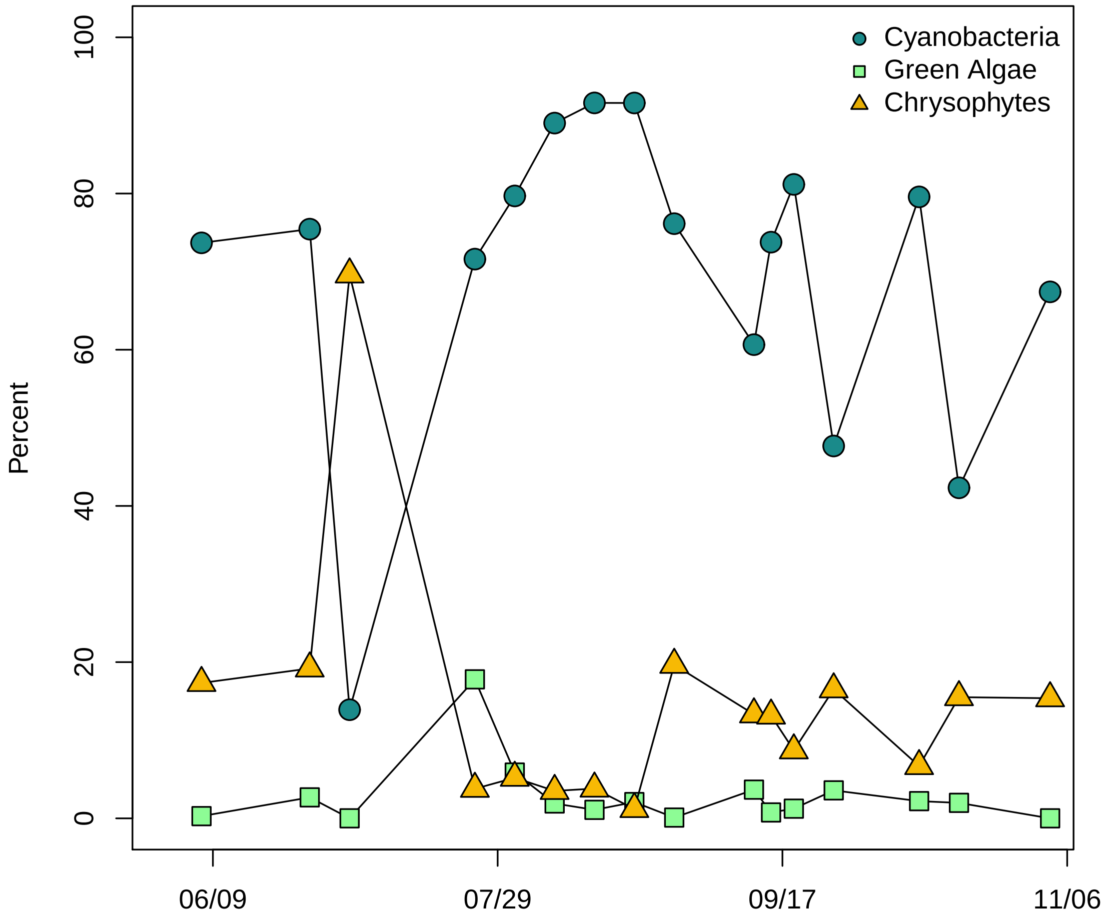



Figure 18: Lake Padden 2012 settled algae percents (excluding *Aphanocapsa*/*Aphanothece*). The percent of each algal group shows which types of algae dominated the settled counts. As expected, cyanobacteria made up most of the total count, even after removing the *Aphanocapsa*/*Aphanothece* counts. Chrysophytes, which often bloom during spring, formed one significant bloom on July 3. The bloom was dominated by diatoms (especially *Cyclotella* and *Fragilaria*) and coincided with a very low densities of any type of cyanobacteria other than *Aphanocapsa*/*Aphanothece*.

# A Water Quality Data

Table 2: Summary of analytical methods used by the Institute for Watershed Studies in the Lake Padden monitoring project.

| Analyte | Abbr. | Method | Det. Limit/ Sensitivity |
|---|---|---|---|
| Dissolved oxygen-Winkler | DO.lab | 4500-O C azide† | ±0.1 mg/L |
| Dissolved oxygen-YSI | DO.field | 4500-O G field meter† | ±0.1 mg/L |
| Temperature-YSI | Temp | 2550 field meter† | ±0.1 C |
| | | | |
| pH | pH | 4500-H lab meter† | ±0.1 units |
| Conductivity | Cond | 2510 lab meter† | ±0.1 units |
| | | | |
| Ammonium | NH3 | 4500-NH3 H phenate† | 10 $\mu$g-N/L |
| Total nitrogen | TN | 4500-NO3 I and 4500-P J† | 10 $\mu$g-N/L |
| Nitrate/nitrite | NO3 | 4500-NO3 I Cd reduction† | 10 $\mu$g-N/L |
| | | | |
| Total phosphorus | TP | 4500-P G and 4500-P J† | 5 $\mu$g-P/L |
| Orthophosphate | SRP | 4500-P G† | 3 $\mu$g-P/L |
| | | | |
| Algae counts | – | 10200 C sedimentation† | NA |
| Chlorophyll | Chl | 10200 H† | ±0.1 mg/m$^3$ |
| | | | |
| Microcystin | Micro | EnviroLogix‡ | 0.16 $\mu$g/L |

†APHA 2012; ‡EnviroLogix 2010

Table 3: Water quality data collected at the Lake Padden outlet (Figure 1, page 6). See Table A (page 27) for analytical methods, abbreviations, and detection limits.

| Date | NH3 | TN | NO3 | SRP | TP | Chl | Cond | pH | Temp | DO.lab |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/13/2011 | 11.1 | 486 | 216 | 3.4 | 10.0 | 3.4 | 98.0 | NA | NA | 9.1 |
| 6/27/2011 | 11.5 | 402 | 144 | 3.3 | <5 | 4.5 | 98.4 | 8.2 | 19.0 | 9.5 |
| 7/11/2011 | <10 | 337 | 67 | 3.0 | <5 | 4.7 | 98.9 | 8.6 | 22.2 | 9.4 |
| 7/25/2011 | <10 | 328 | NA | <3 | <5 | 5.5 | 98.3 | 8.6 | 20.5 | 9.2 |
| 8/8/2011 | <10 | 302 | <10 | <3 | <5 | 3.0 | 99.0 | 8.0 | 21.2 | 8.9 |
| 8/22/2011 | <10 | 297 | <10 | <3 | 5.0 | 3.1 | 100.2 | 8.0 | 21.1 | 8.5 |
| 9/7/2011 | 10.6 | 268 | <10 | <3 | <5 | 2.0 | 100.8 | 7.9 | 21.5 | 8.6 |
| 9/19/2011 | <10 | 392 | <10 | 4.8 | 9.8 | 11.8 | 101.6 | 7.6 | 18.4 | 8.2 |
| 10/3/2011 | 20.8 | 268 | <10 | 6.0 | 14.5 | 5.9 | 102.0 | 7.6 | 16.5 | 8.5 |
| 10/17/2011 | 16.9 | 270 | <10 | 6.4 | 19.9 | 7.3 | 103.1 | 7.4 | 14.4 | 8.7 |
| 10/31/2011 | 24.9 | 347 | <10 | 8.7 | 24.2 | 10.8 | 102.9 | 7.5 | 12.0 | 9.6 |
| 11/14/2011 | <10 | 288 | <10 | 3.5 | 18.6 | 7.8 | 103.0 | 7.5 | 9.2 | 10.5 |
| 11/28/2011 | <10 | 285 | 19 | 5.0 | 11.3 | 2.8 | 103.1 | 7.5 | 7.0 | 10.9 |
| 12/15/2011 | 30.1 | 300 | 32 | 7.1 | 12.4 | 2.2 | 104.4 | 7.3 | 4.9 | 10.5 |
| 1/26/2012 | 30.5 | 456 | 147 | 7.3 | 20.5 | 3.6 | 104.2 | 7.3 | 3.8 | 12.0 |
| 2/16/2012 | <10 | 506 | 193 | 5.3 | 15.4 | 5.2 | 104.9 | 7.3 | 5.2 | 12.0 |
| 3/15/2012 | <10 | 585 | 298 | 5.2 | 12.9 | NA | 98.9 | 7.2 | 5.6 | 11.8 |
| 4/3/2012 | <10 | 566 | 276 | <3 | 15.4 | 6.8 | 98.1 | 7.0 | 7.1 | 11.6 |
| 4/17/2012 | <10 | 540 | 249 | 3.3 | 9.2 | 4.7 | 97.4 | 7.3 | 11.6 | 11.3 |
| 5/1/2012 | <10 | 473 | 201 | <3 | 11.7 | 4.7 | 97.6 | 7.4 | 12.5 | 10.6 |
| 5/15/2012 | <10 | 457 | 194 | 4.6 | 13.9 | 2.4 | 97.1 | 7.7 | NA | 9.9 |
| 6/12/2012 | <10 | 360 | 92 | <3 | <5 | 4.6 | 99.1 | 8.0 | 17.5 | 9.8 |
| 6/26/2012 | <10 | 351 | 14 | <3 | 8.2 | 8.8 | 96.8 | 8.3 | 17.0 | 9.7 |
| 7/5/2012 | <10 | 317 | <10 | <3 | 6.8 | 3.1 | 98.4 | 8.2 | 18.0 | 9.7 |
| 7/24/2012 | <10 | 265 | <10 | <3 | <5 | 2.7 | 99.8 | 8.0 | 20.0 | 8.7 |
| 8/7/2012 | <10 | 285 | <10 | <3 | <5 | 1.6 | 101.0 | 7.9 | 22.5 | 8.6 |
| 8/21/2012 | <10 | 289 | <10 | 3.9 | 5.8 | 2.1 | 101.4 | 7.9 | 21.5 | 8.4 |
| 9/12/2012 | <10 | 257 | <10 | 9.0 | <5 | 1.3 | 102.7 | 7.6 | 19.6 | 8.4 |
| 9/25/2012 | <10 | 265 | <10 | 3.6 | 7.0 | 10.7 | 102.9 | 7.6 | 13.5 | 8.2 |

Table 4: Water quality data collected at the Lake Padden boat launch (Figure 1, page 6). See Table A (page 27) for analytical methods, abbreviations, and detection limits.

| Date | NH3 | TN | NO3 | SRP | TP | Chl | Cond | pH | Temp | DO.lab |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/13/2011 | 12.4 | 508 | 208 | <3 | 13.6 | 4.6 | 100.0 | NA | NA | 9.0 |
| 6/27/2011 | <10 | 434 | 142 | 4.7 | <5 | 5.6 | 98.3 | 8.2 | 19.0 | 9.5 |
| 7/11/2011 | <10 | 346 | 66 | <3 | <5 | 5.9 | 99.3 | 8.6 | 21.5 | 9.5 |
| 7/25/2011 | <10 | 350 | NA | <3 | <5 | 5.8 | 98.6 | 8.5 | 20.5 | 9.2 |
| 8/8/2011 | <10 | 307 | <10 | <3 | 5.3 | 3.5 | 98.6 | 8.1 | 21.5 | 9.0 |
| 8/22/2011 | <10 | 299 | <10 | <3 | <5 | 2.8 | 100.0 | 7.9 | 21.0 | 8.5 |
| 9/7/2011 | <10 | 282 | <10 | <3 | 5.6 | 2.6 | 101.1 | 7.8 | 22.0 | 8.6 |
| 9/19/2011 | <10 | 333 | <10 | 7.1 | 6.8 | 3.9 | 102.0 | 7.5 | 18.2 | 8.0 |
| 10/3/2011 | 10.6 | 265 | <10 | 5.5 | 16.5 | 7.3 | 102.2 | 7.5 | 16.8 | 8.3 |
| 10/17/2011 | 19.4 | 253 | <10 | 7.7 | 18.8 | 4.8 | 104.3 | 7.3 | 15.0 | 8.7 |
| 10/31/2011 | 14.7 | 321 | <10 | 10.7 | 23.3 | 9.4 | 103.3 | 7.5 | 12.0 | 9.5 |
| 11/14/2011 | <10 | 287 | <10 | 4.9 | 16.7 | 7.9 | 102.6 | 7.5 | 9.4 | 10.5 |
| 11/28/2011 | 21.3 | 281 | 20 | 4.8 | 10.9 | 1.9 | 103.2 | 7.4 | 7.4 | 10.8 |
| 12/15/2011 | 24.7 | 294 | 34 | 7.8 | 11.6 | 1.9 | 104.5 | 7.1 | 5.0 | 10.2 |
| 1/26/2012 | 27.5 | 433 | 148 | 7.3 | 20.7 | 3.4 | 105.2 | 7.4 | 3.8 | 12.0 |
| 2/16/2012 | <10 | 466 | 192 | 5.9 | 15.6 | 5.1 | 105.2 | 7.4 | 5.2 | 12.0 |
| 3/15/2012 | <10 | 573 | 303 | 5.0 | 16.6 | NA | 99.4 | 7.1 | 5.6 | 11.7 |
| 4/3/2012 | <10 | 568 | 291 | 3.3 | 15.0 | 7.1 | 97.6 | 7.0 | 7.5 | 11.5 |
| 4/17/2012 | <10 | 545 | 254 | 5.0 | 11.2 | 7.5 | 97.4 | 7.2 | 11.5 | 11.4 |
| 5/1/2012 | <10 | 484 | 207 | <3 | 11.9 | 5.1 | 97.5 | 7.5 | 12.5 | 10.8 |
| 5/15/2012 | <10 | 441 | 193 | <3 | 11.7 | 3.1 | 97.5 | 7.7 | 15.0 | 9.8 |
| 6/12/2012 | <10 | 350 | 92 | <3 | 6.3 | 3.4 | 99.0 | 8.0 | 17.5 | 9.7 |
| 6/26/2012 | <10 | 364 | 19 | <3 | 12.8 | 8.9 | 98.5 | 8.3 | 17.5 | 9.7 |
| 7/5/2012 | <10 | 297 | <10 | <3 | 6.3 | 4.4 | 98.5 | 8.0 | 17.5 | 9.5 |
| 7/24/2012 | <10 | 297 | <10 | <3 | <5 | 4.1 | 100.1 | 8.0 | 19.5 | 8.7 |
| 8/7/2012 | <10 | 259 | <10 | <3 | <5 | 1.5 | 101.1 | 8.1 | 22.5 | 8.5 |
| 8/21/2012 | <10 | 274 | <10 | 4.8 | 5.2 | 2.0 | 101.5 | 7.9 | 22.0 | 8.3 |
| 9/12/2012 | <10 | 248 | <10 | 6.8 | <5 | 2.4 | 102.9 | 7.6 | 19.5 | 8.6 |
| 9/25/2012 | <10 | 254 | <10 | 4.8 | 8.4 | 3.6 | 103.0 | 7.5 | 14.0 | 8.0 |

Table 5: Water quality profiles collected at the Lake Padden deep water site (Figure 1, page 6). See Table A (page 27) for analytical methods, abbreviations, and detection limits.

| Depth | NH3 | TN | NO3 | SRP | TP | Cond | pH | Temp | DO.field |
|---|---|---|---|---|---|---|---|---|---|
| | | | | August 29, 2011 | | | | | |
| 0 | <10 | 287 | <10 | <3 | 5.6 | 100.1 | 8.1 | 20.9 | 9.2 |
| 1 | NA | NA | NA | NA | NA | NA | NA | 20.9 | 9.2 |
| 2 | NA | NA | NA | NA | NA | NA | NA | 20.8 | 9.2 |
| 3 | NA | NA | NA | NA | NA | NA | NA | 20.9 | 9.2 |
| 4 | NA | NA | NA | NA | NA | NA | NA | 20.8 | 9.2 |
| 5 | NA | NA | NA | NA | NA | NA | NA | 20.2 | 8.9 |
| 6 | NA | NA | NA | NA | NA | NA | NA | 19.7 | 7.9 |
| 7 | NA | NA | NA | NA | NA | NA | NA | 16.5 | 0.9 |
| 8 | NA | NA | NA | NA | NA | NA | NA | 13.7 | 0.0 |
| 9 | 107.8 | 385 | <10 | 7.7 | 26.5 | 112.9 | 6.8 | 12.2 | 0.0 |

| Depth | NH3 | TN | NO3 | SRP | TP | Cond | pH | Temp | DO.field |
|---|---|---|---|---|---|---|---|---|---|
| | | | | November 7, 2011 | | | | | |
| 0 | 16.3 | 273 | <10 | 7.4 | 21.2 | 102.4 | 7.5 | 9.9 | 10.3 |
| 1 | NA | NA | NA | NA | NA | NA | NA | 9.8 | 10.3 |
| 2 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.2 |
| 3 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.2 |
| 4 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.2 |
| 5 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.1 |
| 6 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.1 |
| 7 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.1 |
| 8 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.1 |
| 9 | <10 | 303 | <10 | 5.3 | 21.4 | 103.1 | 7.5 | 9.9 | 10.1 |
| 10 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 10.1 |

*continued on next page*

Table 5: Lake Padden deep water site, continued

| Depth | NH3 | TN | NO3 | SRP | TP | Cond | pH | Temp | DO.field |
|---|---|---|---|---|---|---|---|---|---|
| August 7, 2012 | | | | | | | | | |
| 0.3 | NA | NA | NA | NA | NA | NA | NA | 22.0 | NA |
| 1 | NA | NA | NA | NA | NA | NA | NA | 22.0 | 9.1 |
| 2 | NA | NA | NA | NA | NA | NA | NA | 21.9 | 9.1 |
| 3 | NA | NA | NA | NA | NA | NA | NA | 21.6 | 9.1 |
| 4 | NA | NA | NA | NA | NA | NA | NA | 21.3 | 9.1 |
| 5 | NA | NA | NA | NA | NA | NA | NA | 20.1 | 8.7 |
| 6 | NA | NA | NA | NA | NA | NA | NA | 19.5 | 7.9 |
| 7 | NA | NA | NA | NA | NA | NA | NA | 15.1 | 0.4 |
| 8 | NA | NA | NA | NA | NA | NA | NA | 11.2 | 0.1 |
| 9 | NA | NA | NA | NA | NA | NA | NA | 9.9 | 0.0 |
| 10 | NA | NA | NA | NA | NA | NA | NA | 9.4 | 0.0 |

# B Quality Control Data

Table 6: Lake Padden quality control data. See Table A (page 27) for analytical methods, abbreviations, and detection limits.

| Site | Date | NH3 | TN | NO3 | SRP | TP | Chl | Cond | pH |
|---|---|---|---|---|---|---|---|---|---|
| Launch ramp | July 11 2011 | <10 | 346 | 66 | <3 | <5 | 5.9 | 99.3 | 8.6 |
| Field duplicate | | <10 | 376 | NA | NA | <5 | NA | 99.2 | 8.6 |
| Launch ramp | Oct 3 2011 | 10.6 | 265 | <10 | 5.5 | 16.5 | 7.3 | 102.2 | 7.5 |
| Field duplicate | | 13.6 | 311 | <10 | 5.1 | 16.3 | NA | 102.6 | 7.5 |
| Launch ramp | Jan 26 2012 | 27.5 | 433 | 148 | 7.3 | 20.7 | 3.4 | 105.2 | 7.4 |
| Field duplicate | | 26.3 | 430 | 145 | 7.2 | 19.1 | NA | 105.1 | 7.4 |
| Launch ramp | Apr 3 2012 | <10 | 568 | 291 | 3.3 | 15.0 | 7.1 | 97.6 | 7.0 |
| Field duplicate | | <10 | 577 | 291 | 6.3 | 13.7 | NA | 98.0 | 6.9 |
| Launch ramp | July 5 2012 | <10 | 297 | <10 | <3 | 6.3 | 4.4 | 98.5 | 8.0 |
| Field duplicate | | <10 | 301 | <10 | <3 | <5 | NA | 98.4 | 8.0 |
| Lake outlet | Aug 22 2011 | <10 | 297 | <10 | <3 | 5.0 | 3.1 | 100.2 | 8.0 |
| Field duplicate | | <10 | 297 | <10 | <3 | <5 | NA | 100.1 | 8.0 |
| Lake outlet | Nov 14 2011 | <10 | 288 | <10 | 3.5 | 18.6 | 7.8 | 103.0 | 7.5 |
| Field duplicate | | <10 | 295 | <10 | 4.2 | 21.7 | NA | 103.2 | 7.6 |
| Lake outlet | May 15 2012 | <10 | 457 | 194 | 4.6 | 13.9 | 2.4 | 97.1 | 7.7 |
| Field duplicate | | <10 | 460 | 187 | <3 | 11.8 | NA | 97.1 | 7.7 |
| Lake outlet | Aug 21 2012 | <10 | 289 | <10 | 3.9 | 5.8 | 2.1 | 101.4 | 7.9 |
| Field duplicate | | <10 | 306 | <10 | <3 | <5 | NA | 101.5 | 7.9 |

# C Algae Data

## C.1 Algae Density in Settled Samples

Table 7: Lake Padden settled algae counts (cells/mL) from whole-water samples preserved with Lugol's iodine solution See Table A (page 27) for a summary of the settling methods.

| | Jun 7 | Jun 26 | Jul 3 | Jul 25 | Aug 1 | Aug 8 |
|---|---|---|---|---|---|---|
| *Anabaena* | 199 | 2974 | 111 | 1345 | 314 | 270 |
| *Aphanizomenon* | 50 | 400 | 0 | 0 | 500 | 400 |
| *Aphanocapsa, Aphanothece* | 26831 | 56065 | 59468 | 58468 | 9911 | 29634 |
| *Chroococcus, Eucapsis* | 0 | 0 | 9 | 9 | 0 | 0 |
| *Cyanodictyon* | 0 | 0 | 0 | 100 | 0 | 250 |
| *Pseudanabaena* | 0 | 0 | 0 | 200 | 100 | 0 |
| *Snowella* | 0 | 0 | 0 | 1601 | 1601 | 2403 |
| *Woronichinia* | 801 | 1602 | 0 | 0 | 0 | 0 |
| *Bitrichia* | 0 | 0 | 0 | 0 | 0 | 4 |
| *Dinobryon* | 44 | 0 | 9 | 18 | 9 | 40 |
| *Epipyxis* | 0 | 0 | 0 | 0 | 18 | 0 |
| *Gloeobotrys* | 0 | 655 | 0 | 71 | 0 | 0 |
| *Mallomonas acaroides* | 0 | 0 | 9 | 4 | 0 | 4 |
| *Mallomonas akrokomos* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mallomonas caudata* | 4 | 0 | 0 | 0 | 0 | 0 |
| *Mallomonas tonsurata* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synura* | 0 | 0 | 0 | 0 | 71 | 0 |
| Cryptomonad - large | 35 | 53 | 18 | 9 | 18 | 13 |
| Cryptomonad - small | 80 | 124 | 115 | 301 | 274 | 173 |
| *Cosmarium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cosmocladium* | 0 | 0 | 0 | 0 | 4 | 0 |
| *Achnanthes* | 97 | 0 | 0 | 0 | 13 | 44 |
| *Asterionella* | 0 | 71 | 35 | 0 | 35 | 0 |
| *Aulacoseira* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cocconeis* shape | 0 | 0 | 0 | 4 | 0 | 4 |
| *Cyclotella* | 49 | 248 | 257 | 75 | 9 | 35 |

*continued on next page*

Table 7: Lake Padden settled algae counts, continued

| | Jun 7 | Jun 26 | Jul 3 | Jul 25 | Aug 1 | Aug 8 |
|---|---|---|---|---|---|---|
| *Cymbella* shape | 9 | 0 | 0 | 0 | 0 | 0 |
| *Fragilaria* | 4 | 274 | 283 | 0 | 0 | 0 |
| *Navicula* shape | 27 | 0 | 4 | 0 | 0 | 0 |
| *Stephanodiscus* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synedra* | 9 | 18 | 4 | 0 | 9 | 0 |
| *Tabellaria* | 4 | 0 | 0 | 0 | 0 | 0 |
| Unk fil diatom | 0 | 0 | 0 | 0 | 0 | 0 |
| Unk nonfil diatom | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ceratium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gymnodinium* | 9 | 0 | 9 | 0 | 0 | 22 |
| *Peridinium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Euglena* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Trachelomonas* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Actinastrum* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ankistrodesmus* | 0 | 35 | 0 | 0 | 0 | 0 |
| *Ankyra, Monoraph., Schroederia* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Asterococcus, Planktosphaeria* | 0 | 0 | 0 | 4 | 0 | 0 |
| *Botryococcus* | 0 | 0 | 0 | 801 | 0 | 0 |
| *Chlamydomonas* | 0 | 0 | 0 | 0 | 4 | 0 |
| *Dictyosphaerium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Elakatothrix* | 4 | 0 | 0 | 0 | 0 | 53 |
| *Eudorina* | 0 | 0 | 0 | 0 | 142 | 0 |
| *Mougeotia* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oocystis* | 0 | 0 | 0 | 0 | 0 | 18 |
| *Quadrigula* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Sphaerocystis* | 0 | 142 | 0 | 0 | 35 | 0 |
| *Tetraedron* | 0 | 0 | 0 | 4 | 0 | 0 |

*continued on next page*

Table 7: Lake Padden settled algae counts, continued

| | Aug 15 | Aug 22 | Aug 29 | Sep 12 | Sep 15 | Sep 19 |
|---|---|---|---|---|---|---|
| *Anabaena* | 181 | 288 | 119 | 221 | 438 | 1522 |
| *Aphanizomenon* | 300 | 4475 | 2853 | 0 | 258 | 0 |
| *Aphanocapsa, Aphanothece* | 19222 | 22025 | 14817 | 9210 | 13415 | 7508 |
| *Chroococcus, Eucapsis* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cyanodictyon* | 250 | 300 | 0 | 250 | 0 | 0 |
| *Pseudanabaena* | 0 | 0 | 0 | 50 | 150 | 149 |
| *Snowella* | 3403 | 3303 | 200 | 800 | 1601 | 100 |
| *Woronichinia* | 0 | 0 | 0 | 0 | 200 | 0 |
| *Bitrichia* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dinobryon* | 27 | 66 | 89 | 128 | 97 | 13 |
| *Epipyxis* | 0 | 0 | 164 | 97 | 111 | 0 |
| *Gloeobotrys* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Mallomonas acaroides* | 4 | 4 | 0 | 13 | 0 | 0 |
| *Mallomonas akrokomos* | 0 | 0 | 0 | 31 | 0 | 58 |
| *Mallomonas caudata* | 4 | 4 | 4 | 4 | 0 | 0 |
| *Mallomonas tonsurata* | 0 | 0 | 22 | 0 | 0 | 71 |
| *Synura* | 0 | 0 | 142 | 0 | 0 | 0 |
| Cryptomonad - large | 53 | 106 | 66 | 40 | 13 | 4 |
| Cryptomonad - small | 93 | 319 | 97 | 438 | 425 | 181 |
| *Cosmarium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cosmocladium* | 0 | 0 | 0 | 9 | 0 | 0 |
| *Achnanthes* | 22 | 13 | 40 | 0 | 31 | 18 |
| *Asterionella* | 0 | 4 | 0 | 0 | 4 | 0 |
| *Aulacoseira* | 13 | 0 | 22 | 0 | 49 | 0 |
| *Cocconeis* shape | 0 | 0 | 9 | 0 | 0 | 4 |
| *Cyclotella* | 18 | 18 | 4 | 13 | 4 | 9 |
| *Cymbella* shape | 0 | 0 | 0 | 0 | 0 | 0 |
| *Fragilaria* | 71 | 0 | 80 | 0 | 168 | 0 |
| *Navicula* shape | 13 | 0 | 22 | 0 | 4 | 4 |
| *Stephanodiscus* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Synedra* | 0 | 0 | 31 | 4 | 0 | 9 |
| *Tabellaria* | 0 | 0 | 0 | 0 | 0 | 0 |
| Unk fil diatom | 0 | 0 | 190 | 0 | 0 | 0 |
| Unk nonfil diatom | 0 | 0 | 0 | 0 | 4 | 4 |

*continued on next page*

Table 7: Lake Padden settled algae counts, continued

| | Aug 15 | Aug 22 | Aug 29 | Sep 12 | Sep 15 | Sep 19 |
|---|---|---|---|---|---|---|
| *Ceratium* | 0 | 9 | 0 | 0 | 4 | 0 |
| *Gymnodinium* | 4 | 13 | 4 | 9 | 0 | 9 |
| *Peridinium* | 4 | 0 | 4 | 0 | 0 | 0 |
| *Euglena* | 0 | 13 | 0 | 0 | 0 | 0 |
| *Trachelomonas* | 4 | 9 | 0 | 0 | 0 | 0 |
| *Actinastrum* | 0 | 0 | 0 | 18 | 0 | 0 |
| *Ankistrodesmus* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ankyra, Monoraph., Schroederia* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Asterococcus, Planktosphaeria* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Botryococcus* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chlamydomonas* | 0 | 0 | 4 | 0 | 0 | 0 |
| *Dictyosphaerium* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Elakatothrix* | 0 | 0 | 0 | 9 | 0 | 0 |
| *Eudorina* | 49 | 190 | 0 | 0 | 0 | 0 |
| *Mougeotia* | 0 | 0 | 0 | 0 | 0 | 27 |
| *Oocystis* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Quadrigula* | 0 | 0 | 0 | 44 | 27 | 0 |
| *Sphaerocystis* | 0 | 0 | 0 | 0 | 0 | 0 |
| *Tetraedron* | 0 | 0 | 0 | 0 | 0 | 0 |

| | Sep 26 | Oct 11 | Oct 18 | Nov 3 |
|---|---|---|---|---|
| *Anabaena* | 659 | 960 | 257 | 137 |
| *Aphanizomenon* | 0 | 1351 | 375 | 2252 |
| *Aphanocapsa, Aphanothece* | 6207 | 7809 | 1801 | 1050 |
| *Chroococcus, Eucapsis* | 0 | 0 | 0 | 0 |
| *Cyanodictyon* | 0 | 0 | 0 | 0 |
| *Pseudanabaena* | 0 | 0 | 100 | 0 |
| *Snowella* | 100 | 400 | 400 | 0 |
| *Woronichinia* | 0 | 0 | 0 | 0 |
| *Bitrichia* | 0 | 0 | 0 | 0 |
| *Dinobryon* | 40 | 13 | 13 | 4 |
| *Epipyxis* | 22 | 0 | 0 | 0 |

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Table 7: Lake Padden settled algae counts, continued

| | Sep 26 | Oct 11 | Oct 18 | Nov 3 |
|---|---|---|---|---|
| *Gloeobotrys* | 0 | 0 | 0 | 0 |
| *Mallomonas acaroides* | 35 | 4 | 13 | 18 |
| *Mallomonas akrokomos* | 119 | 155 | 31 | 27 |
| *Mallomonas caudata* | 0 | 0 | 0 | 0 |
| *Mallomonas tonsurata* | 0 | 0 | 0 | 0 |
| *Synura* | 0 | 0 | 0 | 142 |
| Cryptomonad - large | 115 | 66 | 75 | 137 |
| Cryptomonad - small | 398 | 314 | 991 | 469 |
| *Cosmarium* | 9 | 4 | 0 | 0 |
| *Cosmocladium* | 0 | 0 | 0 | 0 |
| *Achnanthes* | 4 | 0 | 9 | 9 |
| *Asterionella* | 0 | 44 | 155 | 9 |
| *Aulacoseira* | 35 | 0 | 181 | 314 |
| *Cocconeis* shape | 0 | 4 | 0 | 0 |
| *Cyclotella* | 4 | 4 | 9 | 9 |
| *Cymbella* shape | 0 | 0 | 0 | 0 |
| *Fragilaria* | 0 | 0 | 0 | 0 |
| *Navicula* shape | 0 | 4 | 0 | 0 |
| *Stephanodiscus* | 4 | 0 | 0 | 0 |
| *Synedra* | 0 | 0 | 4 | 13 |
| *Tabellaria* | 0 | 0 | 0 | 0 |
| Unk fil diatom | 0 | 0 | 0 | 0 |
| Unk nonfil diatom | 0 | 0 | 0 | 0 |
| *Ceratium* | 0 | 0 | 0 | 0 |
| *Gymnodinium* | 0 | 4 | 0 | 0 |
| *Peridinium* | 0 | 0 | 0 | 0 |
| *Euglena* | 0 | 0 | 0 | 4 |
| *Trachelomonas* | 0 | 9 | 9 | 0 |
| *Actinastrum* | 0 | 0 | 0 | 0 |
| *Ankistrodesmus* | 0 | 0 | 0 | 0 |

