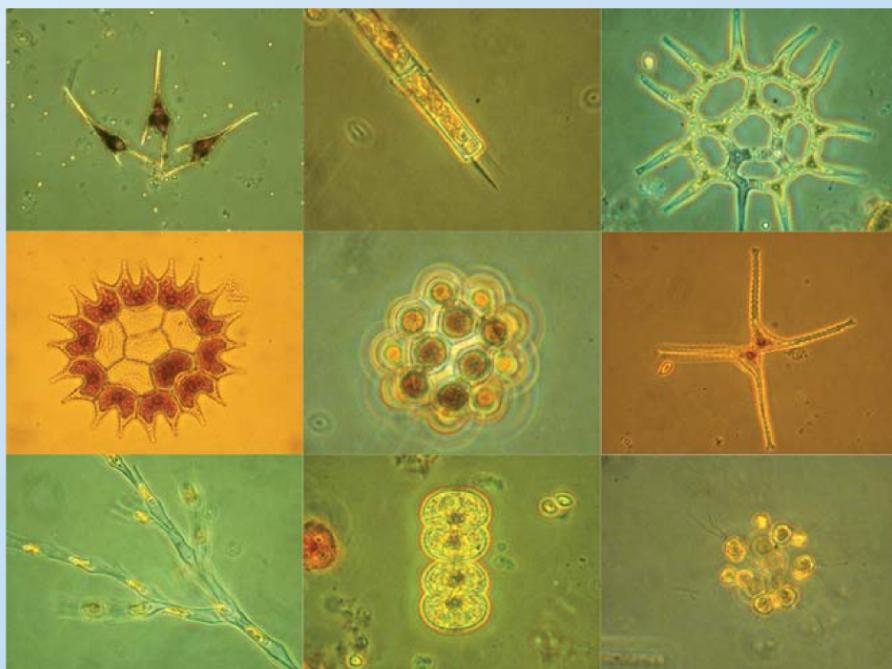




Kärntner Institut für Seenforschung Naturwissenschaftliches Forschungszentrum

Scientific support for microscopic identification and enumeration and biovolume quantification of phytoplankton samples (Lake Varese & Monate)



Coordination: Dr. Roswitha Fresner
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by order of: EC – DG JRC Institute for Environment and Sustainability, I-21020 ISPRA (VA)

Klagenfurt am Wörthersee, Februar 2010

Final Report

Kärntner Institut für Seenforschung

To contract n° 384813

**Scientific support for microscopic identification and
enumeration and biovolume quantification of
phytoplankton samples (Lake Varese & Monate)**

Applicant: EUROPEAN COMMISSION – DG JRC

Institute for Environment and Sustainability
I-21020 ISPRA (VA)

Coordination: Kärntner Institut für Seenforschung

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1 Preface

JRCIES European Ecological Water Quality and Intercalibration (EEWAI) carries out a research project for the development of Water Framework Directive (WFD) compliant biological assessments. Because phytoplankton is used as an important water quality indicator that is sensitive to environmental factors, it was included to the WFD monitoring scheme as relevant element for surface water categories.

The background aim of this contract are to assess the effect of weather conditions and nutrients on seasonal planktonic development in two lakes (Lake Monate and Lake Varese) of different trophic levels and to study the seasonal dynamics of harmful algal blooms and to develop indicators, e.g. phytoplankton bloom frequency to assess the lake's condition.

The main body of work required within the scope of this contract was the microscopic analysis of 228 phytoplankton samples of the above mentioned lakes.

The Carinthian Institute for Lake Research was commissioned to carry out this microscopic analysis. The Kick-off meeting was on 22th July 2009, JRC in Ispra (Italy). The representatives of the JRC gave over the first part (120) of the 228 samples to the Carinthian delegation. During that the counting procedure was discussed and following agreement has been reached:

A taxon list will be compiled during the quantitative analysis of the samples, because no net-samples had been taken. Algae and cyanobacteria will be identified at the highest possible taxonomic resolution enabled by conventional light microscopy. For diatoms as minimum 5-6 NAPHRAX mounted slides per lake will be prepared covering the different seasonal aspects of the phytoplankton community succession. Diatoms will be analysed after the quantitative investigations, so that the samples with major diatomic seasonal peaks could be studied.

As reporting procedures we agreed that the results will be presented in an Excel spreadsheet allowing including the data readily to a database or using them for further calculations.

