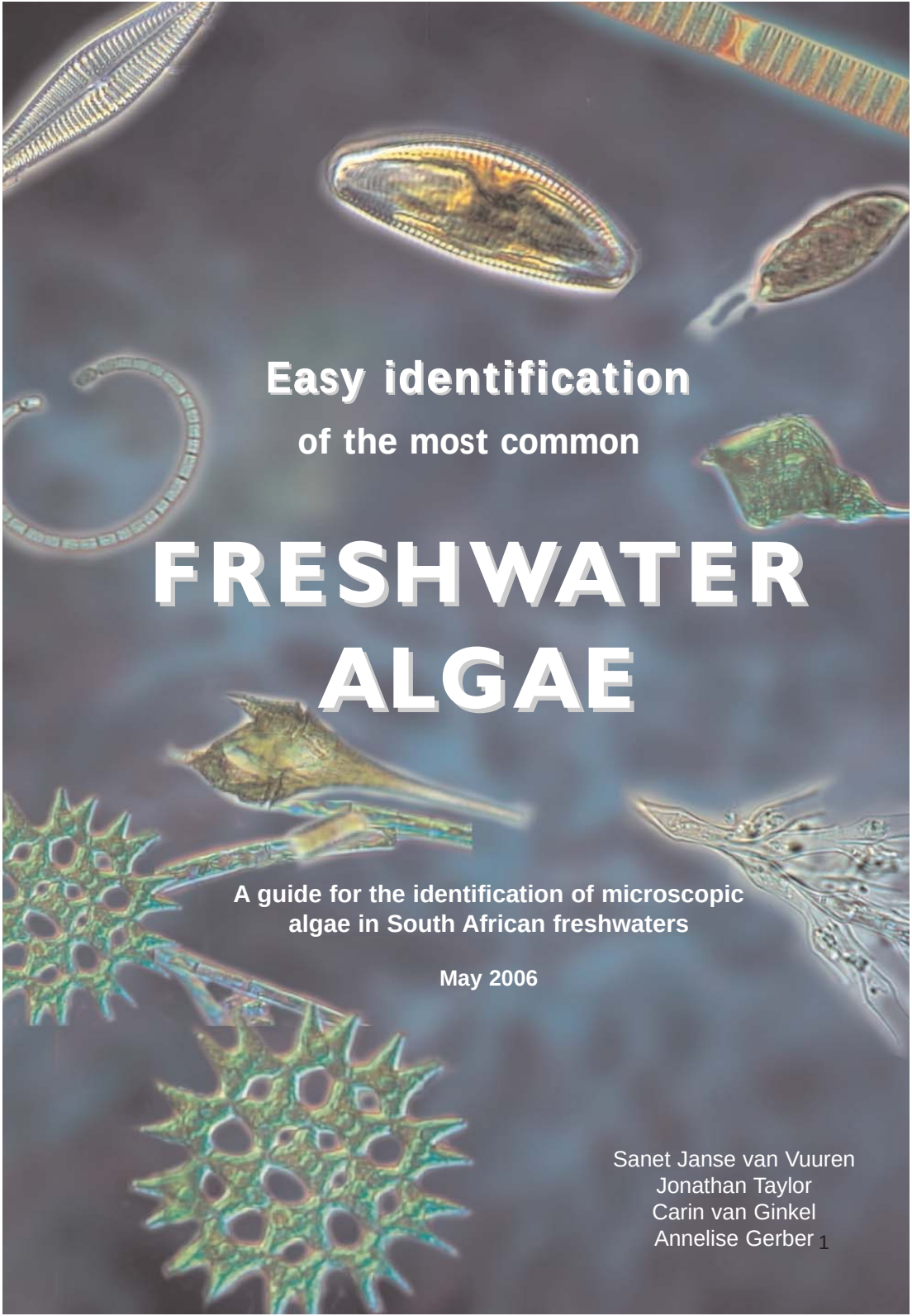

Easy identification

of the most common

FRESHWATER ALGAE

A guide for the identification of microscopic algae in South African freshwaters

May 2006

Sanet Janse van Vuuren
Jonathan Taylor
Carin van Ginkel
Annelise Gerber

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by

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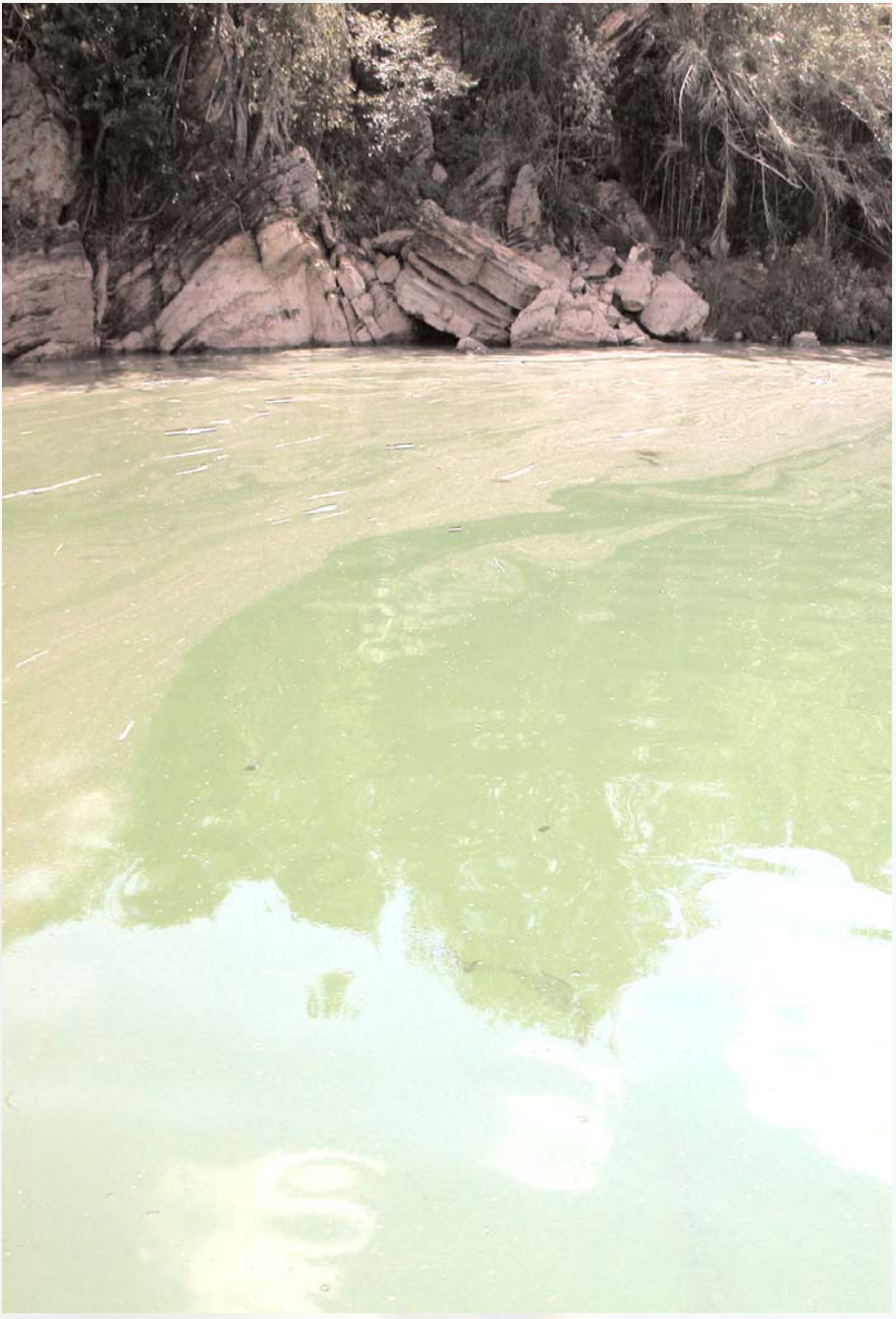

Algal scum on Roodeplaat Dam

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Toxic algal blooms on Hartbeespoort Dam

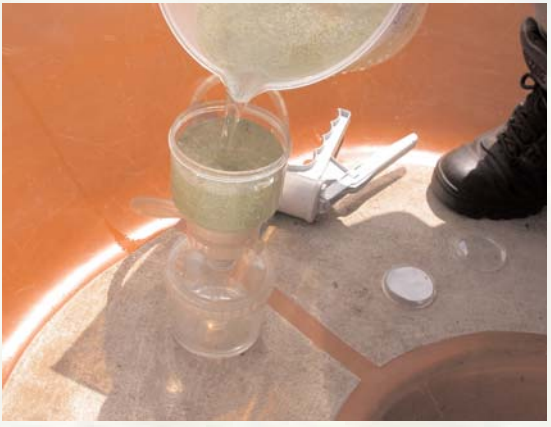
Introduction

The National Water Act (Act 36 of 1998) gave the Department of Water Affairs and Forestry (DWAF) the responsibility to develop National Monitoring Programmes, of which the National Eutrophication Programme (NEMP) is but one. During the development and implementation of the NEMP in 2000, it was identified that there is a need to increase the algal identification capacity in South Africa and to report on problems associated with eutrophication.

Information used to understand the quality of South African freshwater resources can be deduced from the algal composition. The use of diatom indices is gaining popularity and is considered to be a feasible option for the reporting of the eutrophication status of rivers. Identification of algae is a skill valued by, amongst others, the academic world, water purification institutions and governmental organisations whose operators are concerned with the presence of possible taste-, odour-, filter-clogging or toxin-producing algae in their source water. Besides this, the presence of algae contributes to the high cost of water purification. Excessive cyanobacterial blooms produce toxins that can be a serious risk to human health if not treated with caution and the necessary knowledge (WHO 1999).

During the last ten years a number of events in South Africa have led to increased awareness of algae, particularly cyanobacteria (Harding & Paxton 2001; Downing & Van Ginkel 2002). The Hartbeespoort Dam is one of the best known cyanobacterial bloom hazards both nationally and internationally. Many impoundments, e.g. the Hartbeespoort, Bon Accord, Bospoort, Bronkhorstspruit, Klipvoor, Rietvlei, Roodeplaat and Voëlvlei Dams, are known to have a trophic status between eutrophic and hypertrophic, and can, therefore, experience algal and cyanobacterial blooms on a large scale (Van Ginkel *et al.* 2001a). Furthermore, noxious cyanobacterial blooms have spread to freshwater systems where no previous problems have been reported. The Orange River has experienced cyanobacterial blooms on an annual basis since the year 2000. High flow conditions have flushed a new invader species, *Cylindrospermopsis raciborskii*, down the lower Orange River (Van Ginkel & Conradie 2001). There are also reports of increased *Ceratium hirundinella* blooms in freshwater resources of South Africa (Van Ginkel *et al.* 2001b).

The tremendous impact (including potential health impacts) that algal blooms may have on agriculture, recreation and the drinking water industry, is one of the major reasons for the development of this guide.



Eutrophication monitoring

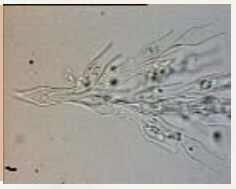
There is a drive within DWAF to improve on the knowledge of algal composition in dams and rivers in order to provide information to management through the National Eutrophication Monitoring Programmes (NEMP) and the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP, formerly known as the RHP).

Freshwater algae are fascinating and diverse living organisms and another purpose of this book is to provide readers with a photo guide to the most common genera of South African freshwater algae. This guide focuses primarily on freshwater phytoplankton and excludes many genera that occur largely in soil or aerial habitats. Identification of algae can be difficult since most are quite small and, therefore, require high-powered microscopes, together with the correct techniques to observe their distinguishing features. The text in the book is divided into seven main algal groups, and combines information on taxonomical characteristics, dimensions, the ecology and problems associated with the 78 genera. Colour images provide the reader with an additional reference source and identification tool.

This photo containing booklet has been prepared to provide students, less experienced and experienced professional aquatic biologists with a means to identify some of the more commonly encountered freshwater algal genera of South Africa. While technical terms were avoided as far as possible, a simple glossary was included to describe the meaning of essential terminology.

Cyanophyta
Blue-green algae

Chrysophyta
Golden-brown algae

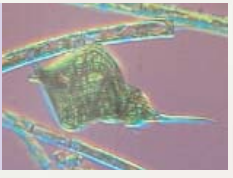


Bacillariophyta
Diatoms

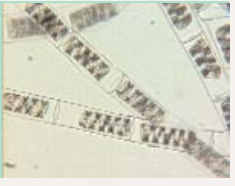
Cryptophyta
Cryptomonads

Dinophyta
Dinoflagellates

Euglenophyta
Euglenoids



Chlorophyta
Green algae



May be in the form of single cells, colonial or filamentous. Organisms mostly blue-green or olive-green or brown in colour, but very seldom bright green. Organisms motile or perform gliding movements.

Mostly single cells or colonies that are yellow or golden-brown in colour. Cells motile by means of two unequal flagella.

Mostly unicellular organisms or adjacent cells may be attached to each other to form of chains. Colour of chloroplasts varies from yellow to yellow-brown. Cells immotile or perform gliding movements. The cell wall is hard and resistant and comprise of two halves fitting into each other.

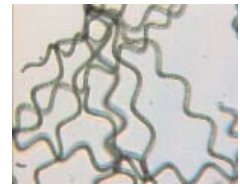
Organisms are always unicellular. Cells may vary in colour from red, blue-green, olive-green to olive-brown. Cells swim by means of two slightly unequal flagella.

Unicellular organisms that are usually brown to yellow-brown in colour. Cells are motile by means of two flagella located inside grooves on the cell surface. In some species, the cell covering consists of conspicuous plates.

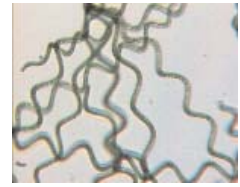
Cells are single and mostly bright green in colour, sometimes with a bright red eyespot. Cells swim by means of one emergent flagellum and some species are able of changing their shape.

Cells may occur single, in the form of colonies or in the form of filaments (branched or unbranched). They are usually grass green in colour, hence the name "green algae". Cells may be immotile, motile by means of two to four flagella, or gliding movements are performed.

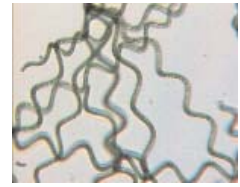
Cyanophyta



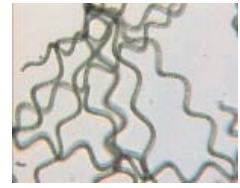
Cyanophyta



Cyanophyta

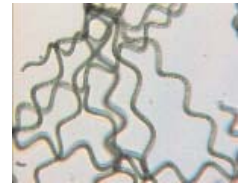


Cyanophyta

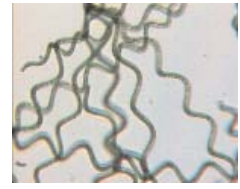


Cyanophyta

Cyanophyta



Cyanophyta



Cyanophyta

Blue-green algae

Cyano is derived from Greek, meaning "blue" and *phyta* meaning "plant". *Cyanophyta* are often referred to as cyanobacteria, blue-green algae or blue-green bacteria. Because they are prokaryotic (no membrane-bounded organelles), blue-green algae are considered to be more closely related to bacteria than to other algae. Representatives may be in the form of single cells, colonies or filaments and are usually blue-green (most common), grey, brownish, blackish or even purple in colour, but never bright green. The blue-green colour is the result of photosynthetic pigments such as chlorophyll-*a* (green pigment) and phycocyanin (blue pigment). Some also contain phycoerythrin (a red pigment). When all three pigments are present, the cells may appear purplish. No flagellated stages are present, but some filaments can perform gliding movements. A characteristic feature of many blue-green algae is the presence of gas vacuoles in the cells, which provide buoyancy to the organism. Cells are covered with a thick, layered cell wall that is often surrounded by mucous. Sexual reproduction is absent. The group include marine as well as freshwater, brackish water and terrestrial species. Under conditions of excessive nutrient (primarily phosphorus) availability, slow moving or stagnant water, and warmth, cyanobacteria may proliferate, producing a variety of problems such as surface scums, tastes and odour problems, skin irritations and the release of toxic substances. When these blooms decompose, severe oxygen depletion may occur, resulting in fish kills.

Anabaena Bory *ex* Bornet *et* Flahault

Origin: From Greek *anabaino,* "to rise" or "to go up".

Characteristics: *Anabaena* has unbranched filaments (trichomes) that can be straight, curved, or coiled. Filaments may be solitary or clustered, forming a gelatinous mass. The filaments are uniformly broad and consist of spherical, ellipsoidal or cylindrical cells, often giving the filaments the appearance of a string of beads. Although the filaments lack a distinct sheath (hence the term trichomes is used to describe them), some species have soft and colourless mucilage enveloping them. Heterocysts (used for nitrogen fixation) are rounded or spherical, solitary and generally intercalary. Within the trichome there are akinetes that are larger than vegetative cells, spherical, ellipsoidal, cylindrical, or curved in shape, solitary or in groups of 2 to 5, intercalary and they can be found distant or adjacent to heterocysts. Gas vacuoles in the cells provide buoyancy for planktonic species.

Dimensions: Cells are 7-12 μm in diameter.

Ecology: *Anabaena* is common, widespread and seasonally abundant (highest concentrations usually occur during the summer months) and it often grows in association with *Microcystis* Kützing *ex* Lemmermann. It occurs in freshwater and marine habitats. Some species are planktonic (common in lakes and ponds, but also occur in slow-flowing waters), others are epiphytic, living in damp soil, or forming gelatinous masses on submersed substrates. Certain species are symbionts in higher plants, e.g. *Anabaena azollae* Strasburger in species of the water fern (*Azolla* Lam.). When nutrients are abundant, some planktonic species are responsible for blooms (visible as surface scums) that result in odours, smells and tastes associated with the water. *Anabaena* is also capable of producing lethal toxins (anatoxin-a), which is a neuromuscular blocking agent causing respiratory arrest, liver and gastro-intestinal damage, and is possibly carcinogenic. Animals and birds may die soon after drinking the infested water. Blooms of *Anabaena* can also cause contact irritations, leading to severe dermatitis.

Notes: *Anabaena* is comparable in morphology with *Nostoc* Vaucher *ex* Bornet *et* Flahault. When clumped, or colonial in soft mucilage, the colony is, however, soft and formless, whereas *Nostoc* colonies are firm and keep a definite shape. *Anabaena* also has less constricted trichomes, akinetes are in different locations, it has more motile hormogonia, and a different habitat.

Problems: Blooms, toxicity, tastes, odours and smells, dermatitis

.

Caption: *Anabaena* filaments consisting of rows of bead-like cells. Heterocysts (visible in photos a to c) are slightly larger than vegetative cells and are responsible for nitrogen fixation. In photos d and e the large oval cells are an akinetes that can survive long periods of unfavourable conditions. The granular appearance of the akinetes is due to the stored food reserves.

Arthrospira Stizenberger *ex* Gomont

Origin: From Greek *arthron,* joint + *speira,* "coil" or "twist".

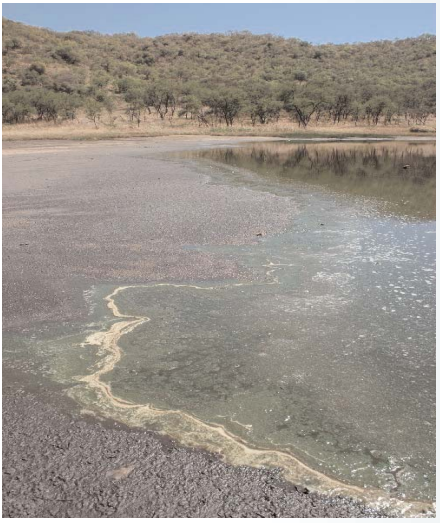
Characteristics: *Arthrospira* filaments (trichomes) are unbranched and usually in the form of large, regular, screw-like coils that results in a spiral. The trichomes may be solitary or in the form of thin mats. Each trichome is cylindrical, isopolar, and may be long or short. The apical or end cells are rounded or cylindrical and may have thickened walls. The genus is multicellular but at times the cross walls are obscure and difficult to see and a short section of a trichome may, therefore, easily be mistaken for *Spirulina* Turpin. *Arthrospira* is usually non-motile, but occasionally glides with a rotating motion. Most species have gas vacuoles. In most cases filaments do not have a mucous sheath or if present, it is very thin and inconspicuous. No akinetes or heterocysts are present. Species are differentiated mostly by size and by the form of the spiral (closely coiled or loose).

Dimensions: Trichomes range from 8-10 μm wide.

Ecology: *Arthrospira* may be present in freshwater ponds or lakes or associated with saline inland and coastal habitats where it is attached or free-floating, often tangled with other algae. Besides being common in these environments, *Arthrospira* has the ability to proliferate in very mineralised, alkaline and warm waters where hardly any other living organism can survive. Filaments can be grouped into slimy benthic clumps coloured blue-green, olive-green or reddish-brown.

Notes: Unfortunately great confusion exists in the classification of *Arthrospira* and *Spirulina.* The confusion comes from errors committed in certain scientific determinations conducted in the 1950s and the naming, for commercial purposes, of certain edible cyanobacteria. *Arthrospira* is an edible cyanobacterium which is mass cultivated and commercially sold under the name of *Spirulina. Arthrospira* is very easy to digest by human beings - it is perfectly assimilable without the need to first be treated in any way. No cyanobacteria of the *Spirulina* genus has scientifically been tested as a source for nutrition, nor does a market exist for it. Although some researchers think *Arthrospira* should be included within the genus *Spirulina,* both genetic and morphological analyses have confirmed that the genera are quite distinct.

Arthrospira and *Spirulina* have similar shapes, however, the former is separated by some authors as having obvious cross-walls.

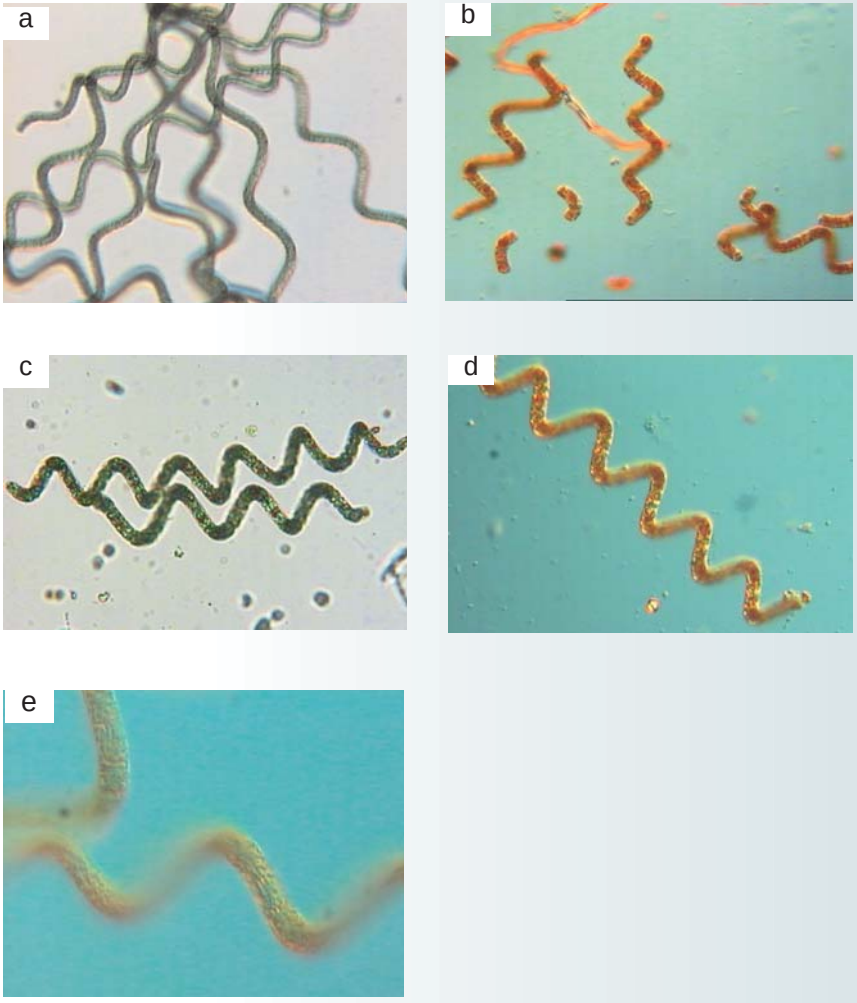


Caption: *Arthrospira* forming a bloom in the Tswaing Crater near Pretoria, growing under extreme environmental conditions (pH = 9.58; Dissolved Oxygen of 16.5 % / 1.19 mg/l and Electrical Conductivity of 7210 mS/m).

A very obvious difference, seen with the light microscope, is the distinct cell wall in *Arthrospira,* reflecting differences in wall layers shown by electron microscopy. In *Arthrospira* a spiral motion may occur, but it is not as active as in *Spirulina. Arthrospira* has broad filaments that are less tightly coiled than those of *Spirulina.* In *Arthrospira* the filaments have a variable length (typically 100-200 μm) and a diameter close to 8-10 μm. In *Spirulina* the spirals are often so tightly coiled that they look like variable long sticks (typically 200-300 μm) with a diameter close to 5-6 μm.

Arthrospira occurs intermingled with *Spirulina* but it is also common in mixtures of miscellaneous algae in the tychoplankton.

Problems: Blooms can be formed.



Caption: Screw-like coils of *Arthrospira* filaments. *Arthrospira* closely resembles *Spirulina* and *Oscillatoria* morphologically. *Arthrospira* is often sold for commercial purposes under the name of *Spirulina*.

Cylindrospermopsis Seenayya *et* Subba Raju

Origin: From Greek *kylindros,* "cylinder" + *sperma,* "seed" + *opsis*, likeness.

Characteristics: Trichomes are solitary, straight, bent, or coiled with the end cells often conical, bluntly or sharply pointed. Unlike *Anabaena* Bory *ex* Bornet *et* Flahault or *Microcystis* Kützing *ex* Lemmermann, the cells of *Cylindrospermopsis* are extremely small, cylindrical or barrel-shaped, pale blue-green or yellowish. A mucilaginous sheath is not evident. In the most common species, *C. raciborskii* (Woloszynska) Seenayya & Subba Raju the cells are not constricted or are only slightly constricted at the cross-walls, which are often indistinct. Heterocysts (nitrogen fixating cells) are elongated and tapered to a narrowed point (drop-like) or roundly conical and are always terminal. Akinetes are ellipsoidal to cylindrical and rounded at the ends. Akinetes develop among vegetative cells, distant or occasionally adjacent to apical heterocysts. Gas vacuoles are present.

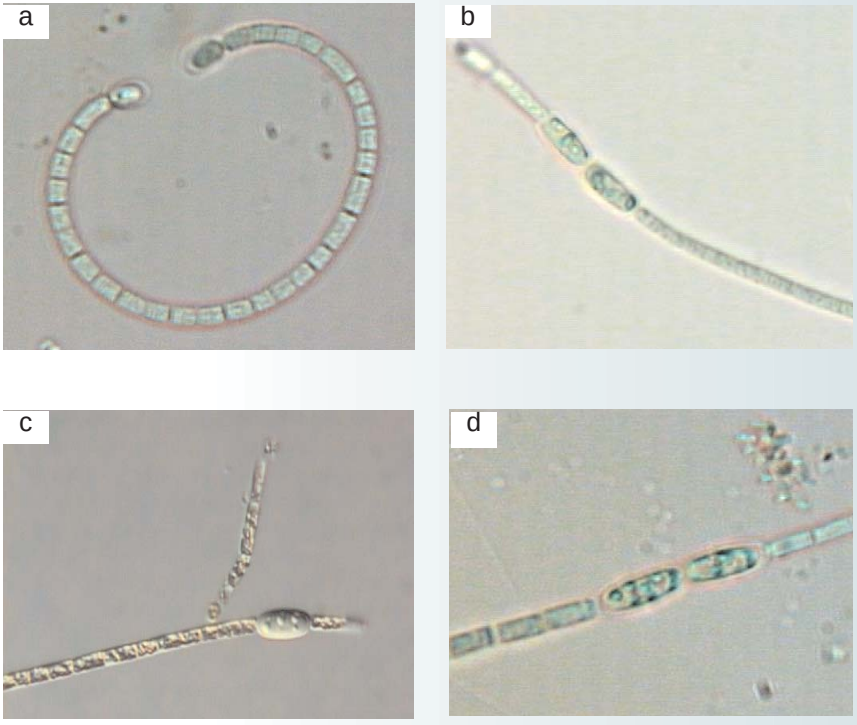
Dimensions: Cells are 2-9 μm long and 2-4 μm broad. Heterocysts are 3-10 μm long and 2-4 μm broad. Akinetes are 7-16 μm long and 3-5 μm broad.