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Table 7: Lake Padden settled algae counts, continued

| | Sep 26 | Oct 11 | Oct 18 | Nov 3 |
|---|---|---|---|---|
| *Ankyra, Monoraph., Schroederia* | 9 | 0 | 22 | 0 |
| *Asterococcus, Planktosphaeria* | 4 | 0 | 0 | 0 |
| *Botryococcus* | 0 | 0 | 0 | 0 |
| *Chlamydomonas* | 0 | 0 | 4 | 0 |
| *Dictyosphaerium* | 0 | 71 | 0 | 0 |
| *Elakatothrix* | 0 | 0 | 0 | 0 |
| *Eudorina* | 0 | 0 | 27 | 0 |
| *Mougeotia* | 0 | 0 | 0 | 0 |
| *Oocystis* | 0 | 0 | 0 | 0 |
| *Quadrigula* | 0 | 0 | 0 | 0 |
| *Sphaerocystis* | 35 | 0 | 0 | 0 |
| *Tetraedron* | 0 | 0 | 0 | 0 |

## C.2 Algae Dominance at Microcystin Sampling Sites

Table 8: Dominant (D) and sub-dominant (CD) algae collected at the microcystin sampling sites using a 20 $\mu$m plankton net. Dominant algae were defined as the most common species present in the sample; sub-dominant algae were listed when other common species were observed in the sample. Algae that were present (*) in the sample or absent (–) in the sample, but present in other samples, are also listed.

| | May 23, 2012 | | | June 7, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | * | * | * | SD | * | * |
| *Aphanizomenon* | * | * | * | – | * | * |
| *Aphanocapsa, Aphanothece* | * | * | * | * | * | * |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | – | – | – | – | – | – |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | – | – |
| *Snowella* | – | – | – | – | – | – |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | D | D | D | D | D | D |
| *Dinobryon* | D | D | D | * | * | * |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | – | – | – | * | * | * |
| *Mallomonas* | * | * | * | * | * | * |
| Single Cell Chrysophytes | * | * | * | – | – | – |
| *Synura* | * | * | * | * | * | * |
| *Uroglena* | * | * | * | * | * | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | – | – | – | – | – | – |
| Single Cell Greens | * | * | * | * | * | * |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | * | * | * | * | – | * |
| *Dictyosphaerium* | – | – | – | – | – | – |
| *Elakatothrix* | – | – | – | – | * | – |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | * | * | * | * | * | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | May 23, 2012 | | | June 7, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Oocystis* | – | – | – | – | – | – |
| *Pandorina* | – | – | – | * | * | – |
| *Pediastrum* | – | – | – | – | * | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | * | * | * | – | * | * |
| *Tetraspora* | – | – | – | – | – | – |
| *Volvox* | * | * | * | SD | * | * |
| Cryptomonads | – | – | * | – | – | * |
| *Ceratium* | – | – | – | * | – | – |
| *Gymnodinium* | – | * | * | * | – | – |
| *Peridinium* | * | * | * | * | * | – |
| *Euglena* | – | – | – | * | * | * |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | * | * | * | – | – | – |

| | June 26, 2012 | | | July 3, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | * | * | * | * | * | * |
| *Aphanizomenon* | – | – | * | – | * | – |
| *Aphanocapsa, Aphanothece* | D | D | * | SD | SD | SD |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | * | – | – | – | – | * |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | – | – |
| *Snowella* | – | – | – | – | – | – |
| *Woronichinia* | * | * | * | * | * | – |
| Diatoms | D | D | D | D | D | D |
| *Dinobryon* | * | * | * | * | * | * |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | * | * | * | – | * | – |
| *Mallomonas* | * | * | – | * | – | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | June 26, 2012 | | | July 3, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Single Cell Chrysophytes | – | – | – | – | – | – |
| *Synura* | – | – | – | – | – | * |
| *Uroglena* | * | * | * | – | * | * |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | – | – | – | – | – | – |
| Single Cell Greens | * | * | * | * | – | * |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | – | * | * | * | * | * |
| *Dictyosphaerium* | – | – | – | – | – | – |
| *Elakatothrix* | * | * | – | – | – | * |
| *Eudorina* | * | * | * | – | * | * |
| Filamentous Greens | * | * | * | * | * | * |
| *Oocystis* | – | – | – | – | – | * |
| *Pandorina* | – | * | – | – | – | – |
| *Pediastrum* | – | – | * | – | – | * |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | – | * | * | * | * | – |
| *Tetraspora* | – | * | * | – | * | – |
| *Volvox* | – | – | – | – | – | – |
| Cryptomonads | * | – | – | – | * | * |
| *Ceratium* | – | – | – | * | * | – |
| *Gymnodinium* | * | * | – | * | * | * |
| *Peridinium* | * | – | – | – | – | * |
| *Euglena* | * | * | * | * | * | * |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | July 25, 2012 | | | August 1, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | SD | * | * | * | – | * |
| *Aphanizomenon* | * | * | * | * | – | – |
| *Aphanocapsa, Aphanothece* | * | SD | * | SD | SD | SD |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | – | – | – | – | * | – |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | – | – |
| *Snowella* | – | – | – | – | – | – |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | D | D | D | D | D | D |
| *Dinobryon* | – | * | * | * | * | * |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | – | * | * | * | * | * |
| *Mallomonas* | – | * | * | – | * | – |
| Single Cell Chrysophytes | – | – | * | * | – | * |
| *Synura* | – | – | – | – | – | – |
| *Uroglena* | * | * | * | – | – | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | – | – | – | – | – | – |
| Single Cell Greens | * | * | SD | * | – | – |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | – | * | * | * | – | – |
| *Dictyosphaerium* | – | – | – | – | – | – |
| *Elakatothrix* | – | * | – | * | – | – |
| *Eudorina* | – | * | * | * | * | * |
| Filamentous Greens | * | * | * | – | * | * |
| *Oocystis* | * | * | * | * | – | – |
| *Pandorina* | – | – | – | – | – | – |
| *Pediastrum* | – | – | * | – | – | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | * | * | – | * | * | – |
| *Tetraspora* | * | * | * | * | * | – |
| *Volvox* | – | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | July 25, 2012 | | | August 1, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Cryptomonads | – | – | – | – | – | – |
| *Ceratium* | – | * | * | – | – | * |
| *Gymnodinium* | – | * | * | * | * | * |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | – | * | * | – | * | – |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | – | – | – | – | – |

| | August 12, 2012 | | | August 15, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | * | * | * | D | SD | SD |
| *Aphanizomenon* | – | * | * | * | * | * |
| *Aphanocapsa, Aphanothece* | SD | * | * | * | * | * |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | * | – | – | * | * | * |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | * | – | – |
| *Snowella* | – | – | – | – | – | – |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | D | SD | SD | * | D | D |
| *Dinobryon* | * | D | D | * | * | * |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | * | * | – | * | * | * |
| *Mallomonas* | * | – | – | * | – | * |
| Single Cell Chrysophytes | – | – | – | * | * | – |
| *Synura* | – | – | – | – | – | – |
| *Uroglena* | * | * | – | * | * | * |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | – | – | – | SD | – | SD |
| Single Cell Greens | * | * | * | * | – | * |
| *Coelastrum* | – | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | August 12, 2012 | | | August 15, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | – | – | – | – | – | – |
| *Elakatothrix* | * | – | – | * | – | * |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | * | * | * | * | * | – |
| *Oocystis* | * | * | – | – | * | * |
| *Pandorina* | – | – | – | – | – | * |
| *Pediastrum* | – | – | – | – | – | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | – | * | – | – | – | * |
| *Tetraspora* | * | – | – | * | * | * |
| *Volvox* | – | – | – | – | – | – |
| Cryptomonads | – | – | – | * | – | – |
| *Ceratium* | * | * | – | – | – | – |
| *Gymnodinium* | * | * | * | * | – | – |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | * | – | – | – | – | * |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | – | – | – | – | – |

| | August 22, 2012 | | | August 29, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | * | * | * | * | * | * |
| *Aphanizomenon* | * | D | SD | D | D | D |
| *Aphanocapsa, Aphanothece* | * | * | * | * | * | * |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | * | – | – | – | – | – |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | * | – |
| *Snowella* | * | * | – | * | – | – |
| *Woronichinia* | – | * | * | * | * | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | August 22, 2012 | | | August 29, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Diatoms | D | SD | D | SD | * | * |
| *Dinobryon* | * | – | – | * | * | * |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | * | – | – | – | – | – |
| *Mallomonas* | * | – | * | * | * | * |
| Single Cell Chrysophytes | * | – | – | – | * | * |
| *Synura* | – | – | – | – | * | – |
| *Uroglena* | – | – | – | – | * | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | – | – | – | * | – | * |
| Single Cell Greens | SD | * | * | * | – | * |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | – | – | – | – | – | – |
| *Elakatothrix* | * | * | – | * | * | – |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | * | * | * | * | * | * |
| *Oocystis* | * | – | * | – | * | * |
| *Pandorina* | – | – | – | – | * | * |
| *Pediastrum* | – | – | – | – | – | – |
| *Quadrigula* | – | – | – | * | * | – |
| *Sphaerocystis* | * | * | – | * | * | – |
| *Tetraspora* | * | * | * | * | * | – |
| *Volvox* | – | – | – | – | – | – |
| Cryptomonads | * | – | * | – | – | – |
| *Ceratium* | * | * | * | * | * | * |
| *Gymnodinium* | * | – | – | * | – | * |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | – | * | * | * | – | * |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | * | * | – | – | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | September 5, 2012 | | | September 12, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | D | SD | D | D | D | D |
| *Aphanizomenon* | – | * | * | * | * | * |
| *Aphanocapsa, Aphanothece* | * | * | * | * | * | * |
| *Gloeotrichia* | – | – | – | – | * | – |
| *Microcystis* | * | – | * | – | – | * |
| *Nostoc* | * | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | * | * | * | – | * |
| *Snowella* | * | * | * | * | * | * |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | D | D | SD | * | SD | * |
| *Dinobryon* | – | * | * | * | * | * |
| *Epipyxis* | – | – | – | * | – | * |
| *Gloeobotrys* | – | – | – | – | – | – |
| *Mallomonas* | – | – | – | * | * | * |
| Single Cell Chrysophytes | – | – | – | * | – | * |
| *Synura* | – | – | – | * | – | – |
| *Uroglena* | – | * | * | * | – | * |
| *Ankistrodesmus* | – | – | – | – | – | * |
| *Botryococcus* | * | – | * | * | * | * |
| Single Cell Greens | * | * | – | * | * | * |
| *Coelastrum* | – | – | – | – | – | * |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | – | – | – | * | * | – |
| *Elakatothrix* | * | * | * | – | – | – |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | * | * | * | * | * | * |
| *Oocystis* | * | – | – | * | * | – |
| *Pandorina* | – | – | – | * | – | – |
| *Pediastrum* | – | – | – | – | – | * |
| *Quadrigula* | * | * | * | * | * | * |
| *Sphaerocystis* | * | * | * | * | * | – |
| *Tetraspora* | * | – | – | * | * | * |
| *Volvox* | – | – | – | * | – | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | September 5, 2012 | | | September 12, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Cryptomonads | * | * | * | * | – | * |
| *Ceratium* | – | – | – | SD | * | SD |
| *Gymnodinium* | * | * | – | * | * | * |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | – | * | * | * | * | * |
| *Phacus* | * | – | – | – | – | – |
| *Trachelomonas* | – | * | * | * | * | * |

| | September 19, 2012 | | | September 26, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | SD | D | D | D | D | D |
| *Aphanizomenon* | * | – | * | * | * | * |
| *Aphanocapsa, Aphanothece* | * | * | * | * | * | * |
| *Gloeotrichia* | – | * | – | – | – | – |
| *Microcystis* | * | * | – | * | * | – |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | * | – |
| *Snowella* | * | * | * | * | * | – |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | * | * | * | * | * | SD |
| *Dinobryon* | – | – | – | * | * | * |
| *Epipyxis* | – | – | – | * | * | * |
| *Gloeobotrys* | – | * | – | – | – | – |
| *Mallomonas* | * | * | * | * | * | – |
| Single Cell Chrysophytes | * | * | * | – | – | – |
| *Synura* | – | – | – | * | – | * |
| *Uroglena* | – | – | – | – | – | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | * | * | * | * | * | * |
| Single Cell Greens | * | SD | * | * | * | * |
| *Coelastrum* | – | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | September 19, 2012 | | | September 26, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | * | * | * | * | * | – |
| *Elakatothrix* | – | – | – | * | – | – |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | – | * | * | * | * | * |
| *Oocystis* | * | * | * | * | – | * |
| *Pandorina* | – | – | – | – | * | – |
| *Pediastrum* | – | – | – | – | – | * |
| *Quadrigula* | * | * | – | – | – | – |
| *Sphaerocystis* | – | – | * | * | – | – |
| *Tetraspora* | * | – | * | * | * | * |
| *Volvox* | – | – | – | – | – | – |
| Cryptomonads | * | – | * | * | * | * |
| *Ceratium* | D | – | SD | * | * | * |
| *Gymnodinium* | * | – | – | * | * | – |
| *Peridinium* | – | – | – | * | – | – |
| *Euglena* | * | * | – | * | * | – |
| *Phacus* | – | – | * | – | * | – |
| *Trachelomonas* | – | – | * | * | * | * |

| | October 2, 2012 | | | October 11, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | D | D | D | D | D | D |
| *Aphanizomenon* | * | – | – | * | * | * |
| *Aphanocapsa, Aphanothece* | * | * | * | * | * | * |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | – | – | – | * | * | – |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | * | – | – | * | – |
| *Snowella* | * | * | * | * | * | * |
| *Woronichinia* | – | * | – | * | * | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | October 2, 2012 | | | October 11, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Diatoms | * | * | * | SD | SD | SD |
| *Dinobryon* | * | * | * | * | * | * |
| *Epipyxis* | * | * | * | * | – | – |
| *Gloeobotrys* | – | – | – | – | – | – |
| *Mallomonas* | SD | * | – | – | * | * |
| Single Cell Chrysophytes | * | * | * | * | * | * |
| *Synura* | * | – | – | – | – | – |
| *Uroglena* | * | – | – | – | – | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | * | * | * | * | * | * |
| Single Cell Greens | * | * | * | * | * | * |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | * | * | – | * | * | * |
| *Elakatothrix* | * | – | – | – | – | – |
| *Eudorina* | * | * | * | * | * | * |
| Filamentous Greens | – | * | – | * | * | SD |
| *Oocystis* | * | * | * | * | * | * |
| *Pandorina* | – | – | – | – | – | – |
| *Pediastrum* | – | – | – | – | – | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | * | * | – | * | * | * |
| *Tetraspora* | – | * | – | * | * | * |
| *Volvox* | * | – | – | * | * | – |
| Cryptomonads | * | * | – | – | * | * |
| *Ceratium* | – | – | – | – | – | * |
| *Gymnodinium* | * | – | – | – | – | – |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | – | – | – | * | * | – |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | * | – | * | * | * |

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Table 8: Dominant algae at the microcystin sites, continued

| | October 18, 2012 | | | October 25, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | D | SD | D | D | D | SD |
| *Aphanizomenon* | * | SD | SD | – | SD | D |
| *Aphanocapsa, Aphanothece* | * | * | * | – | * | * |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | * | * | * | * | * | * |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | * | * | – | – | – |
| *Snowella* | * | * | – | – | – | – |
| *Woronichinia* | * | * | * | * | * | * |
| Diatoms | SD | D | * | SD | * | * |
| *Dinobryon* | * | * | – | * | * | – |
| *Epipyxis* | * | – | – | * | – | – |
| *Gloeobotrys* | – | – | – | – | – | – |
| *Mallomonas* | – | – | – | – | * | * |
| Single Cell Chrysophytes | – | – | – | – | – | – |
| *Synura* | – | * | – | – | * | – |
| *Uroglena* | * | – | – | – | – | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | * | * | * | * | – | * |
| Single Cell Greens | * | * | * | * | * | – |
| *Coelastrum* | – | – | – | – | – | – |
| Desmids | * | * | * | * | * | * |
| *Dictyosphaerium* | * | * | * | – | * | – |
| *Elakatothrix* | – | – | – | – | – | – |
| *Eudorina* | * | * | – | * | * | – |
| Filamentous Greens | * | * | * | * | * | * |
| *Oocystis* | * | * | * | – | * | * |
| *Pandorina* | – | * | – | – | * | – |
| *Pediastrum* | – | – | – | – | – | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | * | – | – | – | * | – |
| *Tetraspora* | * | – | – | – | * | * |
| *Volvox* | * | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | October 18, 2012 | | | October 25, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Cryptomonads | * | * | – | * | * | – |
| *Ceratium* | – | – | – | – | – | – |
| *Gymnodinium* | * | * | – | * | * | * |
| *Peridinium* | * | * | – | * | * | – |
| *Euglena* | * | * | – | * | * | – |
| *Phacus* | * | * | – | – | – | – |
| *Trachelomonas* | * | * | – | * | * | * |

| | November 1, 2012 | | | November 8, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| *Anabaena* | * | – | * | * | D | * |
| *Aphanizomenon* | * | – | SD | SD | * | SD |
| *Aphanocapsa, Aphanothece* | * | * | * | * | – | – |
| *Gloeotrichia* | – | – | – | – | – | – |
| *Microcystis* | * | – | * | – | * | * |
| *Nostoc* | – | – | – | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – | – | – | * |
| *Snowella* | * | * | * | * | * | – |
| *Woronichinia* | * | – | * | * | * | * |
| Diatoms | D | D | D | D | * | SD |
| *Dinobryon* | * | – | * | – | – | – |
| *Epipyxis* | – | – | – | – | – | – |
| *Gloeobotrys* | – | – | – | – | – | – |
| *Mallomonas* | – | – | * | * | * | * |
| Single Cell Chrysophytes | – | – | – | * | – | – |
| *Synura* | * | SD | * | * | * | – |
| *Uroglena* | – | – | – | * | – | – |
| *Ankistrodesmus* | – | – | – | – | – | – |
| *Botryococcus* | * | – | * | – | * | – |
| Single Cell Greens | * | * | * | * | * | * |
| *Coelastrum* | – | – | – | – | – | – |

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Table 8: Dominant algae at the microcystin sites, continued

| | November 1, 2012 | | | November 8, 2012 | | |
|---|---|---|---|---|---|---|
| Site | Outlet | Dog Park | Beach | Outlet | Dog Park | Beach |
| Desmids | * | * | * | * | * | – |
| *Dictyosphaerium* | * | * | * | – | * | – |
| *Elakatothrix* | – | – | – | – | – | – |
| *Eudorina* | * | – | * | * | * | * |
| Filamentous Greens | SD | SD | SD | SD | SD | D |
| *Oocystis* | * | * | – | – | * | – |
| *Pandorina* | * | * | – | – | – | – |
| *Pediastrum* | – | – | – | – | – | – |
| *Quadrigula* | – | – | – | – | – | – |
| *Sphaerocystis* | * | * | – | – | – | – |
| *Tetraspora* | – | – | – | – | – | – |
| *Volvox* | – | – | * | * | – | – |
| Cryptomonads | – | * | * | * | * | * |
| *Ceratium* | – | – | – | – | – | – |
| *Gymnodinium* | – | – | * | – | * | – |
| *Peridinium* | – | – | – | – | – | – |
| *Euglena* | * | * | * | * | * | – |
| *Phacus* | – | – | – | – | – | – |
| *Trachelomonas* | – | * | * | * | – | – |

| | November 15, 2012 | | |
|---|---|---|---|
| Site | Outlet | Dog Park | Beach |
| *Anabaena* | SD | * | SD |
| *Aphanizomenon* | D | D | D |
| *Aphanocapsa, Aphanothece* | * | * | – |
| *Gloeotrichia* | – | – | – |
| *Microcystis* | * | * | * |
| *Nostoc* | – | – | – |
| *Oscillatoria, Phormidium* | – | – | – |
| *Snowella* | – | * | – |
| *Woronichinia* | SD | * | SD |

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Table 8: Dominant algae at the microcystin sites, continued

| | November 15, 2012 | | |
|---|---|---|---|
| Site | Outlet | Dog Park | Beach |
| Diatoms | * | SD | * |
| *Dinobryon* | * | * | – |
| *Epipyxis* | – | – | – |
| *Gloeobotrys* | – | – | – |
| *Mallomonas* | * | * | * |
| Single Cell Chrysophytes | – | – | – |
| *Synura* | * | * | * |
| *Uroglena* | – | – | – |
| *Ankistrodesmus* | – | – | – |
| *Botryococcus* | * | * | * |
| Single Cell Greens | * | * | * |
| *Coelastrum* | * | – | – |
| Desmids | * | – | * |
| *Dictyosphaerium* | * | * | * |
| *Elakatothrix* | – | – | – |
| *Eudorina* | * | * | * |
| Filamentous Greens | * | SD | * |
| *Oocystis* | * | * | – |
| *Pandorina* | – | – | – |
| *Pediastrum* | – | – | – |
| *Quadrigula* | – | – | – |
| *Sphaerocystis* | – | * | * |
| *Tetraspora* | – | * | – |
| *Volvox* | – | * | * |
| Cryptomonads | * | * | * |
| *Ceratium* | – | – | – |
| *Gymnodinium* | – | * | – |
| *Peridinium* | * | * | – |
| *Euglena* | * | * | – |
| *Phacus* | – | – | – |
| *Trachelomonas* | – | * | – |

## C.3 Algae Images

This appendix contains high resolution digital images of the common algae collected in plankton samples and along the shoreline of Lake Padden. The purpose of the appendix is to provide a photographic record of the names assigned to the algal taxa identified in Tables 1, 7, and 8.

Some types of algae are difficult or impossible to distinguish in preserved samples using conventional light microscopy. For the Lake Padden study, some taxa were grouped into categories based on similar structure and algae type. For example, *Asterococcus* and *Planktosphaeria* are both non-motile, single-cell green algae, so these two taxa were placed into a single group.

All taxonomic identifications in this appendix were provided by Dr. R. Matthews and represent my best effort to provide accurate classifications following the nomenclature in AlgaeBase (http://www.algaebase.org), using conventional taxonomic sources. All images were photographed by Dr. Robin Matthews using a Nikon Eclipse 80i microscope with phase contrast or Nomarski (DIC) objectives and a QImaging digital camera. These images may be used for noncommercial purposes under the copyright license described at http://www.wwu.edu/iws, with appropriate credit given to 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.


Figure 19: Chrysophytes: *Bitrichia*. Upper image shows algae preserved in Lugol's iodine solution (Lake Whatcom); lower image shows unpreserved algae (Lake Whatcom).


Figure 20: Chrysophytes: *Dinobryon*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

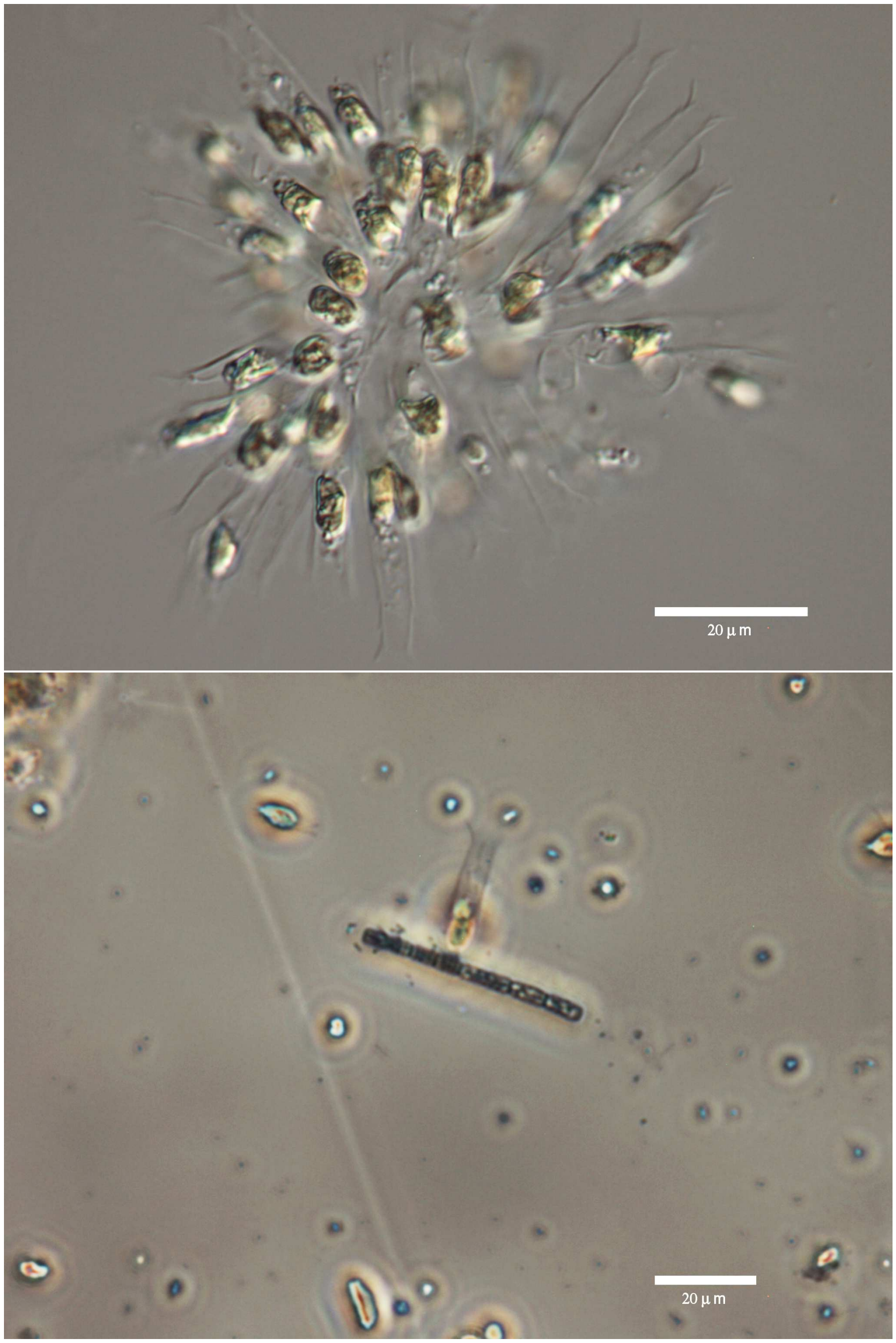


Figure 21: Chrysophytes: *Epipyxis*. Both images shows algae preserved in Lugol's iodine solution (Lake Padden).

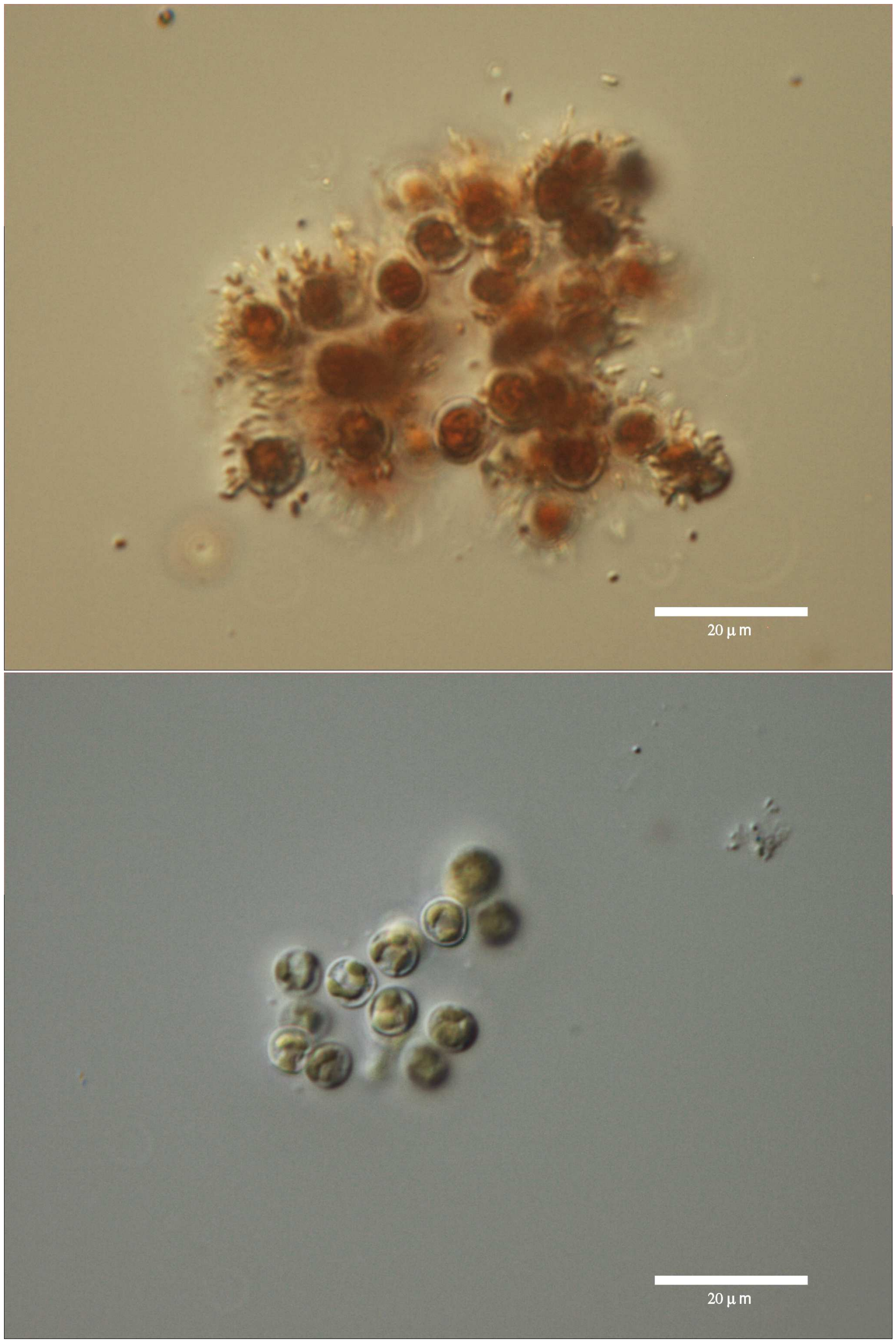


Figure 22: Chrysophytes: *Gloeobotrys*. Upper image shows algae preserved in Lugol's iodine solution (Judy Reservoir); lower image shows unpreserved algae (Lake Padden).