The final meeting was cancelled and replaced through the document send per email until 7th of February 2010.

The first part of the samples was hand over to Mr. Schönhuber during the Kick-off meeting. The second part of the samples (54) was delivered by parcel service on 30th of October 2009 and the third part (24) arrived on 28th of December.

In December we were informed that the total amount of samples will be 198 instead of the planned 228. The reason for this was due to unforeseeable events like weather condition, reduction of personnel and the move of the laboratories to a new building. Therefore the JRC asked us to adjust the final cost of the contract because of reduction of samples. To oblige you, we agreed to calculate the counted samples according to our offer.

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1.1 Work carried out

From each lake 99 samples of three layers, taken with the Ruttner sampler and preserved with Lugol solution, were analysed by the Carinthian Institute for Lake Research by doing taxonomic identification, counting and biovolume calculations of phytoplankton.

One objective was the identification of species composition of phytoplankton. Therefore a taxon list was compiled out of the Lugol solution fixed samples (collected by Ruttner sampler by the applicant) by using a conventional light microscopy. The determination of diatoms was partly done out of the Lugol fixed samples and the net samples after NAPHRAX preparation.

A further objective was the enumeration and measurement of taxa using inverting microscopy. The counting of phytoplankton was routinely performed according to the European standard EN 15204/2006 that was elaborated through the implementation of the water framework directive (WDF) in national law by using inverted microscope (Utermöhl). Our data processing support is adapted to these European standards and we counted transects, as we routinely used to do and as we discussed during the kick off meeting. To detect rare large species the whole bottom of the chamber was checked.

Cells or colonies were measured during determination or counting phase following CEN TG 230/WG 2/TG3. Species with large size variability were counted by division into size classes.

Beyond that photos of each species were made during counting and collected in an image archive and burned on the annexed CD.

Another objective was the calculation of the biovolume. Biovolume of algae was calculated by using the best fitting geometric formula to cell or colony dimension (CEN TG 230/WG 2/G3).

According to the contract the results are presented in an Excel spreadsheet that also is burned on the annexed CD (additionally sent per Email). The Excel file - one per lake - includes all attributes requested like:

Date, Lake, Site Layer, Scientific name and taxon, Average dimension, Geometric shape,
Volume of cell or colony , Transects counted, Cells or colonies counted, Volume of counting
chamber, Abundance (cells or colonies/ml), Biovolume of taxon, Percentage of total
biovolume and Dissolution coefficient.

The counting and determination of phytoplankton was done by Ms. M Mairitsch-Friedl (samples of the eutrophic Lake Varese), Ms. J. Troyer-Mildner (samples of the oligo/mesotrophic Lake Montate) and Mr. M. Schönhuber (diatoms of both lakes).

The following scale lists up all species determined during the analysis. We found in Lake Monate 248 taxa (2008: 252 taxa) (34 diatoms from Naphrax prepared slide) in the phytoplankton community, in Lake Varese we found 174 taxa (39 diatoms).

1.2 Remarks

During the counting procedure Ms. J. Troyer-Mildner and Ms. M. Mairitsch-Friedl noticed some differences in the phytoplankton composition in comparison to the previous year.

Comparing the investigated years 2008 and 2009 of the eutrophic Lake Varese the phytoplankton-composition showed some differences.

The main part of Bacillariophyceae (*Cyclotella* sp.) and Crysophyceae (*Mallomonas* sp.) was not found in springtime like 2008, but in early winter. The dominant species of the year 2008 was *Woronichinia naegeliana* (Cyanophyceae) with maximum in July. Over the year 2009 this species was rare. Instead of *Woronichinia naegeliana* appeared *Ceratium furcoides* (Dinophyceae) in summer 2009 and built very high biomass during July. Some species like *Aphanizomenon issatschenkoi* (Cyanophyceae) and *Acanthoceras zachariasii* (Bacillariophyceae) were only determined in 2009.

The composition of the phytoplankton of Lake Monate was in the year 2009 more constant than 2008. The changes in species-composition between the seasons were not as abrupt as 2008 and no species developed high dominances. The coccal Cyanophyceae *Cyanodictyon plancticum* was present during the whole year 2009. The Chrysophyceae in springtime were less dominant than last year. In opposition to 2008 the Cyanophyceae *Anabaena* sp. and *Fragilaria crotonensis* (Bacillariophyceae) occurred uncommonly.