Ecology: *Cylindrospermopsis* is a planktonic, bloom-forming freshwater cyanobacterium that is becoming increasingly prevalent in water bodies worldwide, although it is best known from tropical regions. *Cylindrospermopsis* forms blooms in rivers, freshwater lakes, ponds and reservoirs with high levels of phosphorus and other nutrients. Unlike several other blue-green algae, *Cylindrospermopsis* does not form a surface scum during bloom formation. The algal cell densities may be very high (hundreds of thousands per millilitre) during which it produces a brown tint to the water, however, it cannot easily be distinguished from suspended sediment or other types of algae that also appear brown, such as diatoms. Dense bands are typically located several feet below the surface in a reservoir, lake or other slow moving or still water. *Cylindrospermopsis* can fix nitrogen from the air and so can live without relying on nitrogen sources in the water. In recent years, this cyanobacterium has begun replacing other bloom-forming microorganisms as the dominant genus following the nutrient enrichment of lakes, reservoirs, and rivers. There is now evidence that it appears to be moving into more temperate climates as well.

Notes: *Cylindrospermopsis* differs from morphologically quite similar genera in having a terminal heterocyst at one or both ends of the trichome and none in an intercalary position.

Trichomes occasionally lack any heterocysts and might be confused with a form of *Raphidiopsis* Fritsch and Rich or *Oscillatoria* Vaucher *ex* Gomont.

Problems: *Cylindrospermopsis,* when found in large quantities, can produce several substances that show toxicity, including cylindrospermopsin (that affects the liver, kidneys, heart and other organs), saxitoxin (a neurotoxin that can cause paralytic fish poisoning) and anatoxin-a (a neuromuscular agent that can result in paralysis, respiratory distress and convulsions). There is no taste or odour associated with *Cylindrospermopsis* or its toxins.



Caption: *Cylindrospermopsis raciborskii* filaments, a potential threat for freshwater systems in South Africa. Characteristic of this genus is the heterocysts that are terminally located (photo a). Intercalary akinetes, in the form of large oval cells, filled with food reserves, can be seen in photos b, c and d.

Lyngbya Agardh *ex* Gomont

Origin: After H.C. Lyngbye, a Danish phycologist.

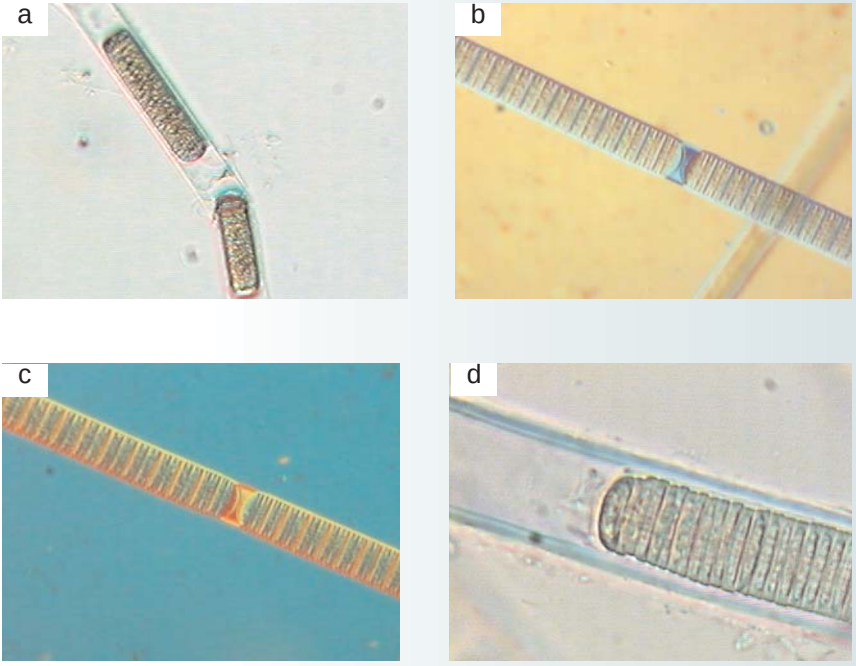
Characteristics: Filaments of *Lyngbya* can be solitary or aggregated together forming large, layered, leathery mats of varied thickness. These mats are often dark bluish-green, olive or purplish-brown in colour, with a characteristic, raw sewage-like smell. The unbranched filaments are cylindrical and generally straight or slightly wavy. Filaments of *Lyngbya* are composed of uniseriate cells enclosed by a very distinctive, firm rigid sheath. Sheaths are clear or may become yellowish-brown, slightly red or occasionally blue. The filaments can creep along slowly by mucous secretions and under extreme conditions the trichomes may leave the sheaths. Filaments are not constricted at the cross walls. The cells are usually shorter than broad. Filaments are mostly rounded or conical at the apex with end cells that usually have thickened terminal walls or caps. Some planktonic species have gas vacuoles for buoyancy, but many do not. Heterocysts and akinetes are absent.

Dimensions: The diameter of the trichomes usually varies from 1 to 30 μm, or even more.

Ecology: *Lyngbya* inhabits freshwater, brackish, and marine environments where they are free-floating or growing attached to rocks, sediment or other algae. Some species live on wet rocks and damp soils in terrestrial or sub-aerial environments. They often form dense mats at the bottoms of nutrient enriched habitats such as lakes, ponds, and streams. These mats produce gasses during photosynthesis that often cause it to rise to the surface. At the surface, winds blow the mats against shorelines or in navigation channels; these mats can be several acres in size.

Notes: *Oscillatoria* Vaucher *ex* Gomont, *Lyngbya* and *Phormidium* Kützing *ex* Gomont are three genera difficult to distinguish, even by specialists. *Oscillatoria* usually lacks a sheath, *Phormidium* has a looser, very thin and sticky sheath, while *Lyngbya* has a firm, rigid sheath. Because of its protective mucilage, *Lyngbya* is particularly troublesome to control using chemicals such as copper sulphate and chelates.

Problems: *Lyngbya* is known to release toxins (debromoaplysiatoxin, aplysiatoxin and *Lyngbya* toxin) into the water. These three toxins have been found to be a major cause of contact irritations, possibly leading to severe dermatitis.



Caption: Filaments of *Lyngbya*, a genus known to secrete toxins. Trichomes of *Lyngbya* resemble those of *Oscillatoria.* The major difference between the filaments of these two genera is the absence of a mucous sheath in *Oscillatoria*, while *Lyngbya* is surrounded by a thick prominent mucous sheath as illustrated in the photos.

Merismopedia Meyen

Origin: From Greek *merismos,* "division" + *pedion,* plane.

Characteristics: This genus is easily distinguished by characteristic colonies consisting of small rounded or oval cells which divide in only two directions to produce flat (or slightly wavy) rectangular plate-like colonies. The colonies reproduce only by fission. Eventually the large mother colony will fragment into smaller daughter colonies. *Merismopedia* cells, in multiples of four, are arranged in a single layer in perpendicular rows within colourless and structureless mucilage. Except for a few species, the colonies are usually microscopic, and may have sub-colonies. The cells are usually blue-green or occasionally reddish in colour. Some planktonic species have gas vesicles for buoyancy. Colonies can perform very slow gliding movements (the larger the colony, the slower the movement). Species are differentiated by cell size, presence or absence of vacuoles, and by the size of the colony.

Dimensions: Cells range from 1-10 μm in diameter.

Ecology: *Merismopedia* is found in freshwater and marine habitats, including ponds, lakes, bogs and slow rivers. In these habitats the colonies are free-floating or resting on the bottom sediments where they may form thin films. Several common species occur across temperate regions in the plankton of eutrophic and mesotrophic waters.

Notes: *Merismopedia* is closely related to *Eucapsis*, but *Eucapsis* occurs in the form of cubical colonies as a result of cell division in 3 planes. In *Merismopedia* the cells divide in 2 directions in only 1 plane resulting in flat, plate-like colonies.

Problems: None known of.

Caption: Colonies of *Merismopedia* are flat and rectangular as a result of cell division in two directions in one plane. In the photo fragmentation of the mother colony into smaller daughter colonies is visible.

Microcystis Kützing *ex* Lemmermann

Origin: From Greek *mikros,* "small" + *kystis,* "sac" or “bladder”.

Characteristics: Cells of *Microcystis* are arranged in colonies that are initially spherical, but become irregular or perforated over time. The cells may be grouped tightly or sparsely within the fine, colourless colonial mucilage. The mucilage is often not clearly seen in preserved material. Smaller colonies are microscopic, while larger colonies may be viewed with the naked eye. Each colony consists of thousands of very small individual cells that are spherical to sub-spherical without individual mucilage sheaths. Although the protoplast is a pale blue-green colour, the cells, when viewed through the light microscope, often appear black as a result of gas vacuoles that are located within the cells. The gas vacuoles allow the colony to drift through water layers to find the optimal amount of sunlight. In some species the gas vacuoles appear glistening or reddish because of the reflection of light. Species are differentiated by, amongst others, cell-size, presence of gas vacuoles, the nature of the sheath, and the shape of the colony.

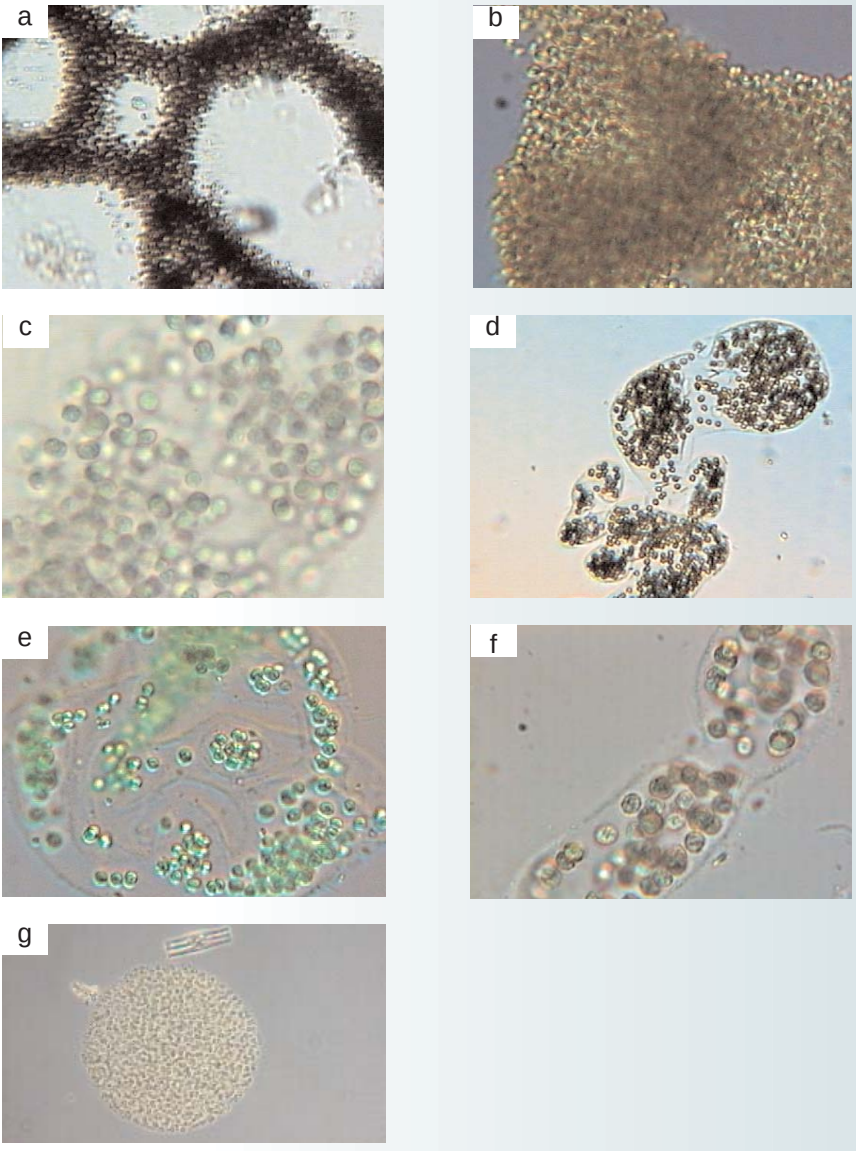
Dimensions: Cells vary from 0.5-9 μm in diameter.

Ecology: *Microcystis* is usually part of the phytoplankton, but may also form granular clumps on bottom substrates. Colonies are common in enriched lakes, ponds and reservoirs or in slow-flowing eutrophic rivers. *Microcystis,* like many other cyanobacteria, prefers high water temperatures and usually form blooms during the summer periods under conditions of adequate nutrient supply. When environmental conditions are favourable, large numbers (blooms) can sometimes be seen floating on the surface of the water, giving a blue-green tinge to the water. It is interesting that, where blooms of some species (e.g. *M. aeruginosa* (Kützing) Kützing) occur, the habitat is completely dominated by this species to the exclusion of almost all other forms of cyanobacteria.

Notes: In contrast to *M. aeruginosa* colonies, which are highly irregular and clathrate when mature, *M. flos-aquae* (Wittrock) Kirchner occurs in nearly globular colonies. *M. wesenbergii* (Komárek) Komárek also has intensely lobed colonies, but it can be distinguished from *M. flos-aquae* and *M. aeruginosa* by a smooth, very firm and colourless mucilage with the outer margin of the colony clearly delimited and extending 3-6 μm beyond the cell aggregations. The presence of gas vacuoles (which appear black or dark brown under the light microscope) easily distinguishes *Microcystis* from *Aphanocapsa* Nägeli (which lacks gas vacuoles).

Caption: *Microcystis* blooms in Roodeplaat Dam

Problems: *Microcystis* is a common cause of algal blooms, sometimes secreting chemicals that inhibit other algae. Because of the presence of gas vacuoles that render them buoyant, they produce surface scums and cause a great deal of disturbance in lakes and reservoirs. Dense growths may lead directly or indirectly to the death of fish through suffocation (as a result of oxygen depletion) or by poisoning. *Microcystis* can produce a polypeptide, called microcystin (named after *Microcystis*), which is toxic to animals ingesting contaminated water. It has also been implicated in human illnesses, such as necrosis of the liver (from ingestion) and severe dermatitis (from skin contact). Blooms of *Microcystis* can also impart taste and odour to the water and interfere with recreational activities.



Caption: Colonies of *Microcystis*, an extremely toxic blue-green bacterium. *M. aeruginosa* is a very common, well-known species in which the colonies are irregular and perforated with holes (photo a). Colonies of *M. wesenbergii* have a characteristic sac-like appearance with the outer margin of the colony clearly delimited by the smooth, firm and colourless mucilage (photos d, e and f). Colonies of *M. flos-aquae* are globose with densely packed cells (photo g).

Oscillatoria Vaucher *ex* Gomont

Origin: From Latin *oscillare,* "to swing".

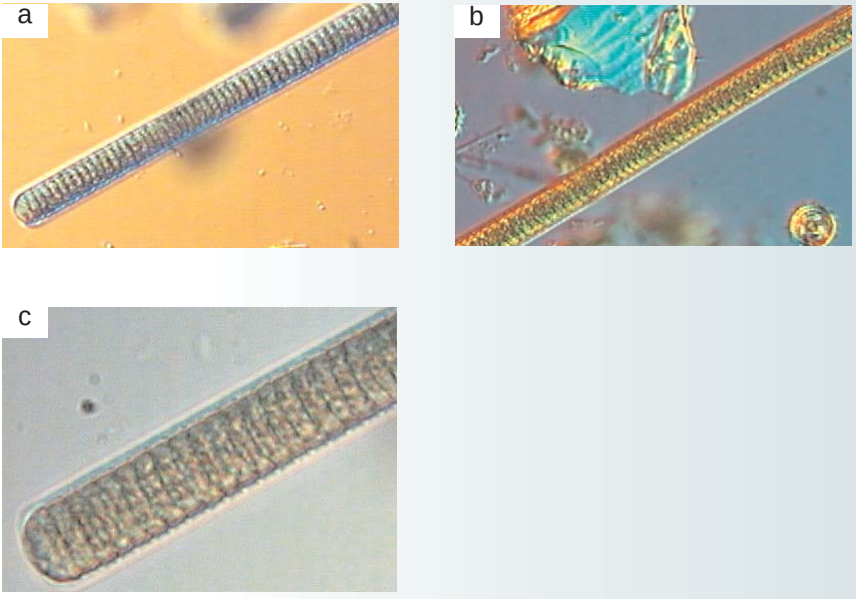
Characteristics: *Oscillatoria* has cylindrical, unbranched trichomes that are straight or slightly wavy, and often very long. Cells of the trichome are discoid and shorter than broad. Although some species do show constrictions at cross walls, the edges of the trichome usually form unbroken parallel lines. Sometimes the trichomes are slightly tapering, often with rounded or capitate apical cells. The shape and size of the end cell of the filament can be important identification features. Unlike *Lyngbya* Agardh *ex* Gomont and *Phormidium* Kützing *ex* Gomont, *Oscillatoria* does not usually have a true sheath, although parallel filaments may form a thin film. Mucilage sheaths may also occasionally form under stressful conditions, such as desiccation or hyper salinity, or in culture. Gas vacuoles are common in planktonic forms. Besides the lack of a definite, firm sheath, the other main characteristic of this genus is the oscillating movement performed when the trichomes are in contact with a solid substrate - the genus is named after the gliding, rotating, or oscillating motion of the filament around its axis. Despite the fact that there is no mucilage sheath, trichomes leave a thin mucilaginous trail as they glide. Mucilage is secreted through pores in the cell walls. There are numerous species (subject to various interpretations) differentiated on the basis of size, cell proportions and the morphology of the apical region.

Dimensions: Trichome diameter usually varies from 8-30 μm or more.

Ecology: *Oscillatoria* is widespread and common in a variety of habitats. It occurs in a diverse range of conditions in freshwater, in the sea and in hot springs. It occurs both in water and on moist sub-aerial substrates such as soil or dripping rocks. When aquatic, it is free-floating or entwined with attached filamentous algae. When benthic, the filaments form dense, slimy, mats on substrates such as mud, plants, stones, or sand. Parts of large mats may dislodge and float to the surface. *Oscillatoria* is common in farm ponds and lagoons where sewage is treated. Some *Oscillatoria* species are tolerant to high levels of organic pollution and trichomes of *Oscillatoria* are often found, together with *Euglena* Ehrenberg, in waters with high nitrogen levels. Some species are shade-tolerant and can adjust their levels of chlorophyll-*a* and use accessory pigments to compensate for low light levels - this enables them to survive in water below blooms of green algae. *Oscillatoria* sometimes uses buoyancy control mechanisms to regulate its position in the water column.

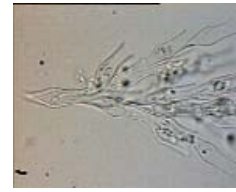
Notes: *Oscillatoria, Lyngbya* and *Phormidium* are three genera difficult to distinguish from one another, even by specialists (see page 28 for differences). *Oscillatoria* is also closely related to genera such as *Planktothrix* Anagnostidis and Komárek, *Limnothrix* Meffert and *Pseudanabaena* Lauterborn. Several former species of *Oscillatoria* with thinner filaments and differences in morphology are now classified as species of *Planktothrix, Pseudanabaena,* or *Limnothrix.* One interpretation of the genus disregards the sheath characteristic and unites *Lyngbya* and *Oscillatoria.*

Problems: Some species of *Oscillatoria* are known to produce toxins. These include both neurotoxins (anatoxins) and hepatotoxins (microcystins). Anatoxins block the transmission of signals from neuron to neuron and neuron to muscle, while microcystins cause liver bleeding. The toxins pose a greater threat to livestock than to humans. *Oscillatoria* is implicated in irritation of the skin (leading to severe dermatitis) and mucous membranes of people swimming in water containing high *Oscillatoria* concentrations.

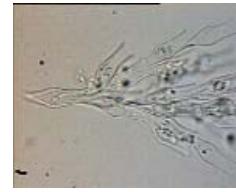


Caption: Unbranched trichomes of *Oscillatoria*, a potential problematic blue-green bacterium. Note, that, unlike *Lyngbya*, there is no clear mucous sheath. The dark spots inside the cells are the gas vacuoles that render the filament buoyant.

Chrysophyta



Chrysophyta



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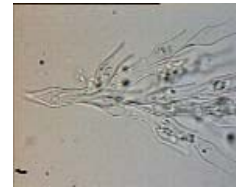

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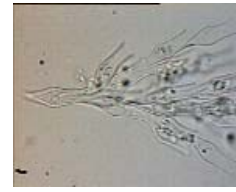
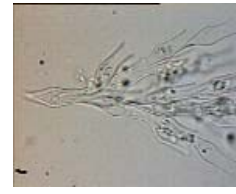


Chrysophyta



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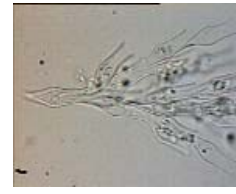
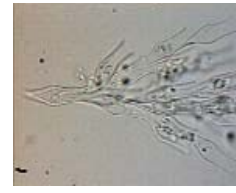


Chrysophyta



Chrysophyta

Golden-brown algae

Chrysophyta is derived from the Greek words *chryso*, which means "golden" and *phyta* that means “plant”. Chrysophyta representatives are, therefore, commonly referred to as the golden-brown algae. Organisms belonging to this group are mostly unicellular or colonial, but filaments may also occur. Chrysophytes are both photosynthetic and heterotrophic, in which case they may be phagotrophic (engulfing particulate matter) or osmotrophic (absorbing organic molecules). Photosynthetic genera usually have yellow to golden-brown chloroplasts as a result of the presence of the pigment fucoxanthin, that masks the green colour of chlorophylls *a* and *c.* Food (chrysolaminarin) is stored outside the chloroplast in the form of a large vesicle. Chrysophyta consists mainly of motile forms, with two anterior implanted flagella of unequal length. One flagellum is long, and protrudes outwards from the cell away from the anterior end, while the other is short, and directed laterally (perpendicular to the long flagellum) or posterior. The long flagellum is used as a feeding apparatus in some species by directing the water current and food particles towards the cell. The flagella and cell surface may be covered by siliceous scales. The scales vary in form, and the scale design is unique to a particular species and important in identification. Like the siliceous remains of diatom cells, scales persist in sediments and are valuable tools for paleolimnologists and ecologists interested in changes in ecological conditions over time. Some chrysophytes are excellent bio-indicators, as they inhabit particular environmental niches in fresh- and marine waters. They are usually most abundant and diverse in freshwaters of neutral or slightly acidic pH with low conductivity, alkalinity and nutrient levels and colder temperatures. Sexual and asexual reproduction can produce cysts, often in response to changes in environmental conditions or population density. Although common, they are often hard to examine as the cells tend to be fragile and they break up readily when mounted. It is, therefore, possible to underestimate or even completely overlook members of this group in a sample.

Dinobryon Ehrenberg

Origin: From Greek *dinco*, "to whorl" + *bryon,* "moss".

Characteristics: The elongated cells are attached, in a highly distinctive shape, to the inside wall of a cylindrical, vase-like envelope (lorica) by a narrow cytoplasmic strand (which is difficult to see). The loricas are usually contained within one another so that branching colonial chains result. The cellulose lorica is usually transparent, but can sometimes be stained yellowish as a result of iron impregnation. Colonies may contain up to 50 cells, but solitary cells may also be present. Cells have one to two lateral chloroplasts, yellow-brown in colour and an eyespot. Each cell has two unequal flagella that render the colony motile.

Dimensions: Cells 20-60 μm long and 3-10 μm wide. Loricas may be up to 70 μm long.

Ecology: *Dinobryon* is free-swimming or attached in freshwater pools, lakes and occasionally rivers. The genus inhabits mostly hard water and eutrophic water bodies, but can also grow well under meso- and even oligotrophic conditions. Sometimes they are so abundant that they form blooms.

Notes: *Dinobryon* commonly produces a spherical cyst within each lorica at certain times of the year.

Problems: In large numbers it may impart a noxious fishy taste or odour to drinking water.

a

b

Caption: Colonies of *Dinobryon* consisting of a branched system of loricas fitting into one another. Each lorica contains a single yellow-brown cell with two flagella.

Mallomonas Perty

Origin: From Greek *mallos,* "a lock of wool" + *monas,* "single organism" or "unit".

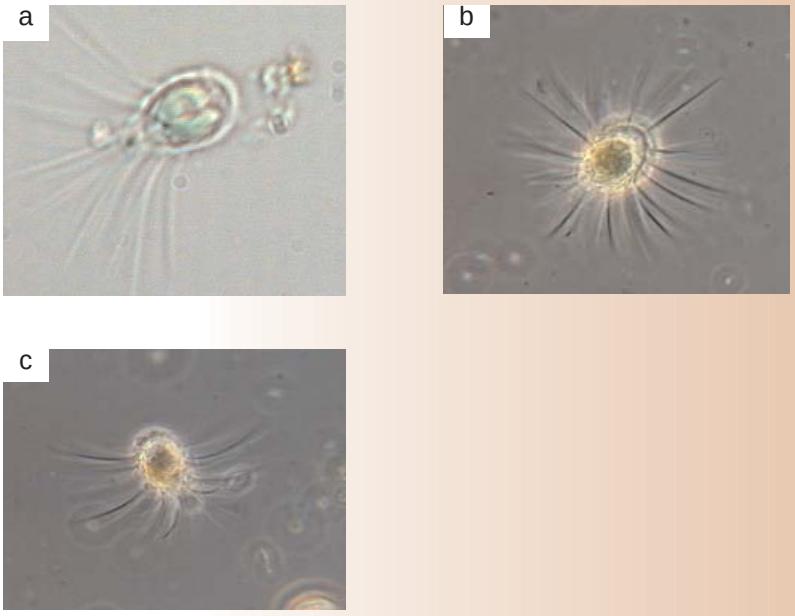
Characteristics: Cells of *Mallomonas* are solitary and elliptical or oval in shape, containing one or two laterally situated golden-yellow to light brown chloroplasts. The cell has a single emergent flagellum with a second non-emergent flagellum situated within an apical opening. Although motile, the emergent flagellum is hardly observable unless the cells are recently collected and viewed under favourable optical conditions. Outside the cell membrane, the cell is covered with numerous overlapping siliceous scales, which bear spines (bristles) either over part or all of the cell. The bristles give the cells a hairy appearance. The spines may become detached from the cells, especially on preservation. Using an electron microscope, the structure, shape and arrangement of the scales provide a means of distinguishing species.

Dimensions: The cells are 25-60 μm long and 10-30 μm wide.

Ecology: *Mallomonas* is widespread and common in freshwater puddles, ditches, ponds and lakes (frequently among weeds). In the open-water plankton they are free-swimming. They are often abundant in hard water lakes and lakes where there is a high degree of pollution.