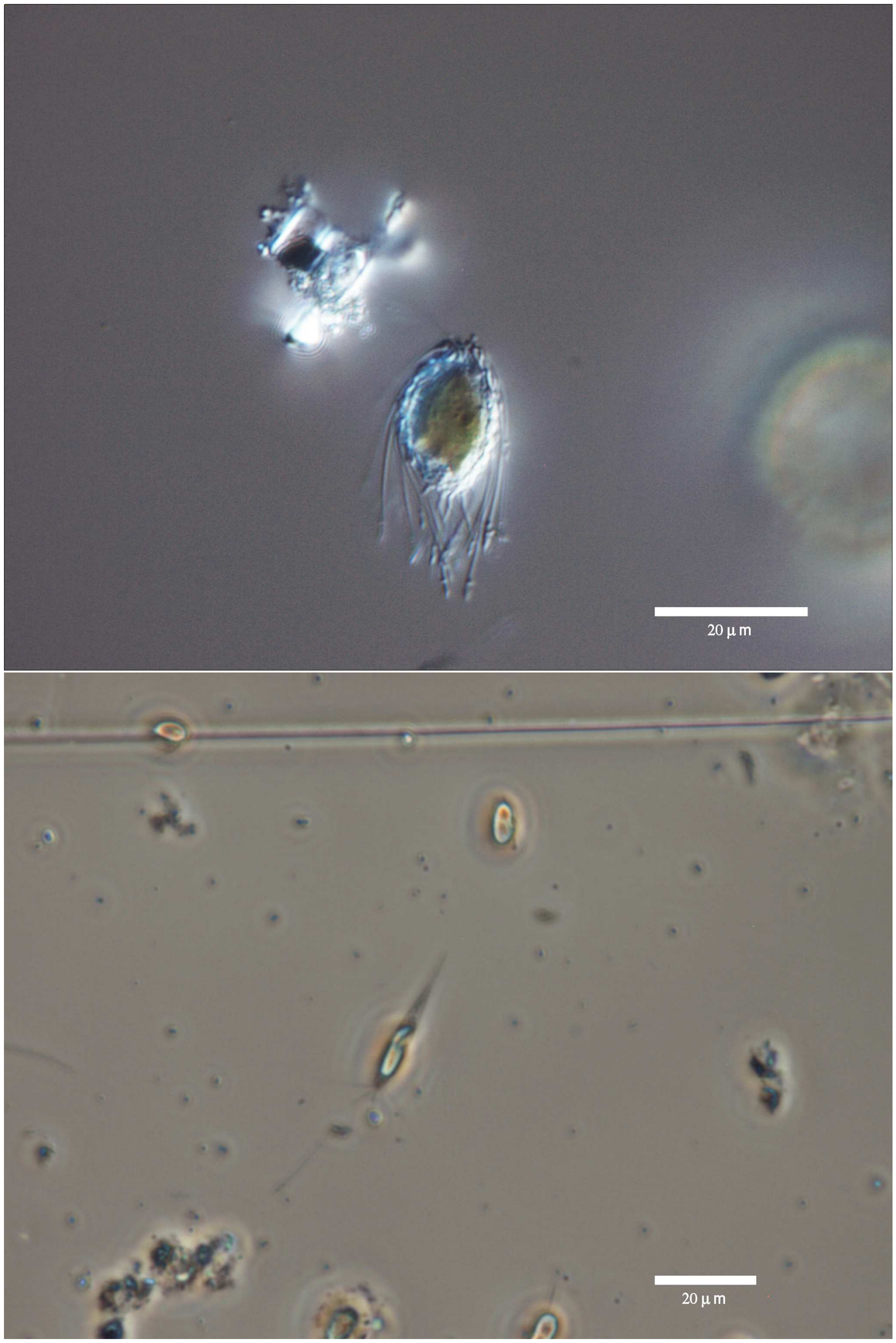


Figure 23: Chrysophytes: *Mallomonas acaroides* (upper) and *Mallomonas akrokomos* (lower). Upper image shows unpreserved algae (Lake Padden); lower image shows algae preserved in Lugol's iodine solution (Lake Padden).

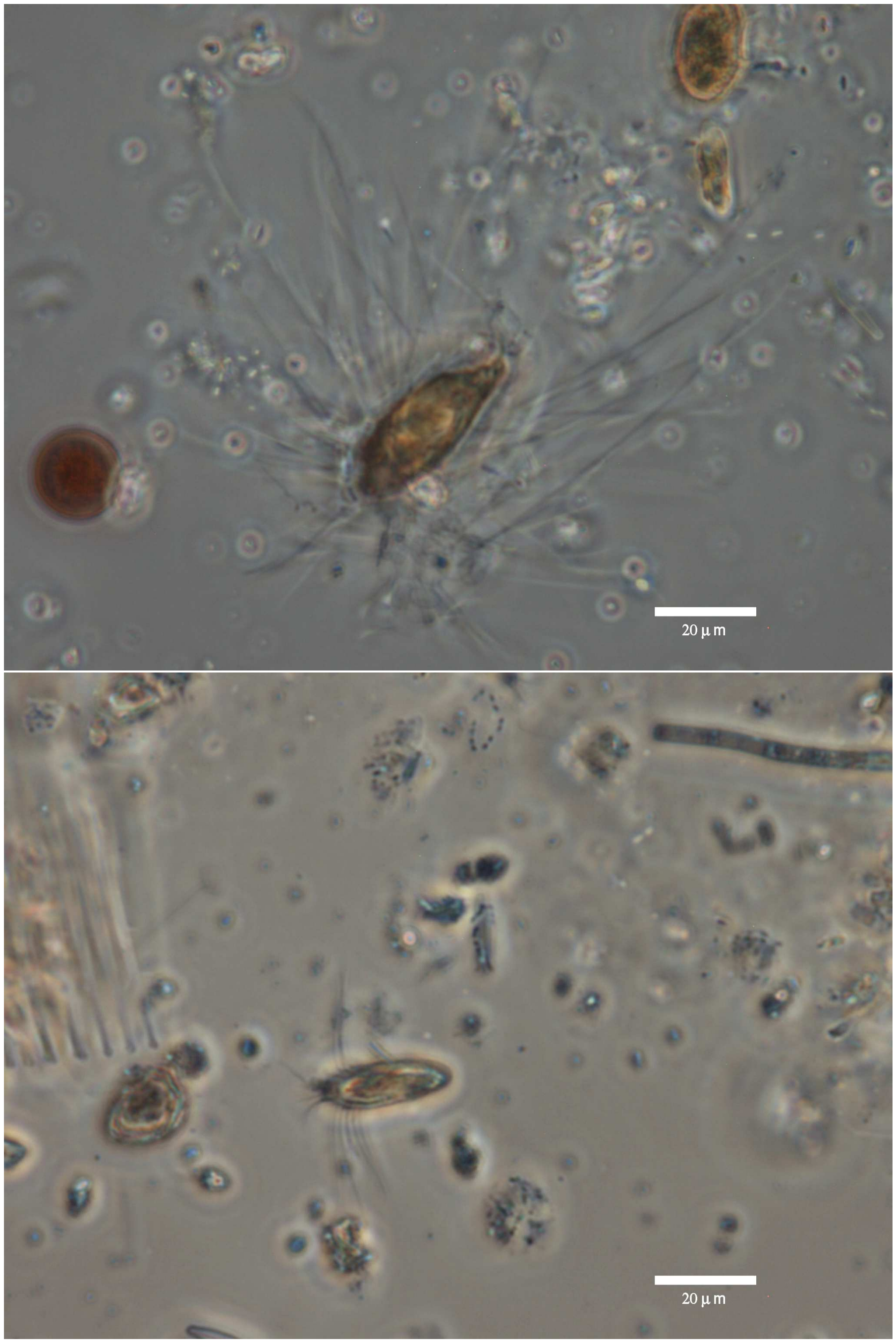


Figure 24: Chrysophytes: *Mallomonas caudata* (upper) and *Mallomonas tonsurata* (lower). Both images show algae preserved in Lugol's iodine solution (Lake Padden).

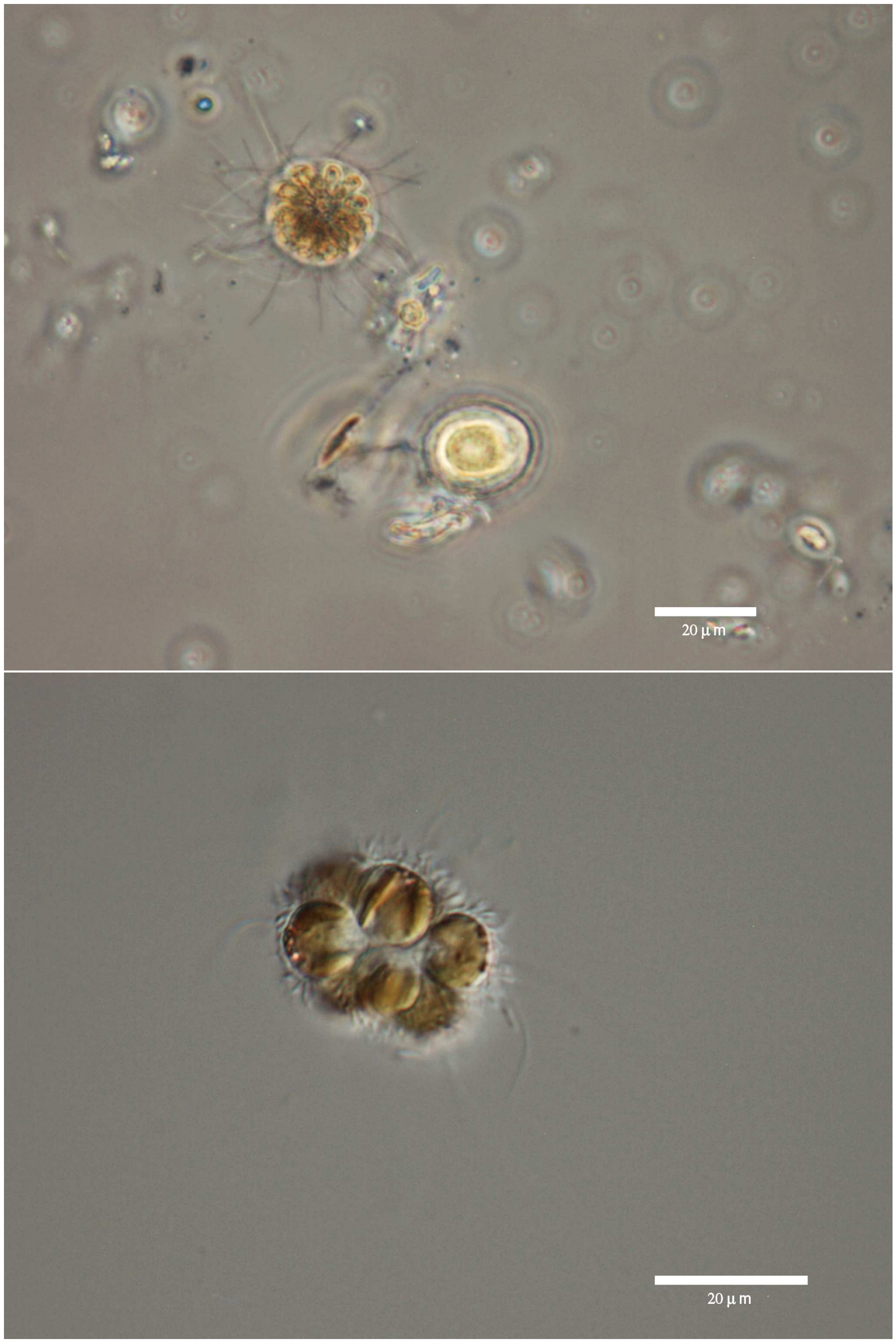


Figure 25: Chrysophytes: *Synura*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

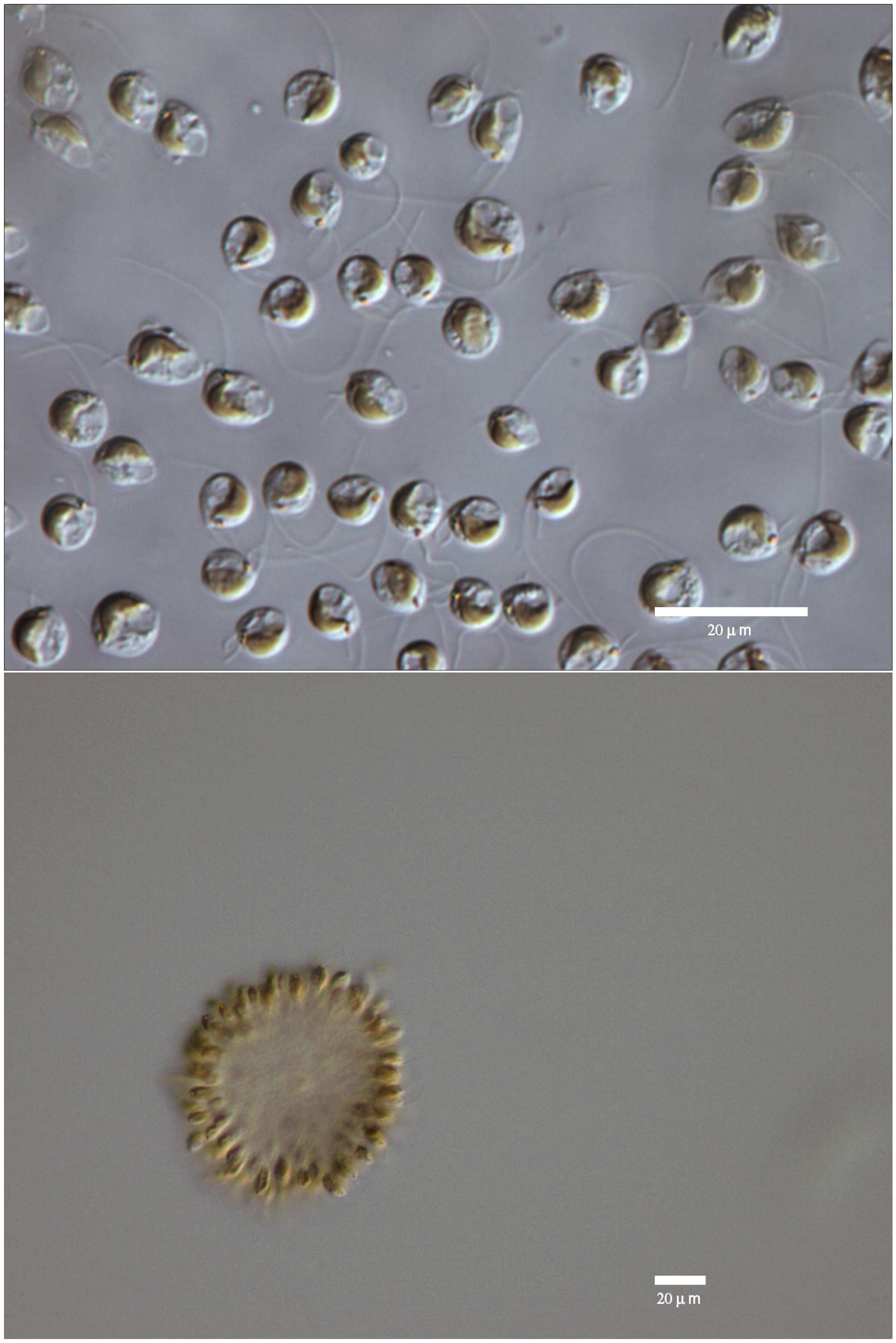


Figure 26: Chrysophytes: *Uroglena*. Both images show unpreserved algae (upper = Toad Lake; lower = Lake Padden).

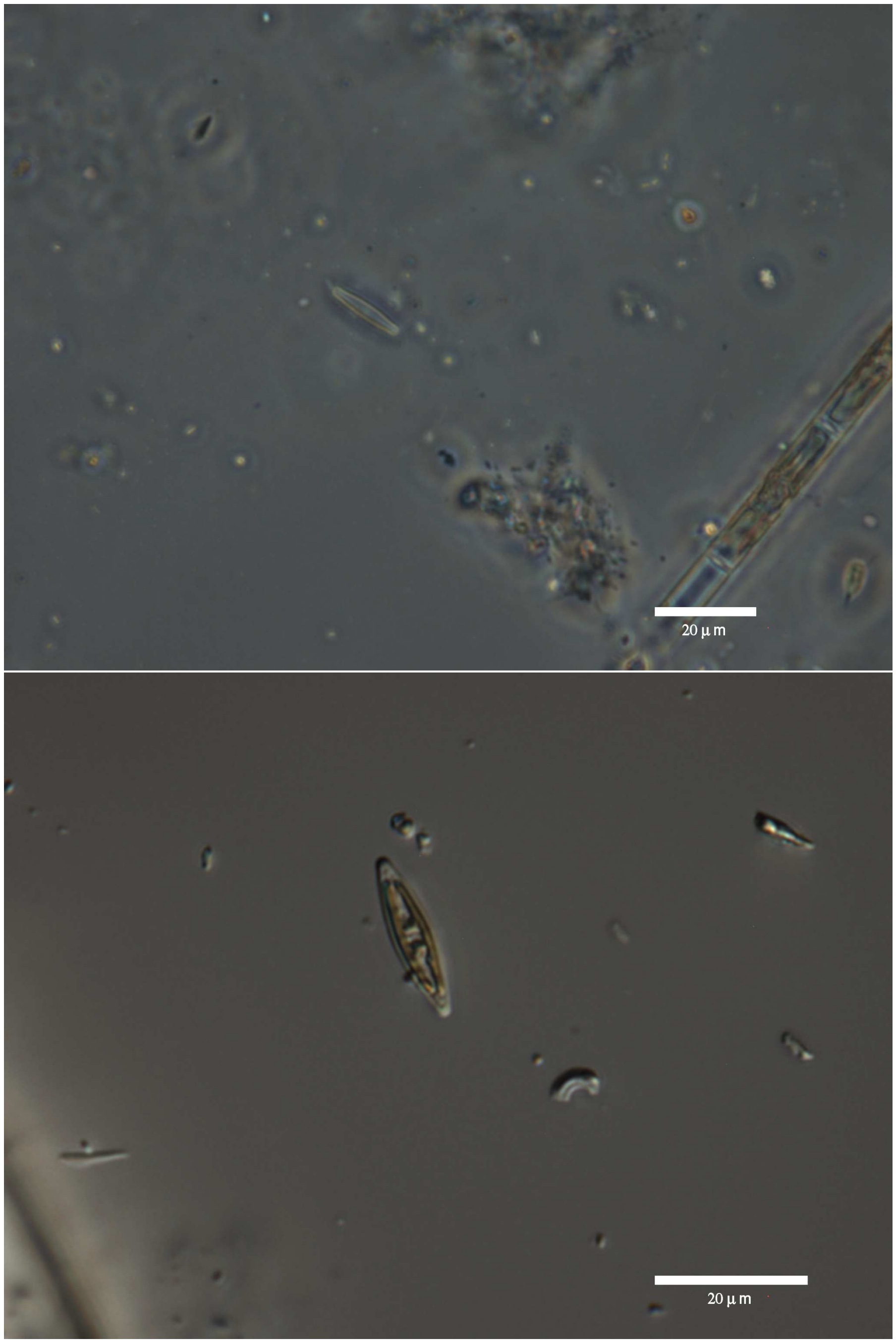


Figure 27: Diatoms: *Achnanthes*/*Achnanthidium*. Both images show algae preserved in Lugol's iodine solution (Lake Padden).

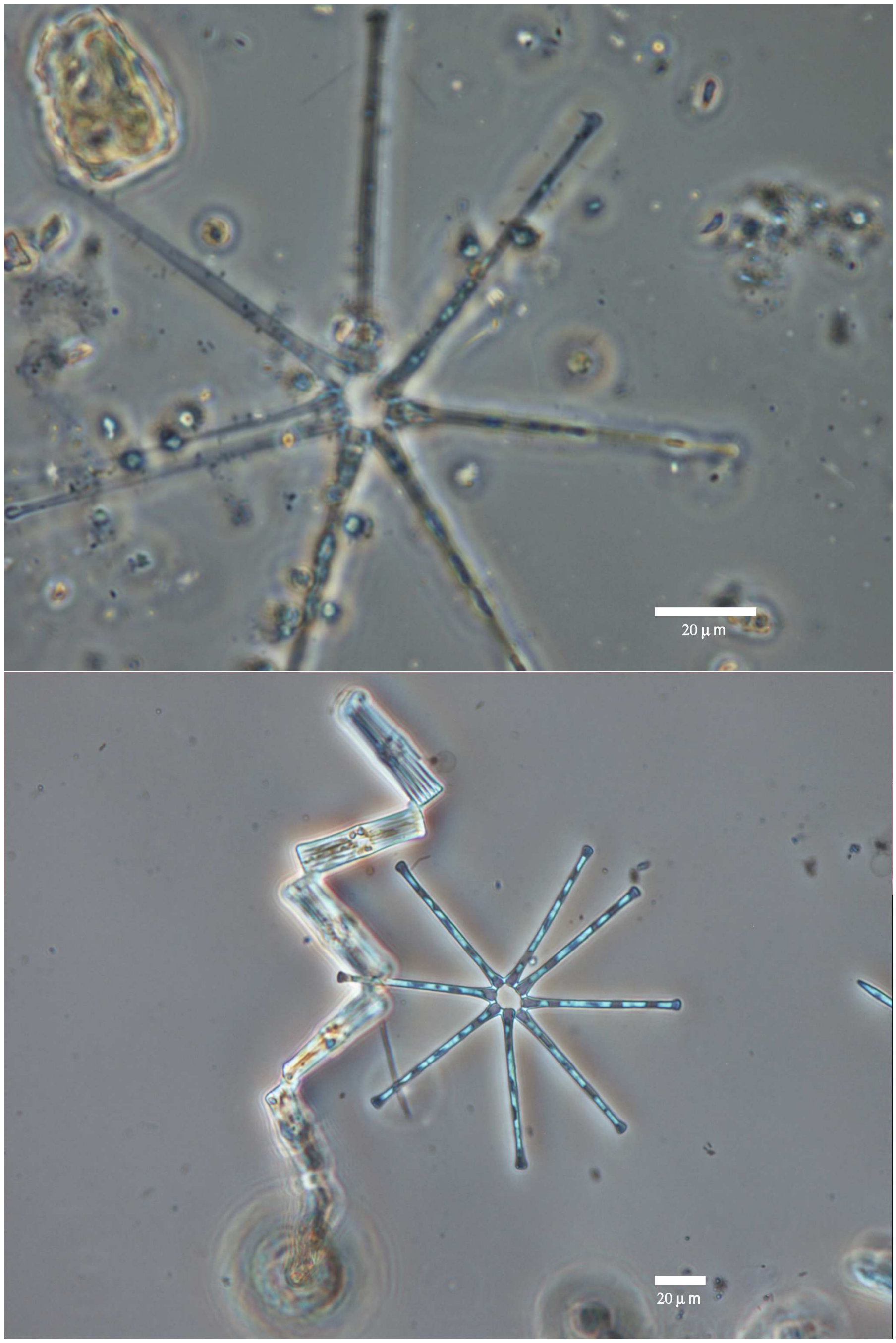


Figure 28: Chrysophytes (diatoms: *Asterionella*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).


Figure 29: Chrysophytes (diatoms): *Aulacoseira*. Upper image shows algae preserved in Lugol's iodine solution (Lake Whatcom); lower image shows unpreserved algae (Fazon Lake).

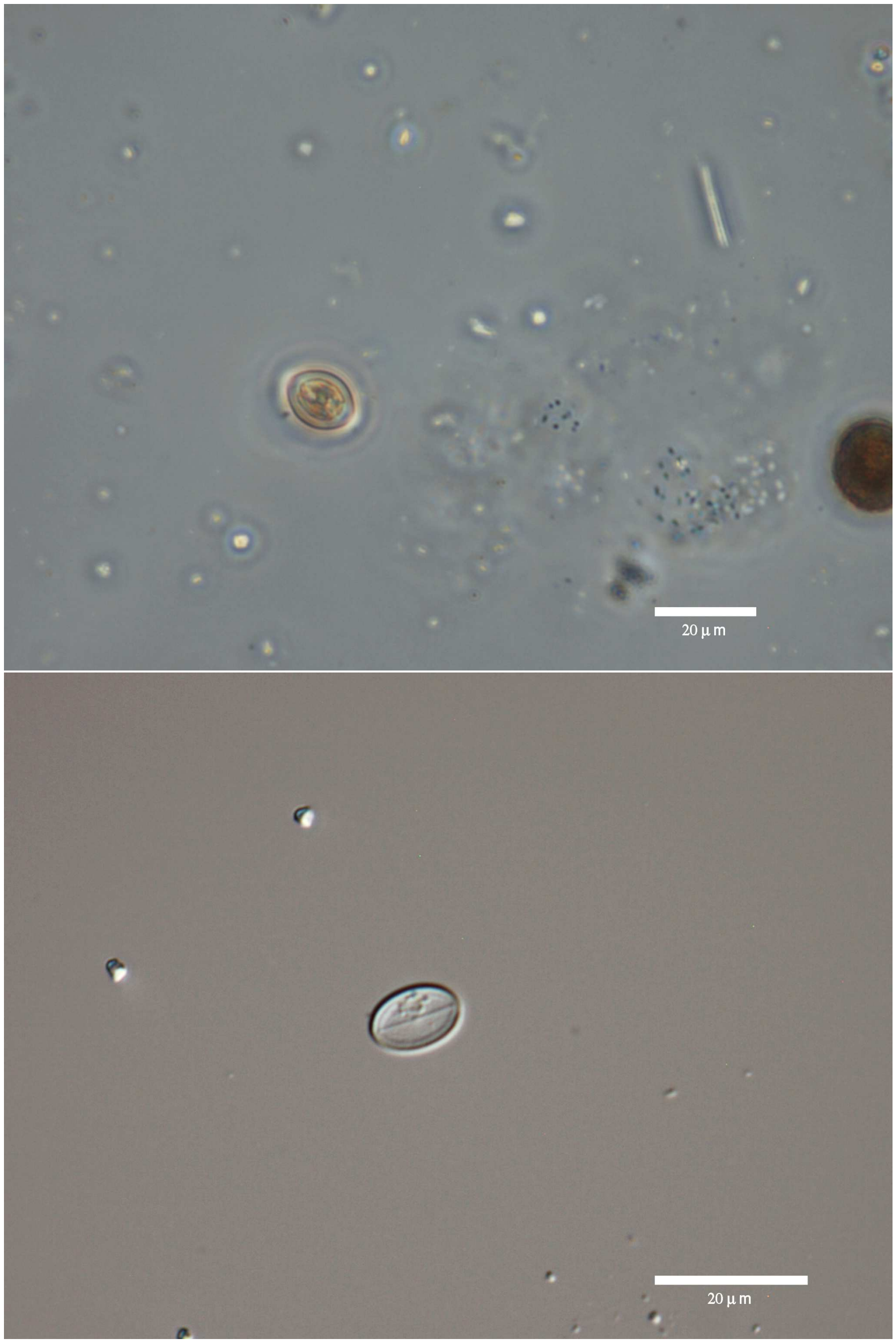


Figure 30: Chrysophytes (diatoms): *Cocconeis* type. Both images show algae preserved in Lugol's iodine solution (Lake Padden).

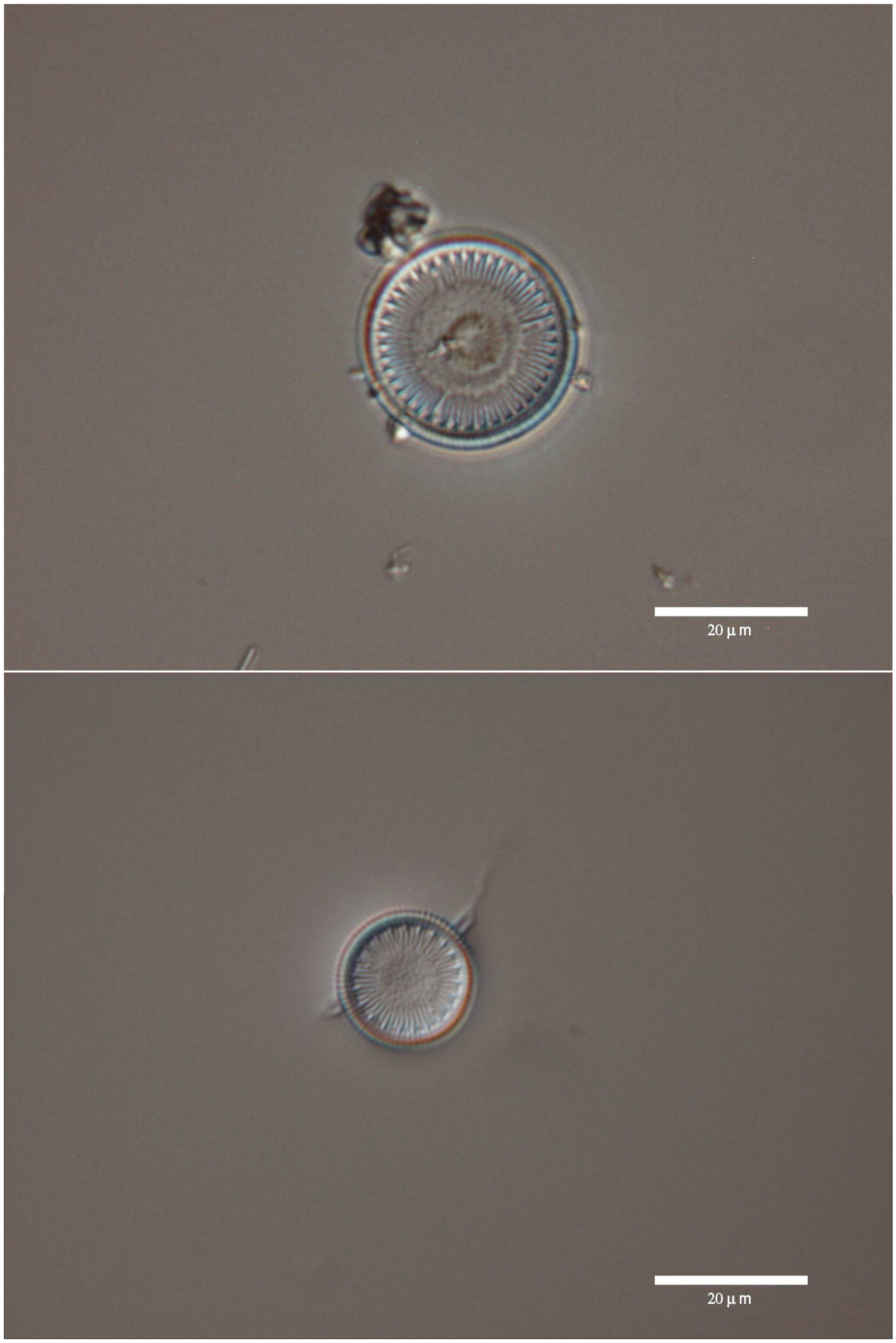


Figure 31: Chrysophytes (diatoms): *Cyclotella*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 32: Chrysophytes (diatoms): *Cymbella* type. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 33: Chrysophytes (diatoms): *Fragilaria*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).


Figure 34: Chrysophytes (diatoms): *Gomphonema* type. Both images show unpreserved algae (Lake Padden).