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Tab. 1: 252 Species of Lake Monate

<i>Acanthoceras zachariasii</i>	<i>Cosmarium depressum</i>
<i>Achnanthes flexella</i>	<i>Cosmarium depressum</i> var. <i>plancticum</i>
<i>Achnanthes minutissima</i>	<i>Cosmarium laeve</i>
<i>Achnanthes</i> sp.	<i>Cosmarium margaritiferum</i>
<i>Actinastrum hantzschii</i>	<i>Cosmarium phaseolus</i>
<i>Amphora pediculus</i>	<i>Cosmarium punctulatum</i>
<i>Anabaena</i> sp.	<i>Cosmarium pygmaeum</i>
<i>Ankistrodesmus bernardii</i>	<i>Cosmarium regnelli</i>
<i>Ankistrodesmus</i> sp.	<i>Cosmarium</i> sp.
<i>Ankistrodesmus spiralis</i>	<i>Cosmarium tenue</i>
<i>Ankyra judayi</i>	<i>Cosmarium undulatum</i>
<i>Ankyra lanceolata</i>	<i>Crucigeniella apiculata</i>
<i>Aphanizomenon aphanizomenoides</i>	<i>Cryptomonas marssonii</i>
<i>Aphanizomenon</i> sp.	<i>Cryptomonas</i> sp.
<i>Aphanocapsa conferta</i>	<i>Cyanodictyon planktonicum</i>
<i>Aphanocapsa delicatissima</i>	<i>Cyanophyceae filamentous unknown</i>
<i>Aphanocapsa elachista</i>	<i>Cyclotella radiosa</i>
<i>Aphanocapsa incerta</i>	<i>Cyclotella</i> sp.
<i>Aphanocapsa parasitica</i>	<i>Cymatopleura solea</i>
<i>Aphanocapsa</i> sp.	<i>Cymbella</i> sp.
<i>Aphanothece endophytica</i>	<i>Cyst</i> unknown
<i>Aphanothece minutissima</i>	<i>Dactylosphaerium jurisii</i>
<i>Aphanothece smithii</i>	<i>Diatoma ehrenbergii</i>
<i>Aphanothece</i> sp.	<i>Diatoma</i> sp.
<i>Aphanothece stagnina</i>	<i>Diatoma vulgaris</i>
<i>Asterionella formosa</i>	<i>Dictyosphaerium</i> sp.
<i>Bicosoeca</i> sp.	<i>Didymocystis bicellularis</i>
<i>Bitrichia chodatii</i>	<i>Didymocystis</i> sp.
<i>Botryochloris minima</i>	<i>Dinobryon-cyst</i>
<i>Botryococcus braunii</i>	<i>Dinobryon divergens</i>
<i>Caloneis</i> sp.	<i>Dinobryon petiolatum</i>
<i>Carteria</i> sp.	<i>Dinobryon</i> sp.
<i>Ceratium furcoides</i>	<i>Dinophycean-cyst</i>
<i>Ceratium hirundinella</i>	<i>Diploneis elliptica</i>
<i>Chlamydocalpsa ampla</i>	<i>Elakatothrix gelatinosa</i>
<i>Chlamydocalpsa planktonica</i>	<i>Elakatothrix spirochroma</i>
<i>Chlamydomonas</i> sp.	<i>Epiyxis</i> sp.
Chlorococcal form large	<i>Epithemia</i> sp.
Chlorococcal form small	<i>Euglena acus</i>
<i>Chlorolobion</i> sp.	<i>Euglena caudata</i>
<i>Chromulina</i> sp.	<i>Euglena rustica</i>
Cyanophyceae coccal unknown	<i>Euglena</i> sp.
<i>Chroococcus limneticus</i>	<i>Euglena spatirhyncha</i>
<i>Chroococcus minutus</i>	<i>Euglena texta</i>
<i>Chroococcus</i> sp.	<i>Eunotia</i> sp.
<i>Chroococcus turgidus</i>	Flagellate form large
<i>Chrysochromulina parva</i>	Flagellate form small
<i>Chrysococcus</i> sp.	<i>Fragilaria capucina</i>
Chrysophyceae-cyst small	<i>Fragilaria construens</i>
<i>Closterium aciculare</i>	<i>Fragilaria crotonensis</i>
<i>Closterium acutum</i>	<i>Fragilaria</i> sp.
<i>Closterium acutum</i> var. <i>variabile</i>	<i>Fragilaria ulna</i>