Notes: This genus consists of many species, which are difficult to identify with a light microscope. The siliceous scales and bristles often form a significant component of the microfossil floras within lake sediments. As a result, *Mallomonas* has become a valuable paleoindicator for the documentation of historical lakewater conditions.

Problems: Blooms of this genus have a characteristic fishy odour.



Caption: Solitary cells of *Mallomonas* in different views. The spine-like projections arise from protective scales on the cell surface.

Synura Ehrenberg

Origin: From Greek *syn,* "together" + *oura,* "tail".

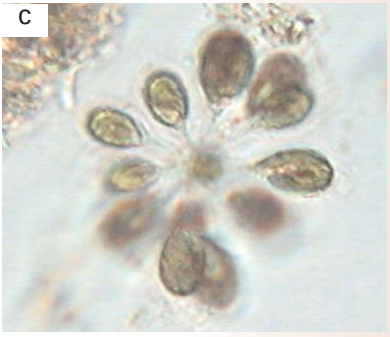
Characteristics: Colonies of *Synura* are spherical to ellipsoidal. Colonies consist of up to 50 closely packed cells which are pear-shaped (broader at anterior end), stalked and radiating from a common centre. Individual cells have two yellow to golden-brown chloroplasts lying along the longitudinal axis of the cell. A large food granule is sometimes visible at the posterior end. No eyespots are present. Each cell has two flagella of almost equal length that protrude along the edge of the colony to permit a rolling, tumbling, swimming motion. The cell membrane is covered with fine silica scales. Most of the anterior scales have spines. If silica is unavailable, synurophytes can survive without scales.

Dimensions: Cells are 30-45 μm long and 7-17 μm broad. Colonies may be 30-500 μm across.

Ecology: *Synura* is widespread and sometimes abundant. Representatives are found in the plankton of freshwater lakes, ponds, and slow moving rivers or streams. This genus is very common in hard water lakes.

Notes: Electron microscopy may be necessary to identify some of the species, but *S. petersenii* Korshikov is by far the most common species observed in rivers. Colonies often break up into separate cells after collection. Like the siliceous remains of diatom cells, the siliceous scales of *Synura* persist in the environment and remain intact within sediments after the cell has died. These preserved scales provide an important tool that helps ecologists to reconstruct environmental changes over time or to better understand the ecology of a particular system.

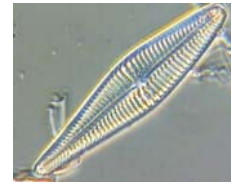
Problems: *Synura* sometimes forms blooms that are often associated with taste and odour problems. *S. petersenii* is especially known to release ketones and aldehydes from the cells that can give the water an unpleasant fish-like odour or taste.



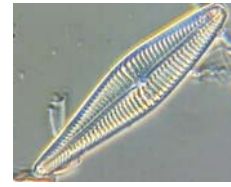
Caption: Golden-brown colonies of *Synura* consisting of pear-shaped cells that are covered by small scales. The stalks of the individual cells are attached to one another in the middle of the colony (photo c).

Bacillariophyta

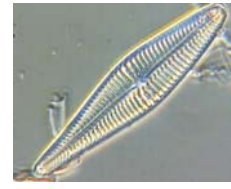
Bacillariophyta



Bacillariophyta



Bacillariophyta



Bacillariophyta

Bacillariophyta

Bacillariophyta

Bacillariophyta

Diatoms

Bacillariophyta comes from the Latin word *bacillus* that means "little stick" or "rod" and the Greek word *phyta* that means "plant". *Bacillariophyta* are commonly referred to as diatoms. The single cells, colonies or filaments are microscopic and usually yellow to light brown in colour. Most diatoms are autotrophic but a few are obligate heterotrophs (they must absorb organic carbon) because they lack chlorophyll altogether. Those with chloroplasts contain the photosynthetic pigments chlorophyll *a* and *c* and fucoxanthin. The storage products are chrysolaminarin and oil droplets, the latter aid in buoyancy. Diatoms are easily recognised by their distinctive siliceous cell walls (called frustules) which have the form of a petri-dish or box. The frustule is usually sculptured with pores and striations, the pattern being used to identify and classify the many different species. Most diatoms are classified within two major morphological groups, the centric and pennate diatoms. Centric diatoms exhibit radial symmetry, while pennate diatoms are bilaterally symmetrical about a longitudinal axis. Centric diatoms are non-motile, while some pennate diatoms possess a slit-like structure, called a raphe, along the surface of one or both valves. Through the secretion of polysaccharides, the raphe allows the cell to perform gliding movements when in contact with a substrate. Except for male gametes, diatoms lack flagella. The primary means of reproduction is asexual, by cell division. A wide variety of diatoms are common in freshwater and marine habitats where they live free-floating or attached to a substrate. Diatoms are extremely important components of phytoplankton. Besides being the largest contributors to global primary production and forming the base of aquatic food webs, they are used as powerful ecological tools to investigate past conditions (fossils) and monitor environmental changes over time. Diatomaceous earth (almost pure deposits of diatom frustules) has a variety of uses, such as filtration and insulation. Diatoms also have many industrial and commercial applications in products such as foods, filters, paints, and cosmetics.

Achnanthidium K tzing

Origin: From Greek *anthos,* "flower" / *achne,* "chaff".

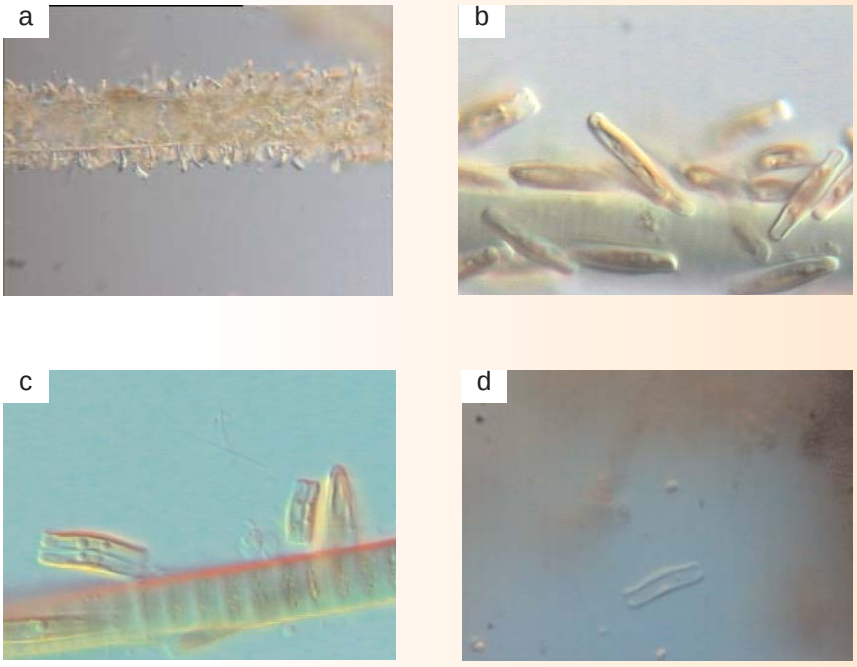
Characteristics: The frustules of *Achnanthidium* are in general, linear, linear-elliptical or linear-lanceolate in valve view, undulate-rectangular and bent in girdle view. The cells are symmetrical in valve view, but not when seen from the side. Cells of *Achnanthidium* are heterovalvar, one valve (known as the raphe valve) bearing a true raphe, the other valve (rapheless valve) a pseudoraphe. The shape of ends is broadly rounded to sub-capitate. The raphe and pseudoraphe are central. Striations parallel to slightly radial and may differ in density and pattern on each valve. There may be two to many chloroplasts per cell.

Dimensions: Cells are 10-20 μm long and less than 5 μm wide.

Ecology: *Achnanthidium* is restricted to freshwater or brackish habitats. The genus is generally more diverse in oligo- to mesotrophic conditions; however some taxa may be abundant in eutrophic and organic-rich waters. The cells may be free-living, or more commonly occur as benthic forms attached by a mucilage stalk to various substrates.

Notes: Identification of species within this genus is sometimes difficult because many are small and difficult to resolve with light microscopy. Many species are easily confused with smaller *Navicula* Bory species. A useful feature for distinguishing *Achnanthidium* from *Navicula* is the bent valve when the cell is seen in girdle view; the valve of *Navicula* is straight. In valve view the central area will appear blurred when the ends are in focus. *Achnanthidium* is one of the genera that have recently been reinstated after revisions of the genus *Achnanthes* Bory de Saint-Vincent.

Problems: None known of.



Caption: *Achnanthidium minutissimum* (Kützing) Czarnecki (all photos) with bent cells in girdle view. *A. minutissimum* is very common and occurs as part of the benthos in dams and rivers. Note the attachment of the valves by stalks and the "stacks" of two or more cells.

Amphipleura K tzing

Origin: From Greek *Amphi,* "both" or "around" + *pleura,* "rib".

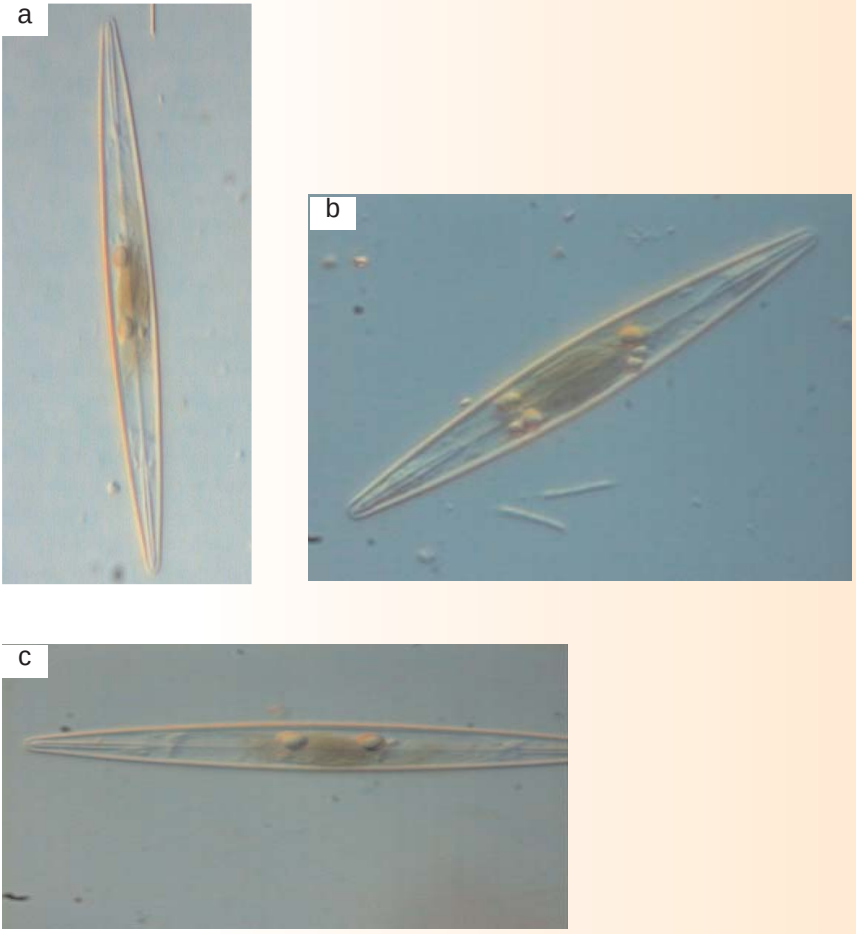
Characteristics: Cells occur individually, or may be enclosed in diffuse, gelatinous tubes. The valve outline is linear, linear-lanceolate or spindle-shaped in valve view. The striae are composed of punctae that are extremely fine so that they are difficult to resolve except under conditions of optimal resolution in the light microscope, and hence the valve appears smooth under ordinary magnifications. A simple, narrow, median rib is evident on the internal valve face, except near the poles. At the poles, the median rib is split into two, forming apparent "needle eyes" in which the raphe is located. The raphe is short compared to other naviculoid genera. Living cells contain one central H-shaped chloroplast.

Dimensions: Cells are 80-140 μm long and 7-10 μm wide.

Ecology: *Amphipleura* is widely distributed in sediment habitats (epipelon) of standing or slow-flowing waters and is generally uncommon in rivers. Cells are usually found in calcareous waters and occur predominantly in alkaline waters, but may also occur over a wider pH spectrum.

Notes: *A. pellucida* Kützing, the type species, is the only commonly recorded species.

Problems: None known of.



Caption: *Amphipleura pellucida*, a spindle-shaped cell with distinctive median rib and "needle eyes" at the poles.

Asterionella Hassall

Origin: From Greek *asterion,* "a kind of spider".

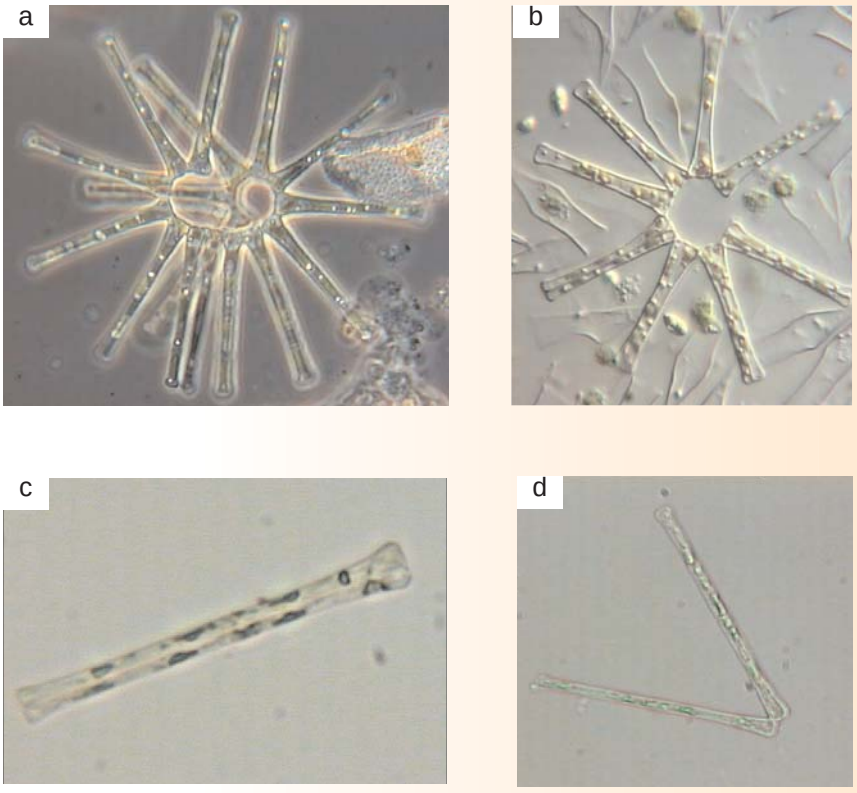
Characteristics: The long, narrow cells are joined by pads of mucilage at one end to form radiating star-shaped colonies of 4, 8 or 16 individuals. Individual cells are straight and narrow with rounded ends. The cells are somewhat expanded at each end (heteropolar), the inner ends at the "hub" of the colony are somewhat larger. The pseudoraphe is narrow and often discerned with difficulty, the transverse striae are very fine and difficult to see (not usually visible under the light microscope). Usually two or more chloroplasts are found per cell.

Dimensions: Cells are 40-130 μm long and 1.3-6 μm wide. Colonies are 60-320 μm in diameter.

Ecology: *Asterionella* is abundant in the plankton of lakes, especially those that are mesotrophic or eutrophic. The common species are usually found in hard water lakes. Populations can frequently reach bloom proportions. During population growth, silica is absorbed from the water and can become limiting causing numbers to decline.

Notes: There is also a form of *Tabellaria* Ehrenberg *ex* Kützing which has stellate colonies similar in size and shape to *Asterionella,* but whose cells are recognised by their longitudinal septa and by the knee-like swellings at the centre of each cell.

Problems: Taste, odour and filter clogging.



Caption: *Asterionella formosa* Hassall (all photos) with individual heteropolar "bone-shaped" cells. *A. formosa* is very common in meso- to eutrophic waterbodies. Note the attachment of the valves at the broadest apex by mucilage pads to form stellate colonies.

Aulacoseira Thwaites

Origin: From Greek *aulos*, "pipe or tube" and *seira,* "chain or rope".

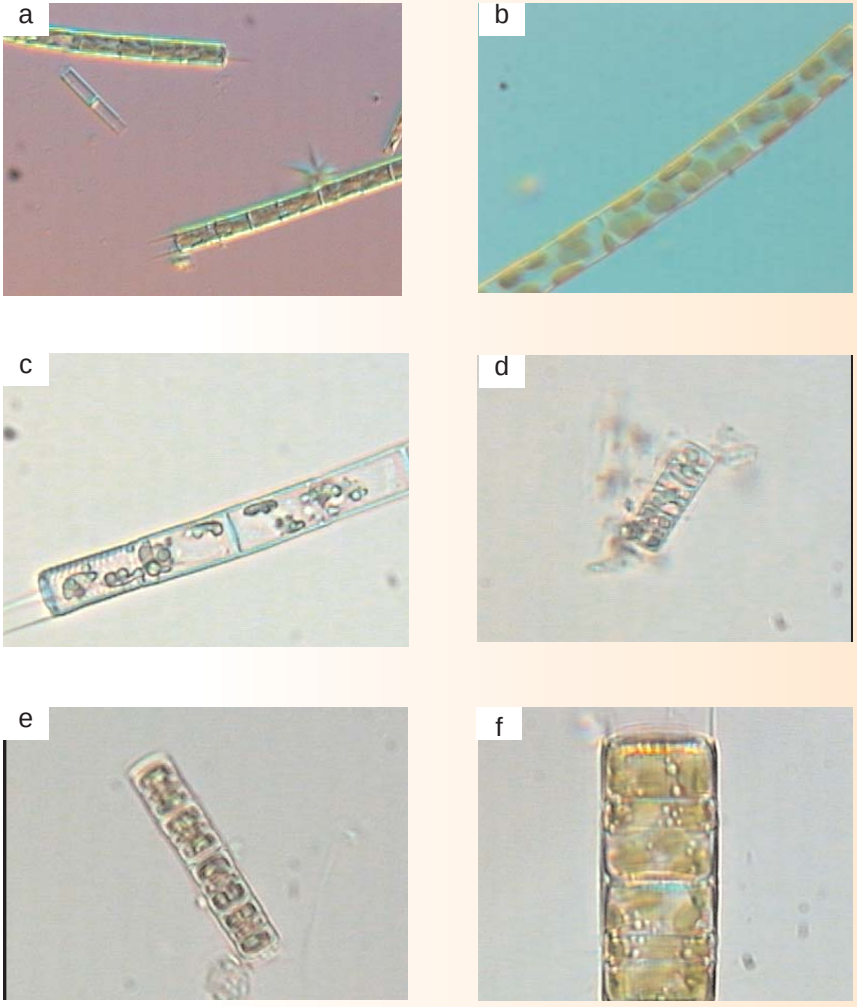
Characteristics: The cells of *Aulacoseira* are mostly longer than broad. These capsule-like cells are cylindrical in appearance; hence the valves are more commonly encountered in girdle view. Cells are round in valve view typical of the Centrales. In some there is a sulcus or ring-like incision around the mid-region, the girdle being smooth. The cell wall or frustule is punctate, coarsely or faintly so. These punctae or surface pits are arranged in straight or spiralled rows. Spines are usually present on the end walls. It is these elongate spines which join the cells together to form cylindrical filaments. Filaments may be straight, curved or coiled. The chloroplasts of this genus are numerous and plate-like in shape with a greenish golden-brown colour.

Dimensions: Cells are 4-20 μm in diameter.

Ecology: Free-floating (planktonic) or attached to rock and aquatic plants (benthic) in slightly eutrophic streams, as well as dams and large slow-flowing rivers. Cells are attached and lie end to end in relatively long unbranched filaments.

Notes: *Aulacoseira* is abundant and forms dark brown strands on many surfaces in streams and large rivers. Species in this genus were previously referred to as *Melosira* Agardh, but many differences in valve ultra-structure between *Melosira* taxa led to the resurrection of the genus *Aulacoseira.* The commonly reported *Melosira varians* Agardh remains in that genus. The species are extremely variable and it is possible to find both long and narrow and short and broad celled filaments mixed together in the same sample. However, the sculpturing of fine punctae, resembling a nutmeg grater, and the terminal spines (one long and several short) are highly characteristic.

Problems: Blooms, filter clogging, taste and odour.



Caption: *Aulacoseira granulata* (Ehrenberg) Simonsen (photos a-c). *A. granulata* is very common and occurs in the plankton and benthos of dams and rivers. Other commonly occurring *Aulacoseira* species are *A. subarctica f. subborealis* Nygaard (photos d-e) and *A. muzzanensis* (Meister) Krammer (photo f). All species of *Aulacoseira* are characterised by cylindrical cells, linked to form chains.

Cocconeis Ehrenberg

Origin: From Greek *kokkos,* "a grain or berry" + *neos,* "a ship".

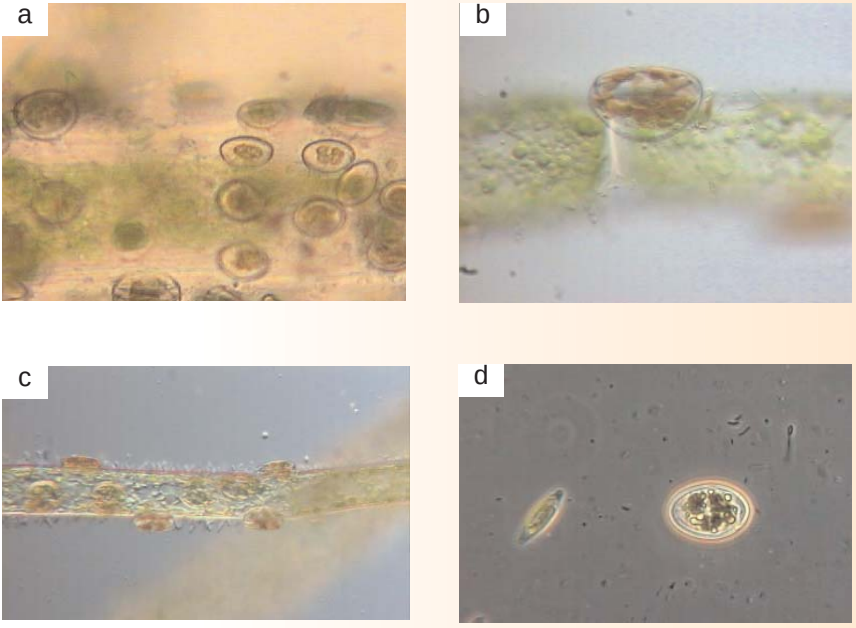
Characteristics: This diatom genus has broadly ovoid-elliptic frustules. Valves of *Cocconeis* are isopolar and isobilateral but are heterovalvar. The convex valve has a pseudoraphe and the concave valve has a true raphe. Striae run from raphe/pseudoraphe to margin. The punctae are often fine, but may be coarse. In many there is a clear marginal band formed by an interruption of the striae on the valve that has the raphe.

Dimensions: Cells are 15-98 μm long and 8-40 μm wide.

Ecology: A very widespread and common genus occurring in all waters from marine to freshwater. The frustules are epiphytic on filamentous algae or on aquatic plants, sometimes occurring so abundantly as to form a coating over the host surface. Cells of *Cocconeis* may also be found attached to stones and various other substrata.

Notes: *Cocconeis* is easily recognisable by its characteristic discoid shape. The striae pattern, structure and density often differ on the two valves.

Problems: None known of.



Caption: *Cocconeis pediculus* Ehrenberg (all photos) with discoid cells. *C. pediculus* is a very common attached diatom; note the adnate attachment of the valves to the surface of a green algal cell (photos a-c).

Craticula Grunow

Origin: From Latin *craticula* diminutive of *crates*, "wickerwork".

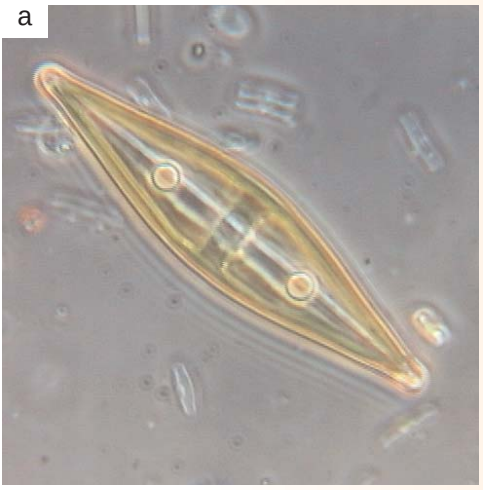
Characteristics: Valves are usually lanceolate, sometimes tending towards elliptical. The cells have more or less capitate ends and the valve margins may undulate slightly. The striae are usually strictly parallel consisting of rows of small round puncta. These cells produce characteristic reduced internal valves called "craticulae" with a changed striae pattern, usually in response to osmotic stress. The cells contain two plate-like chloroplasts, one lying against each side of the girdle. Two conspicuous lipid droplets are present in the cell, one on each side of the cytoplasmic bridge.

Dimensions: Cells are 9.5-170 μm long and 3-35 μm wide.

Ecology: *Craticula* species tend to be associated with fresh to brackish waters and some species are very tolerant to elevated levels of organic pollution. This taxon occurs as single cells in the benthos, but may be washed into the plankton.

Notes: *Craticula* is a relatively small genus distinguished from *Navicula* by different puncta, raphe, girdle and pyrenoid structure as well as its valve polymorphism (i.e. the presence of craticulae).

Problems: None known of.



Caption: Two common species of *Craticula, C. cuspidata* (Kützing) Mann (photos a-b) and *C. ambigua* (Ehrenberg) Mann (photo c). Both of these species are often found in the benthos of brackish, polluted waters.

Cyclotella K tzing *ex* BrØbisson

Origin: From Greek *kyklos,* "circle".

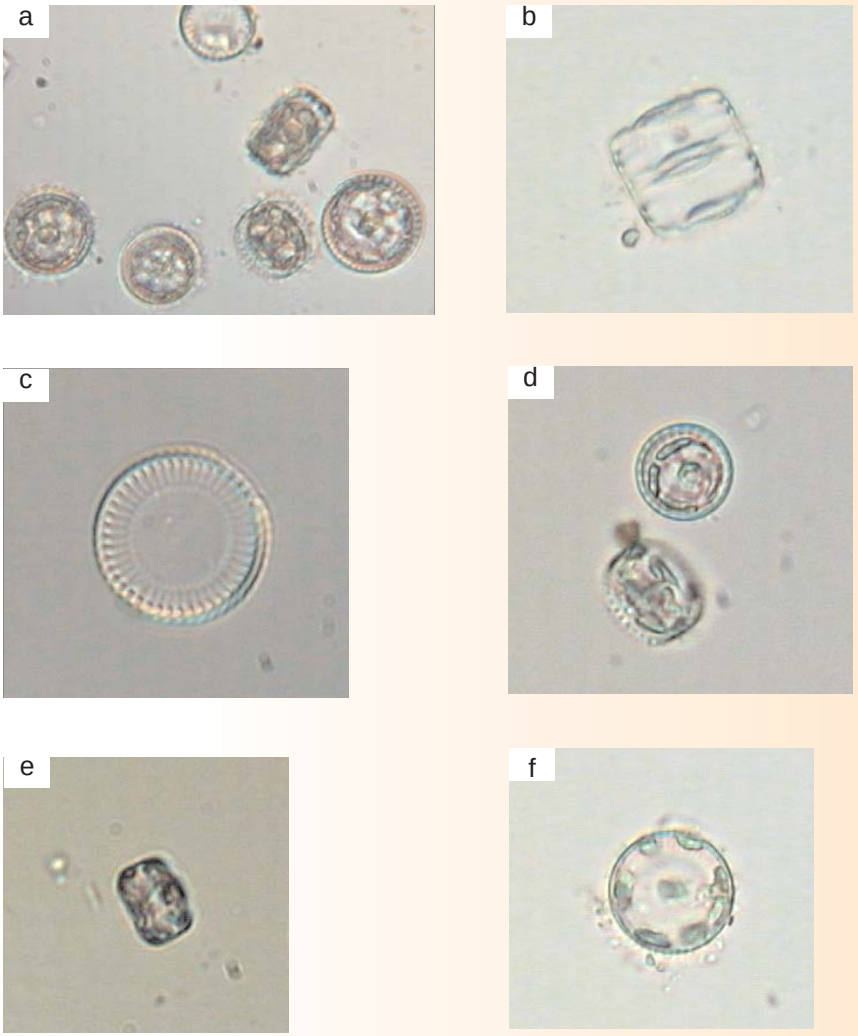
Characteristics: A small disc-shaped diatom differentiated by a distinct valve pattern. The centre of the valve (or inner zone) is plain, except for one or two strutted processes, and may also have small wart-like projections. Around the edge (outer zone) is a broad band of heavy striae. The valve margins are mostly without spines but in some species small tubules (fultoportulae) are present which might be mistaken as spines. Cells of *Cyclotella* are rectangular in girdle view. Each cell contains numerous discoid chloroplasts.