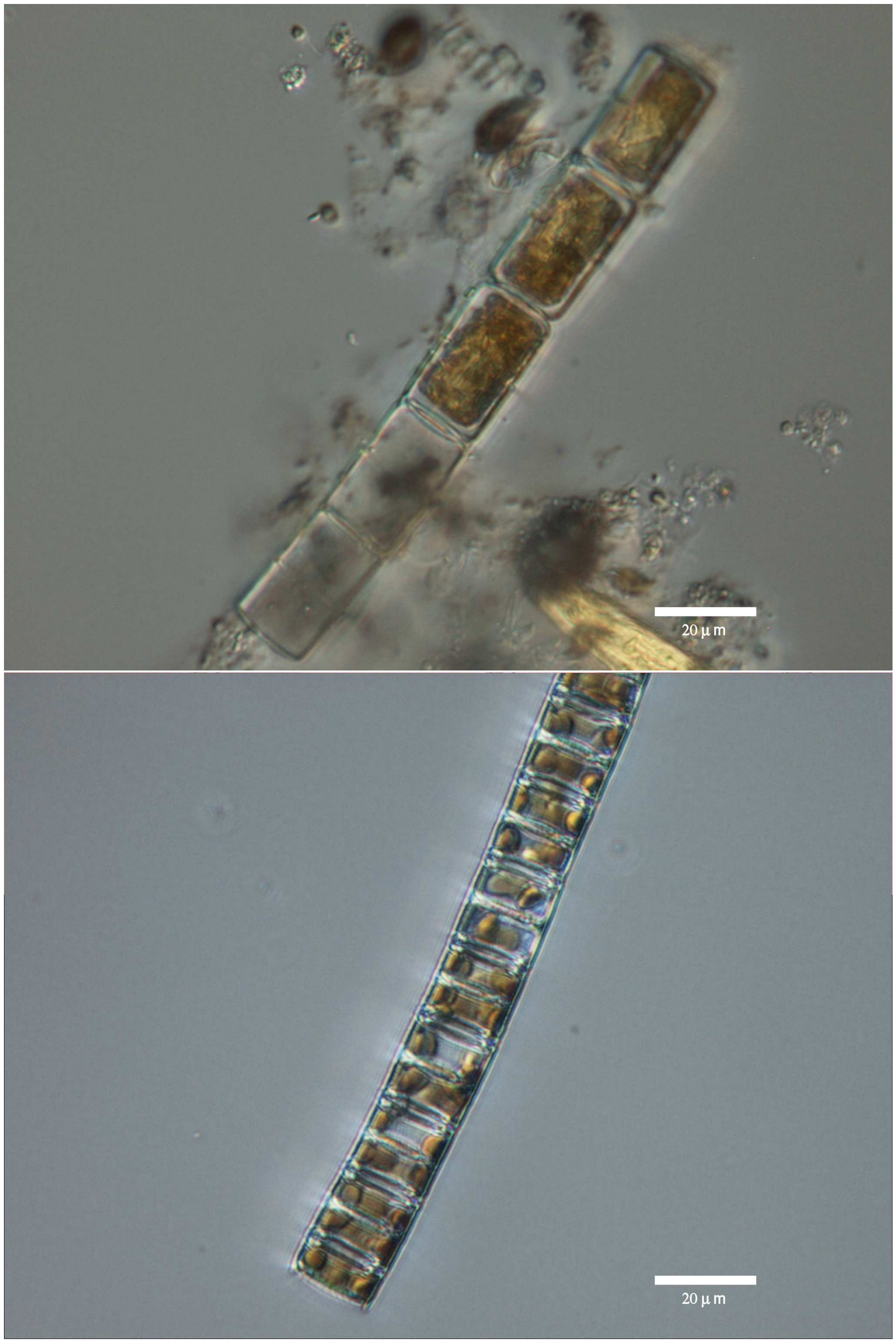


Figure 35: Chrysophytes (diatoms): *Melosira*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 36: Chrysophytes (diatoms): *Stauroneis*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).

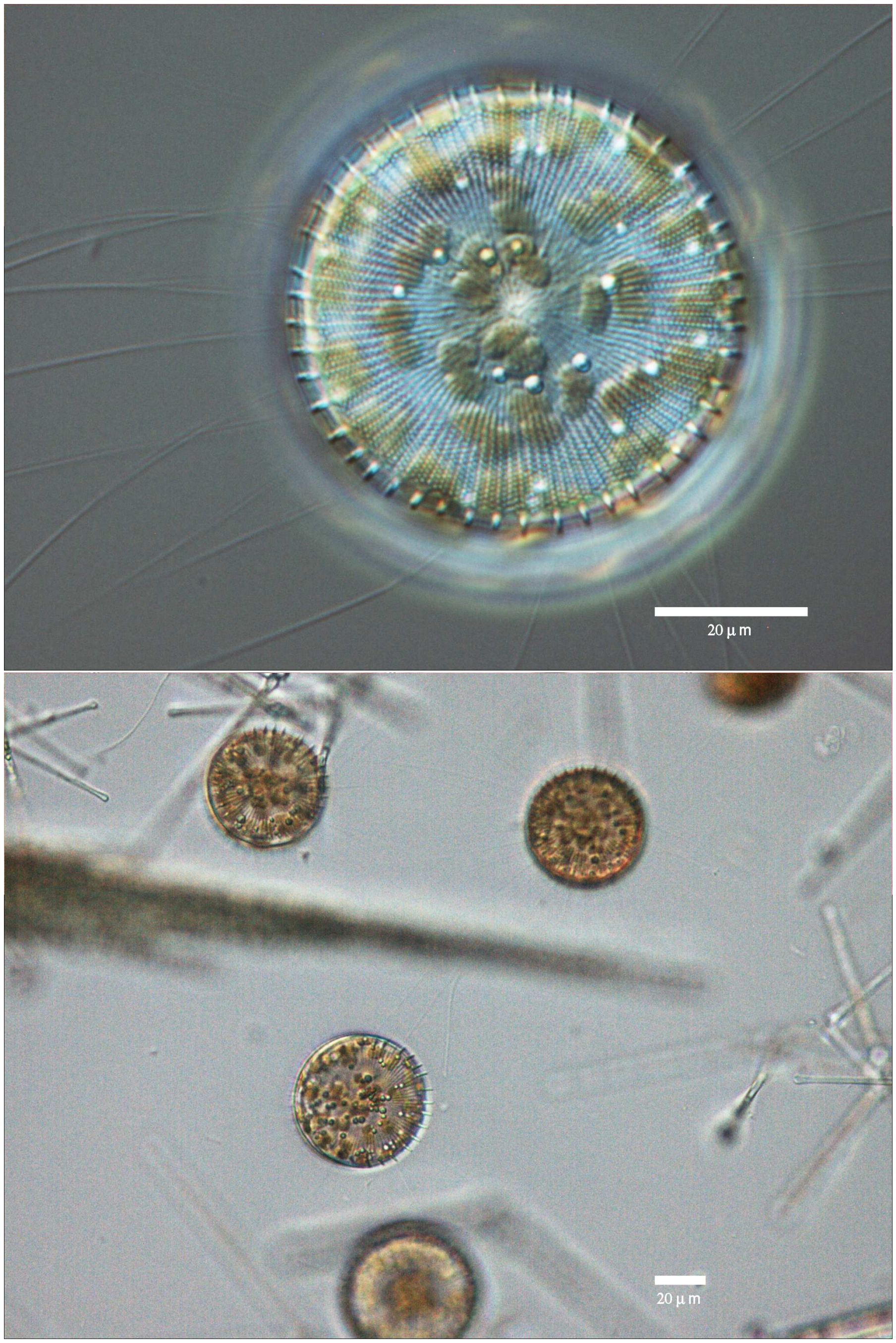


Figure 37: Chrysophytes (diatoms): *Stephanodiscus*. Both images show unpreserved algae (upper = Lake Whatcom; lower = Lake Padden).

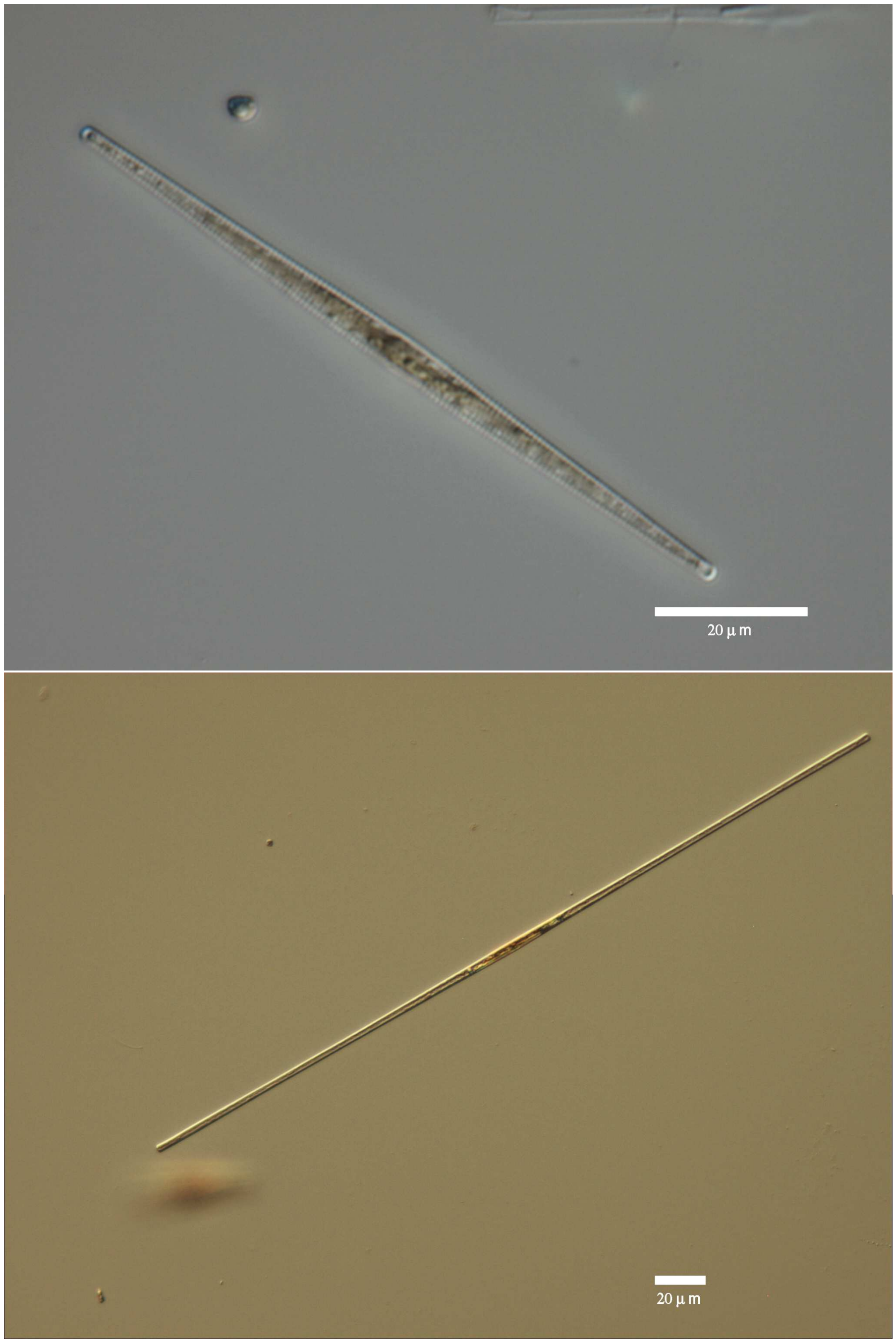


Figure 38: Chrysophytes (diatoms): *Synedra*. Both images show algae preserved in Lugol's iodine solution (upper = Lake Padden; lower = Lake Whatcom).


Figure 39: Chrysophytes (diatoms): *Tabellaria*. Upper image shows algae preserved in Lugol's iodine solution (Lake Whatcom); lower image shows unpreserved algae (Lake Whatcom).

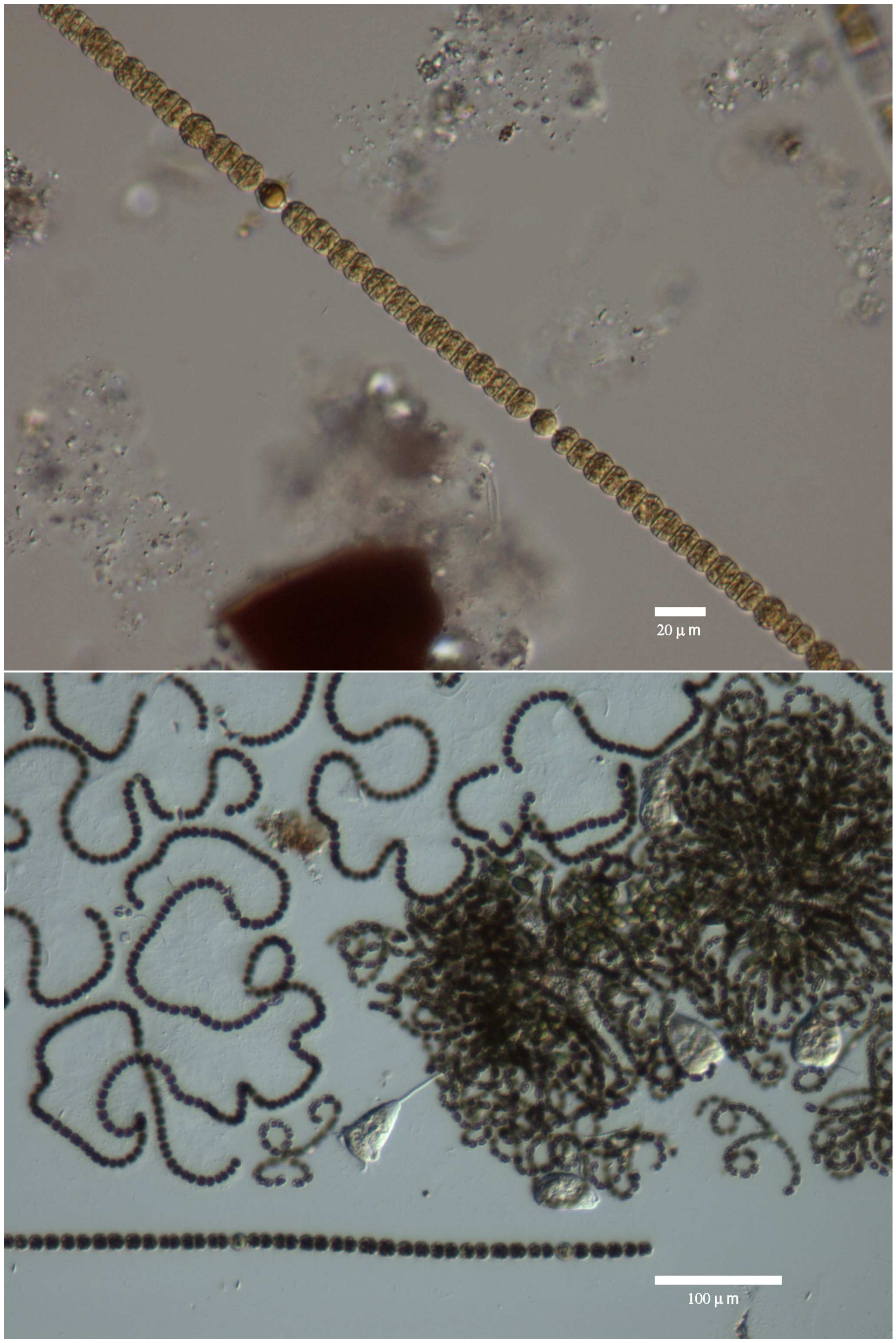


Figure 40: Cyanobacteria: *Anabaena*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

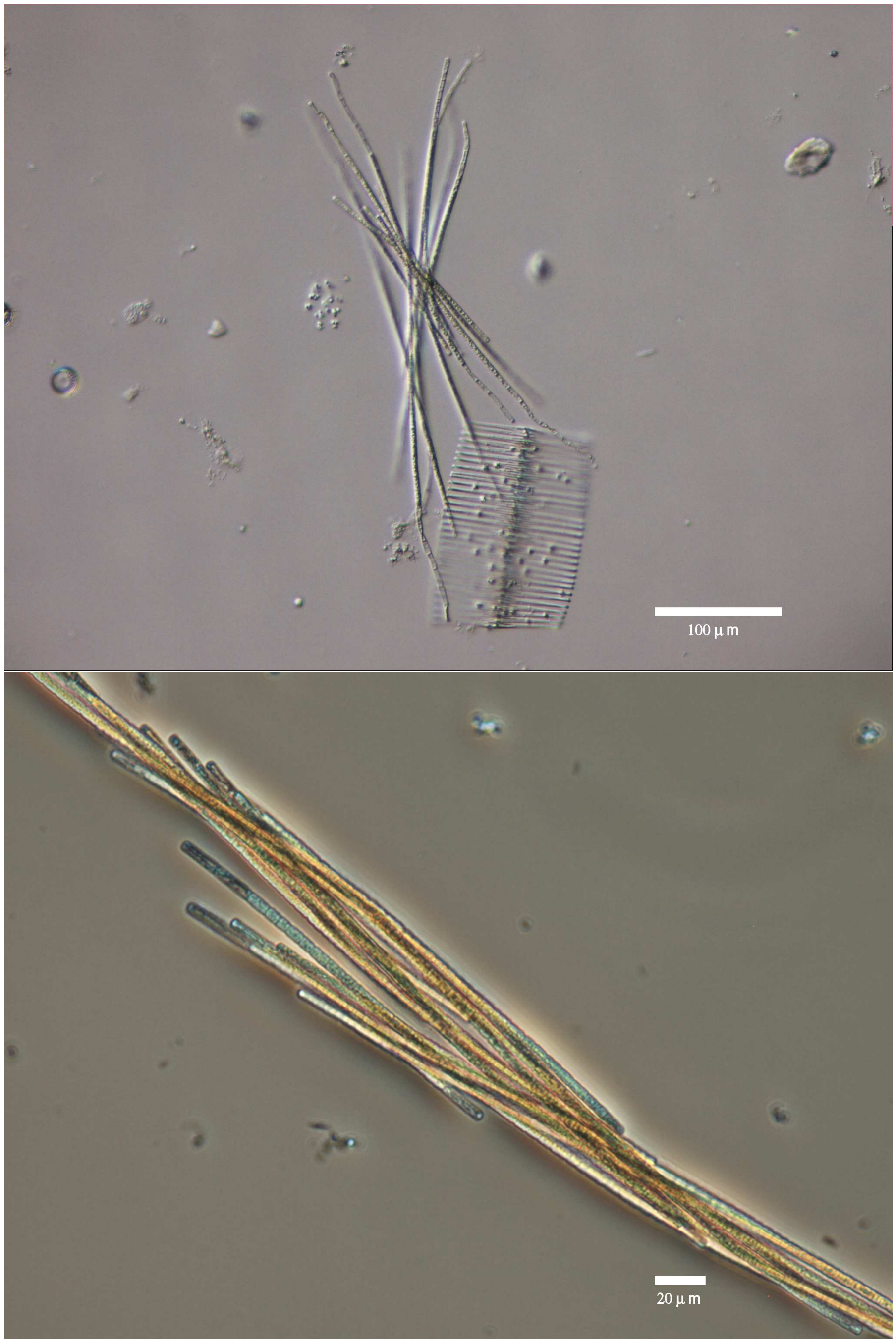


Figure 41: Cyanobacteria: *Aphanizomenon*. Both images show algae preserved in Lugol's iodine solution (Lake Padden).

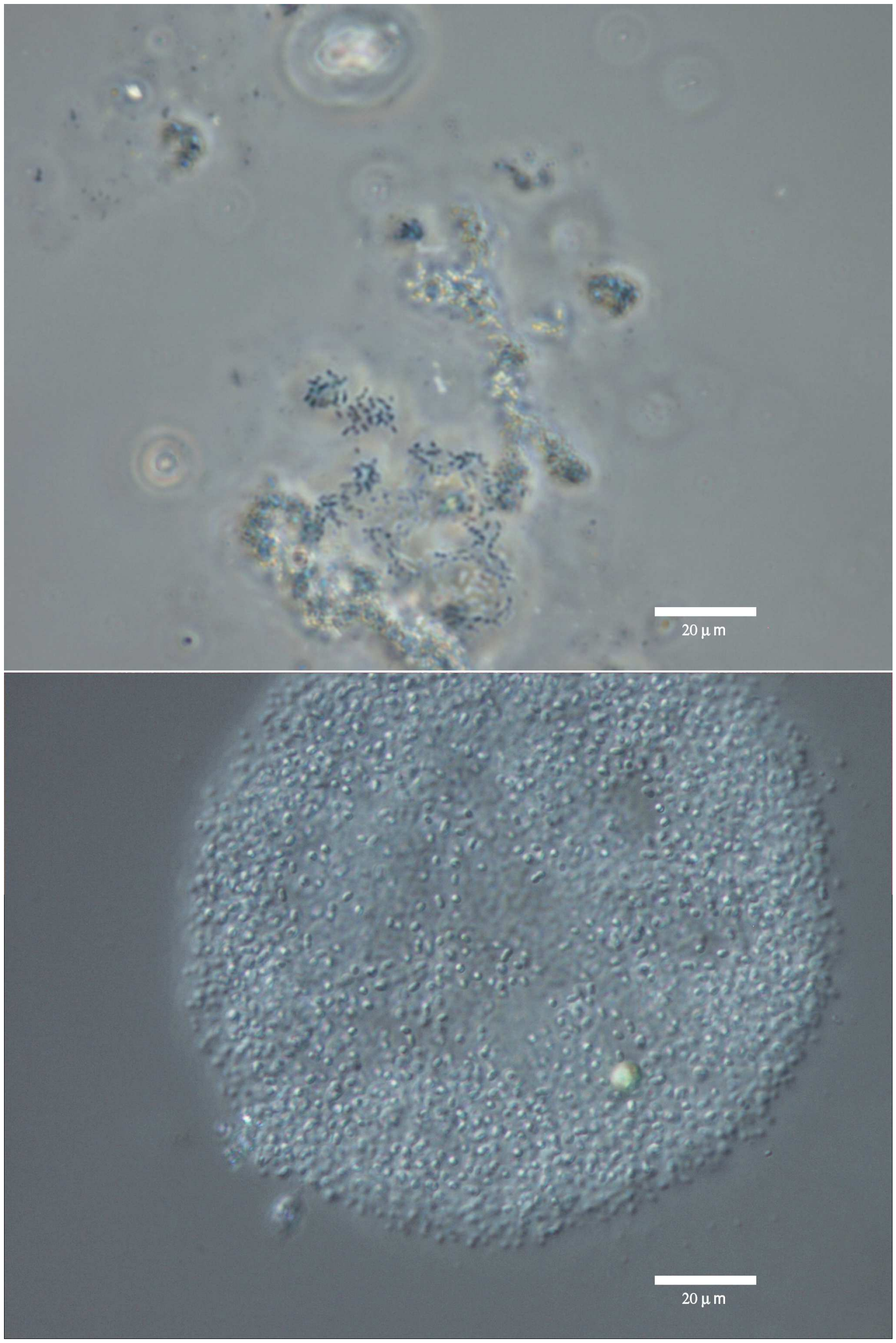


Figure 42: Cyanobacteria: *Aphanocapsa/Aphanothece* (may include other taxa). Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

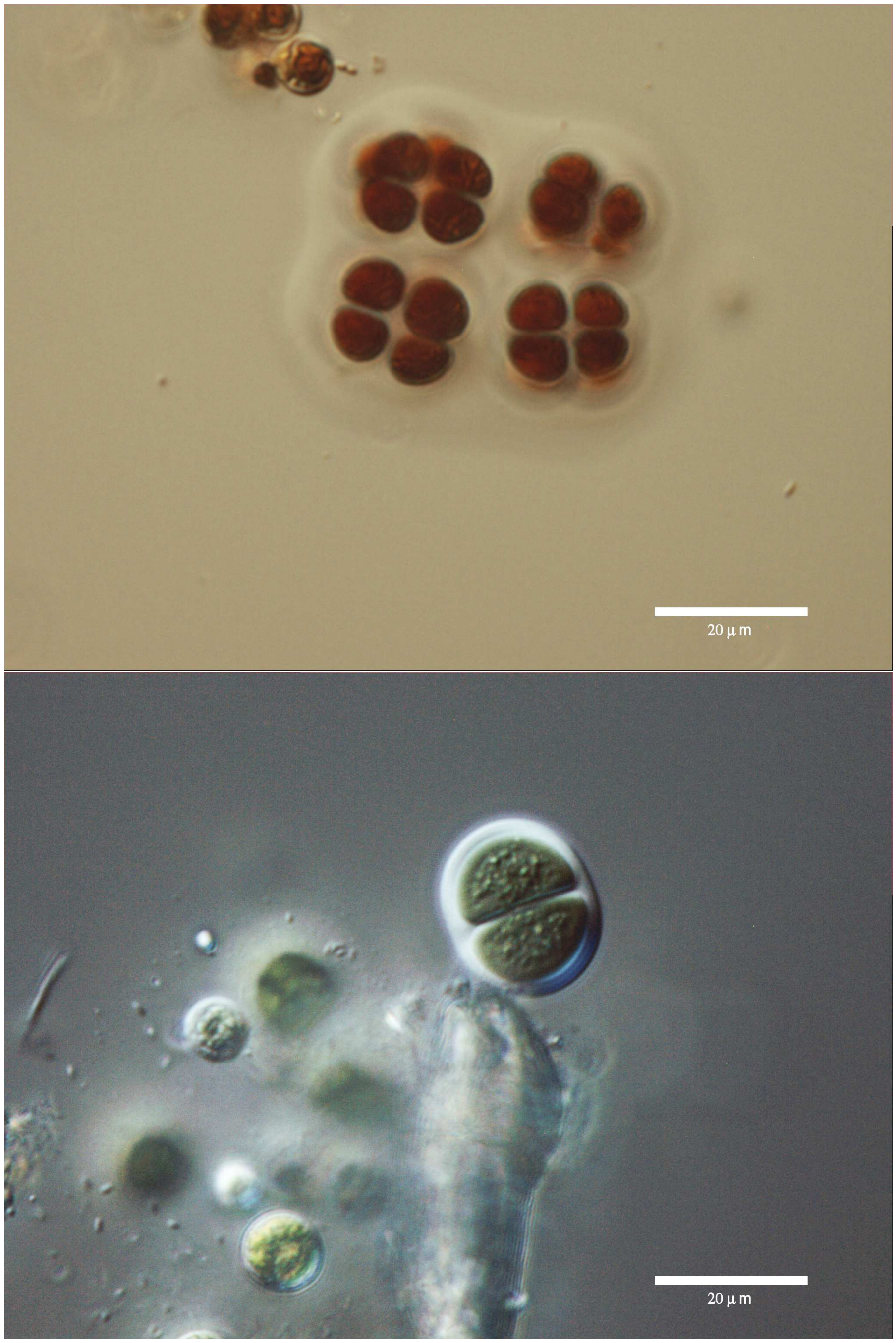


Figure 43: Cyanobacteria: *Chroococcus*. Upper image shows algae preserved in Lugol’s iodine solution (Judy Reservoir); lower image shows unpreserved algae (Lake Padden).


Figure 44: Cyanobacteria: *Cyanodictyon*. Both images show algae preserved in Lugol's iodine solution (upper = Lake Padden; lower = Lake Whatcom).

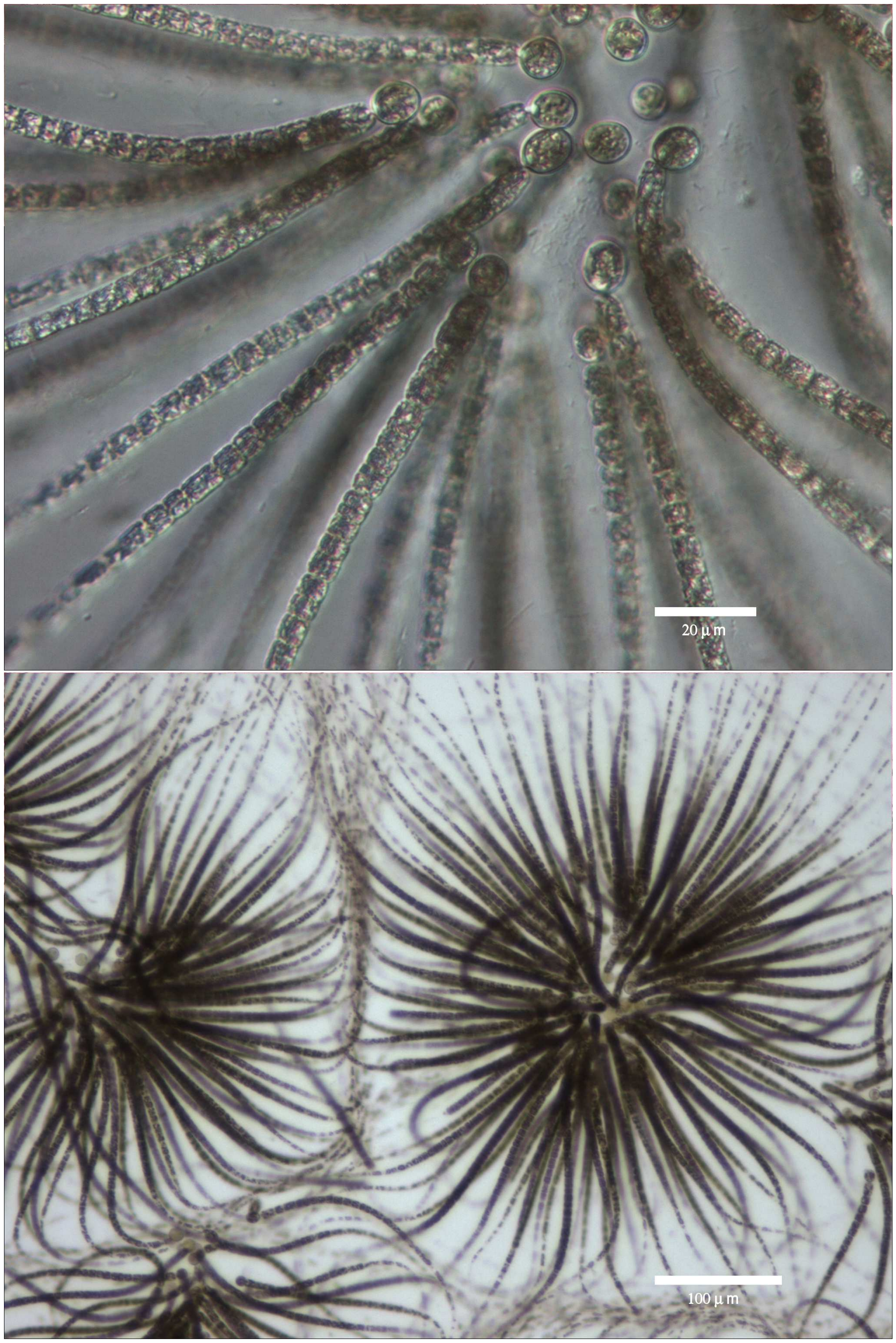


Figure 45: Cyanobacteria: *Gloeotrichia*. Both images show unpreserved algae (upper = Big Lake; lower = Cranberry Lake).