<i>Closterium parvulum</i>	<i>Fragilaria ulna</i> var. <i>acus</i>
<i>Cocconeis</i> sp.	<i>Fragilaria ulna</i> var. <i>angustissima</i>
<i>Coelastrum astroideum</i>	<i>Fragilaria ulna</i> var. <i>ulna</i>
<i>Coelastrum microporum</i>	<i>Geminella interrupta</i>
<i>Coelastrum polychordum</i>	<i>Golenkinia radiata</i>
<i>Coelastrum reticulatum</i>	<i>Gomphonema acuminatum</i>
<i>Coelosphaerium kuetzingianum</i>	<i>Gomphonema</i> sp.
<i>Coelosphaerium</i> sp.	<i>Gymnodinium-cyst</i>
<i>Colacium</i> sp.	<i>Gymnodinium helveticum</i>
<i>Gymnodinium</i> sp.	<i>Pseudokephyrion</i> sp.
<i>Hantzschia amphioxys</i>	<i>Pseudopedinella</i> sp.
<i>Kephrion</i> sp.	<i>Pseudosphaerocystis lacustris</i>
<i>Kirchneriella irregularis</i>	<i>Quadrigula pfizeri</i>
<i>Kirchneriella lunaris</i>	<i>Radiocystis</i> sp.
<i>Koliella longiseta</i>	<i>Raphidонема nivalis</i>
<i>Koliella planktonica</i>	<i>Rhabdoderma lineare</i>
<i>Koliella spiculiformis</i>	<i>Rhabdoderma</i> sp.
<i>Lagerheimia quadriseta</i>	<i>Rhodomonas lacustris</i>
<i>Lagerheimia subsalsa</i>	<i>Rhodomonas lens</i>
<i>Lepocinclis</i> sp.	<i>Rhodomonas minuta</i> var. <i>nannoplantica</i>
<i>Lyngbya limnetica</i>	<i>Romeria</i> sp.
<i>Lyngbya</i> sp.	<i>Salpingoeca frequentissima</i>
<i>Mallomonas acaroides</i>	<i>Scenedesmus acuminatus</i>
<i>Mallomonas akrokomos</i>	<i>Scenedesmus acutiformis</i>
<i>Mallomonas caudata</i>	<i>Scenedesmus antennatus</i>
<i>Mallomonas elongata</i>	<i>Scenedesmus arcuatus</i>
<i>Mallomonas</i> sp.	<i>Scenedesmus brasiliensis</i>
<i>Mallomonas tonsurata</i> var. <i>alpina</i>	<i>Scenedesmus denticulatus</i>
<i>Mallomonopsis</i> sp.	<i>Scenedesmus disciformis</i>
<i>Merismopedia</i> sp.	<i>Scenedesmus linearis</i>
<i>Microcystis aeruginosa</i>	<i>Scenedesmus magnus</i>
<i>Microcystis smithii</i>	<i>Scenedesmus obtusus</i>
<i>Monoraphidium minutum</i>	<i>Scenedesmus</i> sp.
<i>Monoraphidium tortile</i>	<i>Schizochlamys gelatinosa</i>
<i>Mougeotia</i> sp.	<i>Schroederia</i> sp.
<i>Navicula</i> sp.	<i>Snowella arachnoidea</i>
<i>Nephrochlamys</i> sp.	<i>Snowella lacustris</i>
<i>Nephrochlamys subsolitaria</i>	<i>Snowella litoralis</i>
<i>Nephrocystium agardhianum</i>	<i>Snowella</i> sp.
<i>Nitzschia</i> sp.	<i>Sphaerellopsis fluviatilis</i>
<i>Ochromonas</i> sp.	<i>Sphaerellopsis</i> sp.
<i>Oocystis lacustris</i>	<i>Sphaerocystis schroeteri</i>
<i>Oocystis parva</i>	<i>Sphaeroeca volvox</i>
<i>Oocystis</i> sp.	<i>Spondylosium clepsydra</i>
<i>Pandorina morum</i>	<i>Spondylosium</i> sp.
<i>Pediastrum boryanum</i>	<i>Staurastrum messikommeri</i>
<i>Pediastrum duplex</i>	<i>Staurastrum messikommeri</i> var. <i>urnaeforme</i>
<i>Pediastrum integrum</i>	<i>Staurastrum pingue</i>
<i>Pediastrum tetras</i>	<i>Staurastrum planktonicum</i>
<i>Peridiniopsis elpatiewskyi</i>	<i>Staurastrum punctulatum</i>
<i>Peridinium aciculiferum</i>	<i>Staurastrum</i> sp.
<i>Peridinium cinctum</i>	<i>Staurastrum tetracerum</i>
<i>Peridinium inconspicuum</i>	<i>Synechococcus</i> sp.