Dimensions: Cells are 5-30 μm in diameter.

Ecology: *Cyclotella* is a common planktonic diatom found throughout the world and is widespread in lakes, rivers, marine and brackish water environments. Species are known to thrive in environments ranging from oligotrophic to highly eutrophic.

Notes: Valve morphology of *Cyclotella* is highly variable and appears to respond to subtle micro-environmental changes. There are about 100 species, of which *Cyclotella meneghiniana* is perhaps the most common. *Cyclotella* may resemble *Stephanodiscus* Ehrenberg when alive. Cells of *Cyclotella* are usually solitary but may be attached in chains or short filaments by mucilaginous threads.

Problems: Blooms, filter clogging.



Caption: *Cyclotella meneghiniana* Kützing (all photos) with spherical cells. *C. meneghiniana* is very common and may form blooms, and often grows in association with *Stephanodiscus.*

Cymatopleura W. Smith

Origin: From Greek *kyma*, "wave" and *pleuron*, "rib".

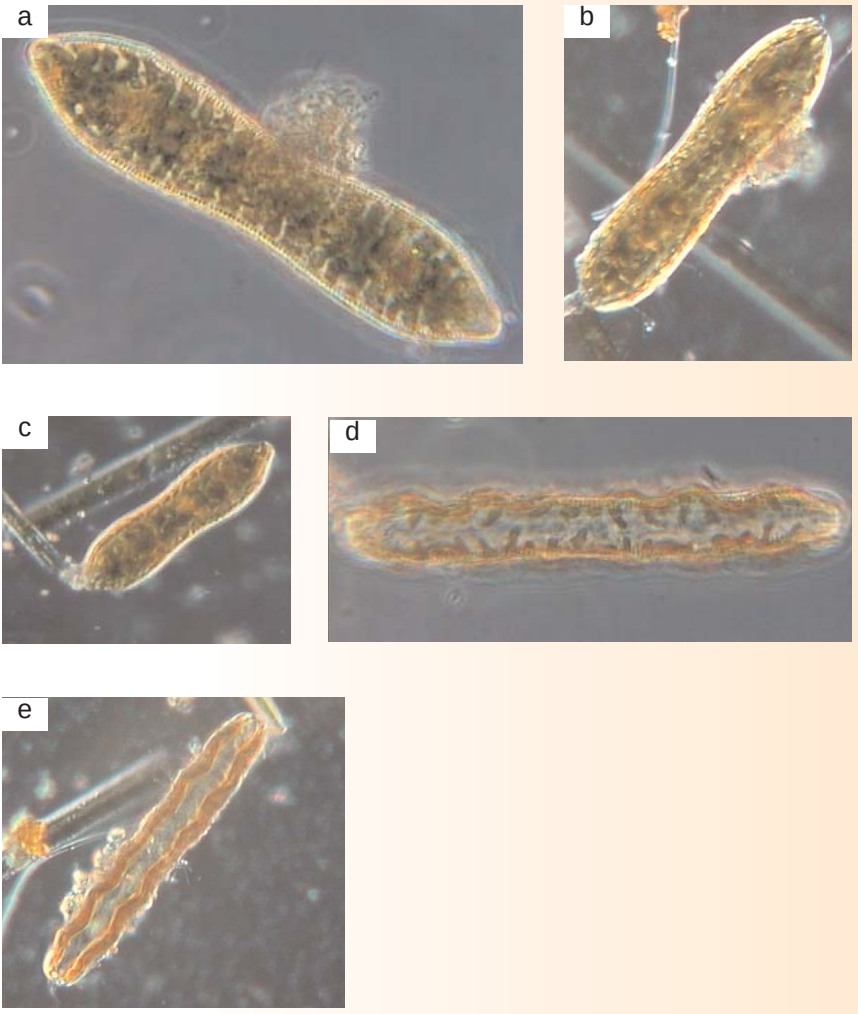
Characteristics: The cells of most species of *Cymatopleura* have a characteristic panduriform or "peanut" shape in valve view, while others are elliptical. The raphe system runs around the circumference of the cell within a keel. The valve face is undulate or wavy as indicated by the name. Members of this genus have a single chloroplast with two plates appressed to the valves and connected by an istmus.

Dimensions: Cells are 30-300 μm long and 10-90 μm wide.

Ecology: Benthic (sometimes washed into the plankton) but mainly epipelic, it is more abundant in alkaline, eutrophic waters with a moderate to high conductivity.

Notes: This genus is easily recognised by the characteristic valve shape and relatively large cells size. The undulations of the valve face of *Cymatopleura* are more easily seen in girdle view.

Problems: None known of.



Caption: *Cymatopleura solea* (Brébisson) W. Smith (photos a-e) with characteristic "peanut-shape" in valve view (photos a-c). Note the undulations of the valve face in photos d & e, only clearly seen in girdle view. *C. solea* is common in the benthos of eutrophic slow flowing waters and is sometimes washed into the plankton.

Cymbella Agardh

Origin: From Latin *kymbe,* "cup".

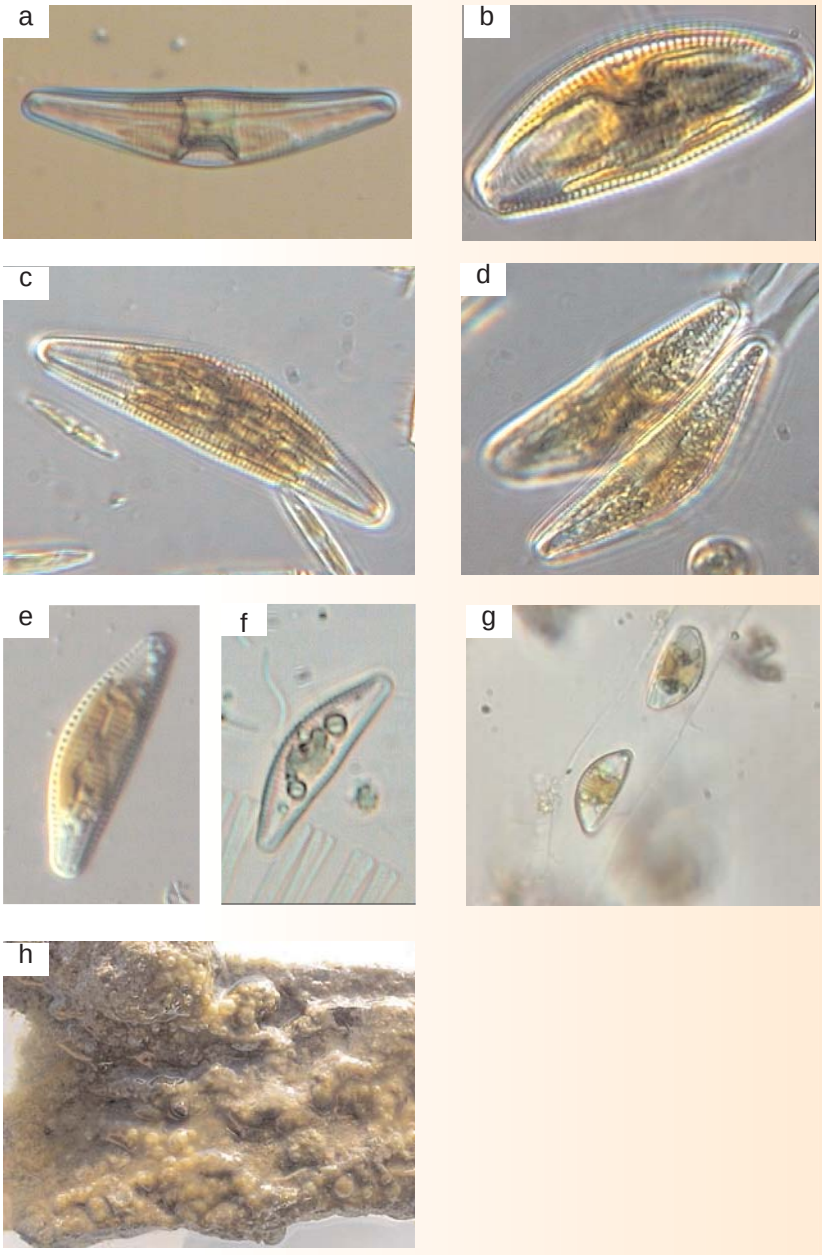
Characteristics: These are mostly gracefully curved, crescent-shaped cells. Valves are dorsiventral and strongly arcuate, with rounded, sub-rostrate to sub-capitate ends. The valves are usually crescent or segment-shaped but in some species they are almost lanceolate to isopolar. The raphe is positioned along the centre or near the centre of the valve and may be curved, sinuous or straight. The terminal raphe fissures are always deflected to the dorsal margin. Striae are coarsely punctate, radiate or nearly transverse. These cells have a single, large, lobed chloroplast with a central pyrenoid.

Dimensions: Cells are 20-220 *µ*m long and 7-32 *µ*m wide.

Ecology: A large common and diverse genus usually restricted to fresh waters. Cells of *Cymbella* may be solitary and free floating or attached to plants and other substrata by mucilage stalks. Alternatively they may occur as linear series of individuals enclosed in mucilaginous tubes. Members of the genus *Cymbella* are usually associated with good quality waters that have low levels of nutrients and organic pollutants.

Notes: This is a very easy genus to identify in light microscopy and includes some very large species that may exceed 200 *µ*m in length (e.g. *C. lanceolata* Ehrenberg). Some of the species of *Cymbella* (none illustrated here) have in recent years been transferred to *Encyonema* Kützing, *Encyonopsis* Krammer, *Cymbopleura* (Krammer) Krammer, *Reimeria* Kociolek & Stoermer and *Afrocymbella* Krammer.

Problems: None known of.



Caption: *Cymbella* spp. crescent-shaped diatoms occurring as solitary cells (photosa,b,c,e,f), cells in mucilage tubes (photo g) or attached to a substratum by mucilage stalks (photo d). Photo h illustrates a dense biofilm on a floating tree bark composed mostly of *Cymbella* spp.

Diadesmis K tzing

Origin: From Greek *dia,* "throughout" and *desmos,* "a chain".

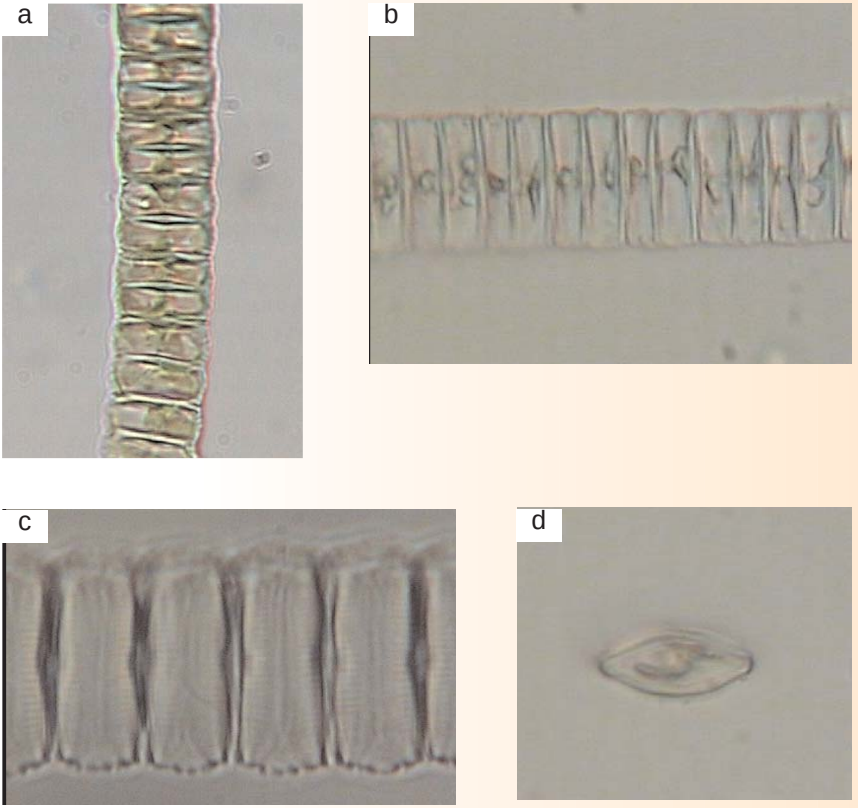
Characteristics: *Diadesmis* cells are often joined at the valve face to form linear colonies comparable to those formed by *Fragilaria* Lyngbye. Valves are biraphid, small and usually linear with rounded ends and sometimes with concave sides. The axial area is broad and there is a hyaline area at the edge of the valve, thus the striae may appear to be short relative to the breadth of the valve. There is a single simple or slightly lobed chloroplast that lies against one side of the girdle and one valve; sometime extending under the other valve.

Dimensions: Cells are 9-28 μm long and 4-10 μm wide.

Ecology: This is a small freshwater genus, virtually restricted to sub-aerial habitats, e.g. damp moss and rocks. However, *D. confervacea* Kützing is commonly encountered in freshwater streams that exhibit elevated levels of nutrients.

Notes: Although *Diadesmis* colonies are similar to those of *Fragilaria, Diadesmis* posseses a true raphe on each valve, the polar nodules of each raphe can be noted even when the cells are seen in girdle view.

Problems: None known of.



Caption: *D. confervacea* (all photos), showing distinctive linking of the cells to form a ribbon shaped colony when seen in girdle view (photo a-c). Photo d illustrates a valve view of the same species.

Diatoma Bory

Origin: From Greek *diatomos,* "cut in two".

Characteristics: The cells occur in zigzag or ribbon-shaped filaments, formed by mucilage pads exuded through pore fields at the corners of the cells. Species in this genus are variously shaped in valve view; frustules araphid, elliptical to linear in outline and with rounded to capitate apices. The species show much variation in shape and size; oval or elongate in valve view, but somewhat rectangular in girdle view. However, all species within this genus have characteristic heavy transverse internal costae (or ribs), which can be seen as ridges or points at the cell margin, in girdle view. The costae are interspersed by striae composed of very fine punctae (almost invisible in light microscopy). A narrow pseudoraphe may be found on the centre of the valve where the wall is not punctate.

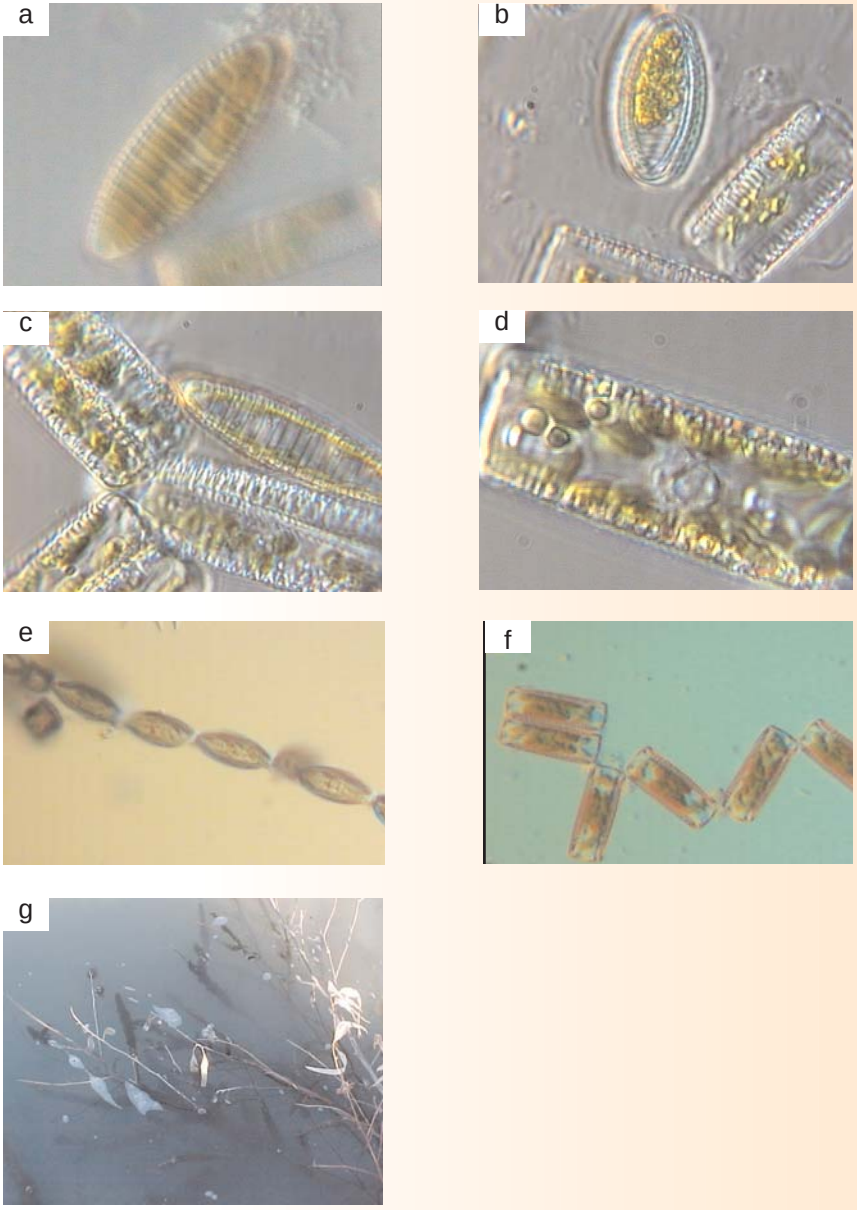
Dimensions: Cells are 8-75 μm long and 7-18 μm wide.

Ecology: *Diatoma* becomes common in river plankton and benthos in the winter and is found in waterbodies of all types. *D. vulgaris* Bory is indicative of hard water with elevated levels of nutrients.

Notes: This genus is easily recognised under the light microscope by their transverse costae (or ribs).

Problems: Filter clogging.

Diatoma colonies



Caption: *Diatoma vulgaris* (photo f) occurring as a zigzag colony or filament. Individual cells (photo a) are easily recognisable by the transverse ribs visible when the cell is in valve view. Dense filament-like colonies of *D. vulgaris* found growing on submerged tree branches (photo g).

Eunotia Ehrenberg

Origin: Uncertain.

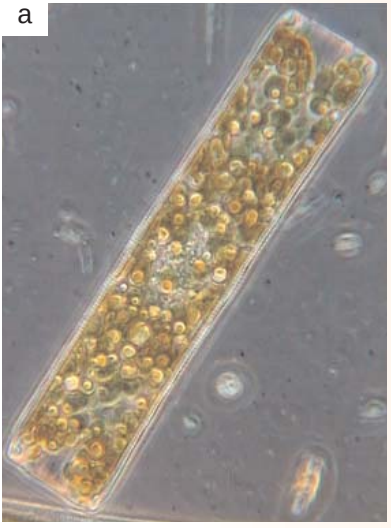
Characteristics: The cells of this species are lunate or curved in valve view. They usually have quite a wide girdle and are often seen lying in girdle view. Valve margins vary from smooth to undulate, the dorsal margin is usually convex and the ventral margin is straight or slightly concave. The raphe slits of this species are very short and often only a small part is visible on the valve face, while the main part extends onto the valve margin. Each cell contains two, or sometimes more, elongate chloroplasts one lying along each valve.

Dimensions: Cells are 10-200 μm long and 2-15 μm wide.

Ecology: *Eunotia* is a common benthic diatom found throughout the world and is widespread in lakes and rivers, but is restricted to freshwaters. Species of *Eunotia* occur in oligotrophic, electrolyte poor, acidic to circumneutral waters. Cells may be attached to substrata, or each other, by apical mucilage pads.

Notes: The valve outline of *Eunotia* differs greatly between species, however, they all have the characteristic lunate or curved shape with uninterrupted, parallel striae running across the valve face.

Problems: None known of.



Caption: The rectangular girdle view of *Eunotia formica* Ehrenberg is illustrated in photo a. Cells of this species may be joined to form long, ribbon-like colonies (photo b). *E. bilunaris* (Ehrenberg) Mills is illustrated in photo c showing the typical curved cell shape of *Eunotia* when seen in valve view. *E. bilunaris* is a common form occurring in the benthos of weakly acidic to circumneutral waters.

Fragilaria Lyngbye

Origin: From Latin *fragilis,* "easily broken".

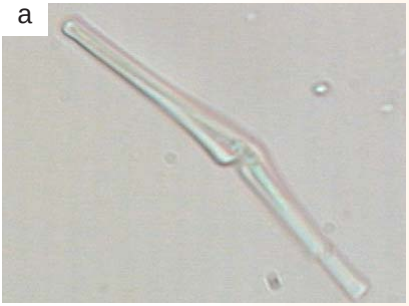
Characteristics: Valves are usually linear to linear-lanceolate, sometimes tending towards elliptical. The cells have more or less capitate ends and may be swollen in the centre. A gap (pseudoraphe) is evident between the transverse markings. The cells contain two chloroplasts, often with three or more pyrenoids.

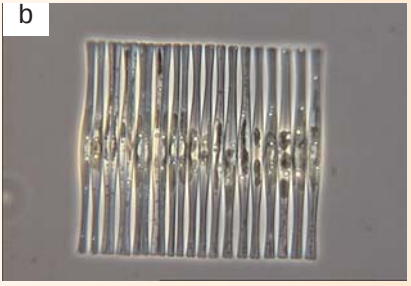
Dimensions: Cells are 10-170 μm long and 2-5 μm wide.

Ecology: *Fragilaria* is an extremely diverse genus including species that occur both as benthic forms in streams and lakes, as well as in the plankton of lakes when they may be attached side to side to form chain or ribbon-like colonies. *Fragilaria* species tend to be associated with circumneutral to slightly alkaline fresh waters.

Notes: *Fragilaria* can be distinguished from *Synedra* Ehrenberg on the basis of their capacity to form chains; in addition they are typically smaller and less robust than *Synedra*. *Fragilaria* valves can be difficult to identify under the light microscope as they are often oriented in girdle view.

Problems: Blooms, filter clogging, taste and odour.





Caption: *Fragilaria crotonesis* Kitton (photos a and b) with linear chain forming cells (25-500 µm long). *F. crotonesis* is very common and occurs as plankton in dams and rivers. Photo c illustrates dense colonies of *Fragilaria* sp. attached to a filamentous green alga.

Gomphonema Ehrenberg

Origin: From Greek *gomphos,* "nail" + *nema,* "thread or filament".

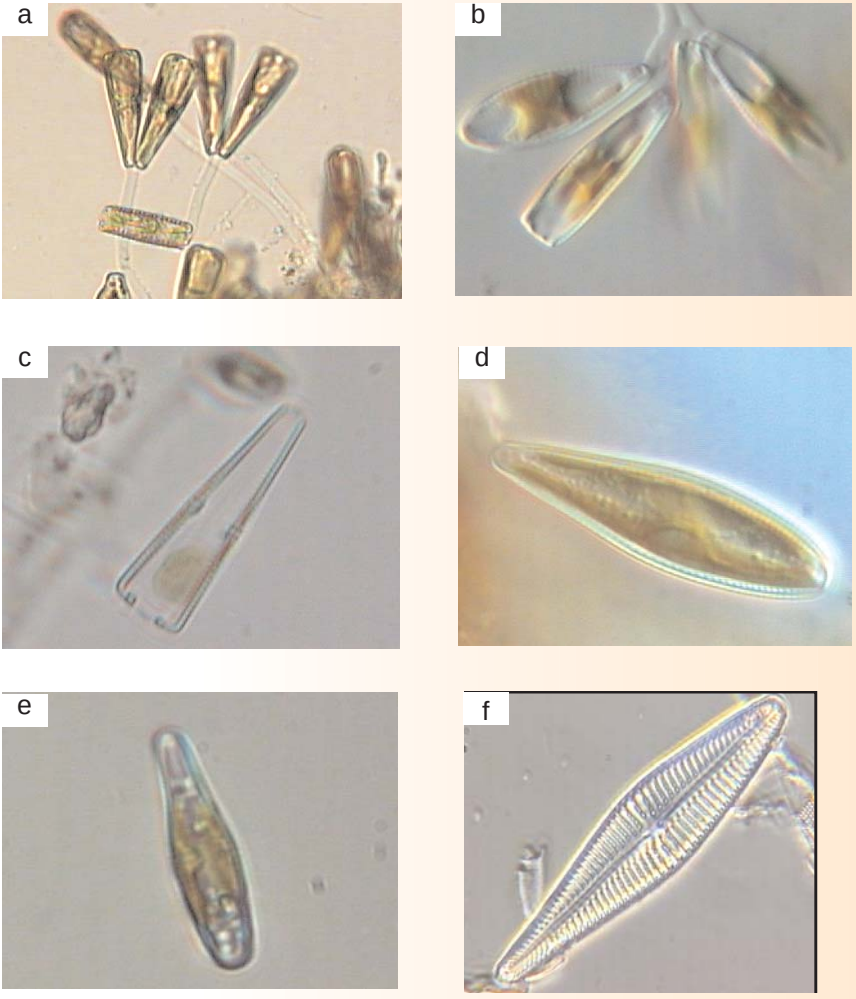
Characteristics: The cells of *Gomphonema* are somewhat clavate (club-shaped) to linear-lanceolate in valve view and wedge-shaped in girdle view (transversely asymmetrical). The elongate axial field is enlarged in the mid-region where there is often an eccentric, coarse punctum (stigma). There are coarse striae extending inward from the valve margins. The cells contain numerous discoid chloroplasts.

Dimensions: Cells are 8-120 μm long and 3.5-17 μm wide.

Ecology: Species of *Gomphonema* are very common epiphytes found attached to substrata by branched, gelatinous stalks originating at their narrow, or base, end. They occur in a wide range of mostly fresh waters including those enriched with sewage.

Notes: Generally an easy genus to identify under the light microscope, however, species within *Gomphonema* have a tendency to display a high degree of morphological variability which can make reliable identifications to species level difficult.

Problems: None known of.



Caption: *Gomphonema* spp. with club-shaped cells. Note the mucilage stalks in photos a and b that are used for attachment by members of this genus.

Gyrosigma Hassall

Origin: From Greek *gyros,* "a circle" and *sigma,* "S - Greek letter S".