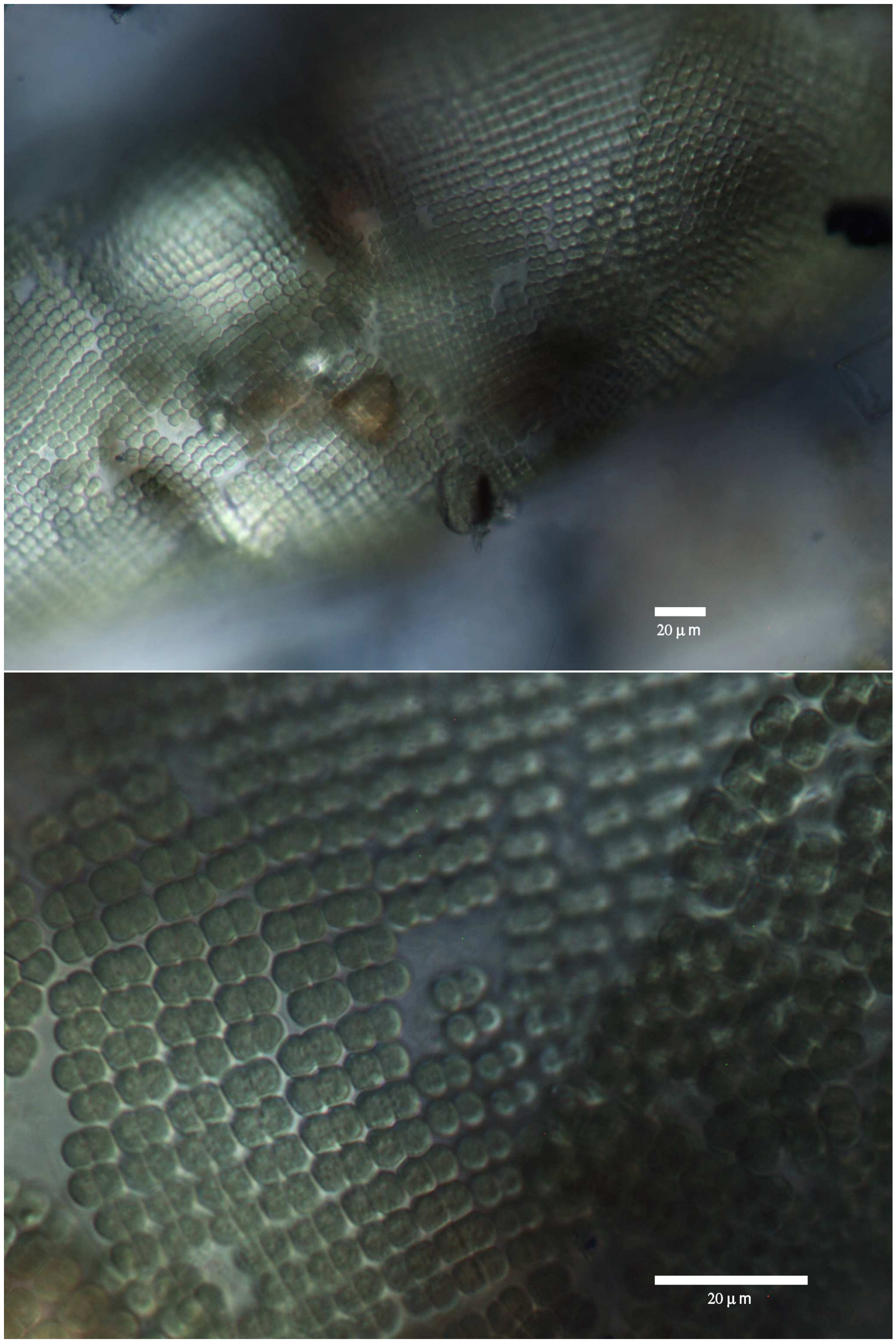


Figure 46: Cyanobacteria: *Merismopedia*. Both images show unpreserved algae (Lake Padden).

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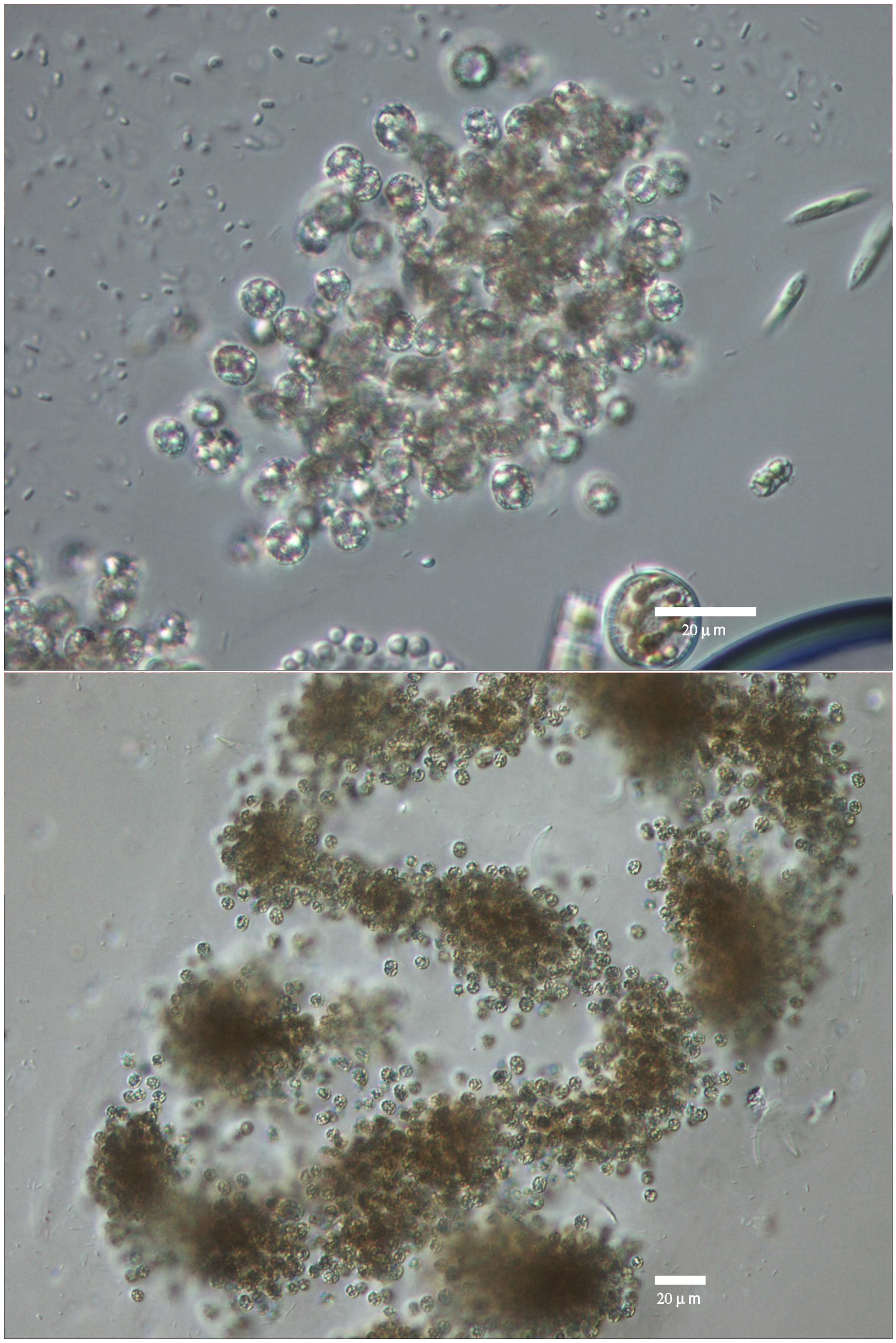


Figure 47: Cyanobacteria: *Microcystis*. Both images show unpreserved algae (Lake Whatcom).


Figure 48: Cyanobacteria: *Oscillatoria*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

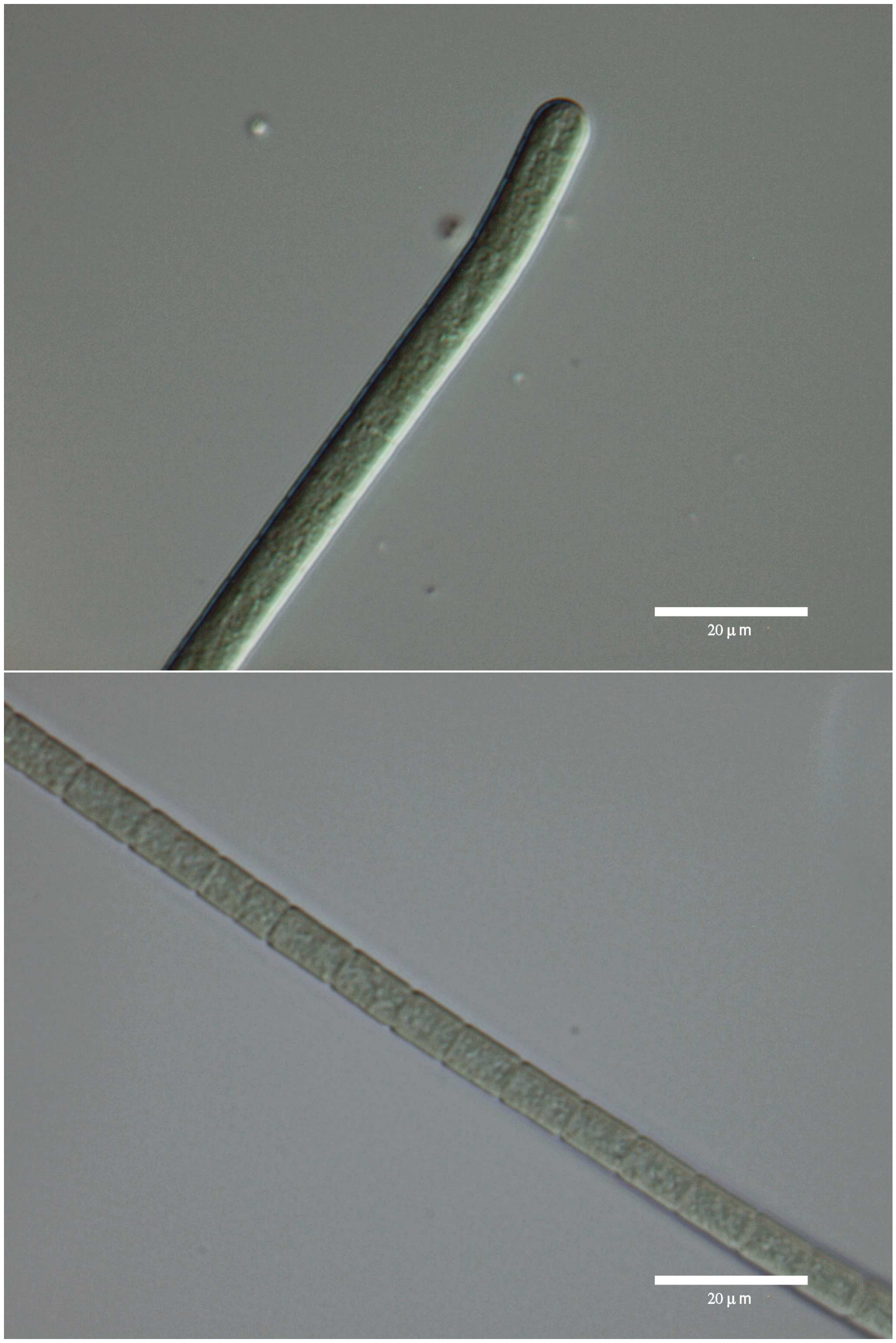


Figure 49: Cyanobacteria: *Phormidium*. Both images show unpreserved algae (upper = Geneva Pond; lower = Lake Padden).

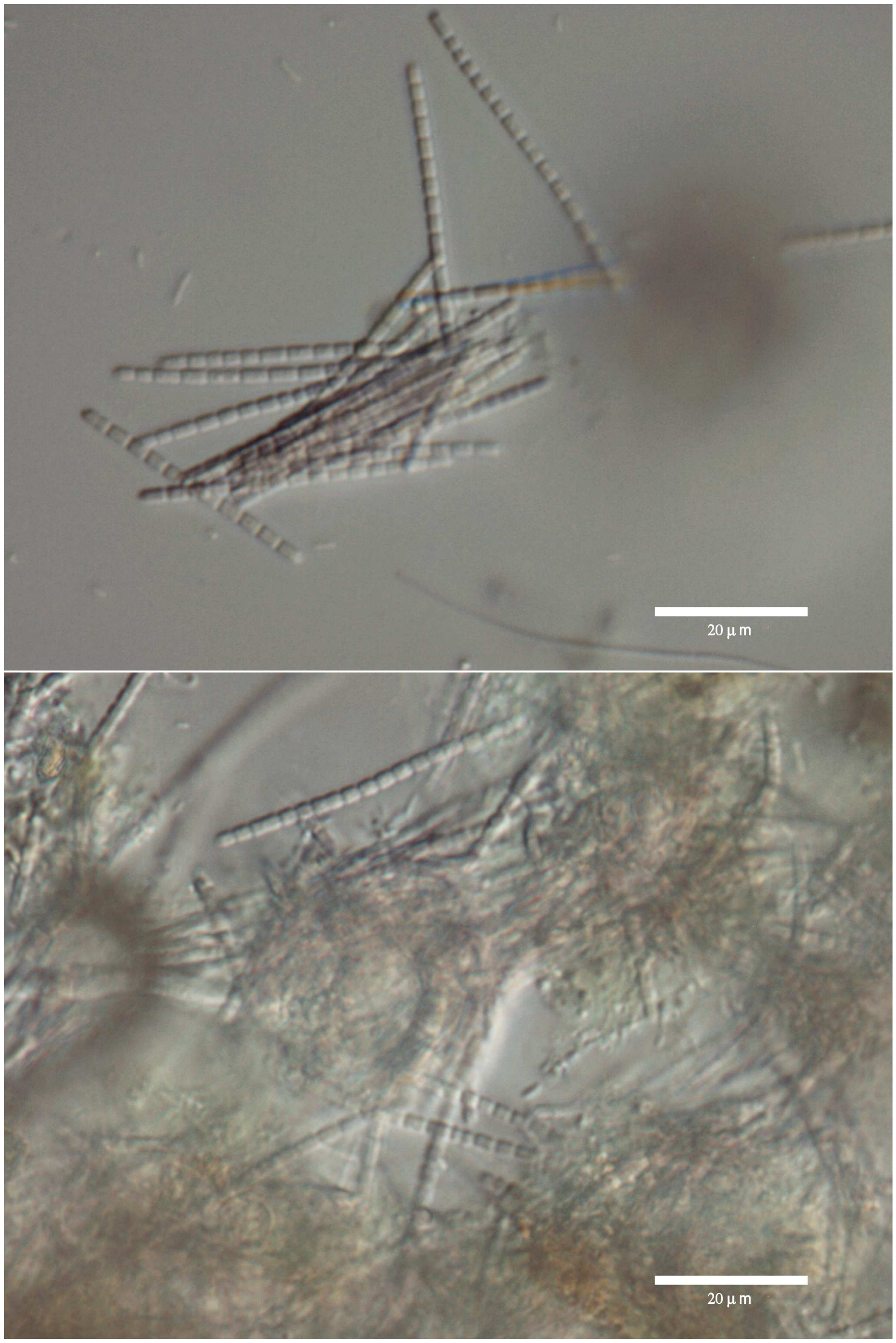


Figure 50: Cyanobacteria: *Pseudanabaena*. Both images show unpreserved algae (Lake Padden).

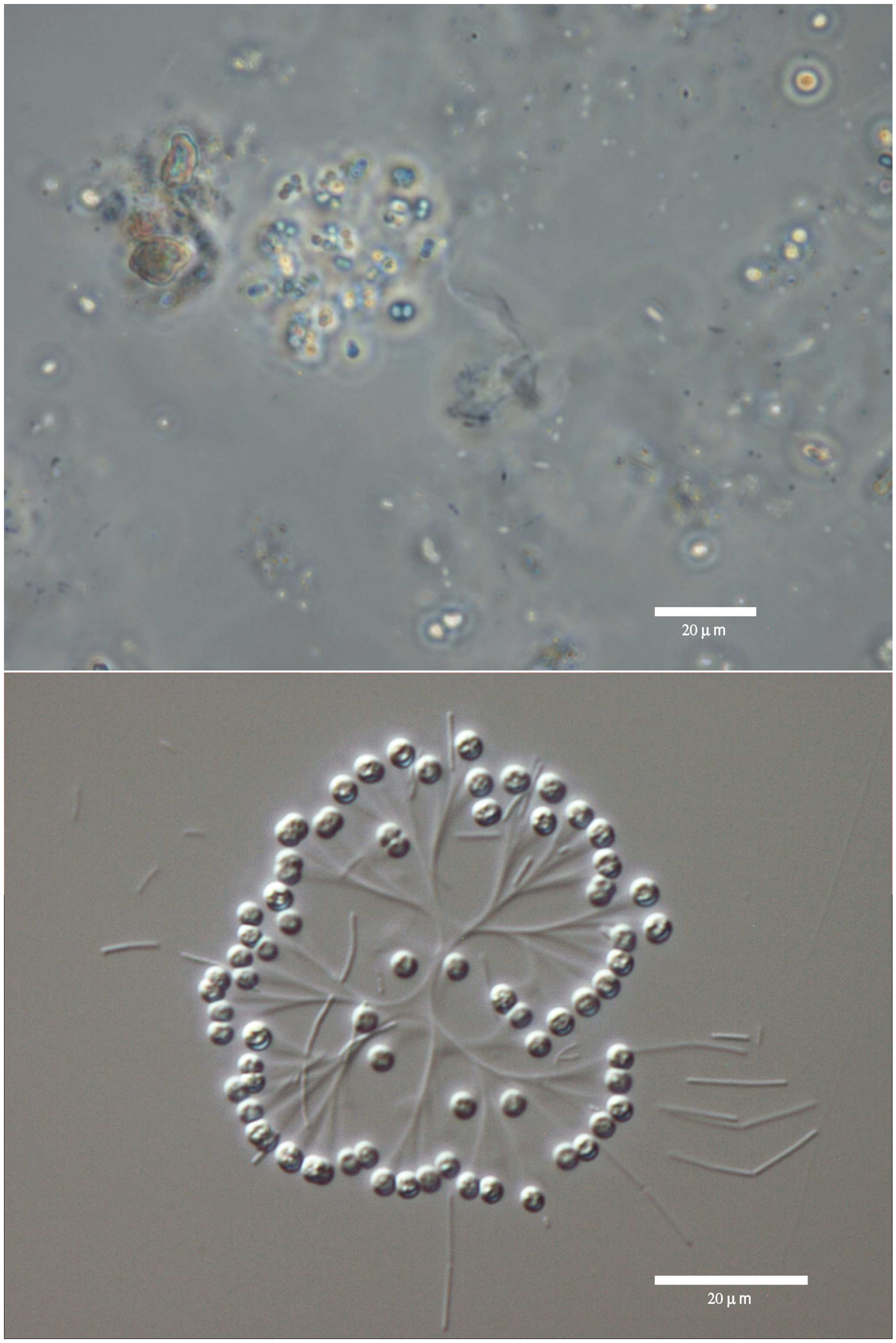


Figure 51: Cyanobacteria: *Snowella*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).

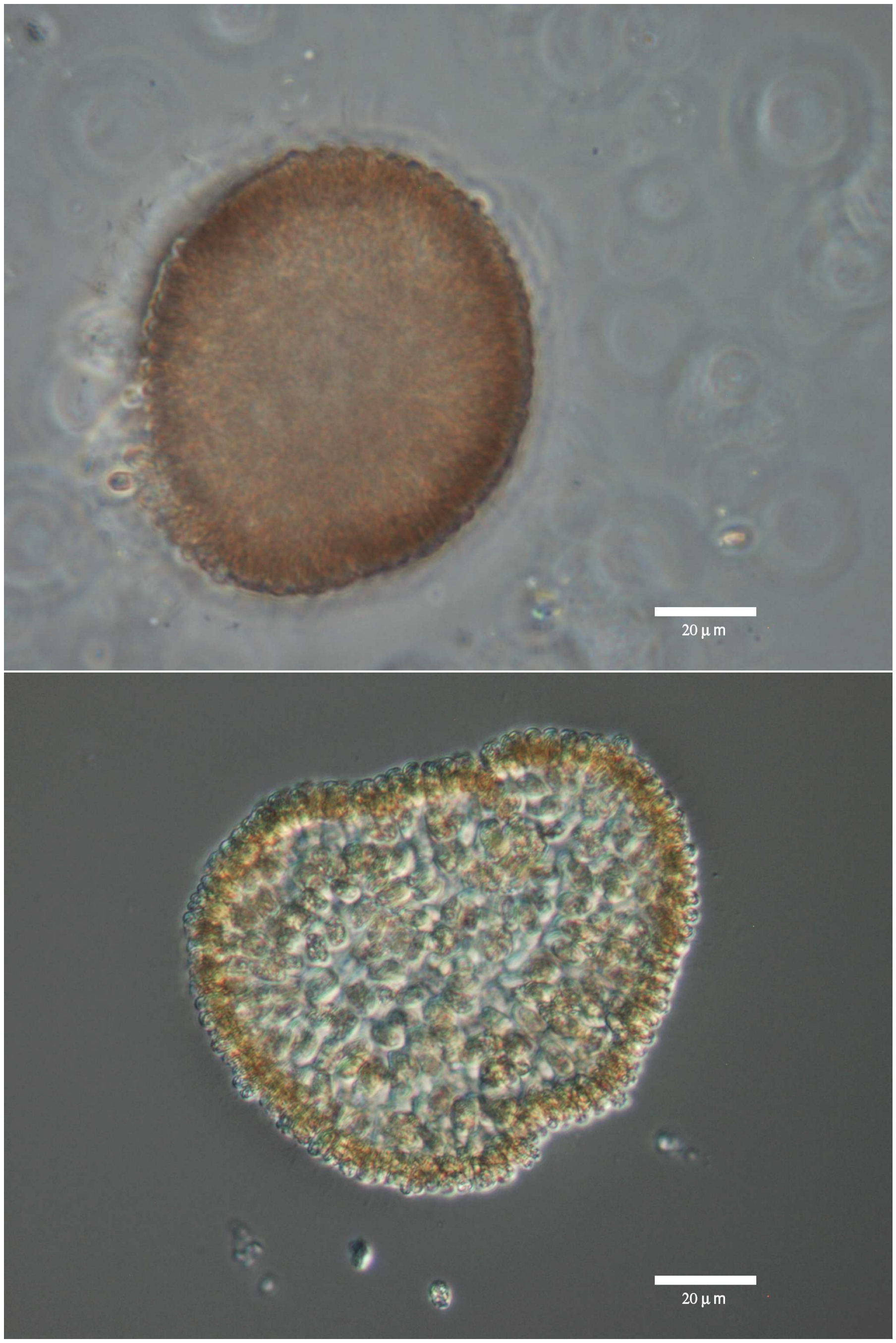


Figure 52: Cyanobacteria: *Woronichinia*. Both images show algae preserved in Lugol's iodine solution (Lake Padden).

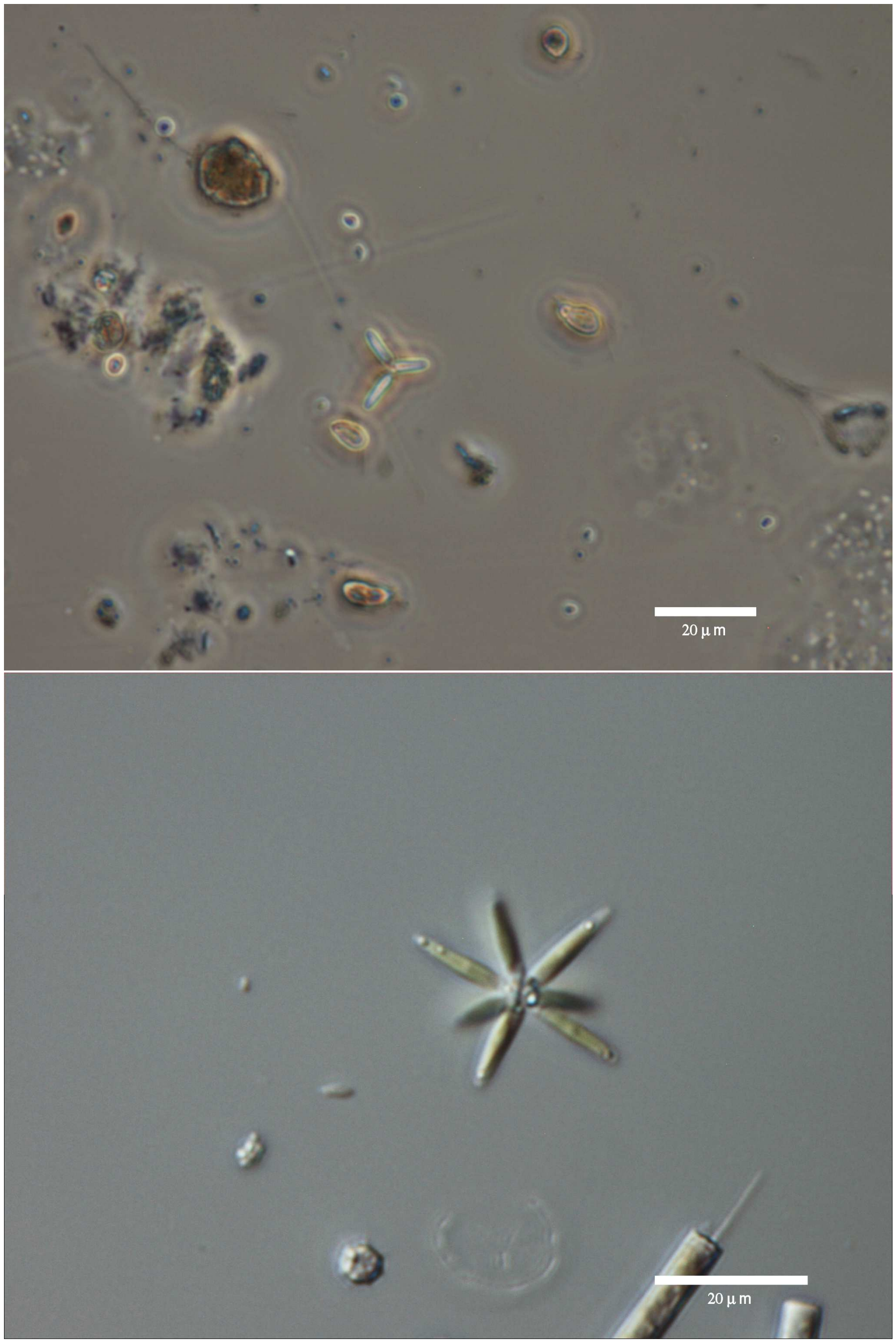


Figure 53: Green algae: *Actinastrum*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Fazon Lake).

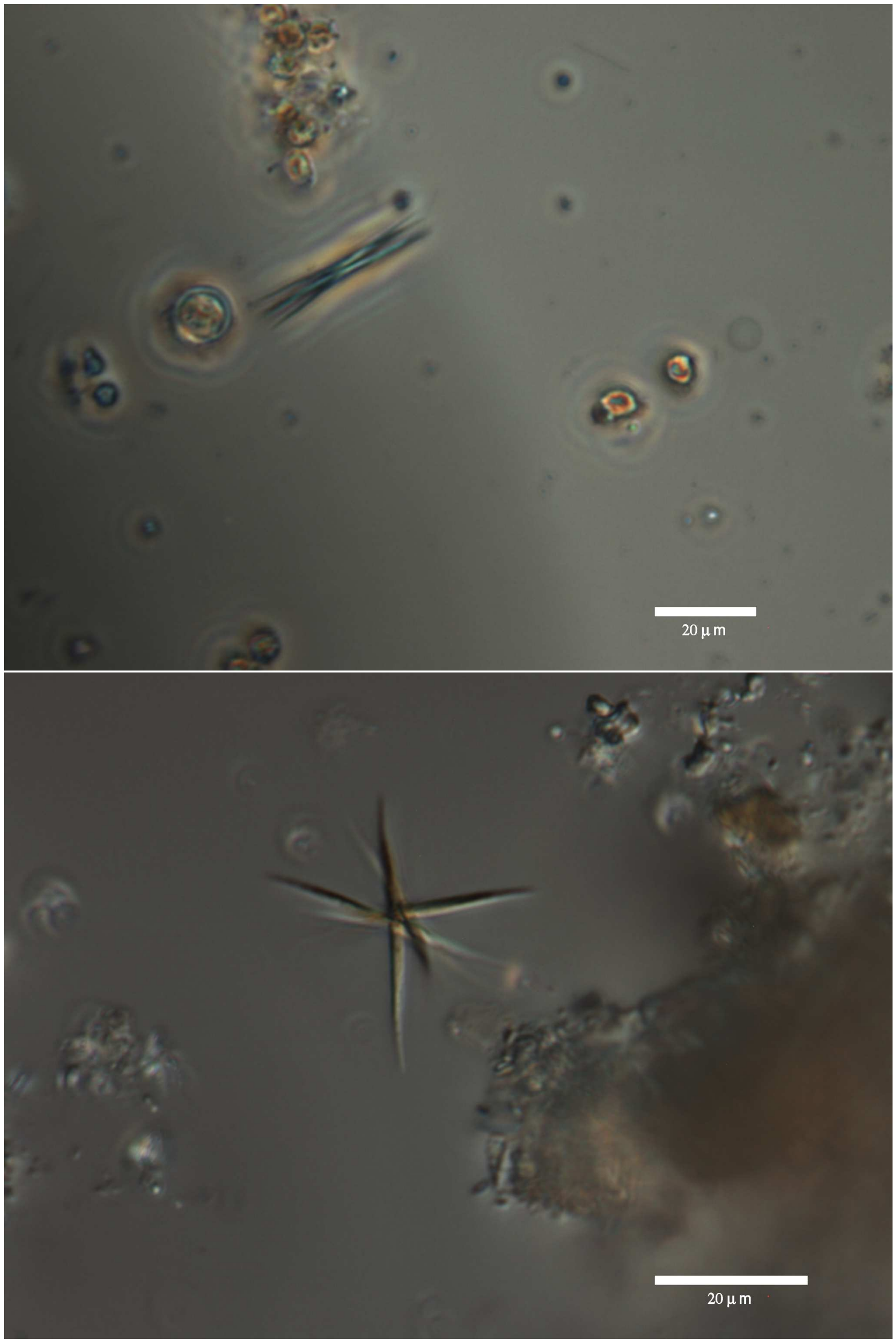


Figure 54: Green algae: *Ankistrodesmus*. Both images show algae preserved in Lugol's iodine solution (Lake Padden).