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<i>Peridinium</i> sp.	<i>Synura</i> sp.
<i>Peridinium umbonatum</i>	<i>Tabellaria flocculosa</i>
<i>Peridinium willei</i>	<i>Tetrachlorella incerta</i>
<i>Phacus</i> sp.	<i>Tetraedron caudatum</i>
<i>Phormidium</i> sp.	<i>Tetraedron minimum</i>
Picoplankton μ -form	<i>Tetraspora lemmermannii</i>
Pinnularia sp.	<i>Trachelomonas cervicula</i>
<i>Planktosphaeria gelatinosa</i>	<i>Trachelomonas globularis</i>
<i>Planktothrix prolifica</i>	<i>Trachelomonas oblonga</i>
<i>Planktothrix rubescens</i>	<i>Trachelomonas</i> sp.
<i>Planktothrix</i> sp.	<i>Trachelomonas volvocina</i>
<i>Pleurotaenium ehrenbergii</i>	<i>Trachelomonas volvocina</i> var. <i>punctata</i>
<i>Polytoma granuliferum</i>	<i>Ulothrix zonata</i>
<i>Pseudanabaena catenata</i>	<i>Uroglena</i> sp.
<i>Pseudanabaena limnetica</i>	<i>Uronema</i> sp.
<i>Pseudanabaena endophytica</i>	<i>Willea vilhelmi</i>
<i>Pseudanabaena</i> sp.	<i>Woronichinia compacta</i>
<i>Stephanodiscus neoastraea</i>	<i>Woronichinia naegeliana</i>
<i>Stephanodiscus</i> sp.	<i>Woronichinia robusta</i>