Characteristics: *Gyrosigma* cells occur singly. Valves are linear to lanceolate s-shaped (sigmoid) and have rounded ends. The striae are fine and run both parallel to the raphe and transverse to it. The raphe is narrow and s-shaped. In girdle view the frustules are lanceolate. There are two chloroplasts that lie on opposite sides of the girdle and partly overlap the valve face. The chloroplasts may have a smooth or irregular outline and generally contain several pyrenoids.

Dimensions: Cells are 60-400 μm long and 11-40 μm wide.

Ecology: Species within this genus are often found in dense algal mats growing on the bottoms of lakes and dams. These mats may become dislodged and float up from the bottom, bringing cells into the plankton. This genus may be found living in freshwater, brackish and marine habitats.

Notes: *Gyrosigma* is a relatively common genus. Both *Gyrosigma* and another diatom genus *Pleurosigma* Smith are large s-shaped naviculoid diatoms easily recognised under light microscopy. The longitudinal and transverse striae in *Gyrosigma* cross at right angles, whereas the striae run obliquely to the main axis in *Pleurosigma*.

Problems: None known of.

Caption: Gyrosigma spp. (photos a-e), distinctive s-shaped cells with rounded ends.

Melosira Agardh

Origin: From Greek *melon,* "apple" + *seira*. “chain”.

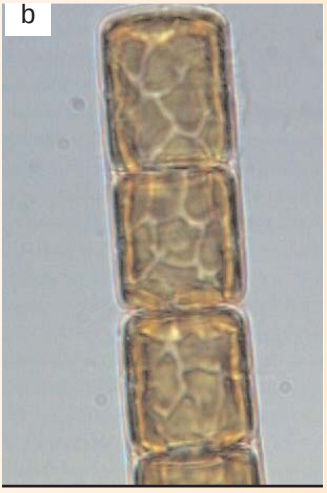
Characteristics: The valves of individual cells are joined by mucilage secreted from the valve centre to form cylindrical filaments. Similarly, the cells may also be attached to a substrate by mucilage pads. Elongate spines such as those found in *Aulacoseira* Thwaites are lacking. Cells are cylindrical, generally a little longer than wide. The valve surface contains many small pores. These pores are not often visible under the light microscope and the valves appear completely without markings, like the bottom of a glass beaker. In each cell there are several lobed dark-brown chloroplasts.

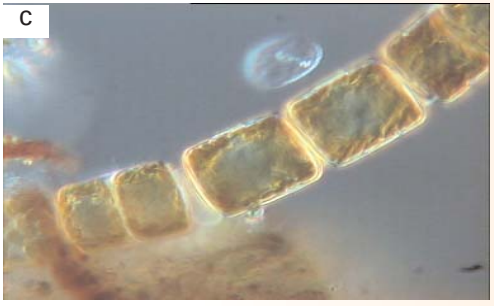
Dimensions: 8-40 μm in diameter.

Ecology: Common in shallow still waters, especially if fresh to brackish and slightly eutrophic. Only one species of *Melosira,* namely *M. varians* Agardh, is commonly found in freshwater. *M. varians* is a common benthic form but may often be swept into the phytoplankton.

Notes: Cells of *Melosira* are more commonly observed in girdle view and have the appearance of "44 gallon drums". These cells are easily recognised under light microscopy.

Problems: Filter clogging.





Caption: *Melosira varians* Agardh often occurs as cylindrical filaments (photo a & b). These filaments may be attached to a substrate (photo c) and are easily recognisable by their capsule-like appearance.

Navicula Bory

Origin: From Latin *navicula,* "small ship or boat".

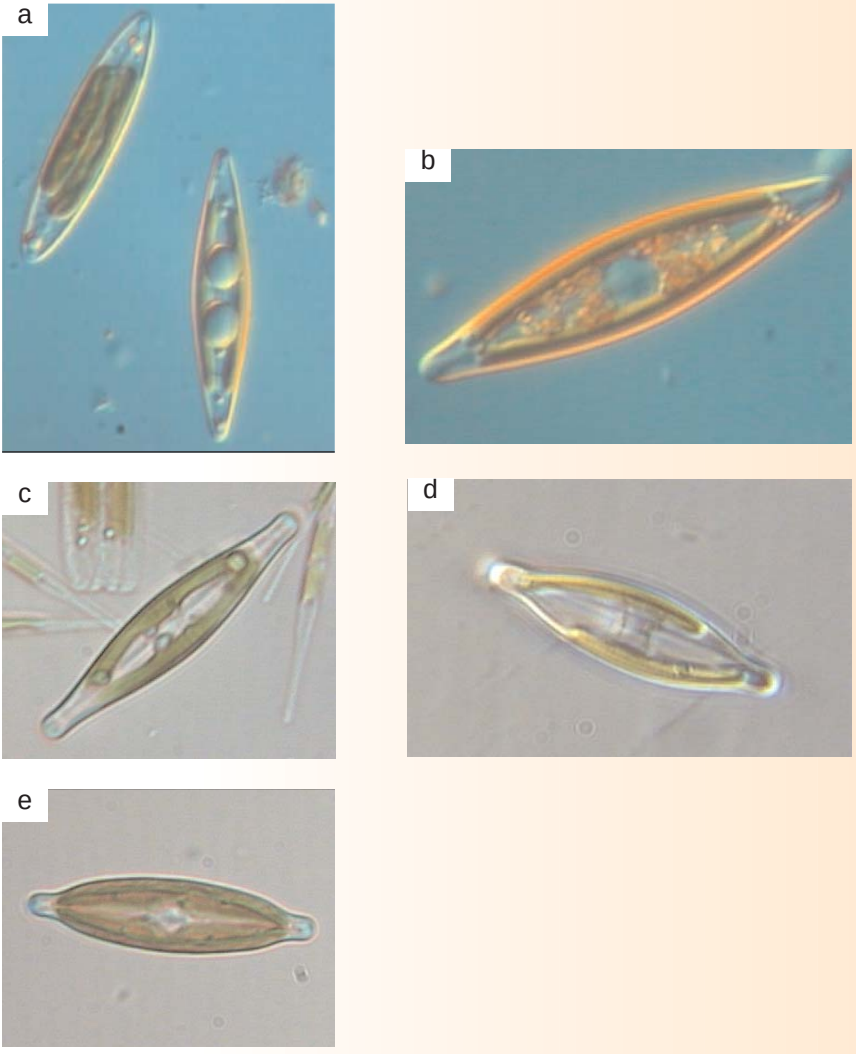
Characteristics: The cells vary considerably in shape, especially in valve view, but in the main they are naviculoid (boat-shaped) or cigar-shaped, and may have rounded, acute, or capitate ends. There is a raphe in both valves. Striae are composed of elongate (linear) punctae. These striae are usually not visible when live specimens are examined. In girdle view the cells are rectangular. All species have two chloroplasts, one on each side of the cell, when seen in valve view.

Dimensions: Cells are 6-42 μm long and 4-12 μm wide.

Ecology: *Navicula* is found in all types of waters from marine to freshwaters as well as in waters ranging from oligotrophic to eutrophic. Cells inhabit the plankton or benthos. In benthic habitats the cells may occur singly, in films on submersed substrates and sediments, or as colonies within a mucilage tube (e.g. *N. recens* (Lange-Bertalot) Lange-Bertalot). *Navicula,* like many other raphe-bearing diatoms, secretes mucilage from the raphe to enable the cells to glide along a substratum.

Notes: For many years, the genus *Navicula* has included a number of species that simply did not fit into other genera and is probably still to some extent an unnatural group. Recently, taxonomists have created new taxa to sub-divide this very large, diverse genus using differences in morphology. Some *Navicula* species are now part of the new genera *Cavinula* Mann and Stickle*, Chamaepinnularia* Lange-Bertalot and Krammer*, Craticula* Grunow*, Geissleria* Lange-Bertalot and Metzeltin*, Kobayasiella* Lange-Bertalot and *Sellophora* Mann.

Problems: Clog filters at water treatment plants.



Caption: *Navicula* spp. (photos a-e) with boat-shaped cells. Note the two distinctive chloroplasts, one on each side of the cell.

Nitzschia Hassall

Origin: Named after Christian Ludwig Nitzsch, a German naturalist.

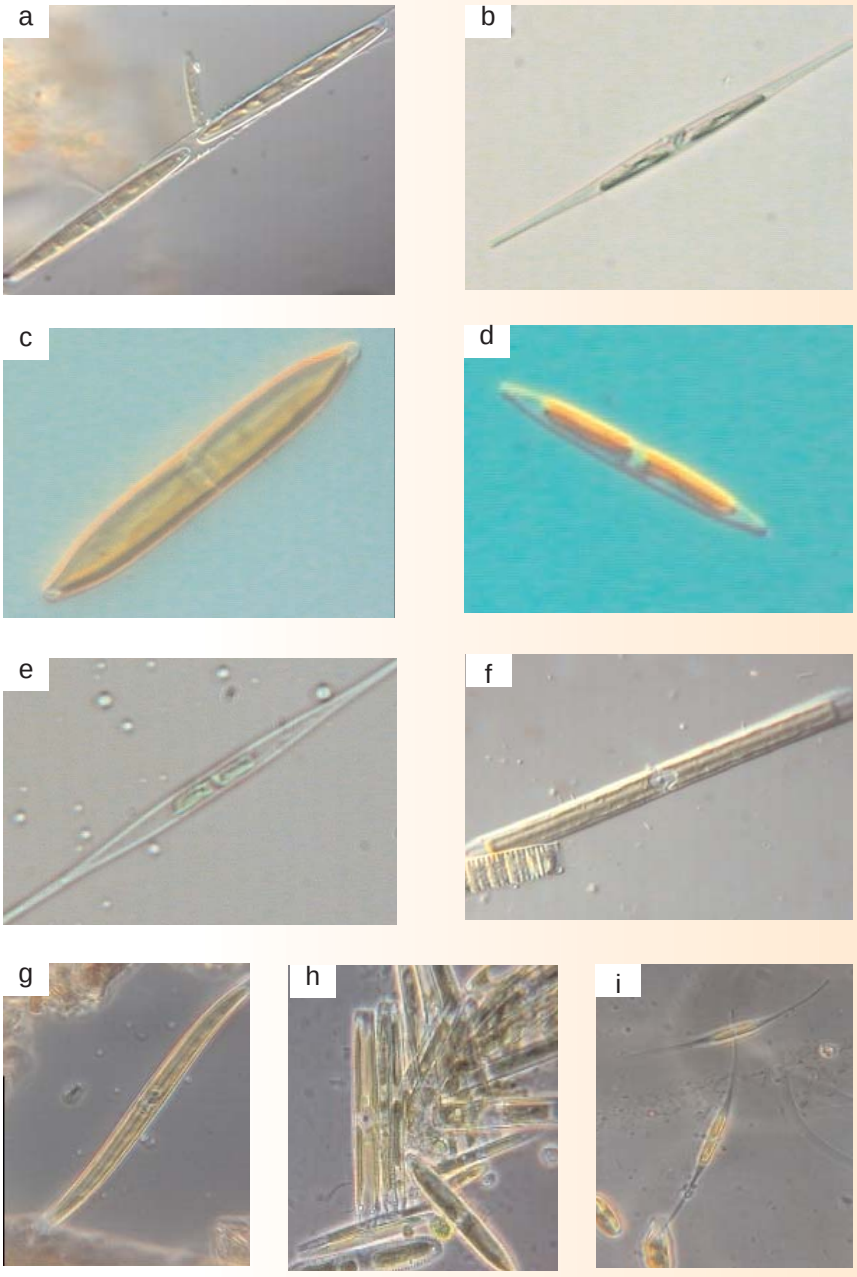
Characteristics: Although commonly solitary, *Nitzschia* may often occurs in gelatinous, tube-like strands (mucilage tubes). Cells of *Nitzschia* are elliptical, linear or sigmoid in valve view and have a raphe on each valve. The raphe is displaced to one margin, but the raphes of each valve are diagonally opposite. The raphe structure itself is supported by bars (fibulae) that appear as dots along the margin of the valve under light microscopy. These fibulae may nearly reach across the valve face in some specimens. There is no clear central area and the valve is decorated with transverse striae of punctae right across the valve. The punctae composing the striae may be fine or coarse. Two large chloroplasts are present.

Dimensions: Cells are 5-100 (exceptionally 600) μm long and 2.5-12 μm wide.

Ecology: *Nitzschia* is a large, diverse and ecologically versatile genus. They are mostly benthic, but include some planktonic taxa (e.g. *N. acicularis* (Kützing) W. Smith). The genus can yield much ecological information since several taxa are indicative of nutrient enrichment (eutrophication), while others are useful indicators of elevated salinities. *Nitzschia* may also occur in oligotrophic waters, but they are rarely a major component of these assemblages.

Notes: *Nitzschia* may be distinguished from *Navicula* Bory by having two chloroplasts at the ends of the cells instead of side by side. Identification to species level requires consideration of numerous characters that are not always clearly visible under light microscopy.

Problems: None known of.



Caption: *Nitzschia* spp. (photos a-i) with long, narrow cells. Note the two distinctive chloroplasts, one on each end of the cell.

Pinnularia Ehrenberg

Origin: From Latin *pinnula,* "small feather".
Botanical meaning: "A compound leaf that consist of pairs of leaflets arranged in two rows on either side of a central axis or mid-rib" cf. the arrangement of the striae in *Pinnularia*.

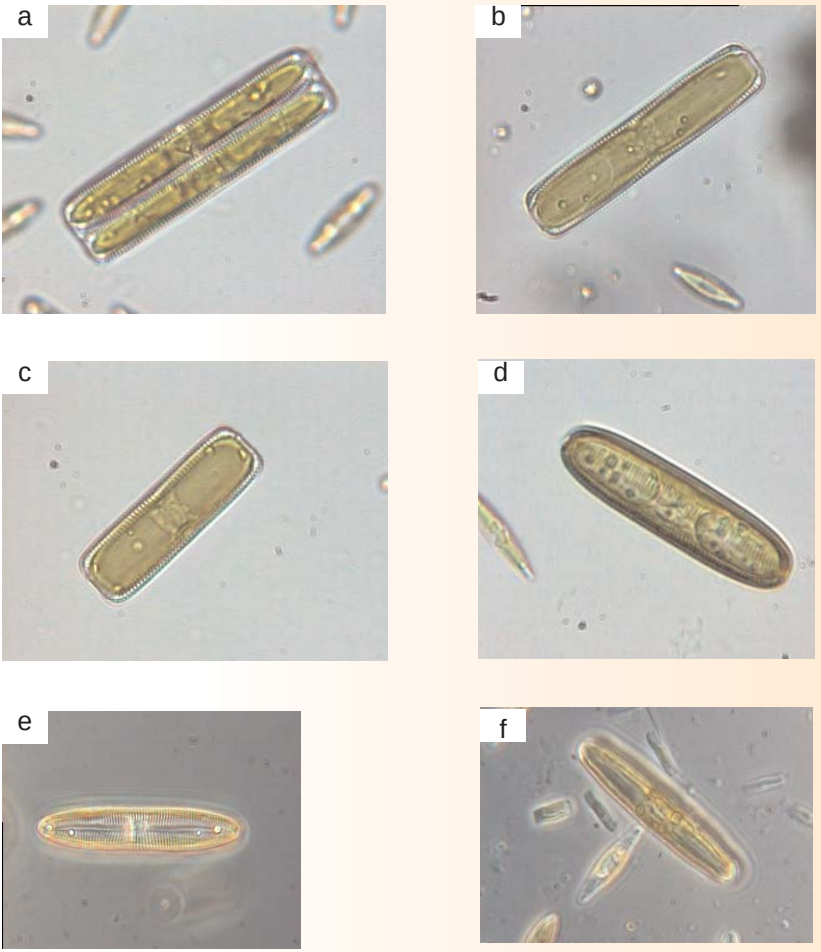
Characteristics: Cells of *Pinnularia* are linear to elongate-elliptical. Poles usually broadly rounded, capitate or rostrate. Frustules are biraphid with the raphe positioned centrally. The raphe fissure may be straight or curved. Centrally the raphe ends usually turn to the same side. There are two plate-like (flattened) chloroplasts. In girdle view the frustules are rectangular with truncate poles. A few species, especially *P. viridis* (Nitzsch) Ehrenberg have the characteristic habit of lying side by side (in valve view) in groups of 2 or 4.

Dimensions: Cells are 24-110 μm long and 5-18 μm wide.

Ecology: A very common benthic genus living on stones and sediment mainly in freshwater, they are often abundant especially in acid waters. Cells of *Pinnularia* may also be washed into the plankton.

Notes: *Pinnularia* resembles a large *Navicula* Bory with heavy bar-like striae and rounded ends. Some species have cells which are perhaps the largest among freshwater diatoms.

Problems: None known of.



Caption: *Pinnularia* spp. (photos a-f) with boat-shaped cells. Note the distinctive coarse compound striae which differentiate this taxon from *Navicula.*

Pleurosigma W. Smith

Origin: From Greek *pleuron,* "rib" and *sigma,* "the letter S".

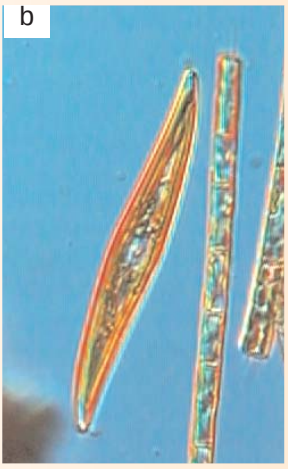
Characteristics: Valves are sigmoid (s-shaped) but not always markedly so, with pointed ends. The striae run obliquely to the raphe. The raphe is narrow and sigmoid. Two or more ribbon-like chloroplasts are present when the cell is viewed live.

Dimensions: Cells are 150-380 *µ*m long and 20-30 *µ*m wide.

Ecology: Cells of *Pleurosigma* are usually solitary, live in sedimentary or sandy habitats and are found in brackish waters, as well as in marine environments. This taxon may also be washed into the plankton of rivers and streams. A common and widespread genus, although usually encountered in low numbers.

Notes: Both *Pleurosigma* and another diatom genus *Gyrosigma* Hassall are large s-shaped naviculoid diatoms easily recognised under light microscopy. The longitudinal and transverse striae in *Gyrosigma* cross at right angles, whereas the striae run obliquely to the main axis in *Pleurosigma*.

Problems: None known of.



Caption: *Pleurosigma elongatum* W. Smith (photos a-c) with s-shaped cells. This is one of the few *Pleurosigma* species commonly encountered in fresh waters.

Rhopalodia Müller

Origin: From Greek *rhopalo,* "club".

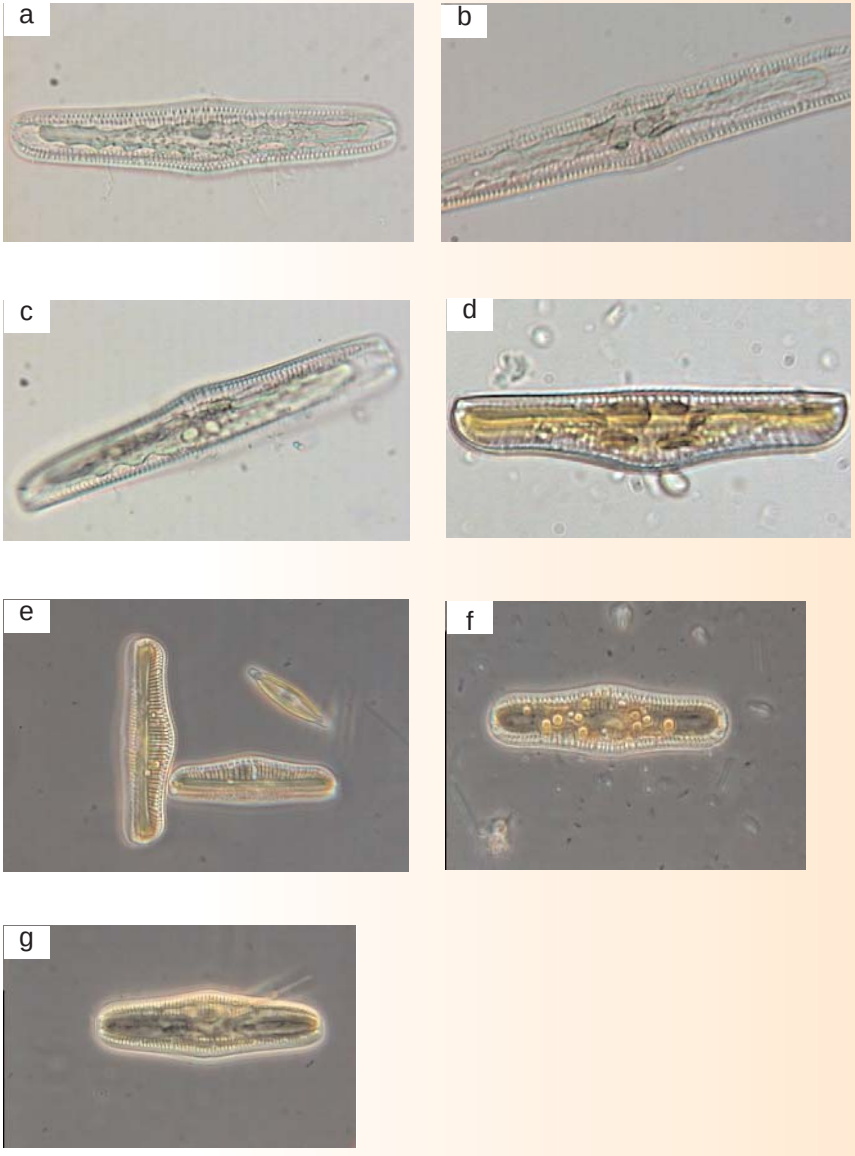
Characteristics: Frustules biraphid, distinctly dorsiventral, linear to arcuate (similar to an orange segment) often with turned down ends. Dorsal margin notched in some species. The valve bears a keel to one side and in this lies the raphe. In this genus, the cells are very different in shape as seen in girdle and valve views. In valve view the frustule is narrow with the poles bowed, giving the appearance of a "half-cell" with an enlargement on the mid-region of the convex margin. The girdle view is much wider than the valve view and may appear elliptical. The valves are coarsely costate (possessing transapical ribs), the costae alternating with the striae. The girdle is smooth. *Rhopalodia,* like other raphe-bearing diatoms, secretes mucilage from the raphe to enable the cells to glide along a substratum.

Dimensions: Cells are 22-300 μm long and 12-40 μm wide.

Ecology: The genus may be found in fresh waters as well as brackish waters. Species of this genus are found mostly in the benthos.

Notes: This is an easy genus to identify in light microscopy and is characterised by prominent transapical costae or ribs. Some *Rhopalodia* species are known to contain small endosymbiotic cyanophytes.

Problems: None known of.



Caption: *Rhopalodia gibba* (Ehrenberg) Müller (photos a-g) with distinct "half cells". Note the characteristic swelling in the mid-region of the cell.

Stephanodiscus Ehrenberg

Origin: From Greek *stephanos,* "crown" and Latin *diskos,* "disk".

Characteristics: Cells of *Stephanodiscus* are disc or barrel-shaped. The valve face is undulate with either the centre raised or depressed compared with the margin. The valve surface is covered with radiating rows of fine punctae (fascicles) almost reaching the centre and alternating with clear smooth zones (inter-fascicular costae). The central area has less well defined rows of punctae. A ring of short spines is found immediately within, but extending beyond, the valve margin. In some species, delicate organic threads that are quite long, may radiate outwards from special structures (fultoportulae) found below the spines. The girdle view (rectangular) is smooth. The chloroplasts are discoid and numerous.

Dimensions: Cells are 5-35 μm in diameter.

Ecology: Species of *Stephanodiscus* are common in freshwater (some extending into brackish waters). They may be abundant, particularly in eutrophic water where they may be used to indicate nutrient enrichment (eutrophy). Cells are found in the plankton and may be solitary or occur in short chains.

Notes: The taxonomy of *Stephanodiscus* has been subject of considerable discussion and species are difficult to distinguish using light microscopy as the diagnostic features can only reliably be viewed using Scanning Electron Microscopy.

Problems: Blooms, filter clogging.

a

b

c

Caption: *Stephanodiscus agassizensis* Håk. and Kling (photos a-c), a distinct disc-shaped cell with strongly curved valve face similar to the hubcap on a car's wheel.

Surirella Turpin

Origin: Uncertain.

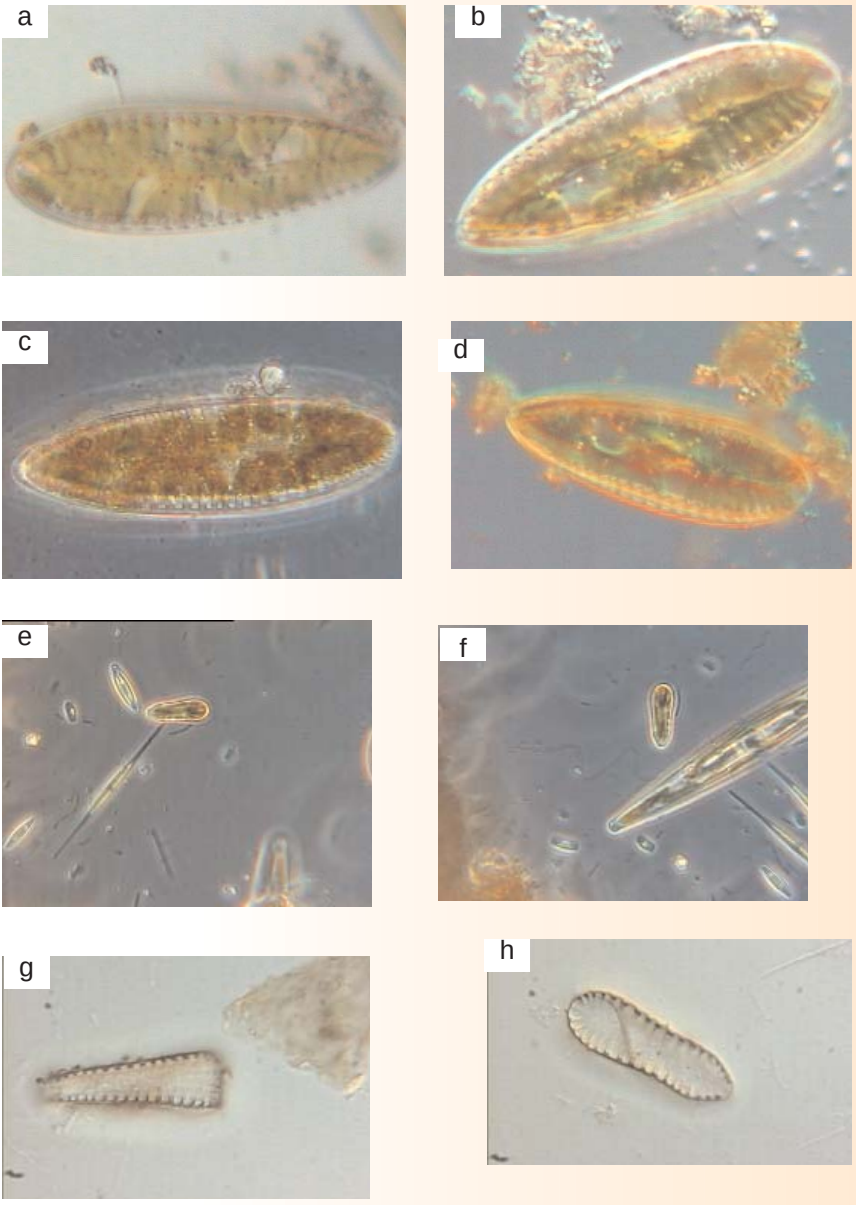
Characteristics: Cells of *Surirella* are solitary and wedge-shaped in girdle view. In valve view they are mostly ovate to egg-shaped and heteropolar with the upper end broadly rounded and the lower end more sharply pointed. Occasionally the cell may be constricted at the centre. The raphe system is around the margin and supported by raised ribs which give rise to the rib-like markings around the valve margin. There is generally a hyaline (naked) area along the apical axis down the valve centre.