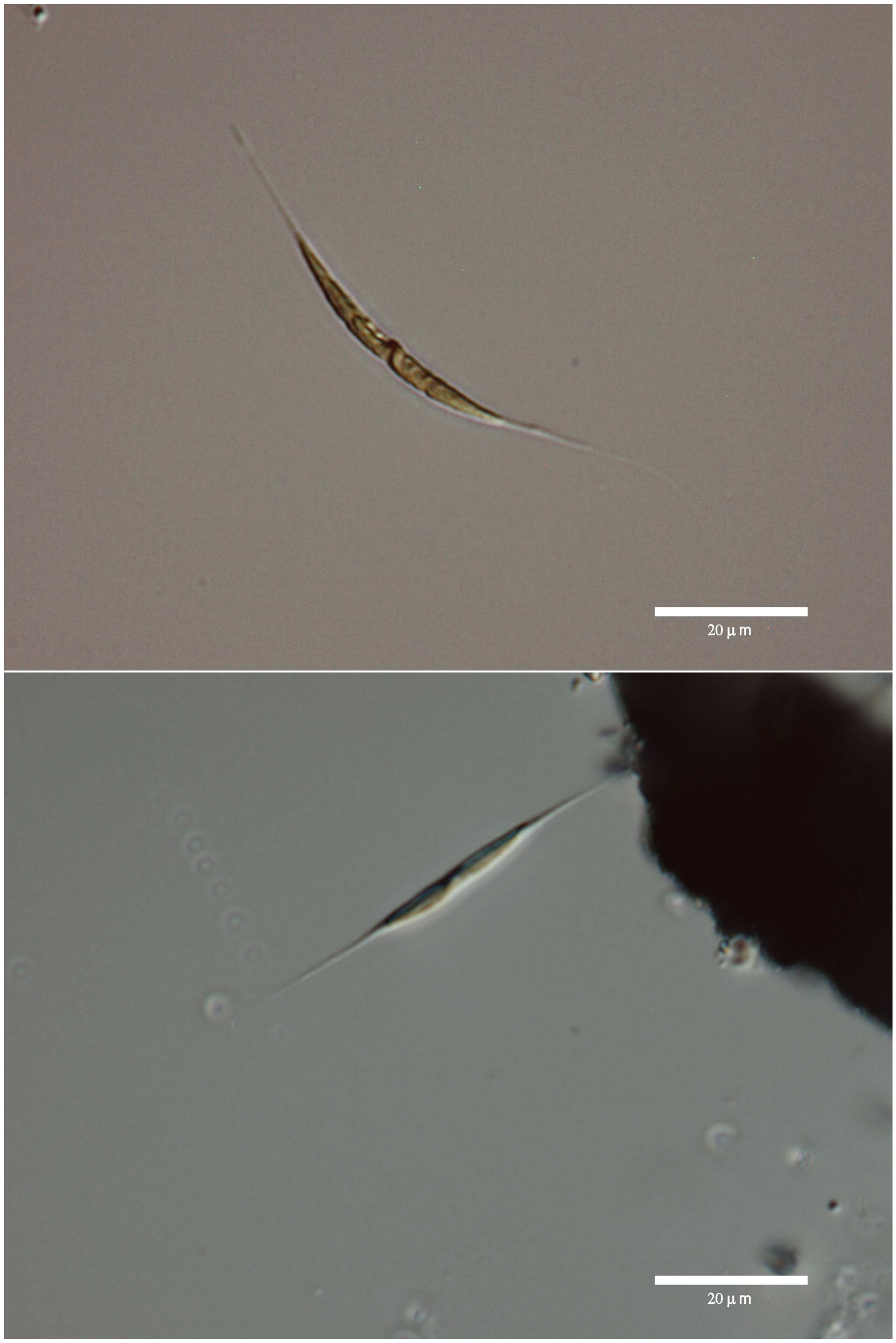


Figure 55: Green algae: *Ankyra/Monoraphidium/Schroederia*. Both images show algae preserved in Lugol's iodine solution (Lake Padden).


Figure 56: Green algae: *Asterococcus/Planktosphaeria*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

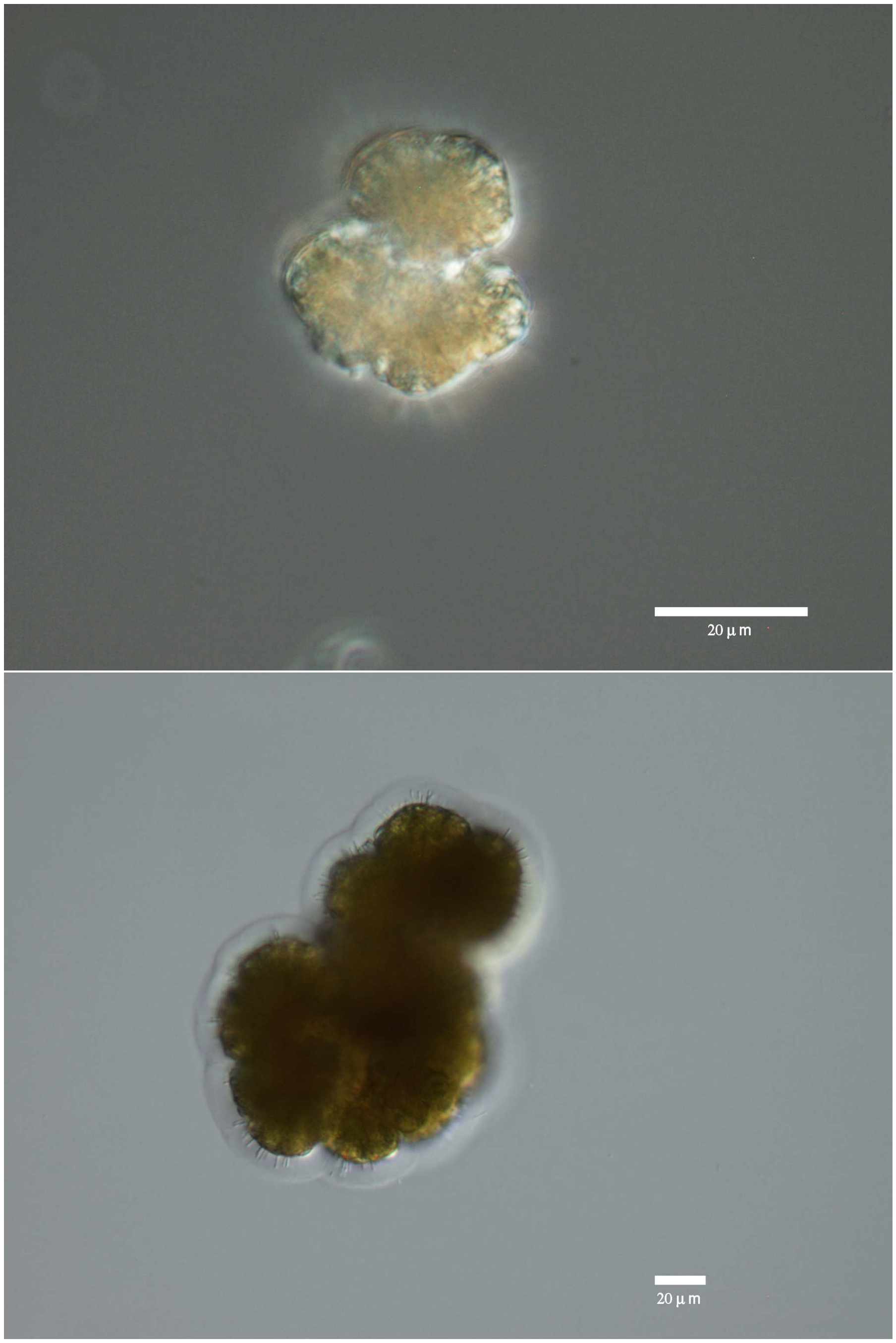

Figure 57: Green algae: *Botryococcus*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 58: Green algae: *Bulbochaete*. Both images show unpreserved algae (upper = Lake Padden; lower = Big Lake).

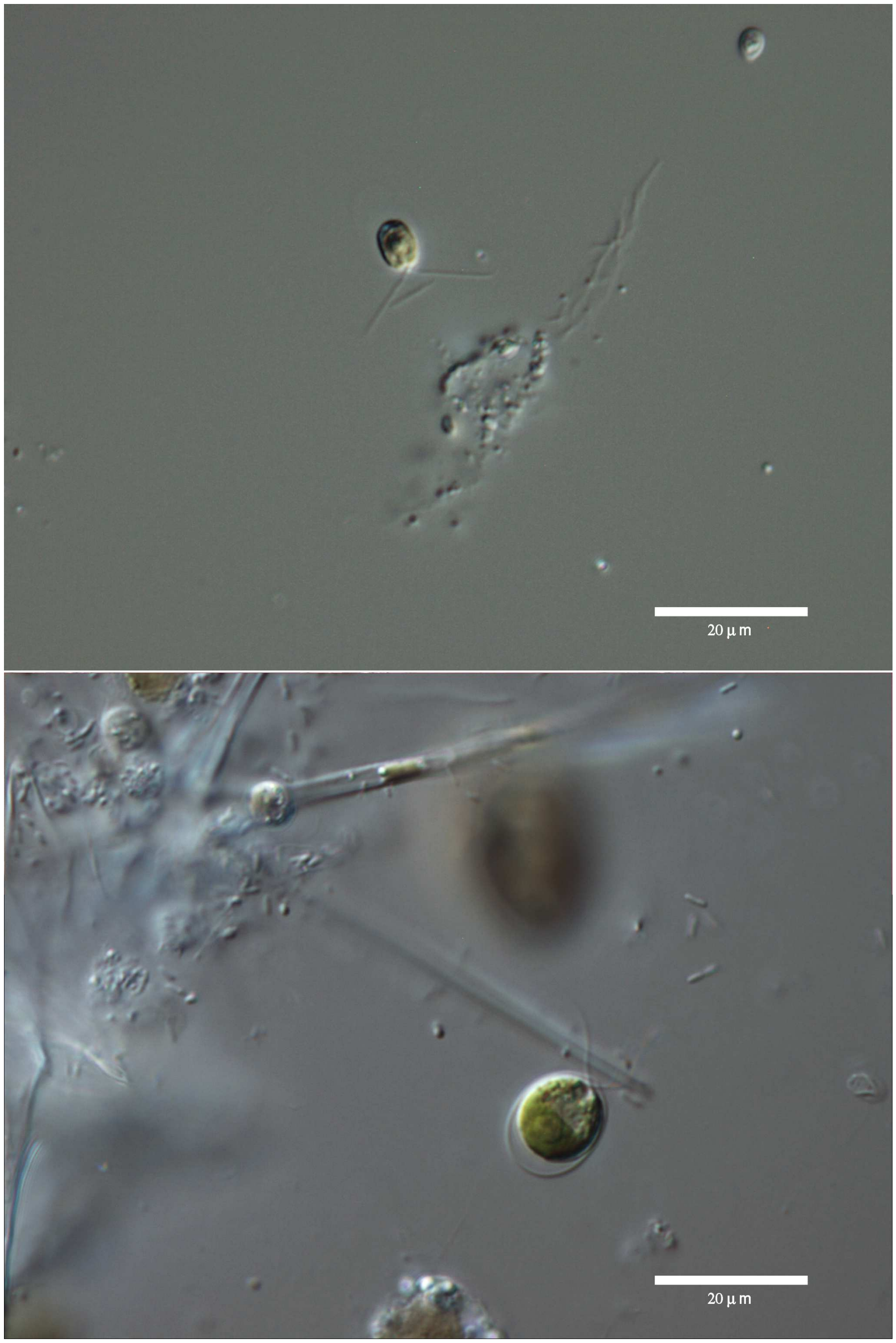


Figure 59: Green algae: *Chlamydomonas*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

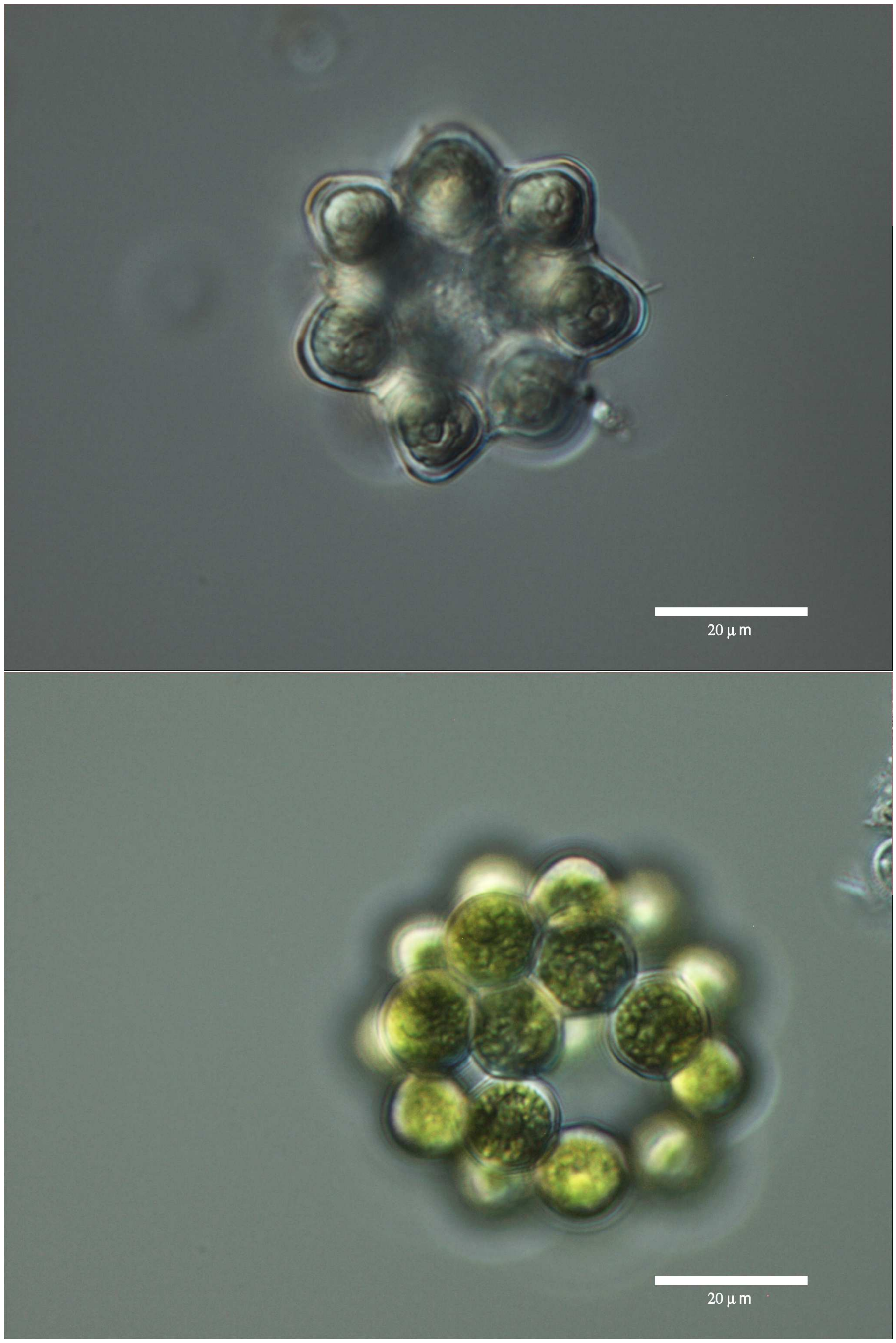


Figure 60: Green algae: *Coelastrum*. Upper image shows algae preserved in Lugol's iodine solution (Lake Campbell); lower image shows unpreserved algae (Lake Whatcom).

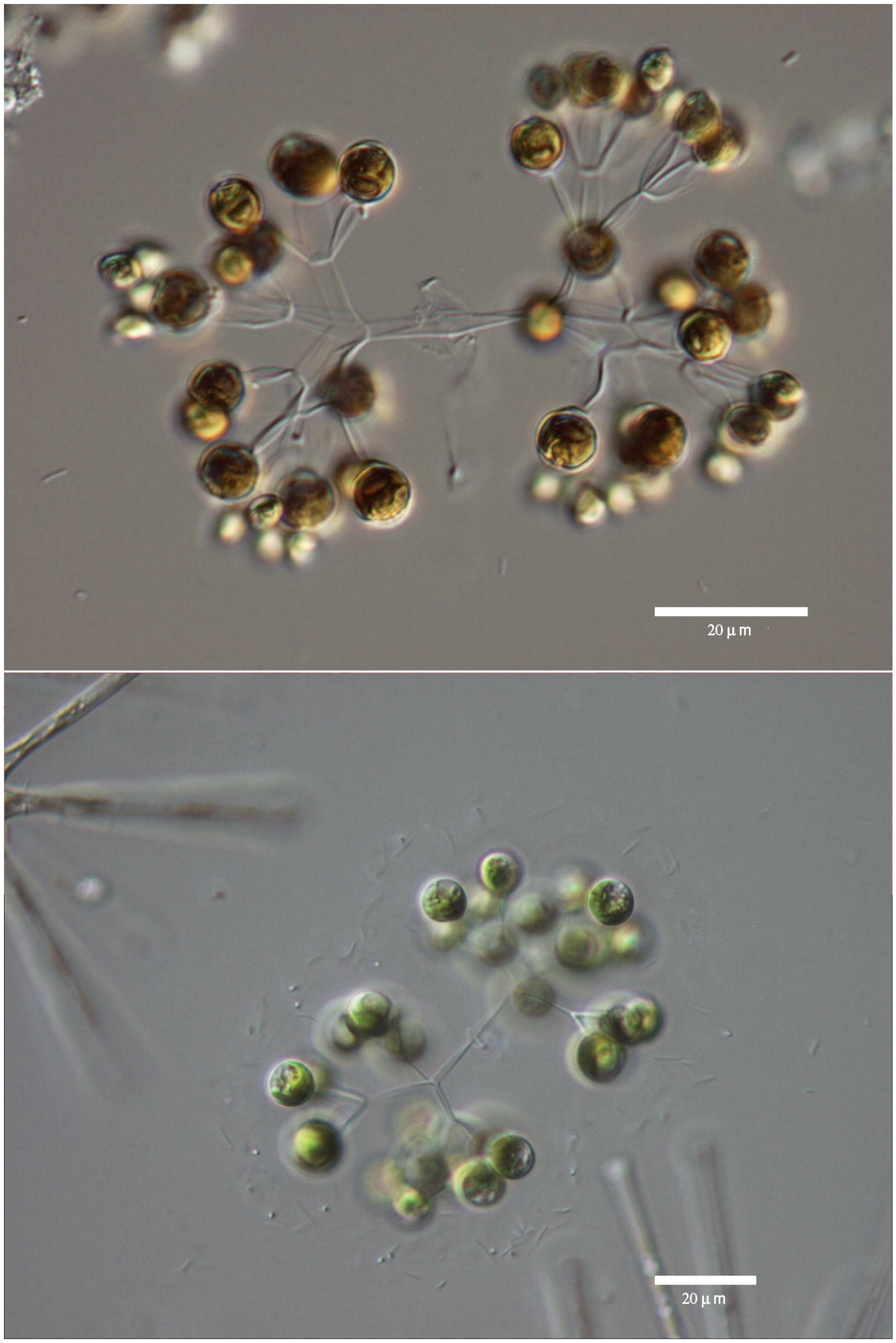


Figure 61: Green algae: *Dictyosphaerium*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

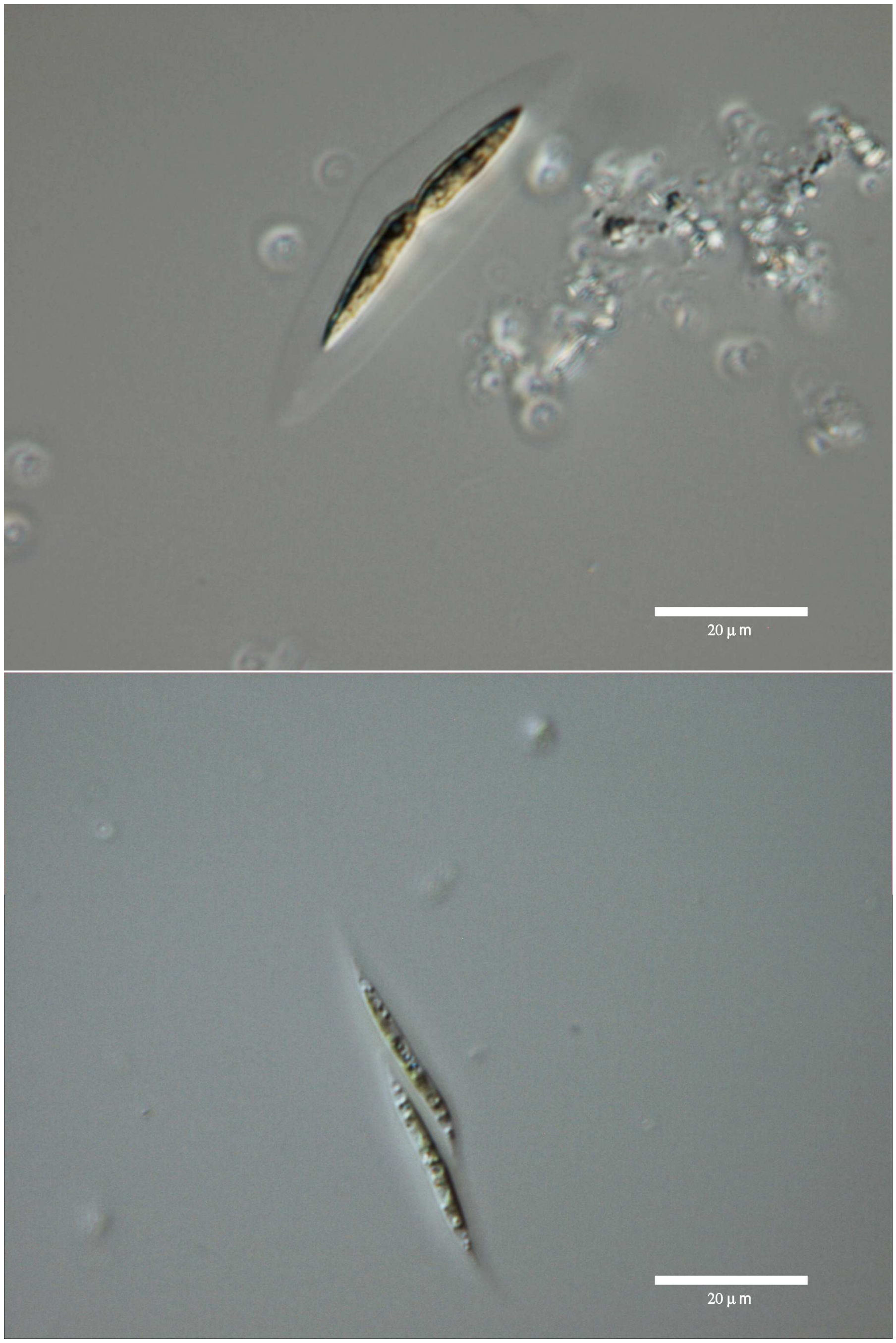


Figure 62: Green algae: *Elakatothrix*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 63: Green algae: *Eudorina*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

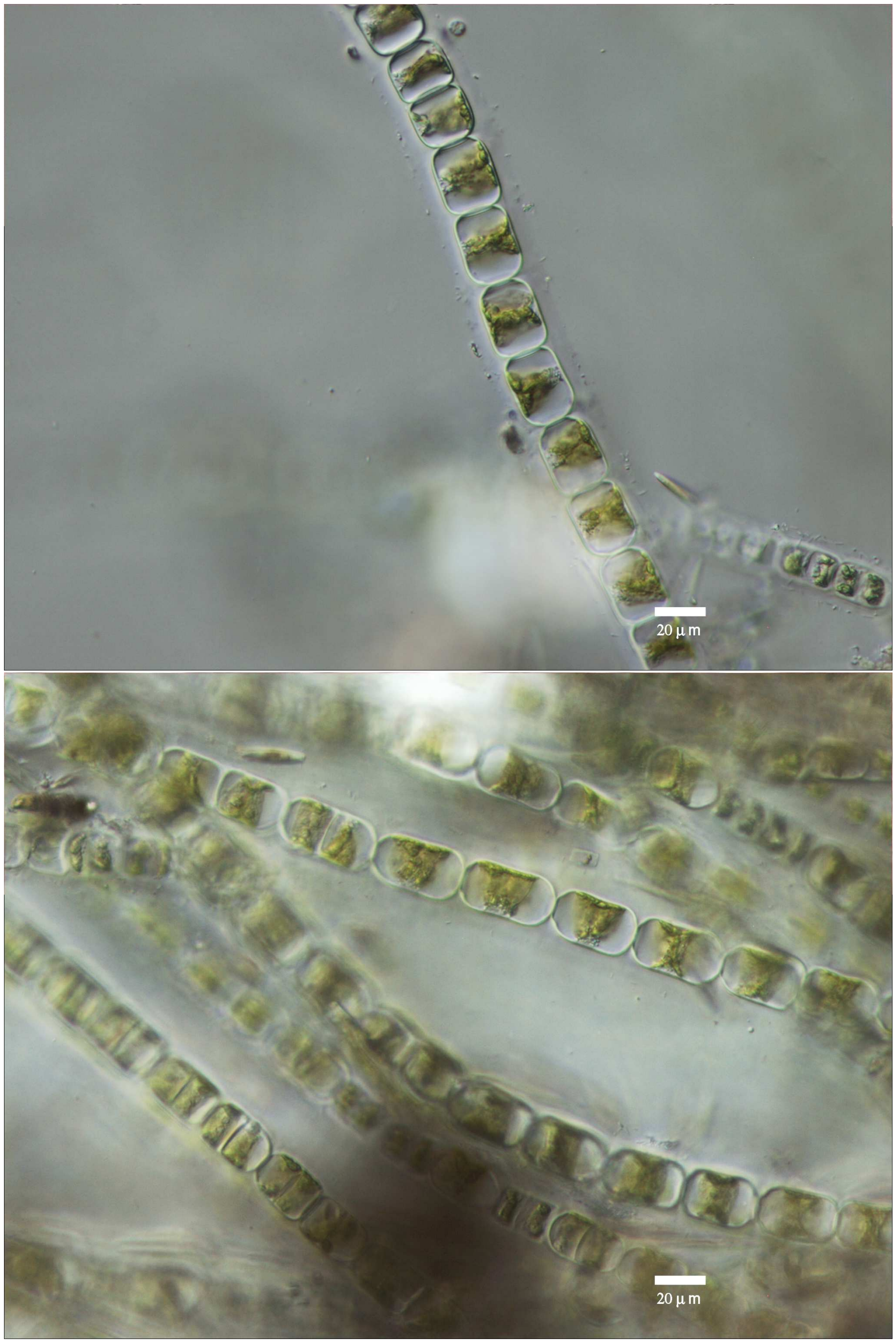


Figure 64: Green algae: *Geminella*. Both images show unpreserved algae (Lake Padden).

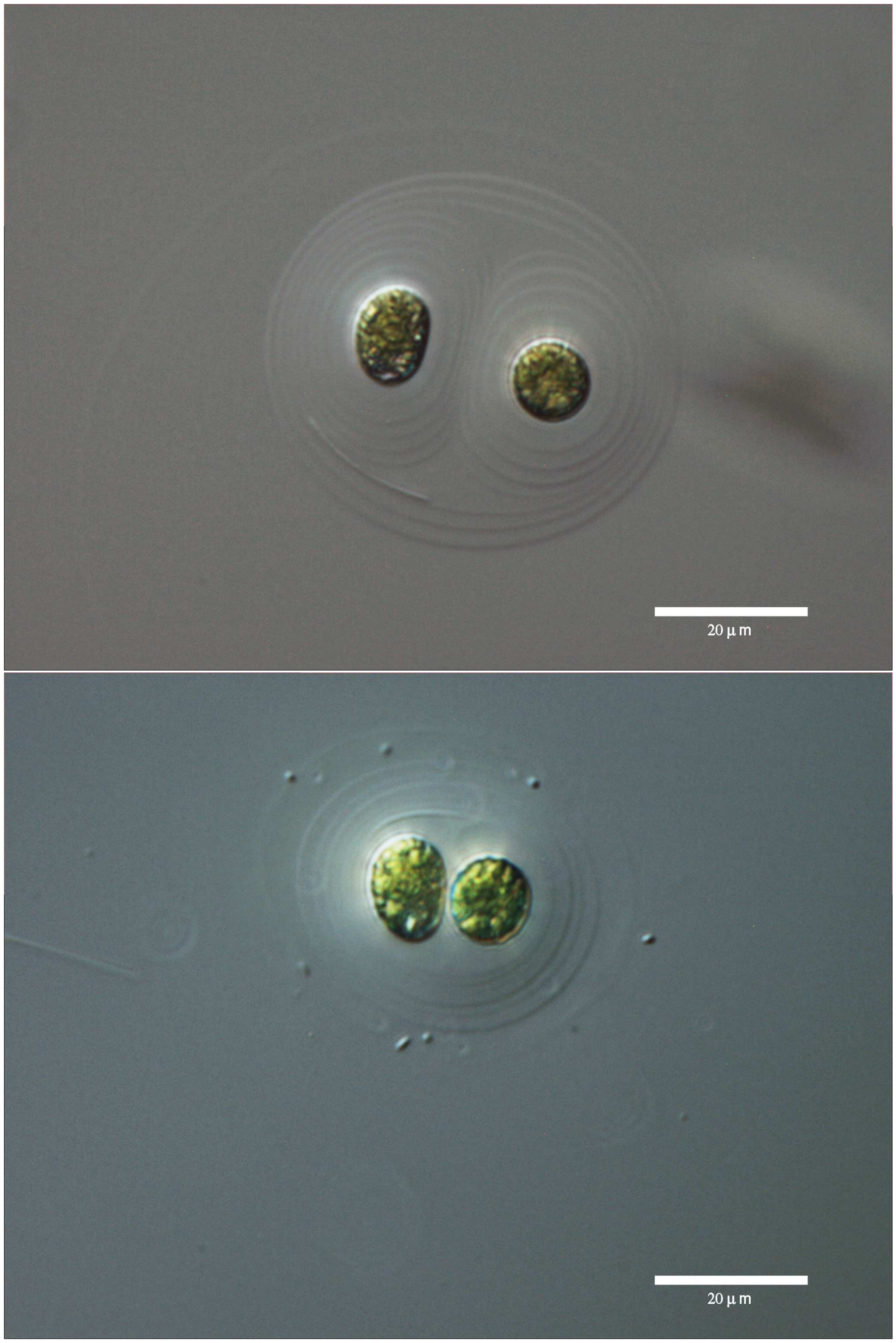


Figure 65: Green algae: *Gloeocystis*. Both images show unpreserved algae (upper = Ki Lake; lower = Lake Padden).

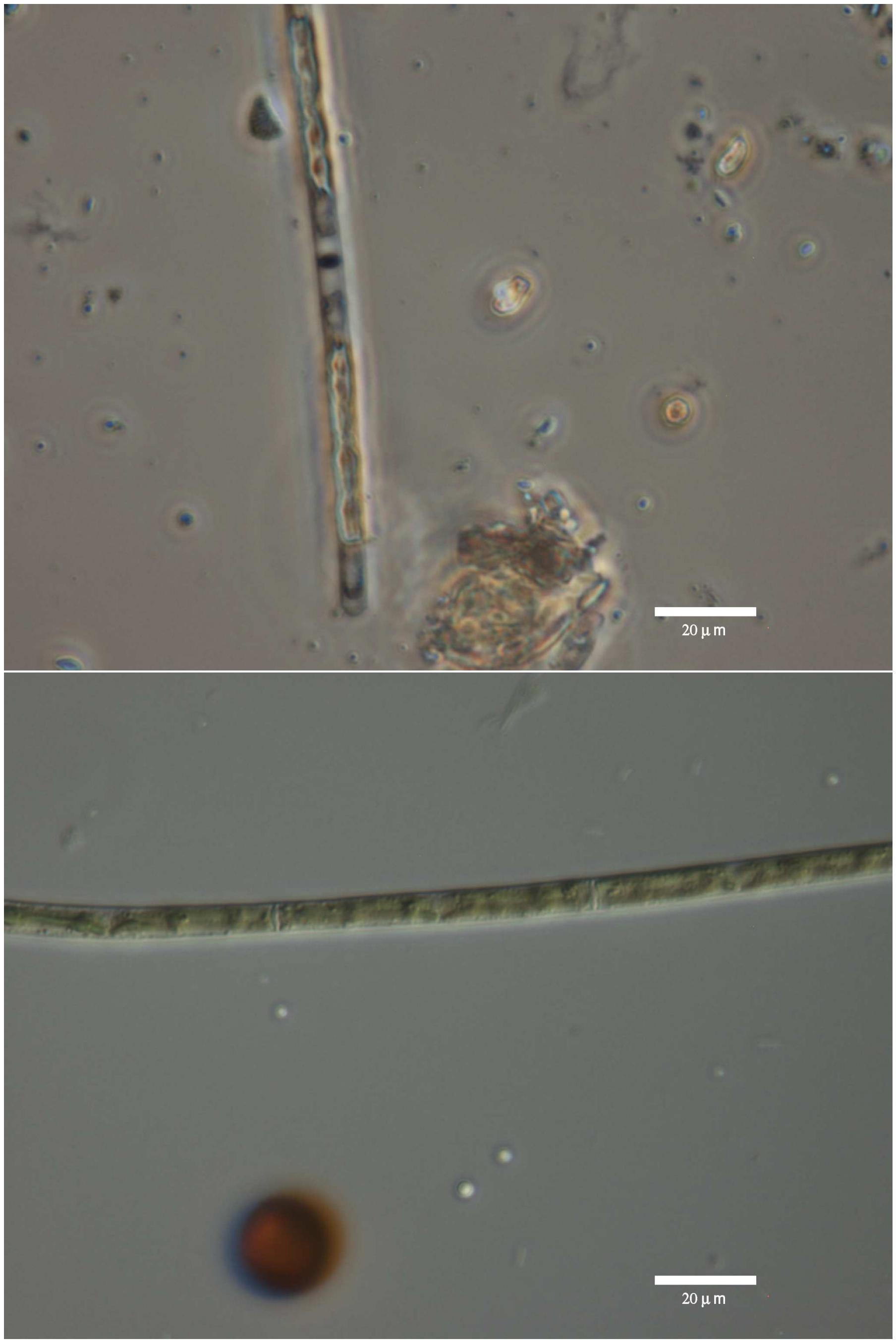


Figure 66: Green algae: *Mougeotia*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).