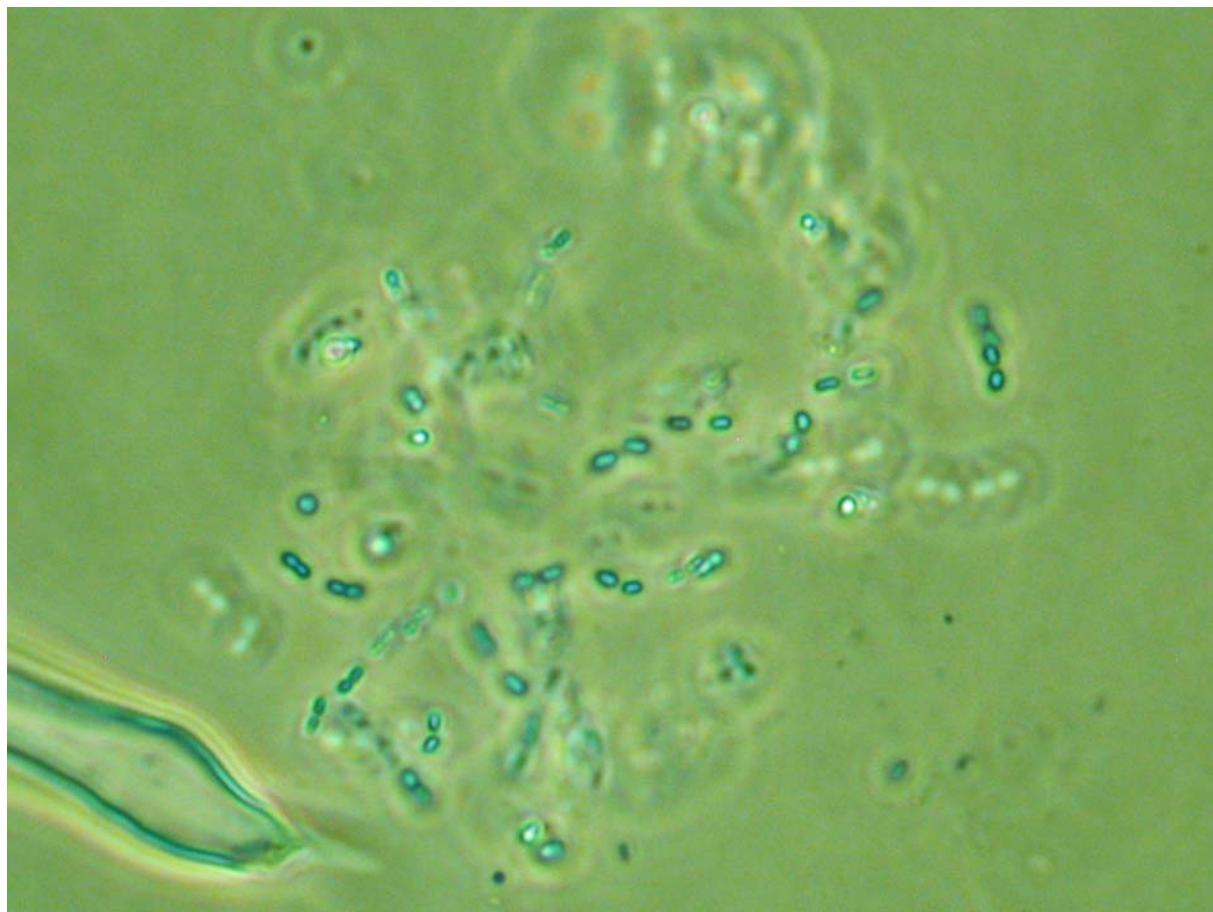


Abb. 1: *Cyanodictyon plancticum* (Lake Monate)

Tab. 2: 204 Species of Lake Varese

<i>Acanthoceras zachariasii</i>	<i>Dactylosphaerium jurisii</i>
<i>Amphora</i> sp.	<i>Dictyosphaerium ehrenbergianum</i>
<i>Anabaena plantonica</i>	<i>Dictyosphaerium pulchellum</i>
<i>Anabaena</i> sp.	<i>Dictyosphaerium</i> sp.
<i>Ankistrodesmus</i> sp.	<i>Dinobryon bavaricum</i>
<i>Ankyra ancora</i> var. <i>spinosa</i>	<i>Dinobryon divergens</i>
<i>Ankyra judayi</i>	<i>Dinobryon sertularia</i>
<i>Ankyra lanceolata</i>	<i>Dinobryon sociale</i>
<i>Ankyra</i> sp.	<i>Dinobryon sociale</i> var. <i>americanum</i>
<i>Aphanizomenon flos-aquae</i>	<i>Dinobryon</i> sp.
<i>Aphanizomenon gracile</i>	<i>Dinophyceen-cyst</i> unknown
<i>Aphanizomenon issatschenkoi</i>	<i>Elakatothrix gelatinosa</i>
<i>Aphanizomenon</i> sp.	<i>Elakatothrix</i> sp.
<i>Aphanocapsa delicatissima</i>	<i>Eudorina</i> sp.
<i>Aphanocapsa</i> sp.	<i>Euglena</i> sp.
<i>Aphanothece</i> sp.	<i>Eutetramorus</i> sp.
<i>Asterionella formosa</i>	<i>Fragilaria crotonensis</i>
<i>Aulacoseira granulata</i>	Flagellate form large
<i>Aulacoseira</i> sp.	Flagellate form small
<i>Bicosoeca</i> sp.	Flagellate form medium
<i>Bitrichia chodatii</i>	<i>Fragilaria</i> sp.
<i>Botryococcus braunii</i>	<i>Fragilaria ulna</i>
<i>Ceratium</i> -cyst	<i>Fragilaria ulna</i> var. <i>acus</i>
<i>Ceratium furcoides</i>	<i>Fragilaria ulna</i> var. <i>angustissima</i>
<i>Ceratium hirundinella</i>	<i>Fragilaria ulna</i> var. <i>ulna</i>
<i>Chlamydocapsa ampla</i>	<i>Gloeotila</i> sp.
<i>Chlamydocapsa planktonica</i>	<i>Gymnodinium</i> sp.
<i>Chlamydocapsa</i> sp.	<i>Gymnodinium uberrimum</i>
<i>Chlamydomonas</i> sp.	<i>Katablepharis phoenikoston</i>
Chlorococcal form large	<i>Kephyrion</i> sp.
Chlorococcal form small	<i>Koliella longiseta</i>
<i>Chlorophyceae</i> unknown	<i>Koliella</i> sp.
<i>Chroococcus limneticus</i>	<i>Komarekia appendiculata</i>
<i>Chroococcus</i> sp.	<i>Mallomonas akrokomas</i>
<i>Chroomonas</i> sp.	<i>Mallomonas caudata</i>
<i>Closterium aciculare</i>	<i>Mallomonas elongata</i>
<i>Closterium acutum</i>	<i>Mallomonas</i> sp.
<i>Closterium acutum</i> var. <i>acutum</i>	<i>Mallomonas tonsurata</i> var. <i>alpina</i>
<i>Closterium acutum</i> var. <i>variabile</i>	<i>Melosira</i> sp.
<i>Closterium limneticum</i>	<i>Merismopedia punctata</i>
<i>Closterium</i> sp.	<i>Merismopedia</i> sp.
Coccal form small	<i>Merismopedia trolleri</i>
<i>Coelastrum astroideum</i>	<i>Micractinium pusillum</i>
<i>Coelastrum polychordum</i>	<i>Microcystis aeruginosa</i>
<i>Coelastrum pseudomicroporum</i>	<i>Microcystis smithii</i>
<i>Coelastrum reticulatum</i>	<i>Microcystis</i> sp.
<i>Coelosphaerium</i> sp.	<i>Microcystis wesenbergii</i>
<i>Coronastrum chodatii</i>	<i>Monoraphidium</i> sp.
<i>Cosmarium laeve</i>	<i>Mougeotia</i> sp.
<i>Cosmarium punctulatum</i>	<i>Navicula</i> sp.
<i>Crucigenia tetrapedia</i>	<i>Nephrocystium agardhianum</i>
<i>Crucigeniella apiculata</i>	<i>Nephrocystium limneticum</i>