Dimensions: Cells are 16-120 μm long and 12-45 μm wide.

Ecology: It is a large and common freshwater to marine genus. Cells found in the benthos of hard waters, are rarely planktonic, and seldom abundant. Some species may tolerate very nutrient-rich conditions.

Notes: These egg-shaped or oval cells are usually identified readily by very prominent costae that extend from the margin as seen in valve view, with a clear, linear region along the axis.

Problems: None known of.



Caption: *Surirella* spp. (photos a-h), elongated oval-shaped cells with distinctive thickened marginal ribs

Synedra Ehrenberg

Origin: From Greek *synedria,* "a sitting together".

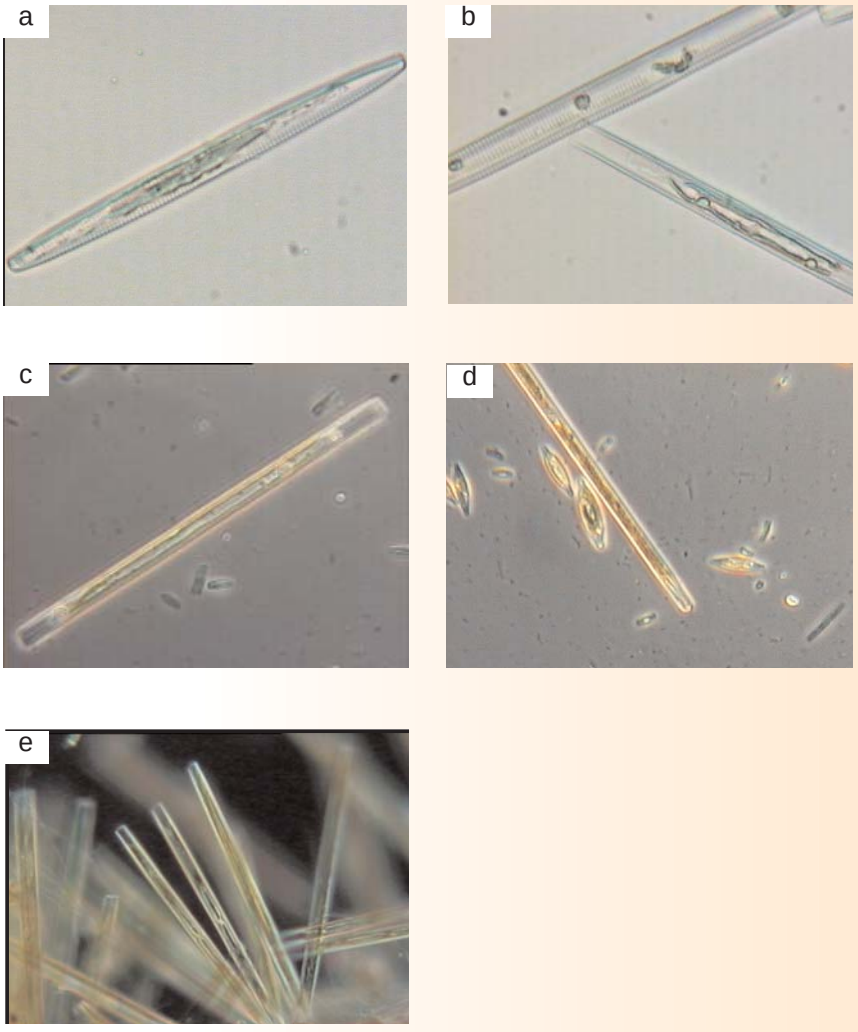
Characteristics: Cells occur singly or in radiate colonies. In the colonies the cells are clustered together at one point by a common mucilage pad that is secreted from a pore field on each cell. Individual cells are long, relatively narrow and needle-like. The cells are usually distinctly linear in outline, sometimes tending towards linear-lanceolate, with more or less capitate ends. The valves are covered by rows of striae which have distinct areolae. At the valve centre, the striae are often occluded, appearing as ghost structures. An apical pore field is present through which the mucilage pad is secreted. Each cell has two long, plate-like plastids.

Dimensions: Cells are 60-500 μm long and 5-9 μm wide.

Ecology: *Synedra* species may occur free-living, inhabiting the plankton of freshwater lakes, dams and rivers. Species of *Synedra* such as *S. ulna* (Nitzsch) Ehrenberg and *S. acus* Kützing may tolerate a broad range of water quality conditions, including eutrophy and organic enrichment. However, they are principally restricted to fresh or slightly brackish waters.

Notes: This is a very easy genus to recognise under light microscopy on account of the large, typically linear cells that usually occur singly or in radiate colonies. The cells appear rectangular when viewed from the girdle or side.

Problems: Filter clogging.



Caption: *Synedra ulna* occurring as single cells (photos a-d) or radiate colonies (photo e) Individual cells are easily recognisable by their needle-like shape in valve view (photo a) or rectangular appearance in girdle view (photos b, c and d).

Tabellaria Ehrenberg

Origin: From Latin *tabella*, "small board".

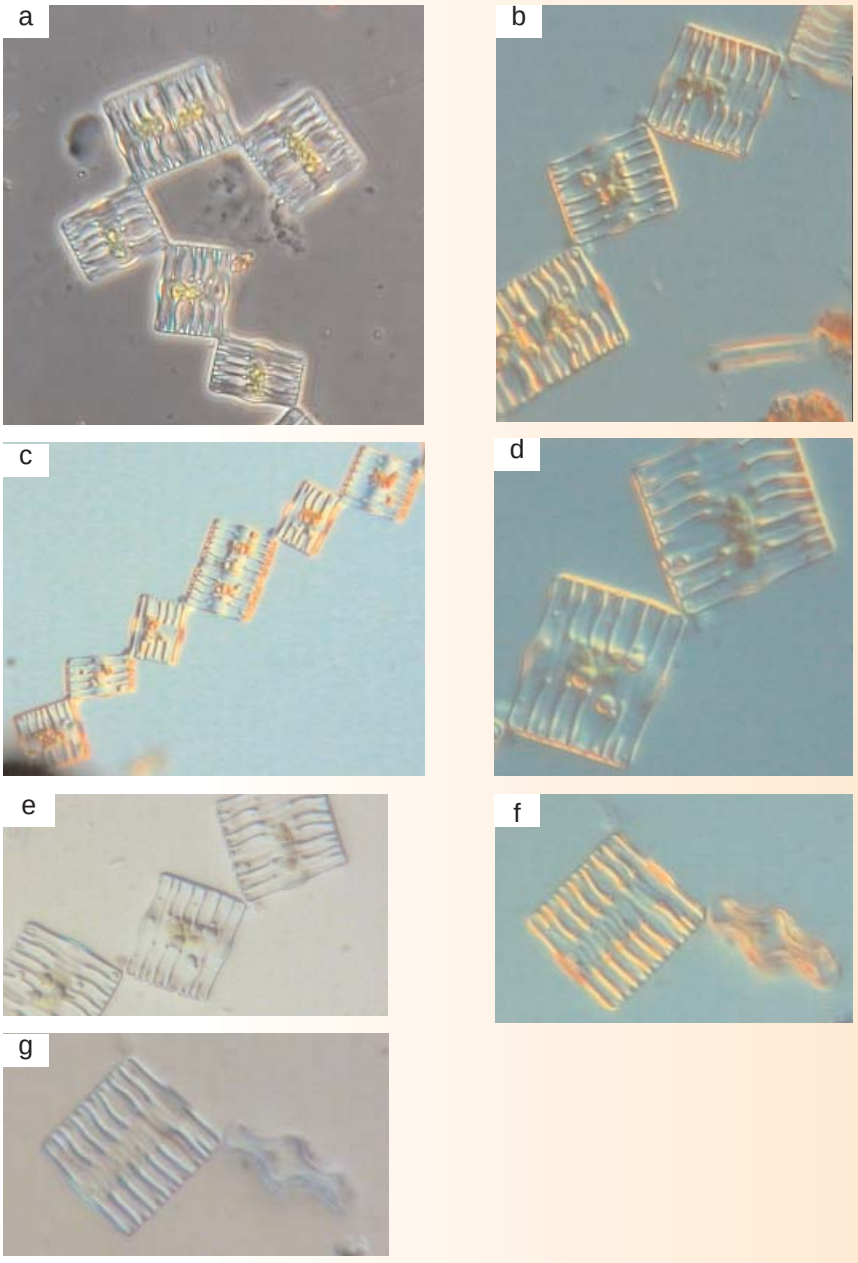
Characteristics: The cells of *Tabellaria* are usually seen in girdle view and are square to oblong in shape. Many septa are present on the girdle bands, extending almost half the length of the cell, giving the impression of a number of cells joined valve to valve, instead of a large single cell as is the case. In valve view the cells are elongated with capitate apices and are inflated in the central region. Short strip-like chloroplasts lie between the septa.

Dimensions: Cells are 6-130 μm long and 4-8.5 μm wide.

Ecology: Species of *Tabellaria* are common epiphytes and may also occur in the plankton. The cells are attached to each other, and the substrate, by mucilage pads at the corners of the cells. The colonies are zigzag-shaped or stellate. Often found in oligo- to mesotrophic, electrolyte-poor, slightly acid or circumneutral waters.

Notes: Generally an easy genus to identify under the light microscope, however, it may be confused with *Diatoma*, which also forms zigzag colonies. *Diatoma*, however, is more elongated (oblong) in girdle view, has clearly visible costa on the valve margin and lacks the characteristic septa of *Tabellaria*.

Problems: None known of.



Caption: *Tabellaria flocculosa* (Roth) Kützing (photos a-g) with zigzag colonies. Note the characteristic septa on the girdle and the attachment of the cells at the corners.

Cryptophyta

Cryptophyta

Cryptophyta

Cryptophyta

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Cryptophyta

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Cryptophyta

Cryptomonads

Cryptos comes from Greek and means "hidden", and *phyta* refers to "plant". Cryptophyta are commonly referred to as cryptomonads. The Cryptophyta is a small group of eukaryotic algae whose members consist of unicellular organisms that are asymmetrical, flattened dorsiventrally and generally heart- or leaf-shaped. Cells appear mostly olive-brown, blue-green or sometimes red in colour due to photosynthetic pigments that include, amongst others, chlorophyll-*a* and *c*, *alpha*-carotene and phycobilin pigments (phycoerythrin and phycocyanin). The phycobilin pigments are not located in phycobilisomes as they are in the Cyanobacteria, but in the lumen of the thylacoids. Colourless forms are also present. All cells are motile by means of two, slightly unequal, flagella. At the anterior end of the cell, near the base of the flagella, there is an opening known as the gullet (although they do not take in solid food). The gullet is lined with ejectisomes (explosive organelles), called trichocysts. There are usually two chloroplasts in each cell. Underneath the cell membrane a proteinaceous cell covering (pellicle) is present in the form of plates. The food reserves are starch-like. The genera are easy to recognise, but the species are usually difficult to determine. Cryptophyta are widespread and often abundant and occur in both marine and freshwater environments. Cryptomonads are often used to feed small zooplankton, which is the food source for small fish in fish farming.

Cryptomonas Ehrenberg

Origin: From Greek *kryptos*, "covered, hidden, concealed" + *monas*, "unit".

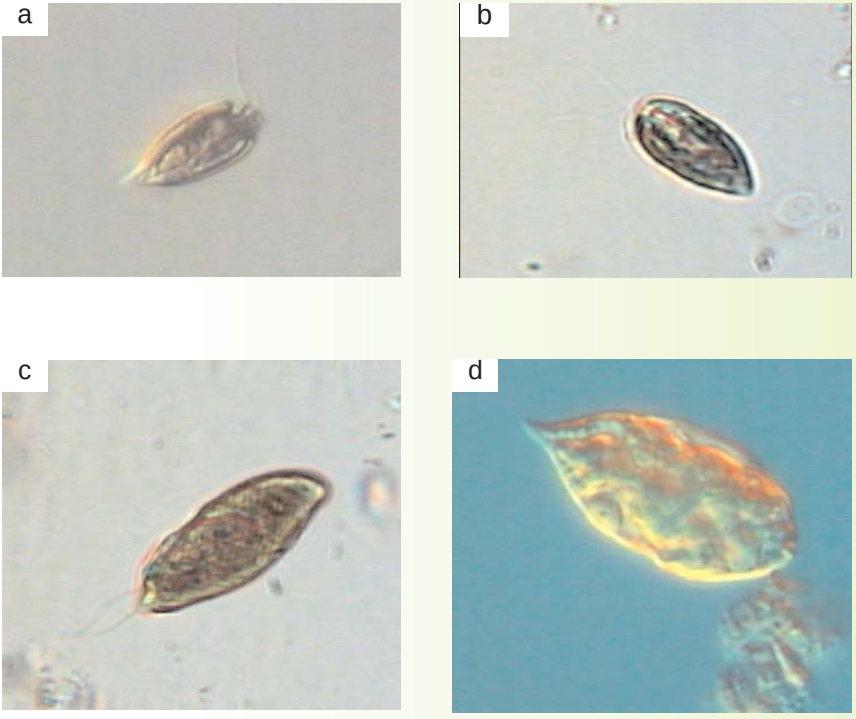
Characteristics: *Cryptomonas* is the name-giving genus of the cryptomonads. These organisms are easily overlooked in dense mixtures of algae. Cells are solitary, dorsiventrally flattened (slightly concave on the ventral side and convex on the dorsal side), and the cell body is commonly slipper-shaped, being broader at the anterior end. Cells can also be elongated, ovoid or elliptical and they have one or two large olive-brown, olive-green or yellowish-green chloroplasts that are laterally arranged in the cells. In the anterior end of the cells 1 to 3 contractile vacuoles are present. Underneath the cell membrane there is a firm pellicle consisting of proteinaceous plates. Cells are fast-moving by means of two unequal flagella arising from a gullet, a longitudinal furrow extending inwards from the anterior end. When the organisms are slowed in their movement, and under proper optical conditions, the characteristic gullet is easy to observe, especially when the organisms rotates on its axis. The gullet is lined with trichocysts, looking like rows of spots.

Dimensions: Cells 15-80 μm long.

Ecology: *Cryptomonas* is reported rarely but it is widespread and common in freshwater habitats, where they are free-floating. They usually occur in small to moderate numbers, especially in organically enriched waters.

Notes: Species of *Cryptomonas* are difficult to determine. *Chroomonas* Hansgirg is morphologically very similar to *Cryptomonas* but it has no gullet, is relatively smaller, the flagella are of equal length (the flagella of *Cryptomonas* are unequal) and the chloroplast is blue-green in colour. *Chilomonas* Ehrenberg is another cryptomonad genus very similar to *Cryptomonas*, but it lacks chloroplasts. *Rhodomonas* Karsten, the other common member of the cryptomonads, is much smaller (10-15 µm) than *Cryptomonas* with as single red chloroplast containing a large, centrally positioned pyrenoid.

Problems: None known of.



Caption: *Cryptomonas*, a single celled organism that is motile by means of two flagellae implanted at the anterior (rounded) end (photo c). Note the two laterally arranged chloroplasts in photos a and b.

Rhodomonas Karsten

Origin: From Greek *rhodon*, "rose, red" + *monas*, "unit".

Characteristics: The gullet of this genus is granulated, there is one bilobed chloroplast (mostly red or golden-brown to olive-brown) with a single, central pyrenoid and two slightly unequal flagella.

Dimensions: Cells 8-15 µm long, 3-8 *µ*m wide.

Ecology: Occur in freshwater. *R*. *lacustris* var. *nannoplactica* is probably cosmopolitan and frequently found in the plankton of lakes and small water bodies.

Notes: Great confusion exists regarding the taxonomy of *Rhodomonas*. Sometimes this taxon is also assigned to the genus *Plagioselmis* Butcher *emend*. Novarino and sometimes to the genus *Pyrenomonas* Santore. For further discussion on the taxonomic and nomenclature problems associated with *Rhodomonas*, see Javornický (2001). The most common representative of the genus, is *R. lacustris* var. *nannoplanctica* which has heart-shaped cells with the anterior end rounded and posteriorly prolonged into a conical tail, one-tenth to one-fifth the cell length. The cells of *R. lacustris* var. *nannoplanctica* (Skuja) Javornický are pale olive-brown in colour. A conspicuous refractive granule in the tail is a useful aid to recognition.

Problems: None known of.

Caption: *Rhodomonas*, indicated by the yellow circle. Note the small cell size (compared to *Cryptomonas*), the two flagellae and the central pyrenoid.

Dinophyta

Dinophyta

Dinophyta

Dinophyta

Dinophyta

Dinophyta

Dinophyta

Dinophyta

Dinoflagellates

Dinophyta comes from the Greek word *dineo,* which means "to whirl" and *phyta* that means "plant". Representatives of Dinophyta are commonly referred to as dinoflagellates. In systematics, dinoflagellates have been claimed by both botanists and zoologists because they share features common to both plants and animals (they can swim, many have cell walls, and both photosynthetic and non-photosynthetic species are known). Representatives are eukaryotic and unicellular and exhibit a wide variety in morphology and size. Autotrophic species are usually golden-brown in color and possess the green pigments chlorophylls *a* and *c*, and golden-brown pigments such as peridinin. About half of the dinoflagellates are, however, colourless and their nutrition varies from heterotrophy (absorption of organic matter) to mixotrophy (cells engulf other organisms). The name "dinoflagellate" refers to the forward whirling and spiraling swimming motion of these organisms. The movement is accomplished by two flagella implanted in grooves on the cell surface. One flagellum is directed backwards and the other stretches around the center of the cell. Dinoflagellates are often covered with armour-like cellulose plates within the cell membrane. The presence of these thecal plates differentiates dinoflagellates from other algal groups and the arrangement of the plates is used in distinguishing genera and species within the group. The cell covering of unarmoured (naked) species is comprised of a membrane complex. Dinoflagellates primarily exhibit asexual cell division, but some species reproduce sexually, while others have unusual life cycles. Dinoflagellates are important members of the phytoplankton in marine and freshwater ecosystems (majority of species are found in sea water). They are usually free-swimming, but some may be benthic, living attached to sediments, sand, corals, macroalgal surfaces or to aquatic plants. Some species live symbiotically with, or parasitic on, other organisms. Blooms of dinoflagellates can cause sea water to turn a reddish-brown colour (known as "red tide") during which certain species produce neurotoxins. These toxins are carried up the food chain, ultimately to humans and can, sometimes result in permanent neurological damage or even death. In general, the species are hard to identify and need specialist keys.

Ceratium Schrank

Origin: From Greek *keration,* "small horn".

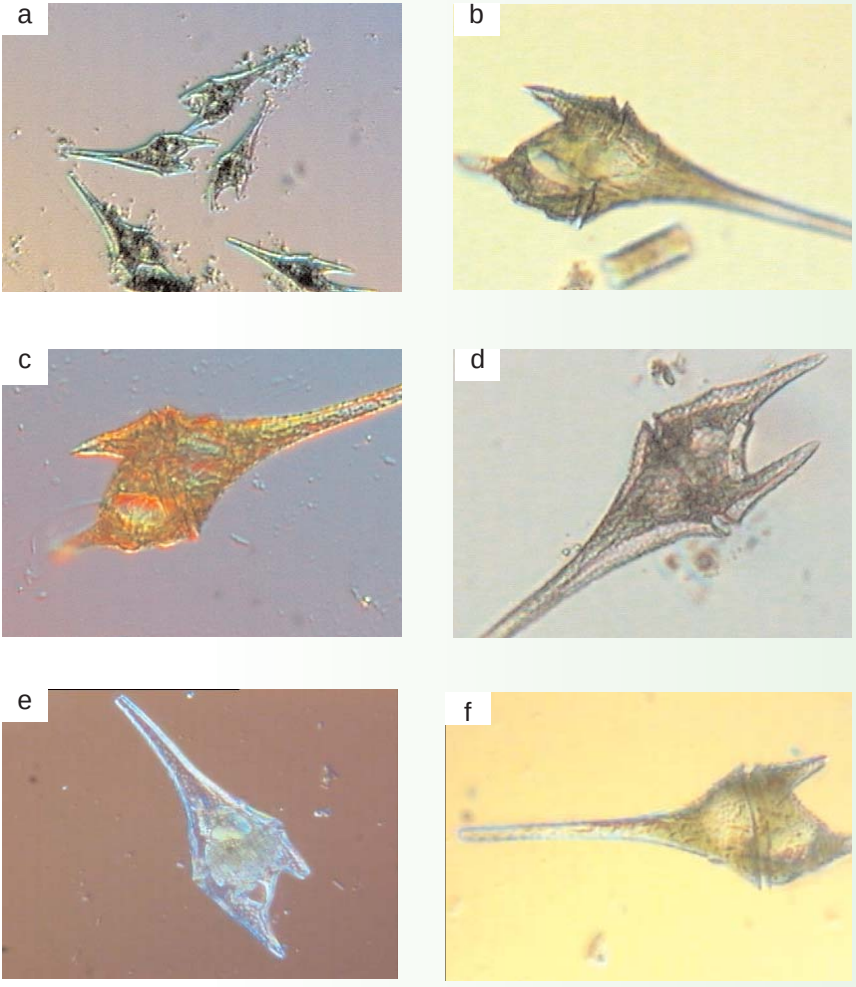
Characteristics: *Ceratium* cells possess such a distinct shape that the genus can be identified readily. Cells are large, strongly flattened and may be curved if viewed from the end. There is one anterior process (horn) and one to three posterior processes. There is a narrow, but obvious, transverse furrow (the cingulum) across the middle of the cell that houses the vibrating, band-like transverse flagellum. A much more shallow, less obvious furrow (sulcus) leads downwards (the bottom being taken as the part with 2-3 horns) from a flatter area in the centre that houses the trailing ventral flagellum. *Ceratium* swims relatively slowly. Numerous small yellow-brown to brown, disc-shaped chloroplasts are present. The body is covered by a specifically arranged series of thecal plates, which are smooth or bearing reticulations.

Dimensions: Large cells of up to 450 μm long and 30-100 μm wide.

Ecology: Free-swimming in freshwater and marine habitats. They are widely distributed in the eu- or tychoplankton of enriched eutrophic lakes and ponds where they may dominate. During bloom formation *Ceratium* often produces a brown discoloration of the water. *Ceratium* is the most common of all the freshwater dinoflagellates, while *C. hirundinella* (Müller) Bergh is the most common freshwater species, usually (but not always) having three posterior horns.

Notes: Cysts are commonly produced at the end of the growing season. Cysts are without the long horns, but are dense, thick walled and often with short spiny processes.

Problems: It has been reported as imparting taste and odour to the water.



Caption: Cells of *Ceratium hirundinella*, a large dinoflagellate with a very characteristic shape. Some of the thecal plates are extended into horn-like protuberances. Note the position of the cingulum and sulcus grooves that are clearly visible in photo b.

Peridinium Ehrenberg

Origin: From Greek *peridineo,* "to whirl around".

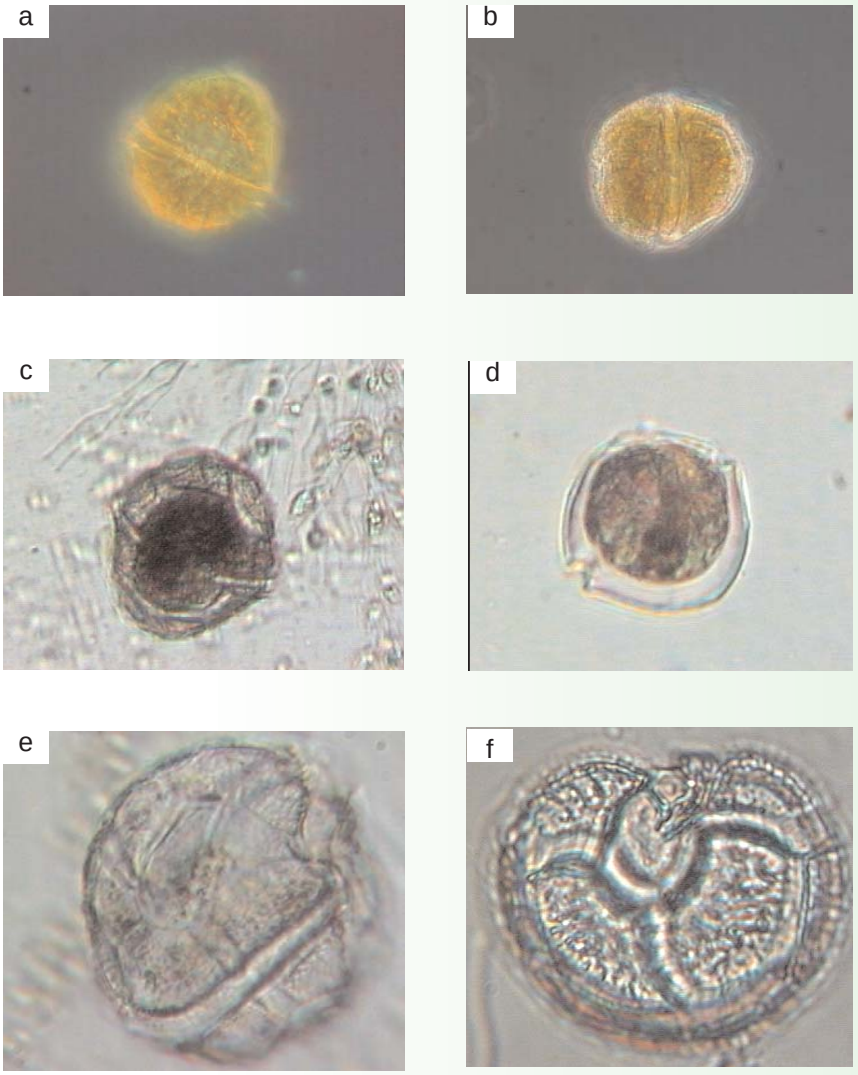
Characteristics: *Peridinium* is a medium to large sized dinoflagellate. The cells are more or less round to oval-shaped, and slightly flattened when seen from the side (convex dorsal surface and a concave ventral surface). Most cells are without horns, although a few species may possess dorsal flanges and distinctive horns. Grooves on the cell surface are quite noticeable, and the cingulum groove (encircling the cell) is deep and nearly at the cell median. Most representatives are photosynthetic with numerous yellowish-brown chloroplasts. Flagella are implanted in the cingulum and sulcus grooves. The cells are enclosed in a number of thick, angular thecal plates. The thecal plates are generally smooth or reticulated and sometimes small groups of spines may be present. Often the apical view shows a terminal pore. Species are differentiated by shape and size of the cell, and by the number, shape and arrangement of the thecal plates.

Dimensions: 10-100 μm long, 15-90 μm wide.

Ecology: *Peridinium* is a free-swimming, widespread and common dinoflagellate which may be abundant in the plankton of ponds, lakes and rivers. Most species are found in fresh or brackish waters, and cannot tolerate high salinity levels. The genus is nearly cosmopolitan in hard waters rich in calcium, but can also be found in waters of low pH and low nutrients.

Notes: Most researchers agree that *Peridinium* should be separated into two genera. The first group would include large cells (as much as 65 μm in diameter) with three intercalary plates. The second group would have significantly smaller cells less than half that size, with only two intercalary plates. For the proper identification of *Peridinium* species, it is essential to be able to observe the number and arrangement of the thecal plates on the surface. Similarly shaped but unarmoured (naked) cells are likely to belong to the genus *Gymnodinium* Stein. Resting cysts may be produced.