Figure 67: Green algae: *Oocystis*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

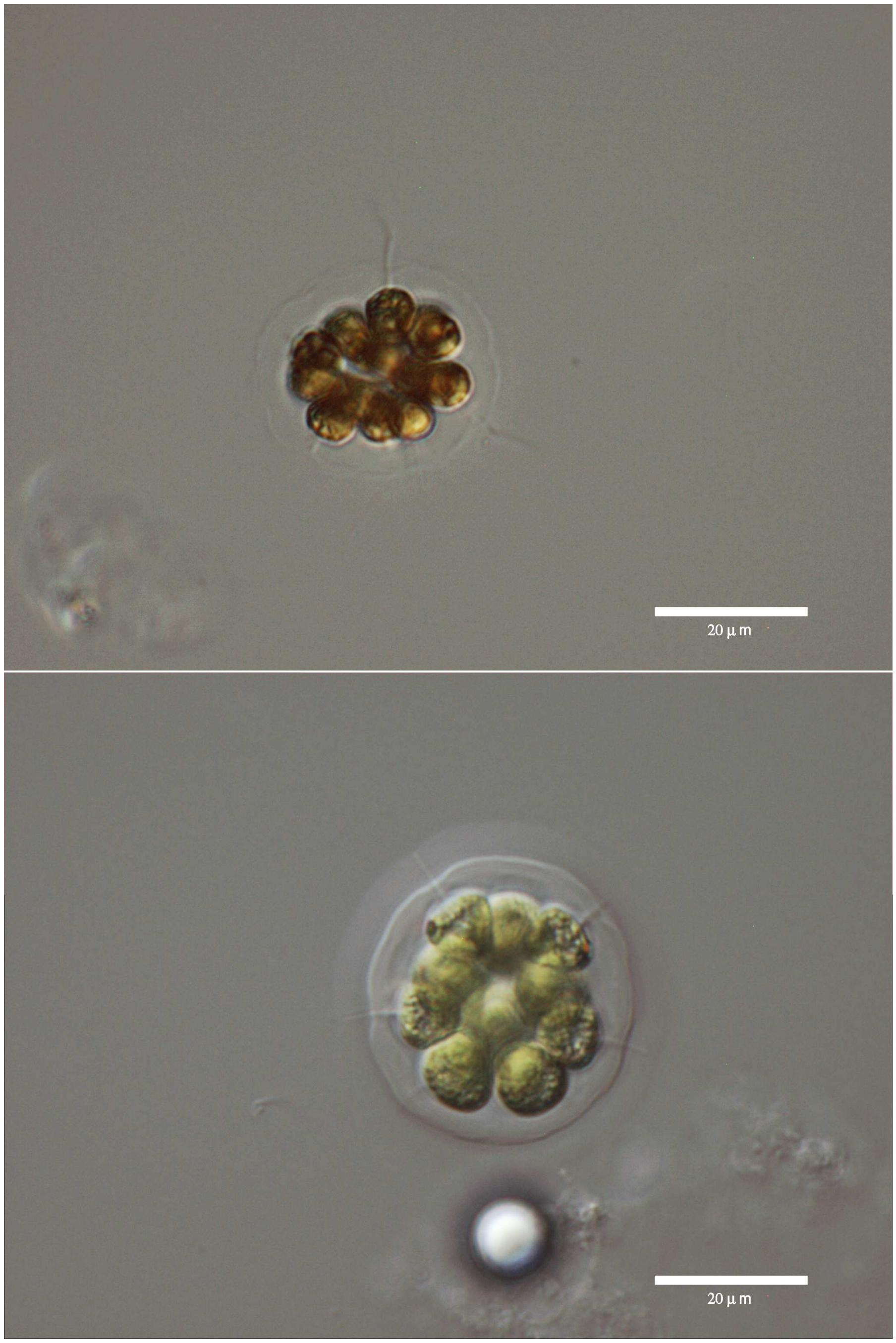


Figure 68: Green algae: *Pandorina*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Judy Reservoir).

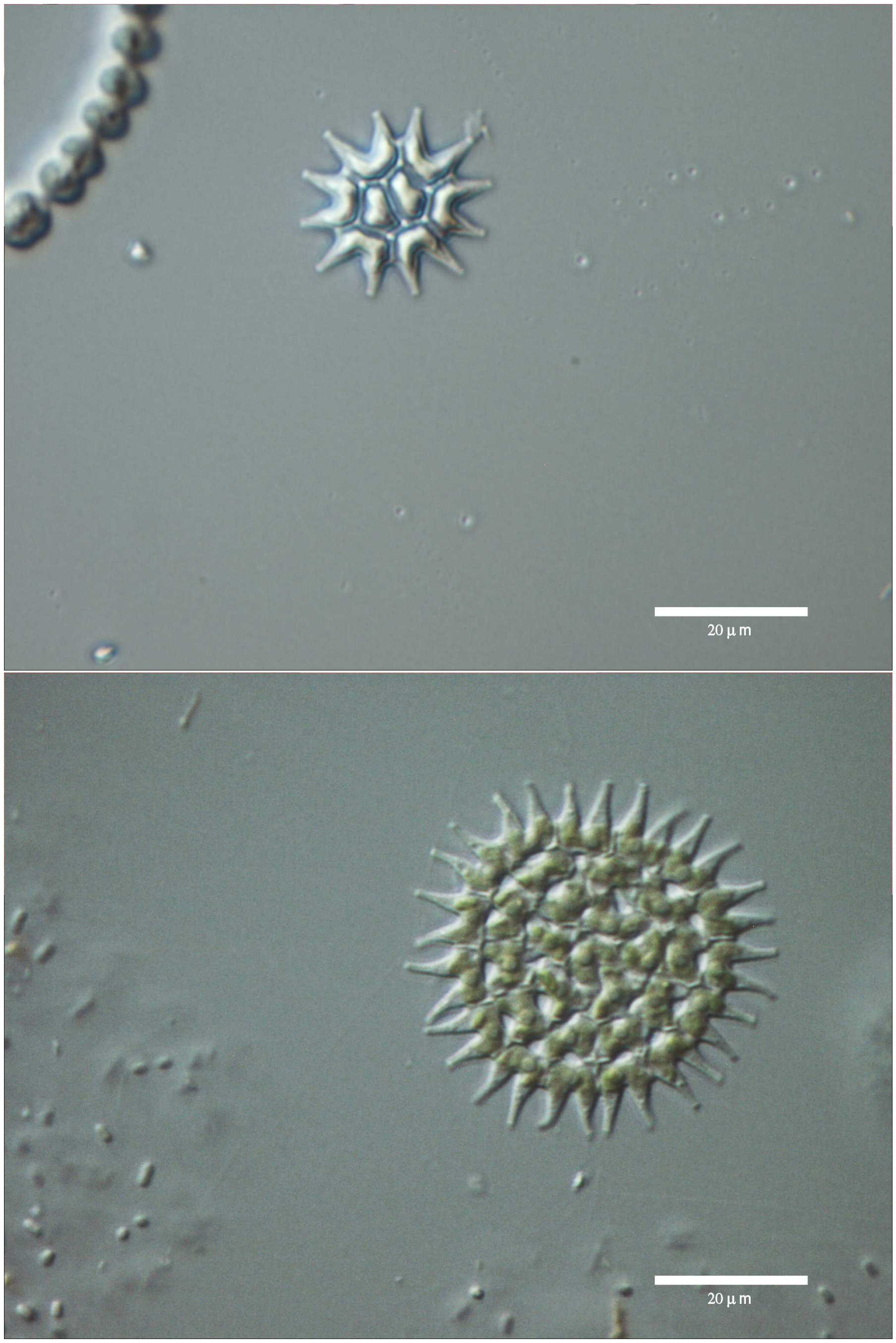


Figure 69: Green algae: *Pediastrum*. Upper image shows algae preserved in Lugol's iodine solution (Lake Campbell); lower image shows unpreserved algae (Lake Whatcom).

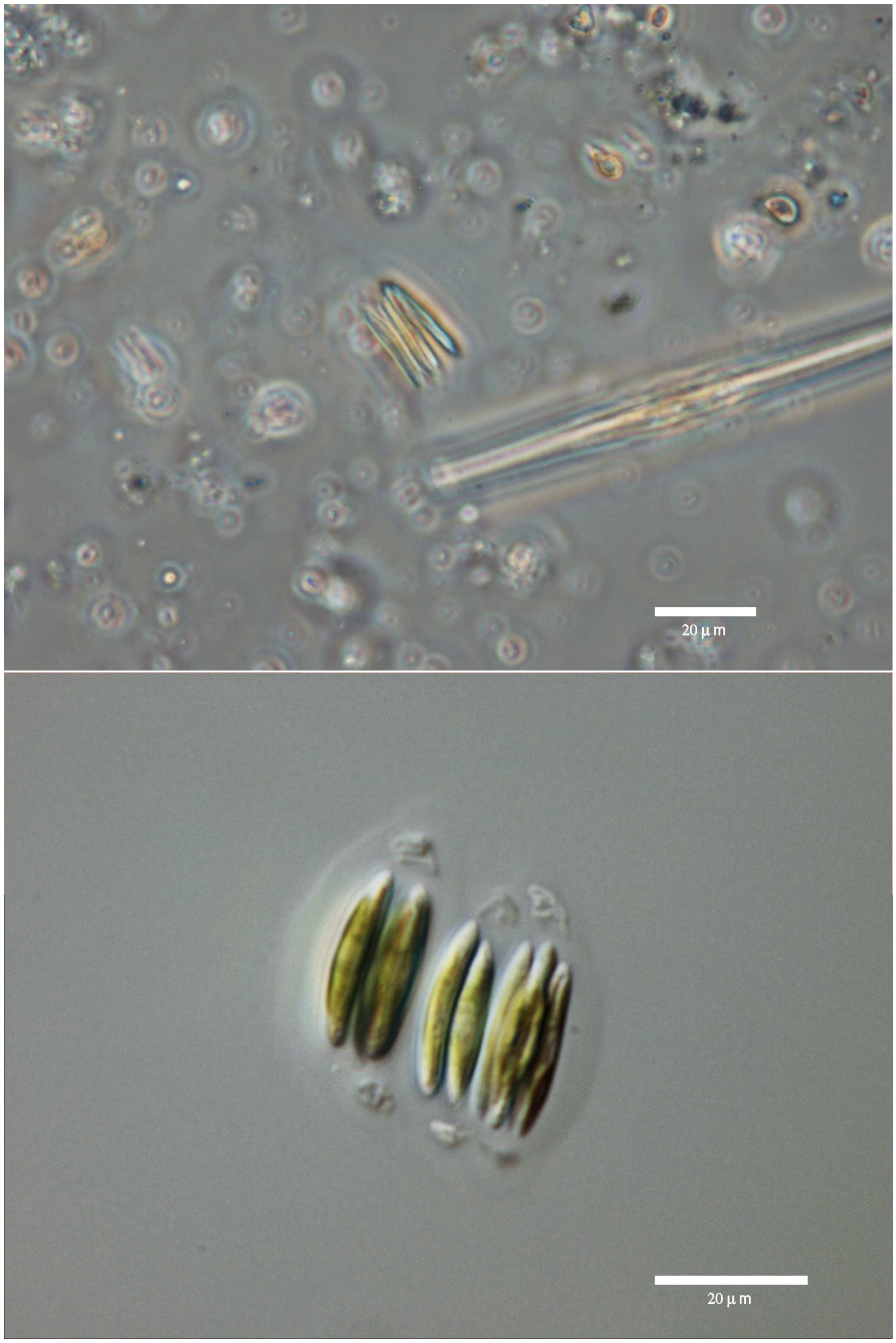


Figure 70: Green algae: *Quadrigula*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

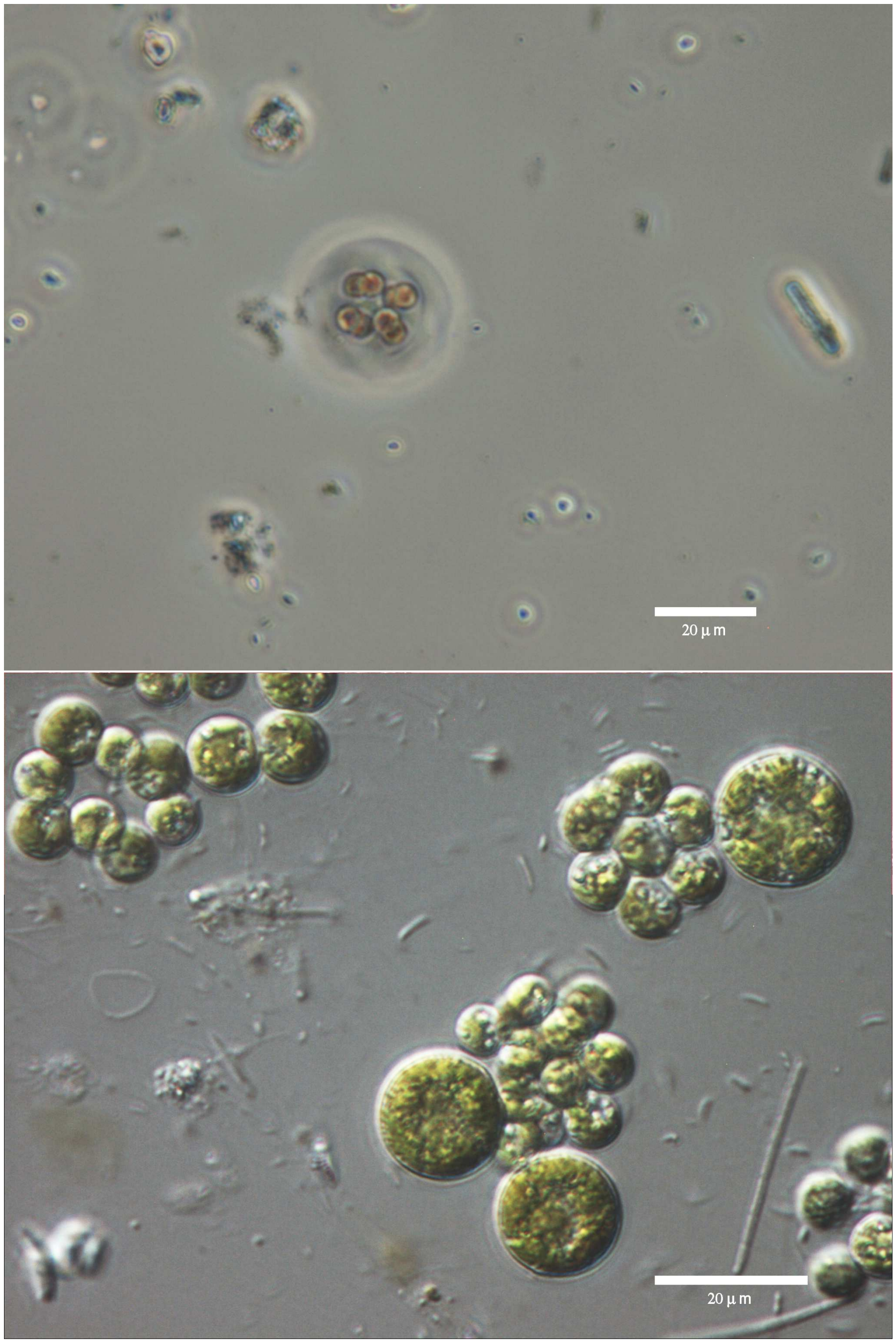


Figure 71: Green algae: *Sphaerocystis*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).

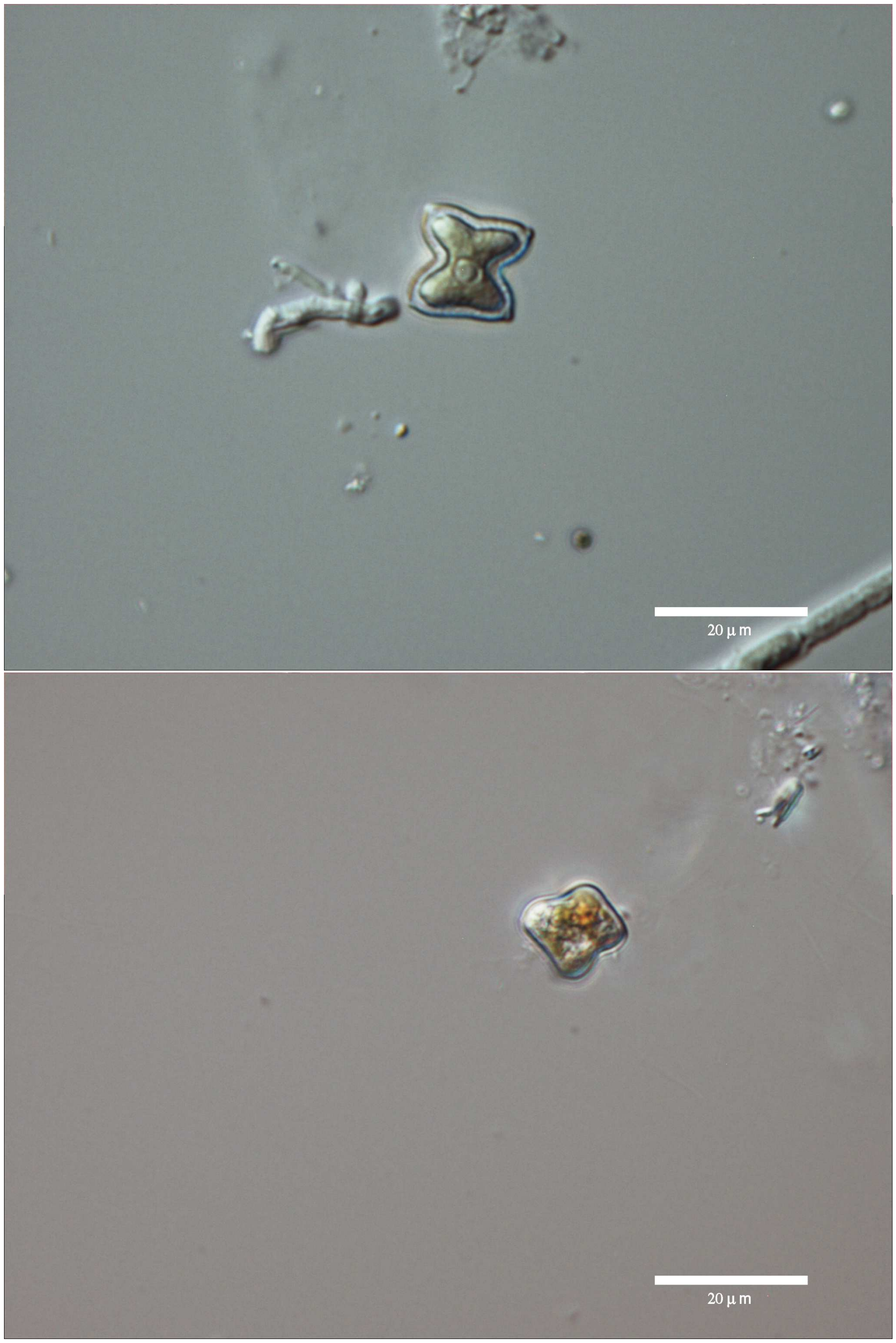


Figure 72: Green algae: *Tetraedron*. Upper image shows algae preserved in Lugol's iodine solution (Lake Campbell); lower image shows unpreserved algae (Lake Whatcom).

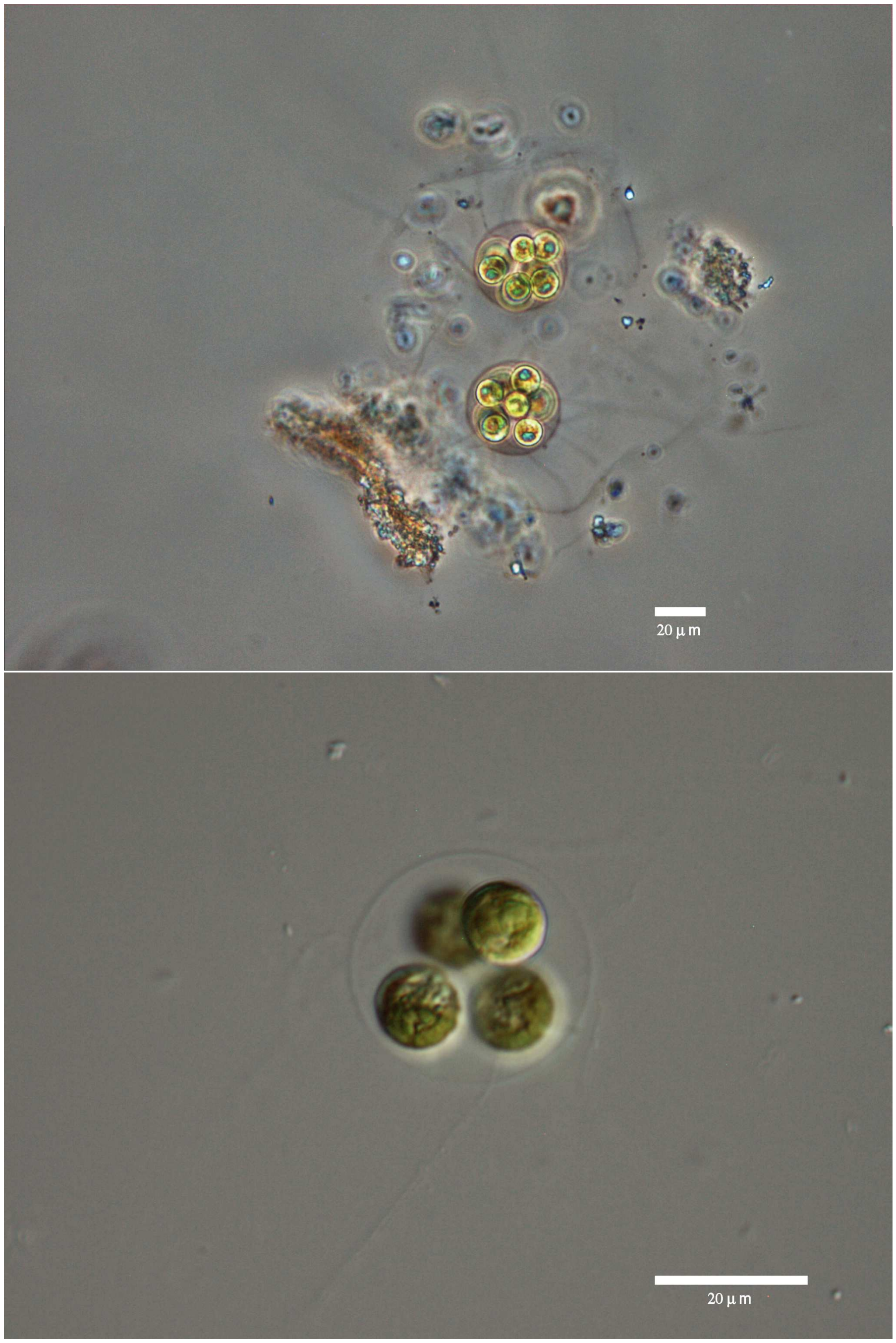


Figure 73: Green algae: *Tetraspora*. Both images show unpreserved algae (Lake Padden).

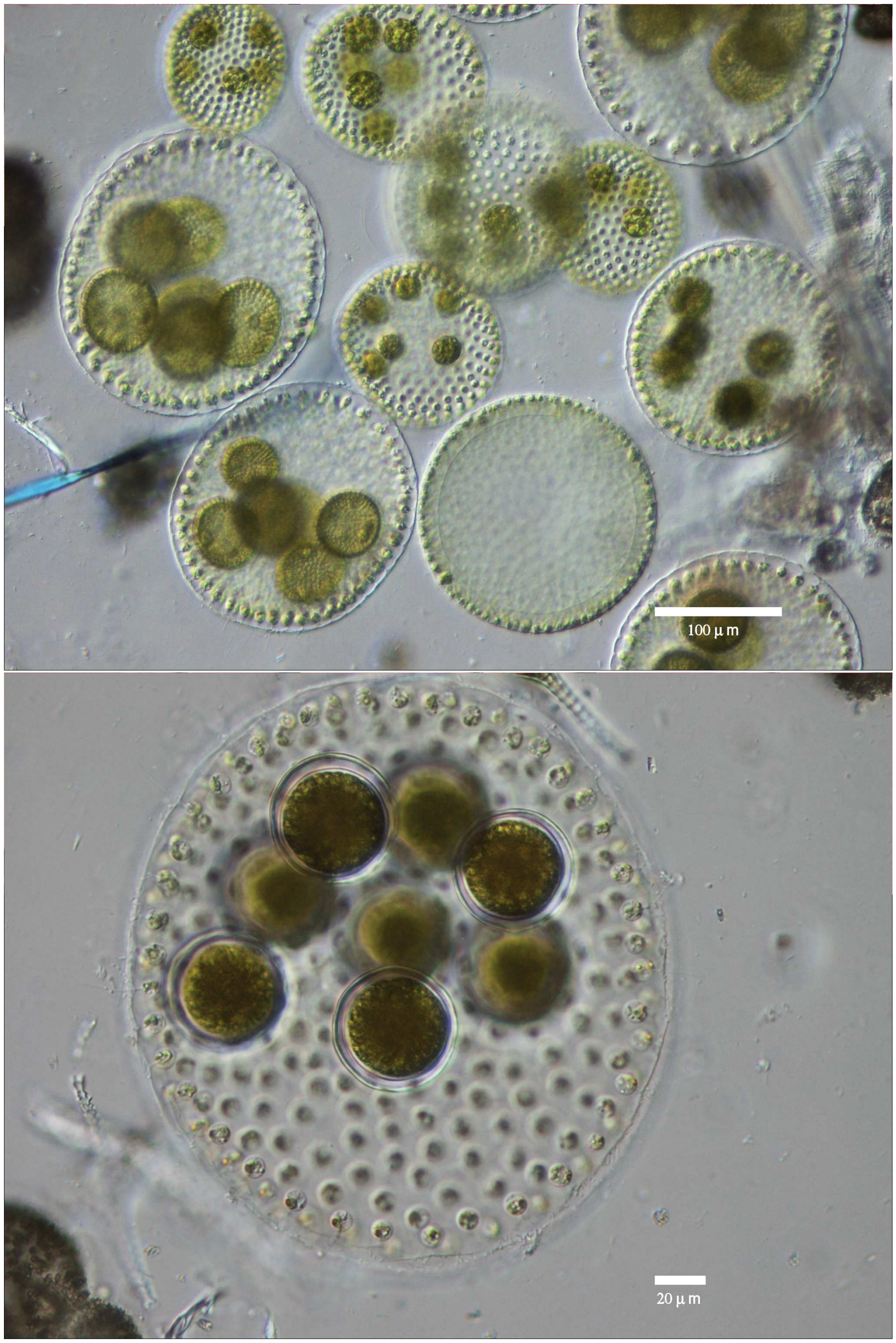


Figure 74: Green algae: *Volvox*. Both images show unpreserved algae (Lone Lake).

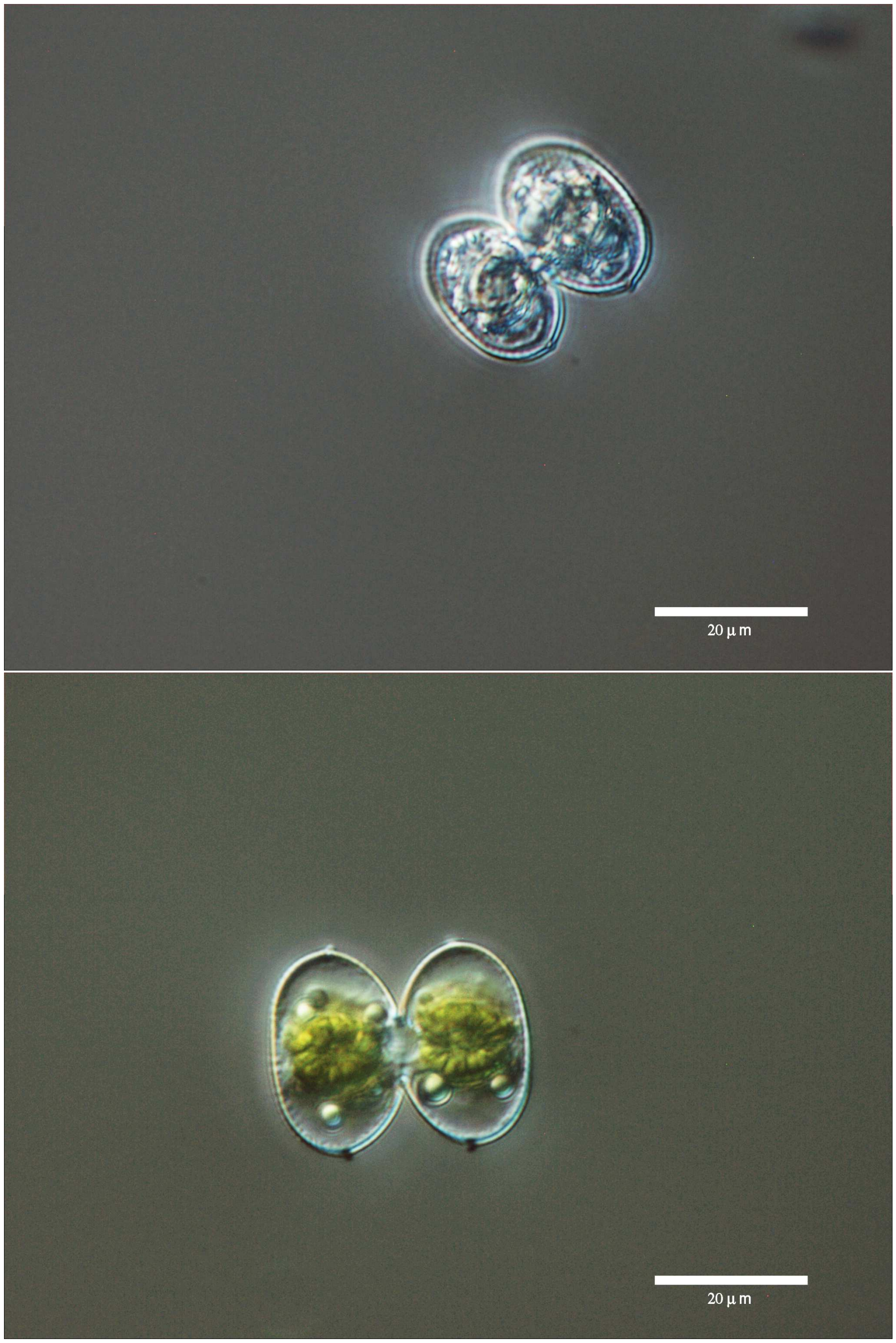


Figure 75: Green algae (desmids): *Cosmarium*. Upper image shows algae preserved in Lugol's iodine solution (Lake Whatcom); lower image shows unpreserved algae (Lake Whatcom).