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<i>Crucigeniella rectangularis</i>	<i>Nitzschia holsatica</i>
<i>Cryptomonas marssonii</i>	<i>Nitzschia</i> sp.
<i>Cryptomonas rostratiformis</i>	<i>Ochromonas</i> sp.
<i>Cryptomonas</i> sp.	<i>Oocystis</i> sp.
<i>Cyanodictyon planktonicum</i>	<i>Oscillatoria</i> sp.
<i>Cyclotella comta</i>	<i>Pandorina morum</i>
<i>Cyclotella meneghiniana</i>	<i>Paradoxa multiseta</i>
<i>Cyclotella ocellata</i>	<i>Pediastrum boryanum</i>
<i>Cyclotella</i> sp.	<i>Pediastrum duplex</i>
<i>Pediastrum duplex</i> var. <i>subgranulatum</i>	<i>Tetrastrum komarekii</i>
<i>Pediastrum gracillimum</i>	<i>Tetrastrum</i> sp.
<i>Pediastrum simplex</i>	<i>Thorakochloris planktonica</i>
<i>Pediastrum simplex</i> var. <i>biwaense</i>	<i>Trachelomonas</i> sp.
<i>Pediastrum tetras</i>	<i>Uroglena</i> sp.
<i>Peridinium cinctum</i> f. <i>westii</i>	<i>Willea vilhelmii</i>
<i>Peridinium inconspicuum</i>	<i>Woronichinia naegeliana</i>
<i>Peridinium</i> sp.	<i>Woronichinia robusta</i>
<i>Peridinium umbonatum</i>	<i>Scenedesmus disciformis</i>
<i>Phacus</i> sp.	<i>Scenedesmus quadricauda</i>
<i>Phacus tortus</i>	<i>Scenedesmus semipulcher</i>
<i>Phacus triqueter</i>	<i>Scenedesmus</i> sp.
<i>Picoplankton</i> μ -form	<i>Scenedesmus tenuispina</i>
<i>Planktosphaeria gelatinosa</i>	<i>Snowella arachnoidea</i>
<i>Planktothrix</i> sp.	<i>Snowella</i> sp.
<i>Pseudanabaena</i> sp.	<i>Sphaeroeca volvox</i>
<i>Pseudopedinella</i> sp.	<i>Staurastrum chaetoceras</i>
<i>Pseudosphaerocystis lacustris</i>	<i>Staurastrum messikommeri</i>
<i>Rhabdoderma lineare</i>	<i>Staurastrum pingue</i>
<i>Rhabdogloea</i> sp.	<i>Staurastrum planktonicum</i>
<i>Rhizosolenia longiseta</i>	<i>Stephanodiscus</i> sp.
<i>Rhodomonas lacustris</i>	<i>Synura</i> sp.
<i>Rhodomonas minuta</i> var. <i>nannoplanctica</i>	<i>Teilingia granulata</i>
<i>Romeria</i> sp.	<i>Tetrachlorella</i> sp.
<i>Scenedesmus aculeolatus</i>	<i>Tetraedron minimum</i>
<i>Scenedesmus bernardii</i>	<i>Tetraspora lemmermannii</i>