Problems: Some species may form large, conspicuous blooms. It can be responsible for taste and odour problems.



Caption: Cells of *Peridinium* may be fairly large or medium-sized, depending on the species. When cells are dead and the inner contents released, the prominent thecal plates are clearly visible (photos e and f). Living cells are usually yellow-brown in colour. The position of the cingulum groove is clearly visible.

Sphaerodinium Woloszynska

Origin: From Greek *sphaira,* "ball" + *dinein,* "to whorl".

Characteristics: Cells are generally round in ventral view, sometimes dorsiventrally flattened. The epitheca and hypotheca are more or less equal in size, separated by a shallow cingulum groove. There are numerous discoidal, yellow-brown to brown chloroplasts and some species possess a large eyespot. The cell covering is thin with delicate, smooth or lightly ornamented plates (these plates are sometimes difficult to see with the light microscope).

Dimensions: Cells are 42-53 μm long and 32-46 μm in diameter.

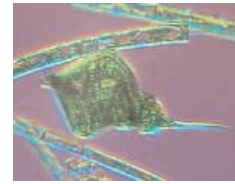
Ecology: Known from marine and especially freshwater habitats, where they are found free-swimming amongst the plankton of pools, peat bogs and occasionally in rivers.

Notes: The genus is sometimes considered a synonym of *Glenodinium* Ehrenberg *ex* Ralfs, based on the description of *G. cinctum* Ehrenberg. There were no plates originally figured for *Glenodinium,* but there is a known pattern for *Sphaerodinium* (4', 4a, 7'', 6''', 2''''). It is useful to maintain *Sphaerodinium* until *Glenodinium* can be defined by the arrangement of its thecal plates.

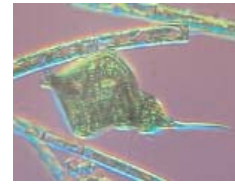
Problems: None known of.

Caption: *Sphaerodinium*, a delicate dinoflagellate covered with very thin thecal plates that are not readily observable with an ordinary light microscope. The position of the cingulum groove is visible more or less in the middle of the cell.

Euglenophyta



Euglenophyta



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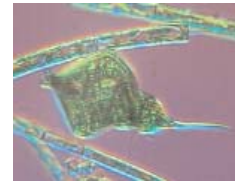
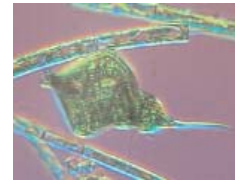
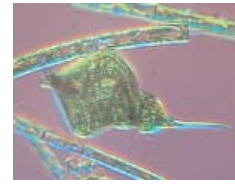


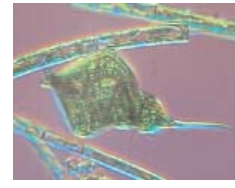
Euglenophyta



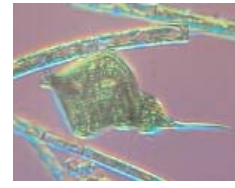
Euglenophyta



Euglenophyta



Euglenophyta



Euglenophyta

Euglenoids

The phylum Euglenophyta is named after the common genus *Euglena*, which, in turn, comes from Greek, *eu* meaning "well, good or true" and *glene,* referring to "eye". Representatives of the Euglenophyta are also sometimes called the euglenoids. The unicellular organisms have bright green chloroplasts (although colourless forms also occur) and a conspicuous red eyespot at the front end. The chloroplasts contain the pigments chlorophyll *a* and *b* and carotenoids. The cytoplasm contains many paramylon storage granules and a contractile vacuole (in freshwater members). On the inside of the cell membrane, the cells are covered by a pellicle composed of ribbon-like, helical arranged strips of proteinaceous material. The motile cells usually have two flagella inserted in a gullet at the anterior end of the cell, but one flagellum is short and mostly non-emergent. In most euglenoids only one flagellum is, therefore, clearly visible. *Euglena,* and some other euglenoids, are best known for their characteristic undulating, shape-changing motion, called metaboly. Most species live in freshwater environments. Euglenoids live in hard or soft water habitats of varied pH and light levels - mainly marshes, swamps, bogs and other wetlands with an abundance of decaying organic matter. Populations thrive under high nutrient levels and are, therefore, useful bio-indicators of such conditions. Euglenophyta may also be found in marine or brackish sand and mud flats, farm ponds, the digestive tracks of small aquatic creatures, and the interfaces of air and water, and water and sediment. Euglenoids usually reproduce asexually.

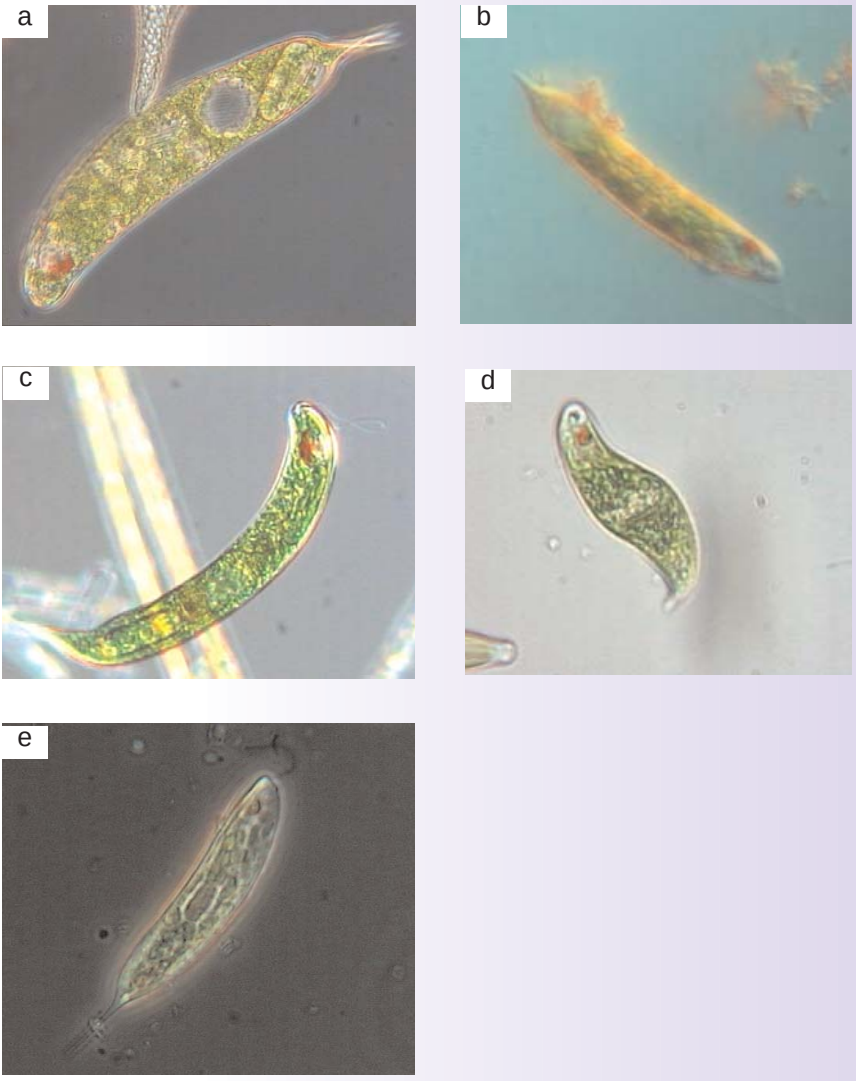
Euglena Ehrenberg

Origin: From Greek, *eu,* "well, good or true" + *glene,* "eye".

Characteristics: *Euglena* is unicellular with a spindle-shaped, cylindrical or oval body, consisting of a more or less pointed posterior end (opposite to flagella) and a rounded anterior end with a gullet. Cells are usually bright green due to numerous conspicuous chloroplasts that are often discoidal in shape, but it can also be ovate, lobate, elongate, U-shaped, or ribbon-shaped, occasionally with pyrenoids. Sometimes cells may be coloured red as a result of carotenoid pigments. Even though they are able to photosynthesize, *Euglena* cells also have a phagotrophic ingestion apparatus. At the anterior end of the cell, a prominent eyespot, used to sense light, is usually present (lacking in some species). In freshwater species one or more contractile vacuoles can be found near the base of the flagella. The cytoplasm contains numerous storage granules of paramylon that may vary in shape (they are often rod-shaped). Cells usually swim slowly by means of a single emergent flagellum implanted into the apical gullet. The second flagellum is short, located inside the gullet, and it does not emerge from the cell. Besides flagellar movement, some species are capable of contraction, thereby changing their shape (metabolic movement) and, thus creeping through the water. Other species are rigid and maintain a constant shape. The cell covering consists of a pellicle in the form of helically arranged, proteinaceous strips. *Euglena* reproduces asexually by splitting longitudinally from the anterior end. Identification of species is not easy and relies on characteristics associated with cell shape, pellicle markings, form and numbers of chloroplasts and paramylon bodies, as well as the presence or absence of pyrenoids.

Dimensions: Cells are 20-540 μm long and 5-50 μm wide.

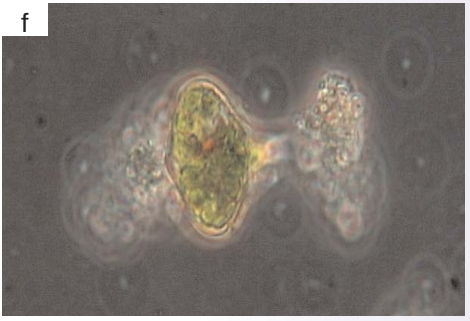
Ecology: *Euglena* is widespread and often abundant, occasionally colouring the water of ponds dark-green, or forming green films on the surface. These films may change from green to reddish in a few hours. *Euglena* is free-swimming in a wide variety of habitats - it can be found in almost any location where there is fresh or brackish water, e.g. ponds, lakes, streams, rivers. It thrives best in polluted or enriched environments, especially where there is an abundance of rich organic waste (from animal wastes or aquatic plants). Cells also live on organic-rich sediments. *Euglena* usually prefers high water temperatures.

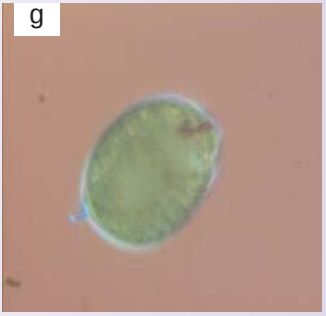


Caption: The general shape of the cell (rounded anterior end, pointed posterior end, numerous discoid chloroplasts and bright red eyespot) is illustrated best in photos a and c. Note the single, emergent flagellum and rod-shaped paramylon granule in photo c.

Notes: There are some species of *Euglena* that are bright red in colour (*E. sanguinea* Ehrenberg) and this is due to the presence of a carotenoid pigment, which can also be found in *Haematococcus* Agardh. *Euglena* can live as autotrophs or mesotrophs, when placed in darkness. As soon as they are re-introduced to light, however, the cells regain their chlorophyll.

Problems: Blooms (usually not harmful).





Caption: Cells of *Euglena,* a common genus in organic polluted waterbodies. Note the flagellum and paramylon granules in photo i. Metabolic movement (contraction) is performed by the cell in photo g.

Phacus Dujardin

Origin: From Greek *phakos,* "lentil".

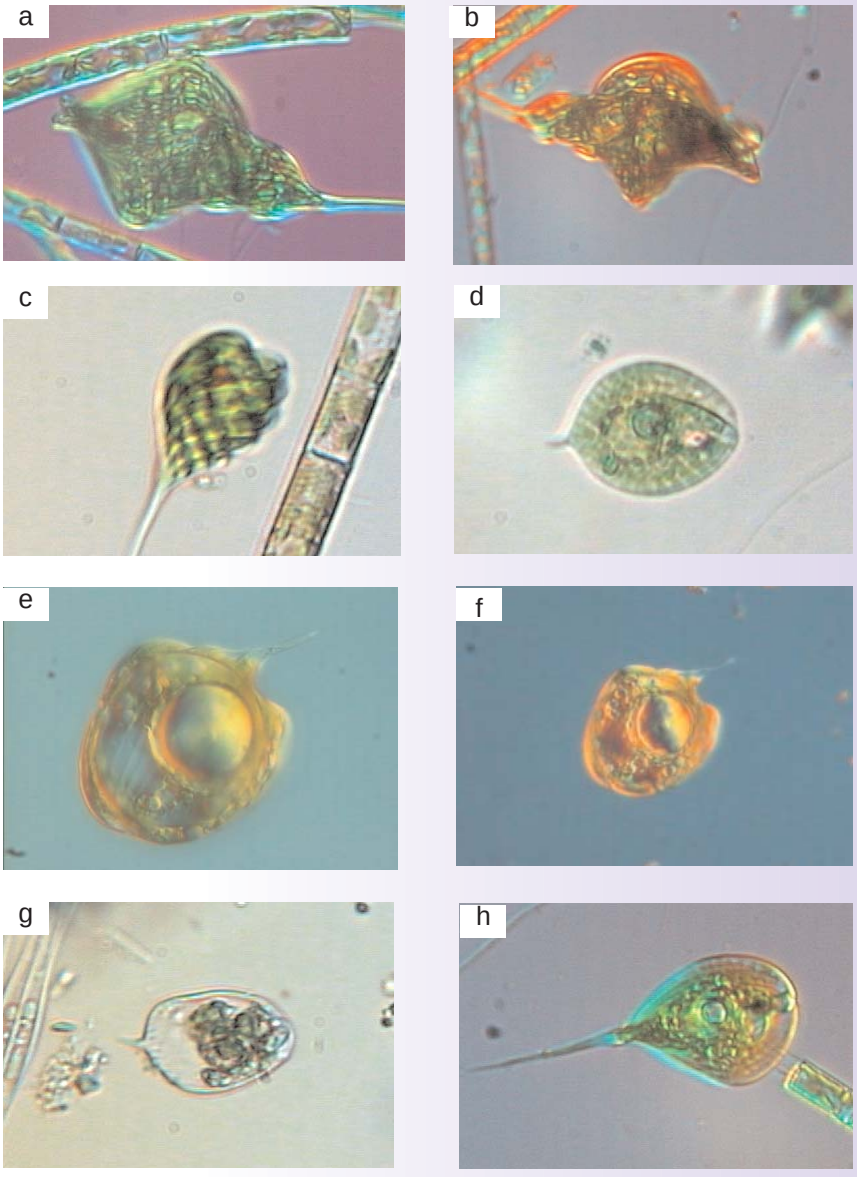
Characteristics: The cells are solitary, oval or ellipsoidal, pear- or spindle-shaped, often twisted along the longitudinal axis and much flattened (plate-like or leaf-like). Cells are rounded at the anterior end, with a straight or slightly bent tail of variable length (depending on the species) at the posterior end. Most species have discoidal chloroplasts that are small, numerous, and without pyrenoids, or large and discoidal with pyrenoids. There are one or two large paramylon bodies or several circular or elongated donut-shaped disks. An eyespot may or may not be present. Like other freshwater euglenoids, *Phacus* cells have contractile vacuoles. Cells are free-swimming by means of a single emergent flagellum which arises from an anterior invagination. As in *Euglena* Ehrenberg, a second shorter flagellum is non-emergent. The pellical strips are, unlike that of *Euglena,* longitudinal (stretching from pole to pole) and they are rigid (for this reason cells cannot change shape). Reproduction takes place by the longitudinal division of cells.

Dimensions: Cells are 10-140 μm long and 5-50 μm wide.

Ecology: *Phacus* is widespread and common and it is found in similar habitats to *Euglena* (farm-yard ponds, with rotting vegetation or in the plankton), but unlike *Euglena, Phacus* is not as common in stagnant environments. It often occurs free-swimming in freshwater habitats such as swamps, ditches, ponds and lakes. Cells are common in nutrient-enriched water.

Notes: *Phacus* is similar to *Euglena* but the cells are rigid, rather than plastic, and can't contract (perform metabolic movement). *Lepocinclis* Perty also has rigid cells and discoid chloroplasts, but differs in being unflattened and having two very large and conspicuous paramylon bodies. Colourless *Phacus*-like cells are placed in the genus *Hyalophacus* Pringsheim.

Problems: None known of.



Caption: Rigid cells of a variety of *Phacus* species. In some species the cells may be twisted (photos a, b and c), while they are flattened in others (photos d to h). Note the large paramylon granules clearly visible in photos e, f and h, the red eyespot in photo c, and the longitudinally arranged pellicle strips (visible in photos e and h). The single, emergent flagellum can be seen in photo b.

Strombomonas Deflandre

Origin: From Greek *strombos,* "a turban" + *monas,* "single organism" or "unit".

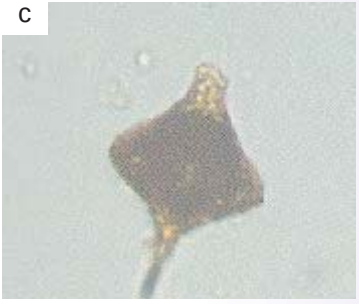
Characteristics: Cells are like that of *Euglena*, but surrounded by a yellow to brown coloured lorica (colour varies with the impregnation of iron and/or manganese) that tapers gradually toward the anterior, apical opening. The collar tapers to a somewhat narrower, straight or slightly flaring neck, resulting in a lorica that is spindle-, pear-, or urn-shaped, narrowing to a conical point at the posterior end. The chloroplasts are numerous, lateral, plate-shaped or polygonal, usually without pyrenoids. There is a single, slightly sub-apical emergent flagellum. The eyespot is large, situated close to the apical gullet or invagination. The protoplast usually occupies the entire lorica and the cell is capable of metabolic movement within the lorica. The taxonomy is based mostly on the structure of the lorica and the shape of paramylon granules may be used to separate species with similar loricas.

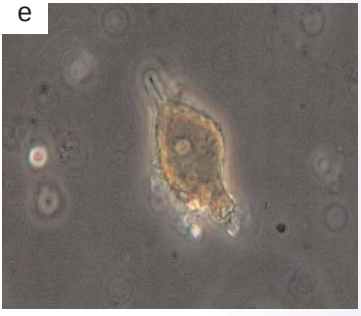
Dimensions: Loricas are usually 13-60 μm long and 18-30 μm wide.

Ecology: *Strombomonas* is cosmopolitan, free-swimming in freshwater and brackish-water ponds, ditches, puddles and slow-flowing rivers.

Notes: Further clarification of criteria for the separation of *Strombomonas* from *Trachelomonas* Ehrenberg is needed, because some species can be classified in both genera, depending on the criteria considered (e.g. Nudelman *et al*., 1998). *Strombomonas* is separated from *Trachelomonas* by Deflandre (1930) by having a generally longer collar, tapering gradually into the lorica (never forms a 90° angle with the lorica) and not sharply demarcated from it with the posterior end of the lorica narrowing to a conical point. The wall of the lorica in *Strombomonas* is often variable in thickness, but very rarely punctate, pitted, furrowed, perforated or ornamented by spines. Irregular, granular particles often collect on the external surface of the lorica. The emergent flagellum is relatively shorter than in *Trachelomonas,* rarely exceeding the length of the lorica. The amount of iron and/or manganese present in the lorica determines the intensity of the colour. Species with colourless or yellowish loricas are sometimes placed in the genus *Strombomonas,* rather than *Trachelomonas.*

Problems: None known of.





Caption: *Strombomonas* cells, each covered by a lorica that has a granular appearance. Note the gradual transition between the collar and the rest of the lorica, which is one of the major differences between *Strombomonas* and *Trachelomonas*. The length of the tail-like appendage may vary between different species.

Trachelomonas Ehrenberg

Origin: From Greek *trachelos,* "neck" + *monas,* "single organism" or "unit".

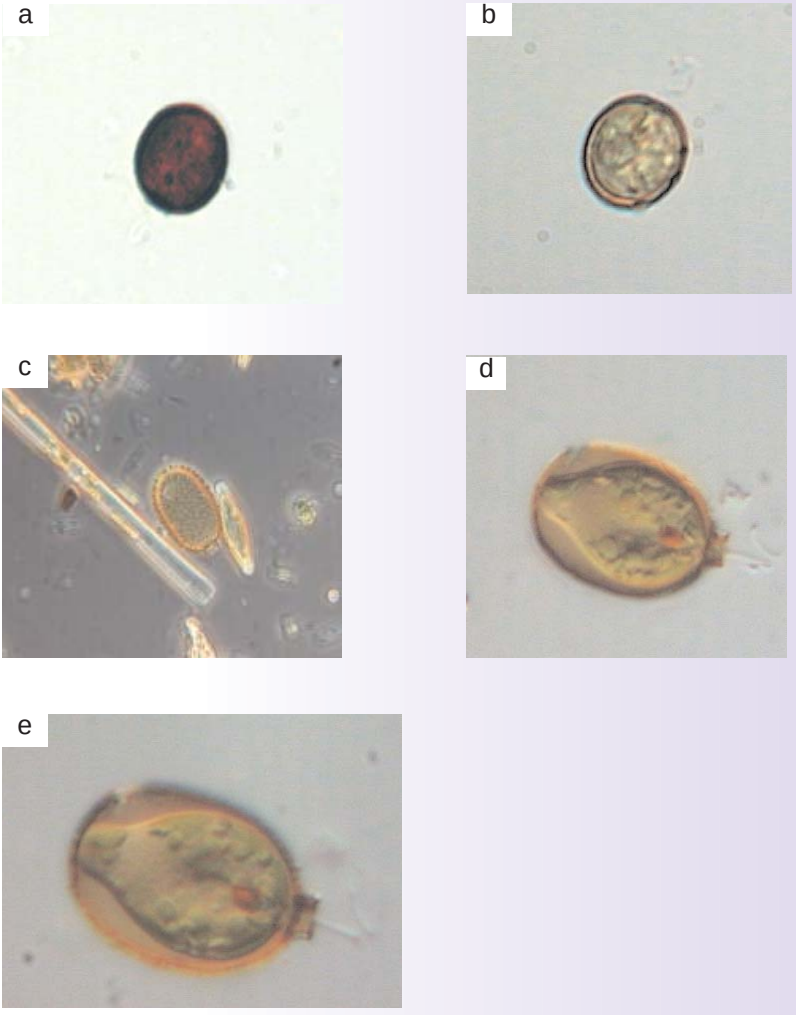
Characteristics: The solitary cells are similar to *Euglena* Ehrenberg, but enclosed within a lorica (like *Strombomonas* Deflandre). The colour of the lorica may vary from yellow to dark brown or red, depending on the degree of iron and/or manganese impregnation. The shape of the lorica may be spherical, cylindrical, ellipsoidal or sometimes spindle- or flask-shaped, sometimes with a distinct collar arising near the apical pore. The wall of the lorica is smooth or ornamented with spines, warts or pits. There are numerous, disc-shaped chloroplasts with or without pyrenoids. The bright green colour of the chloroplasts are usually masked by the brownish colour of the lorica. Paramylon bodies are small and sometimes absent. A single, long flagellum emerges through a wide, circular, apical pore in the lorica. There is a red eyespot at the anterior end. The pellicle of the cell within the rigid lorica is flexible and the cell is capable of metabolic movement within the lorica. These movements are only visible when the loricas are not heavily pigmented. Reproduction takes place by cell division, usually within the lorica. One (or occasionally both) daughter cells emerge and secrete a new lorica. Species are mainly distinguished on the shape of the lorica and the degree and type of wall ornamentation.

Dimensions: Loricas are usually 14-60 μm long and 9-35 μm wide.

Ecology: *Trachelomonas* is widespread, extremely diverse and usually more common under conditions where organic material concentrations and temperatures are higher. Cells are free-swimming in freshwater environments such as shallow ponds or bogs, or among the water plants on lake shores. In large numbers it may colour the water deep red-brown (but will not form a surface film like *Euglena*).

Notes: See that of *Strombomonas.*

Problems: None known of.



Caption: *Trachelomonas* cells may be without a collar (photos a and b) or with one (photos c, d and e), depending on the species. If a collar is present, it usually forms a 90° angle with the rest of the lorica (photos c to e). Note that although the loricas of *Trachelomonas* appear less granular than those of *Strombomonas*, they may possess short spines on the surface (photo c). Also note the red eyespot, the numerous discoid chloroplasts and the long emergent flagellum (photos d and e). Dark-brown to black loricas (photo a) are the result of more concentrated impregnation of iron and manganese.

Chlorophyta

Chlorophyta

Chlorophyta

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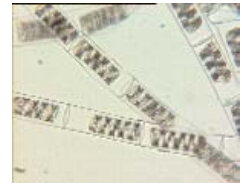
Chlorophyta



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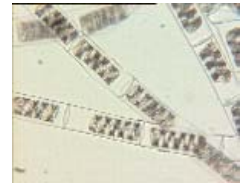

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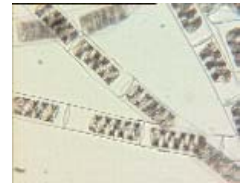


Chlorophyta

Green algae

Chlorophyta comes from the Greek words *chloros* that means "green" and *phyta* that means "plant", and therefore representatives of Chlorophyta are commonly referred to as green algae. Representatives may be unicellular, colonial, filamentous or more complexly structured. The most conspicuous organelle in the cell is the chloroplast, which is mostly bright green in colour due to the presence of chlorophylls *a* and *b*. Certain species may appear yellow-green or blackish-green due to the presence of carotenoid pigments or high concentrations of chlorophyll. The chloroplast morphology varies greatly and is useful for taxonomic purposes. The chloroplast usually contains one or more pyrenoids that store starch as a food reserve. A stigma or red eyespot may be present. The protoplast is surrounded by a more or less firm cell wall (composed of cellulose, along with other polysaccharides and proteins) just outside the plasmalemma. Cells can be non-motile or they swim actively by means of two or four anterior flagella that are mostly smooth and equal in length. The Chlorophyta comprises one of the major groups of algae when considering the abundance of genera and species, and the frequency of occurrence. They grow in waters of a great range of salinity, varying from oligotrophic freshwaters to those that are marine and supersaturated with solutes. A number grow in brackish waters and some are exclusively marine. Both benthic and planktonic species occur. A number grow in sub-aerial habitats.

Actinastrum Lagerheim

Origin: From Greek *actin*, "ray" + from Latin *astrum*, "star".

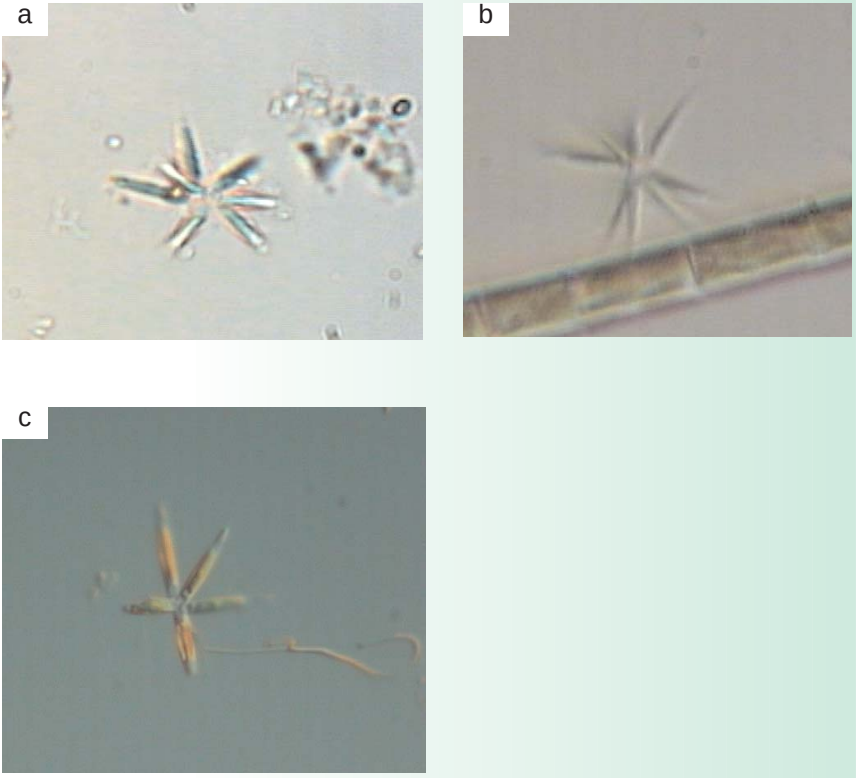
Characteristics: *Actinastrum* forms small, star-shaped colonies consisting of 4, 8 or 16 cells. The cells are much longer than broad, cylindrical, cigar-shaped or elongated and they radiate outwards from a central point of attachment. Colonies are mostly without a mucilage envelope, though it may be present. Each cell contains a single chloroplast that is elongated, parietal and with or without a pyrenoid.