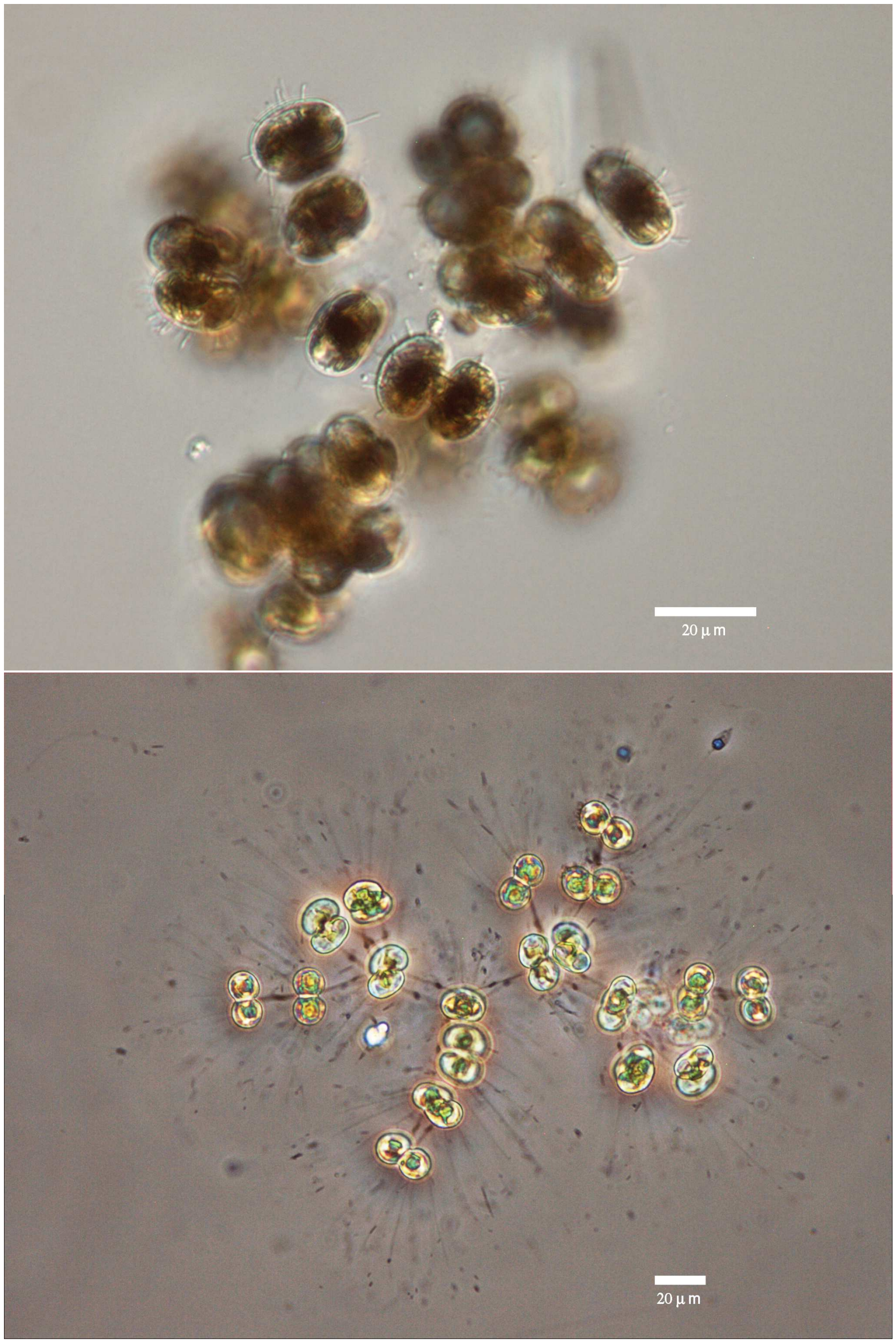


Figure 76: Green algae (desmids): *Cosmocladium*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

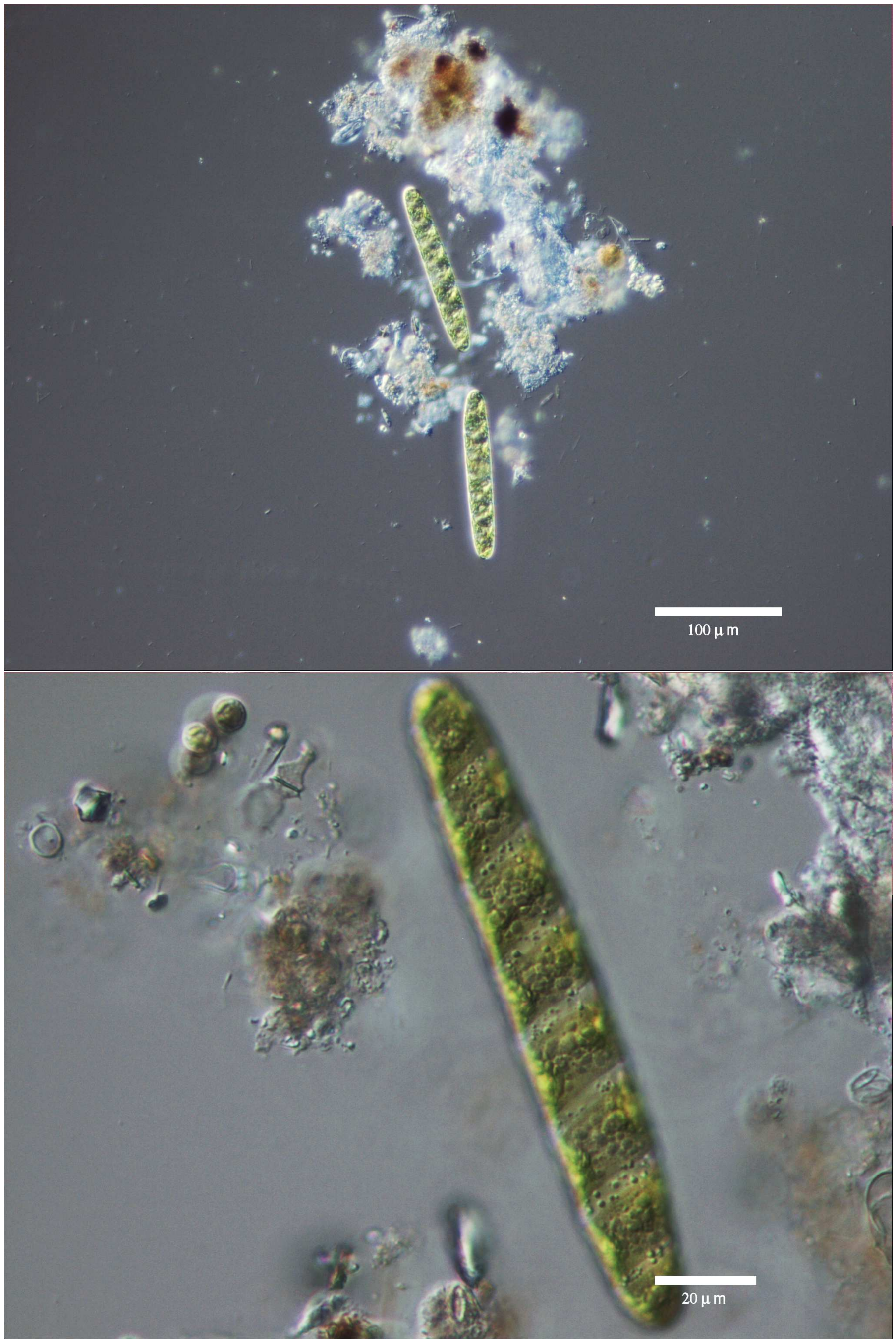


Figure 77: Green algae (desmids): *Spirotaenia*. Both images show unpreserved algae (Lake Padden).

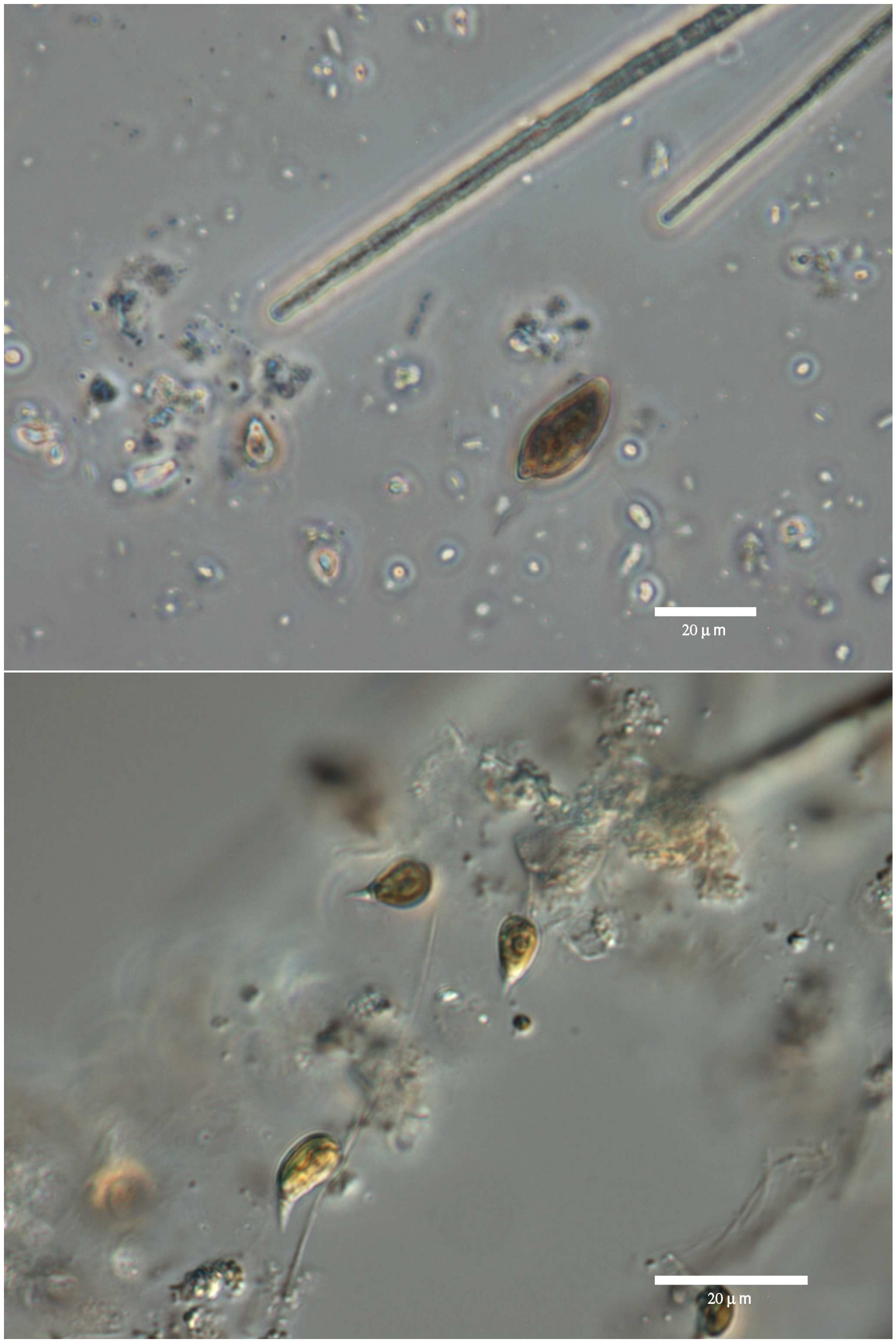


Figure 78: Other algae (cryptomonads). Both images show algae preserved in Lugol's iodine solution (Lake Padden).


Figure 79: Other algae (dinoflagellates): *Ceratium*. Both images show algae preserved in Lugol's iodine solution (upper = Lake Padden; lower = Lake Whatcom).

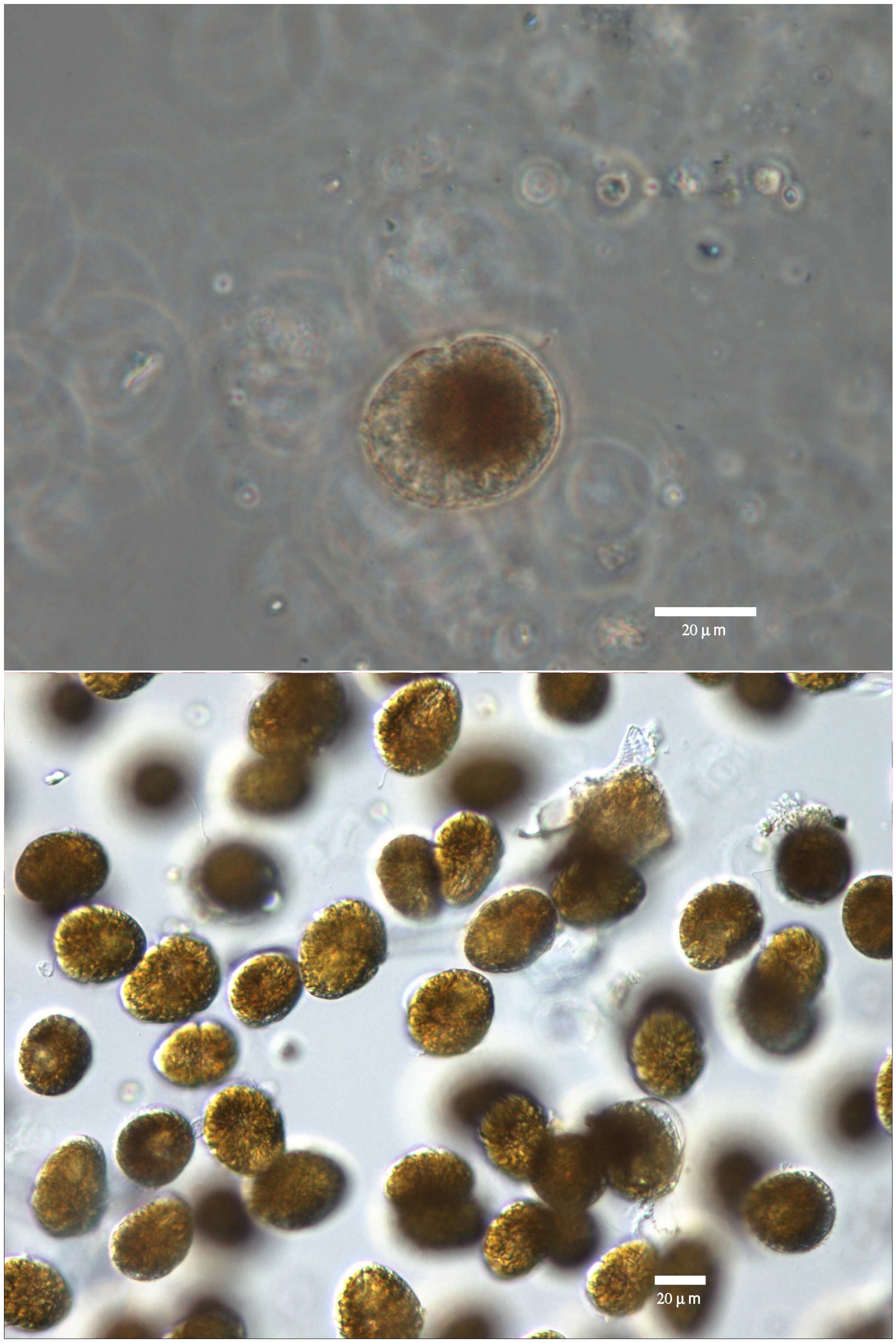


Figure 80: Other algae (dinoflagellates): *Gymnodinium*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

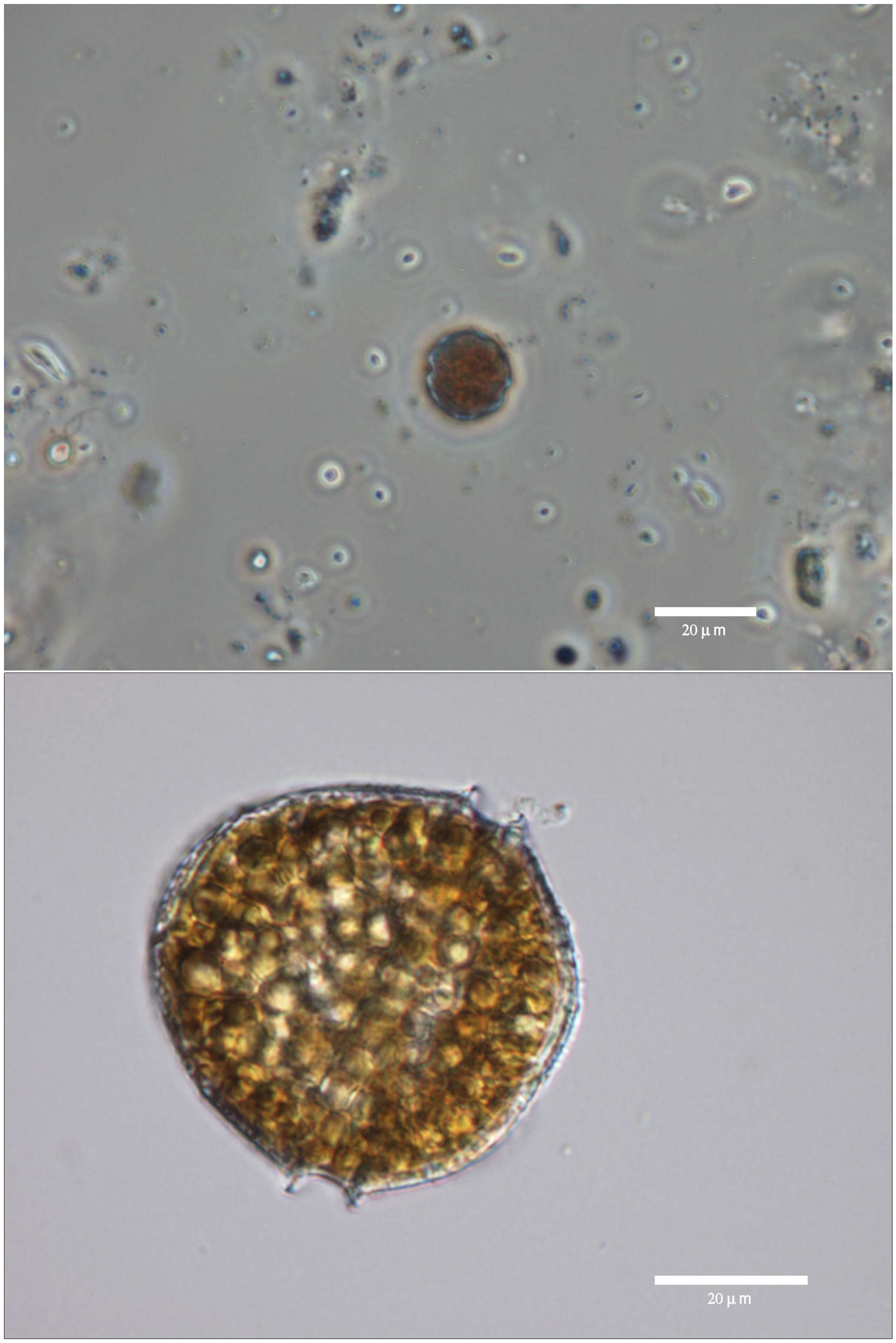


Figure 81: Other algae (dinoflagellates): *Peridinium*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Whatcom).

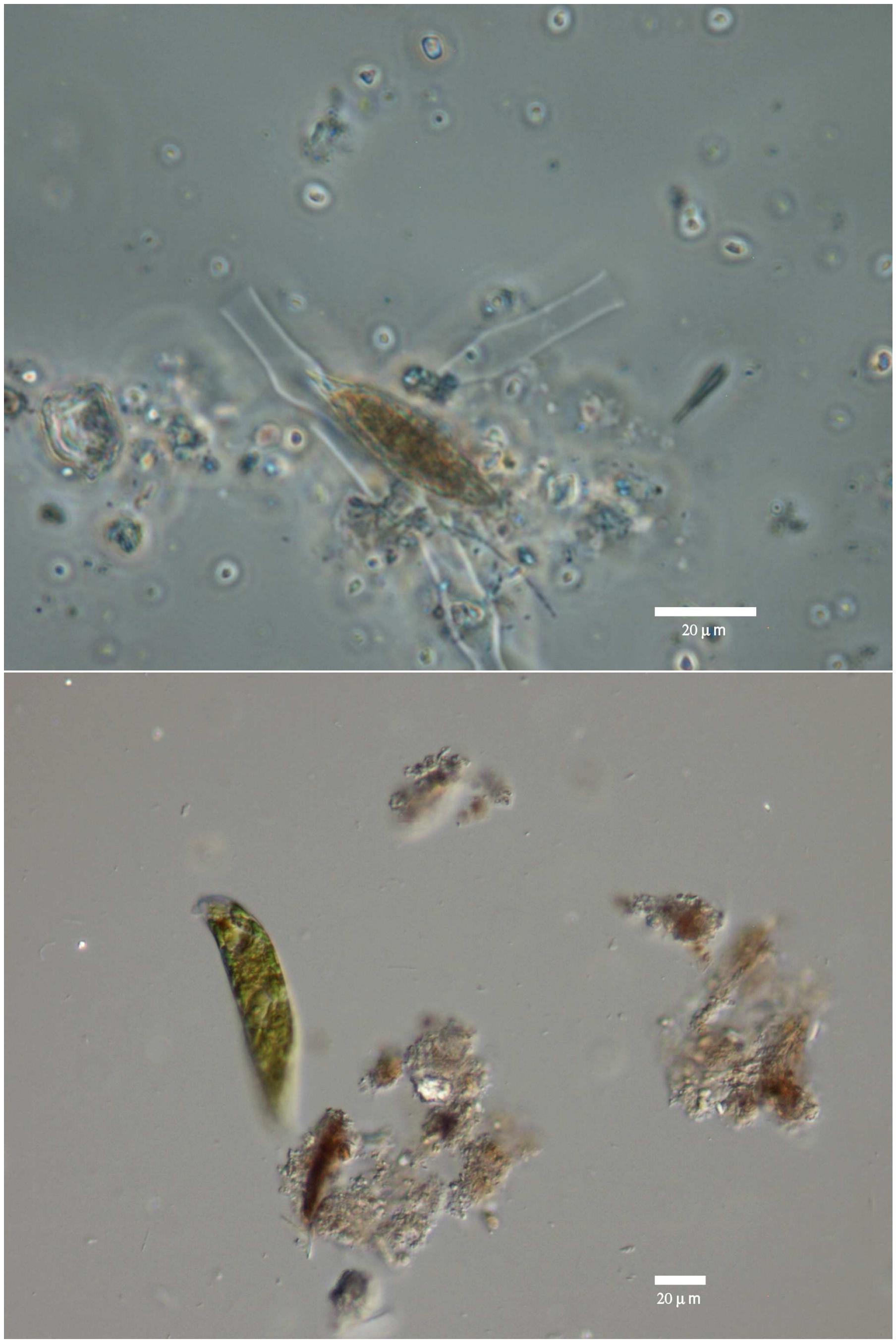


Figure 82: Other algae (euglenoids): *Euglena*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Geneva Pond).

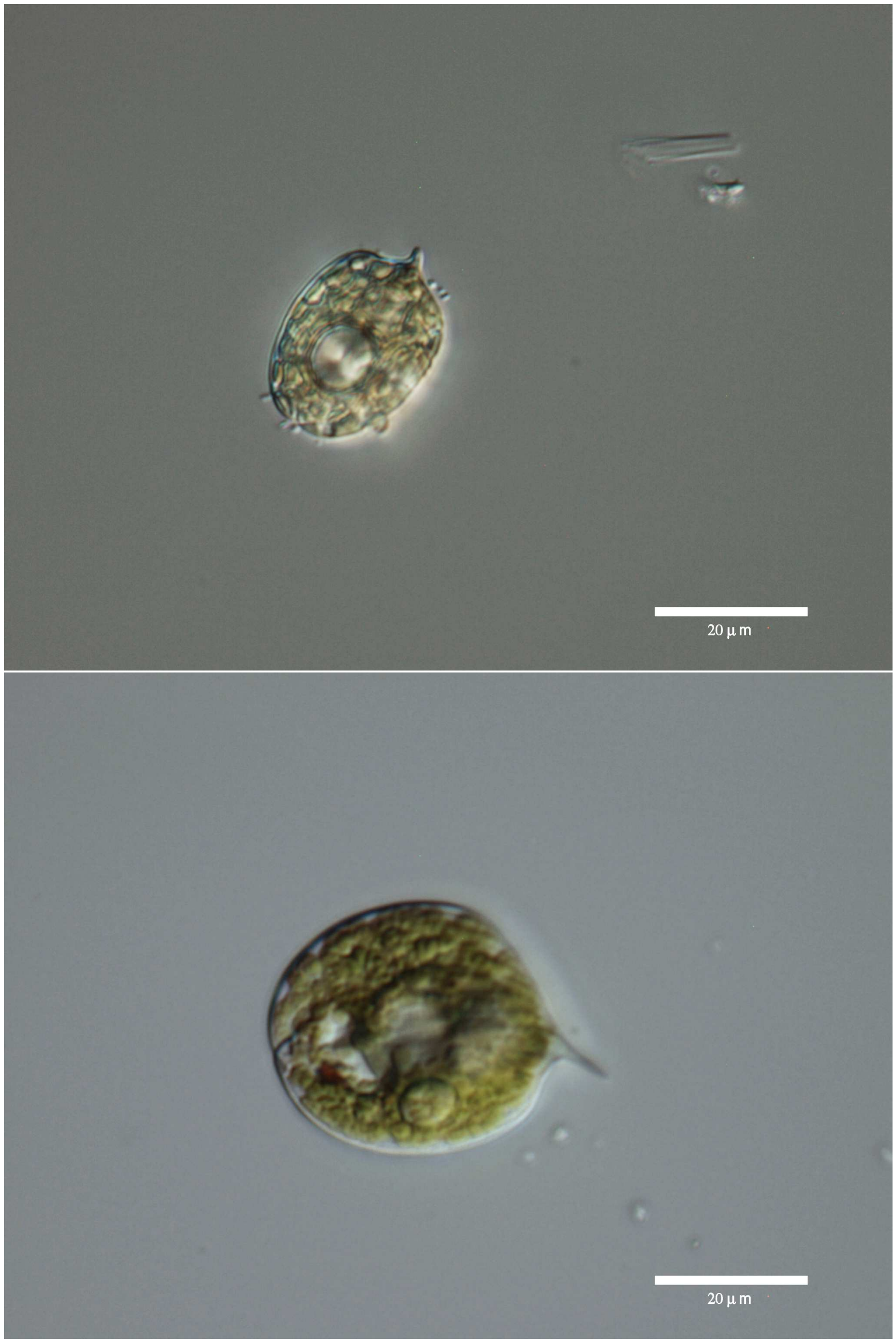


Figure 83: Other algae (euglenoids): *Phacus*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Padden).

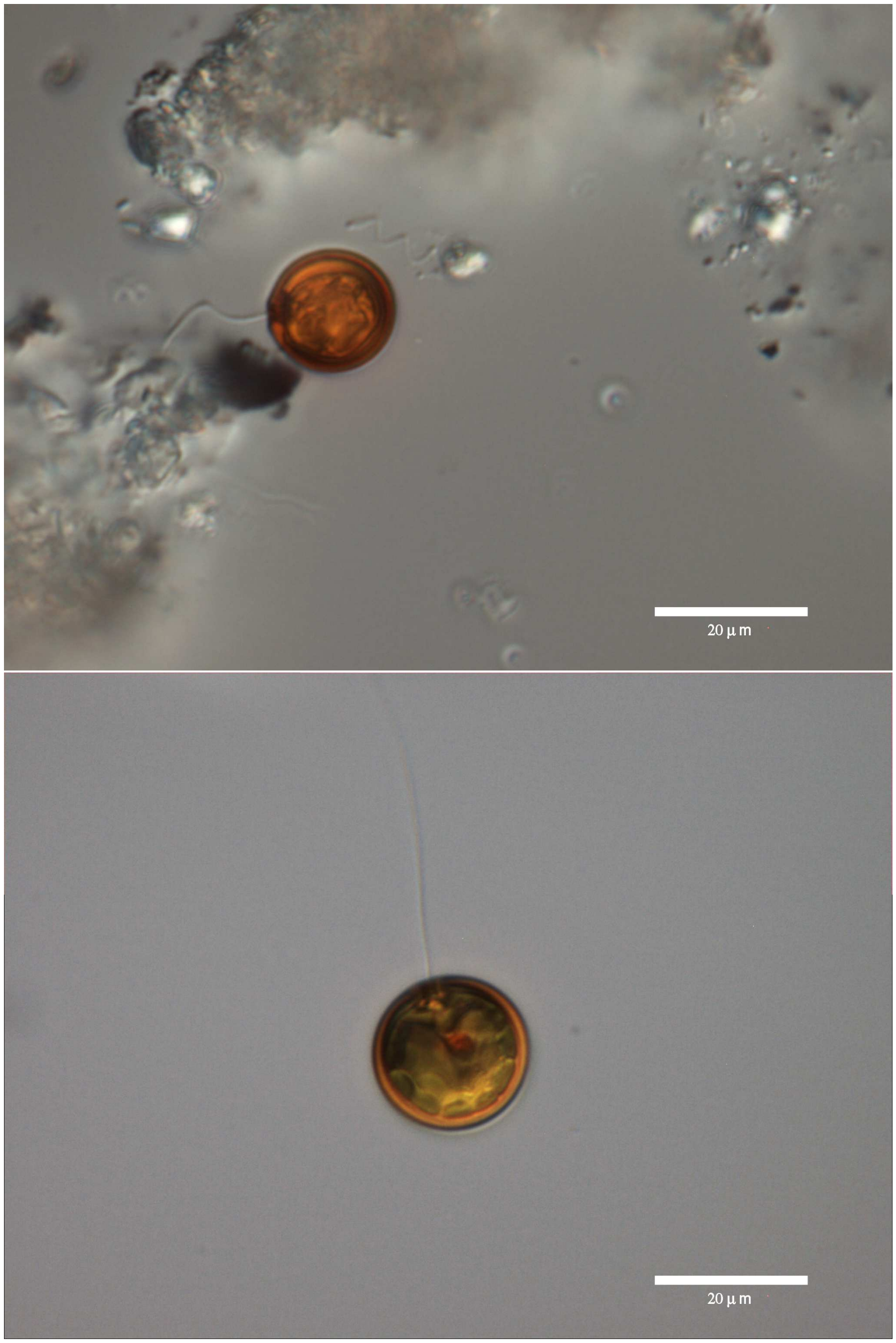


Figure 84: Other algae (euglenoids): *Trachelomonas*. Upper image shows algae preserved in Lugol's iodine solution (Lake Padden); lower image shows unpreserved algae (Lake Campbell).