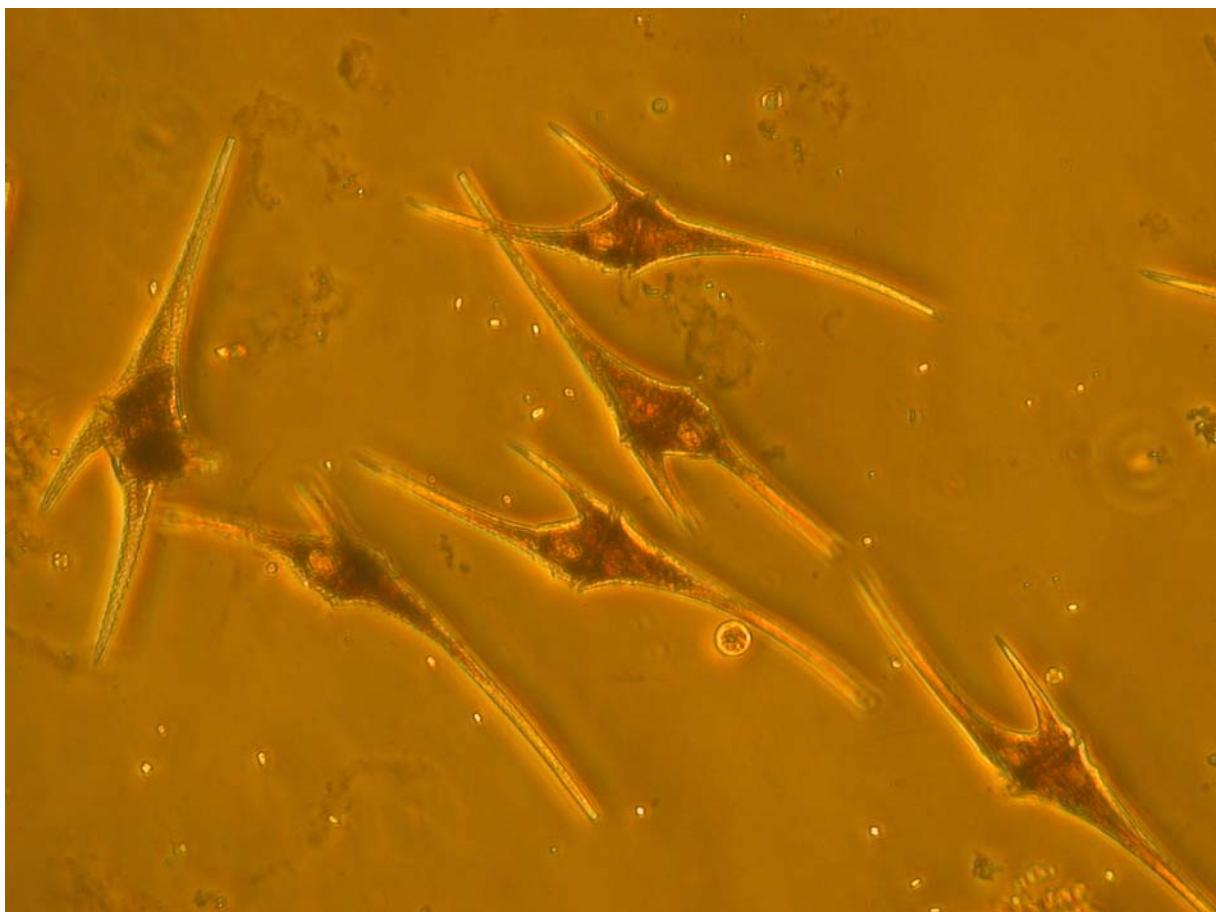


Abb. 2: *Ceratium furcoides* (Lake Varese)

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