Dimensions: Cells are 10-25 μm long and 3-6 μm wide.

Ecology: *Actinastrum* is reported from aquatic habitats worldwide (except in arctic and sub-arctic climates) where it is widely distributed. It is found in the phytoplankton of ditches, bogs, ponds, lakes and slow rivers. They are particularly common in eutrophic freshwater ponds, lakes and rivers.

Notes: *A. hantzschii* Lagerheim is the most common species and is abundant in the plankton of lakes and rivers.

Problems: None known of.



Caption: Star-shaped colonies of *Actinastrum* hantzschii, each colony consisting of eight elongated cells.

Ankistrodesmus Corda

Origin: From Greek *ankistron*, "fishhook"+ *desmos*, "bond".

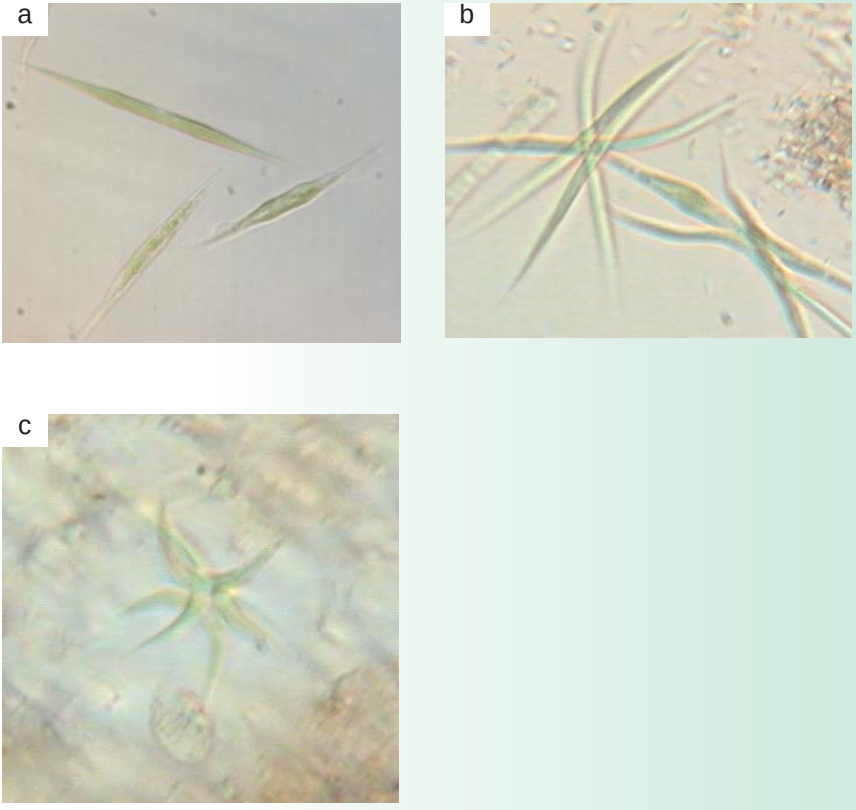
Characteristics: *Ankistrodesmus* is a large genus consisting of thin-walled cells that may be solitary, loosely clustered or twisted around each other in small bundles of 4-32 cells. The young cells are often found in crossed arrangement, while older cells are usually solitary. When in colonial form, the cells are attached to each other at the centre of the body and cells may lie parallel to one another or may be radially arranged. Individual cells are needle-like, tapering at both ends, and may be straight, curved or spirally twisted. Each cell is uninucleate and has a plate-like chloroplast with or without a pyrenoid. No gelatinous sheath is present. Asexual reproduction takes place by autospore formation. Flagellated stages and sexual reproduction are unknown. Species are distinguished from one another mostly by cell shape and size.

Dimensions: Cells are 25-60 μm long and 1-6 μm wide.

Ecology: *Ankistrodesmus* is widespread and common in all types of waterbodies (especially abundant in eutrophic waters). The genus is usually free-floating within the plankton of freshwater ponds and lakes, sometimes forming blooms. They can also grow on soil.

Notes: *Selenastrum* Reinsch and *Ankistrodesmus* are closely related, with some authors considering them synonymous; the key difference being the degree of cell curvature with *Ankistrodesmus* being more or less straight or slightly curved and *Selenastrum* being strongly curved. Cells of *Ankistrodesmus* are also very similar to those of *Monoraphidium* Komárková-Legnerová, except that *Ankistrodesmus* cells more often occur in groups. *Ankistrodesmus* has a high tolerance for copper treatments (usually copper sulfate) that are commonly used to control algal growth in water supplies, reservoirs, and recreational areas.

Problems: None known of, although it may form blooms.



Caption: *Ankistrodesmus* spp., consisting of needle-like cells that are sometimes solitary (photo a), sometimes loosely clustered, lying over one another (photo b) or twisted around each other (photo c). Cells may be straight (photo a) or curved (photo c).

Ankyra Fott

Origin: From Greek *Ankyra,* "anchor" or "hook".

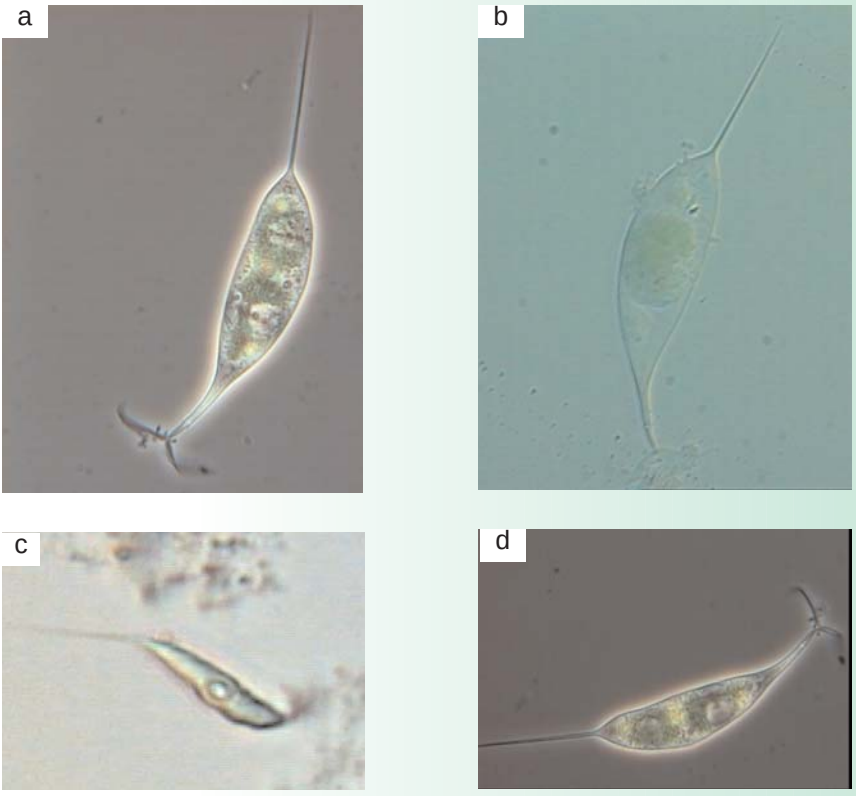
Characteristics: *Ankyra* cells are mostly solitary. The cells are spindle-shaped, curved or bent with a long, straight spine at one pole and a narrowed extension, which is forked at the tip, at the other pole. The cells are uninucleate with a single, parietal, plate-like chloroplast mostly containing one to several pyrenoids (sometimes pyrenoids are absent). *Ankyra* reproduces asexually by zoospore formation. Sexual reproduction is unknown. Species of *Ankyra* are distinguished based on chloroplast shape and the morphology of the forked appendage.

Dimensions: Cells are 15-150 μm long and 2-14 μm wide.

Ecology: *Ankyra* is cosmopolitan and generally found in the plankton of slow- or non-flowing water (lakes, pools and occasionally in rivers). They may also grow attached to microscopic debris.

Notes: *Ankyra* closely resembles *Characium* A. Braun and *Schroederia* Lemmermann, from which it is distinguished by its cell wall dividing into two almost equal parts to release the zoospores. It can also be distinguished from *Schroederia* in that the latter does not have a forked spine.

Problems: None known of.



Caption: Spindle-shaped cells of *Ankyra* with a long, straight spine at one pole and a forked extension at the other pole (photos a and d). Note the clearly visible pyrenoids in photos c and d.

Carteria Diesing

Origin: Named after H.J. Carter.

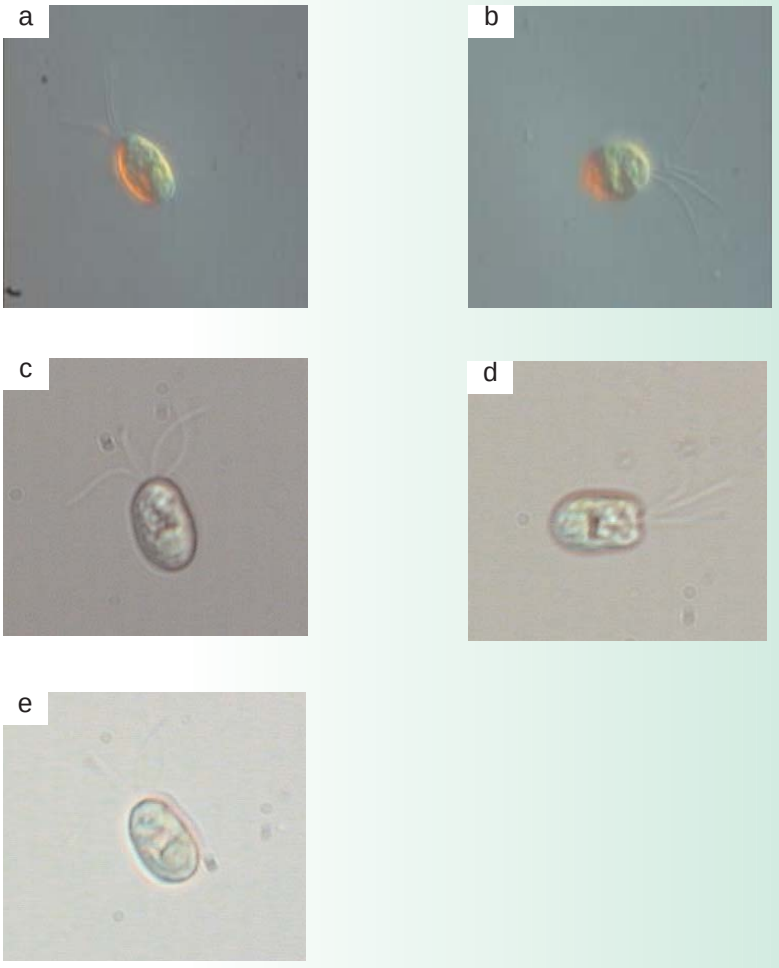
Characteristics: *Carteria* is characterised by having 4 flagella that are equal in length (usually longer than the cell), inserted closely together near an anterior papilla (sometimes absent). The cells are spherical to sub-spherical, and they appear round when seen in end view. The shape of the single chloroplast is variable - it may be cup-shaped, in the form of a thin plate along the wall, or H-shaped with one pyrenoid and an eyespot. There are two or four contractile vacuoles located at the anterior end near the base of the flagella. This is a large genus of many species, which are separated from each other on the basis of the chloroplast shape and the presence or absence, and position of pyrenoids. Asexual reproduction is through the formation of zoospores (most common), but *Carteria* may also reproduce sexually. Palmelloid (non-motile) stages are common.

Dimensions: Cells are 9-45 μm in diameter.

Ecology: *Carteria* often forms blooms, but it is less common in occurrence than *Chlamydomonas* Ehrenberg. *Carteria* is often abundant in still waters, but may also be found in slow-flowing rivers. Some species inhabit extreme environments (snow or ice).

Notes: Cells of *Carteria* are virtually the same as those of *Chlamydomonas*, except for the possession of 4 flagella instead of 2. The colourless genus *Polytomella* Aragão is also closely related to *Carteria*.

Problems: None known of, although it may form blooms.



Caption: *Carteria*, closely resembling the cells of *Chlamydomonas*. The most striking difference is the presence of four flagella in *Carteria* (photos c and e) in contrast to two flagella in *Chlamydomonas*. Note the pyrenoid in photo e.

Chlamydomonas Ehrenberg

Origin: From Greek *chlamys*, "mantle" + *monas,* "single" or "unit".

Characteristics: *Chlamydomonas* is a small, unicellular, green alga. The cells may be spherical, ovoid, ellipsoidal, sub-cylindrical or pear-shaped in lateral view, and circular or slightly flattened in outline. Two flagella of equal length are inserted close to each other at the anterior end of the cell. The flagella are long, usually longer (rarely shorter) than the cells. Each cell contains a single, parietal, cup-shaped, green chloroplast, with one or more pyrenoids. A red coloured eyespot (stigma) is located anterior, embedded in the chloroplast. Usually two contractile vacuoles are present near the base of the flagella. The cell wall is smooth and composed of glycoproteins, rather than cellulose. Asexual reproduction, by cell division, produces zoospores, but sexual reproduction also occurs. Cells sometimes shed their flagella and form colonies in a gelatinous matrix - these palmelloid (non-motile) stages are common. Species distinctions can be quite difficult and are based mainly on the position of the chloroplasts and the number and position of pyrenoids.

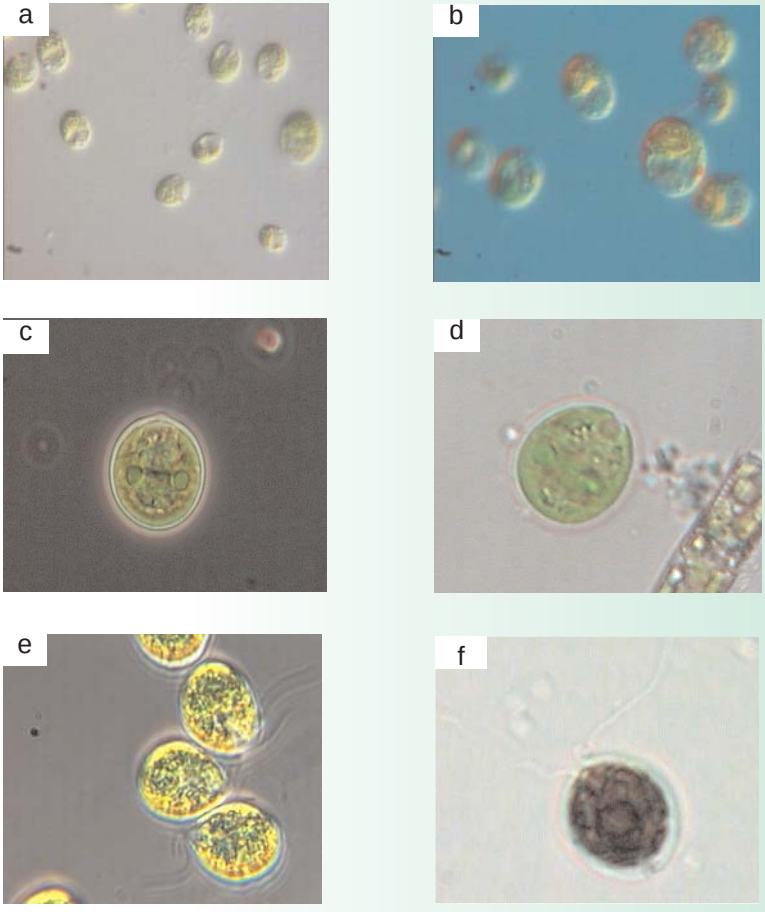
Dimensions: Cells are 2-50 μm long (mostly 5-20 μm) and 8-22 μm wide.

Ecology: Members of the genus are widely distributed, being found in every kind of aquatic habitat. Species of this genus are the most likely green swimming algal cells to be encountered. Habitats range from temporary pools, ditches, ponds, lakes and rivers. *Chlamydomonas* cells are mostly free-swimming in freshwater (where they sometimes form blooms, especially in extremely nutrient-rich waters), but are also found on soil and terrestrial surfaces, snow and ice (where they may appear red due to the presence of carotenoid pigments), and in arctic or antarctic pools. *Chlamydomonas* is phototactic - the cells are attracted to moderate, but not intense, light levels due to a photoreceptor near the eyespot.

Notes: *Chlamydomonas* is a vast genus, with a very large number of species described, but many are probably not true species. Species are difficult to identify. *Carteria* is similar to *Chlamydomonas*, but possesses four flagella instead of two. *Dunaliella* Teodoresco is also similar to *Chlamydomonas*, but it lacks a firm outer wall and it usually causes the pinkish or reddish colour of saline lakes. *Haematococcus* Agardh also resembles *Chlamydomonas* as it also has two flagella, however, the cell contents are contained within a central body connected to the outer wall with fine protoplasmic threads.

Haematococcus cells are normally green, but as growth conditions become unfavourable, red pigmentation increases and these cells often cause a red discolouration of bird baths and garden ponds. Species without a pyrenoid is placed into a separate genus, *Chloromonas* Gobi *emend* Wille, by some specialists. *Chlamydomonas* is widely used as a laboratory genetic model system for researching cell structure and function since it grows rapidly, is easily cultivated, and has a haploid life cycle in which sexual reproduction can be induced easily.

Problems: None known of, although it may form very dense blooms.



Caption: *Chlamydomonas* cells, each with a cup-shaped chloroplast (photos b and c) containing one (photo f) or more (photo c) pyrenoids, a red eyespot (photo b) and two equal flagella at the anterior end (photo f).

Chlorella Beijerinck

Origin: From Greek *chloros*, "green".

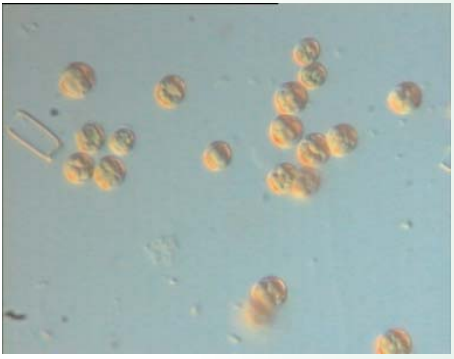
Characteristics: *Chlorella* consists of small, non-motile unicells (rarely aggregated into small groups). The cells are spherical or ellipsoidal with a single, parietal, cup-shaped (sometimes plate-like) chloroplast with or without a pyrenoid. The cell wall is generally thin and smooth. The only method of reproduction is asexual by means of 4 or 8 (rarely 16 or more) autospores which are formed internally through cell division. Autospores are liberated by rupturing of the parent cell wall. No sexual reproduction is known.

Dimensions: Cells are 2-15 μm in diameter (cells are often overlooked because of their small size).

Ecology: *Chlorella* is widespread and common, free-living in freshwater, marine waters, soil and sub-aerial habitats or it may be present as endosymbionts within the cells of freshwater invertebrates such as *Hydra viridis*, sponges, and many kinds of protozoa. *Chlorella* usually occurs in eutrophic waters and it is sometimes present in vast quantities as a green soup in cattle-troughs and similar places.

Notes: The cellular morphology of *Chlorella* is very similar to many other unicellular green algae and it may easily be confused with motionless zoospores of some genera. It is, therefore, necessary to study a large number of individuals, or even better, to culture them for identification purposes (*Chlorella* is easily cultured). *Chorella* can only be differentiated from some *Chlorococcum* Meneghini species by a study of reproductive habits. *Chlorella* usually forms 4 or 8 non-motile daughter cells within the mother cell wall, whereas *Chlorococcum* produces biflagellate zoospores which escape and immediately separate from one another. The species or forms of *Chlorella* that are found in invertebrates have been placed in a separate genus, *Zoochlorella* K. Brandt - they are often referred to as zoochlorellae. *Chlorella* was also one of the first algae grown as a possible food additive and it is still grown for this purpose to some extent, notably in Japan and Taiwan.

Problems: None known of.



Caption: Small, non-motile cells of *Chlorella*, distinguishable from *Chlamydomonas* and *Carteria* by the lack of flagella.

Chlorogonium Ehrenberg

Origin: From Greek *chloros,* "green" + *gonos*, "offspring" or "reproductive structure".

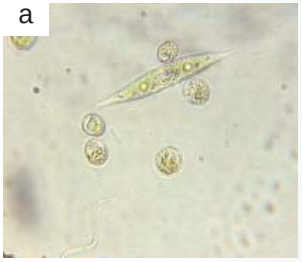
Characteristics: Cells are unicellular and elongated, spindle-shaped and pointed at one or both poles. There are two, apical inserted, equal flagella at the anterior end and they are usually shorter than the length of the cell (about half as long as the cell). The single, large, chloroplast is parietal, and may be with or without pyrenoids, depending on the species. In most species, an eyespot (embedded in the chloroplast) is prominent at the cell anterior. There are two or more contractile vacuoles, generally positioned in both the anterior and posterior halves of the cell, but sometimes distributed only in the anterior portion of the cell. The cell wall is delicate. Asexual reproduction is by zoospore formation, but they can also reproduce sexually. Species are distinguished by the presence or absence of pyrenoids.

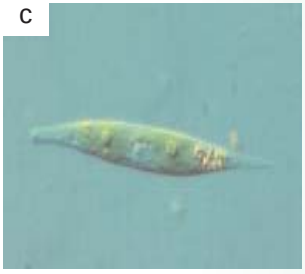
Dimensions: Cells are 14-170 μm long and 1.5-17 μm wide.

Ecology: *Chlorogonium* is probably cosmopolitan and it is found widespread in freshwater. It is often recorded from small, temporary pools rich in humus or pools containing decaying leaves, eutrophic lakes and soil. *Chlorogonium* rarely forms blooms.

Notes: *Chlorogonium* can be distinguished from *Chlamydomonas* Ehrenberg in that the cells are spindle-shaped and normally more than 4 times as long as wide, as well as by the zoospore formation which results solely from transverse divisions of the mother protoplast.

Problems: None known of.





Caption: Spindle-shaped cells of *Chlorogonium*. Note the bright red eyespot in photos d and e, as well as the pyrenoids most visible in photos b, d and e. Two short apically implanted flagella are not clearly visible in the photos.

Closterium Nitzsch *ex* Ralfs

Origin: From Greek *klosterion*, "small spindle".

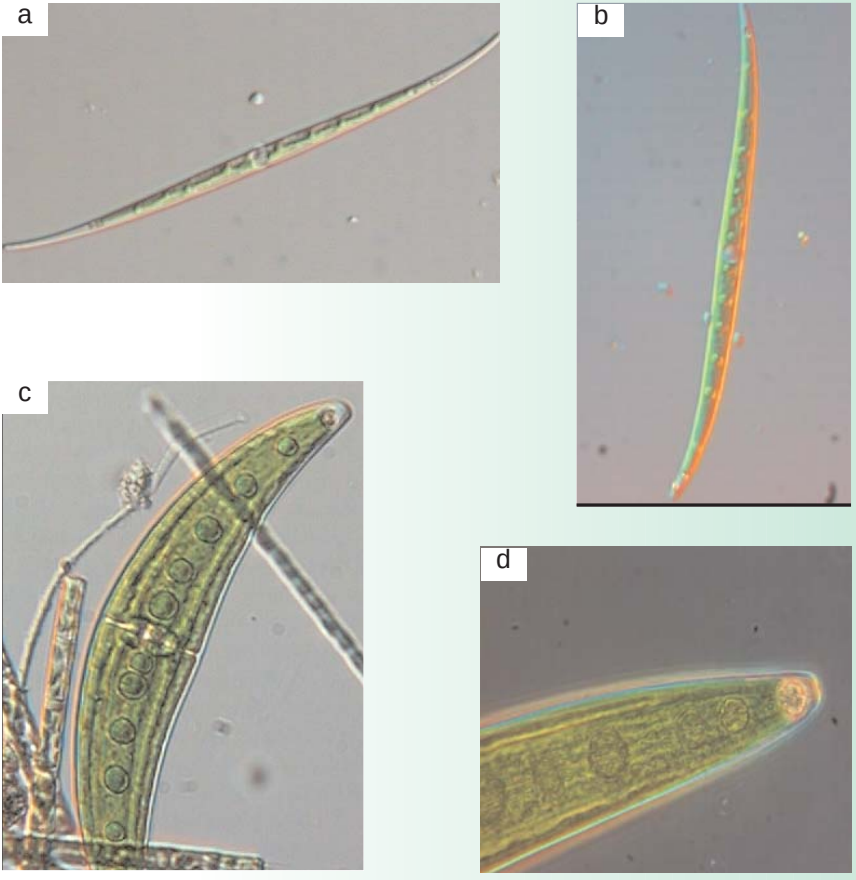
Characteristics: Cells of this unicellular genus are usually elongated and crescent-, sickle- or bow-shaped, with varying degrees of curvature. In cross section, the cells appear circular and the cells are sometimes inflated in the mid-region. The ends of the cell (apices) are usually tapered and may be acutely pointed, rounded or truncate (used as an important taxonomic character). The cells are always longer than broad and divided into two equal semi-cells. The median constriction is insignificant and there is no clear incision or sinus. Each semi-cell contains a single chloroplast. Chloroplasts of narrow species are mostly simple and ribbon-like, while those of larger species often appear like a central axial core, having radiating, longitudinal ridges with one to several pyrenoids arranged in an axial row or scattered throughout the chloroplast. The prominent, central nucleus lies between the two plastids at the equator of the cell. At each end of the cell there is a conspicuous vacuole in which one or more erratically vibrating crystals of barium or calcium sulphate may be observed performing Brownian movement. The function of these vacuoles is unknown. The cell wall of *Closterium* is colourless, or may appear yellowish or brown, due to iron staining. The wall may be smooth or striate and contains pores through which mucilaginous material is secreted. Secretions of mucilage from alternating ends of the cell are responsible for the somersaulting motion of *Closterium*. *Closterium* reproduces asexually by cell division or sexually by conjugation.

Dimensions: Cells are 70-1200 μm long and 4-50 μm wide. At least two species attain lengths of more than 1 mm.

Ecology: *Closterium* is cosmopolitan, widespread (oligotrophic to eutrophic) and often abundant. Because they can attach firmly by one end, they are common in rivers on macrophytes or other surfaces, even where there may be a strong current. They may, however, be dislodged by wave action and then occur free-floating in the open water of ponds, lakes and slow rivers. *Closterium* is very common in acidic, oligotrophic lakes and ponds, while it occurs more rarely in alkaline, eutrophic environments. *Closterium* can also grow in soils. Polymers in the cell wall may help protect the cell from drying out and allow them to survive for months in environments such as dried mud at the edges of lakes.

Notes: The genus is easily identifiable. Some of the species have large and conspicuous cells reaching nearly 1 mm in length, while others, particularly the planktonic ones, may be much more slender and almost straight.

Problems: Creates filter-clogging problems.



Caption: *Closterium*, a desmid common in acidic, clean water bodies. Cells may range from small (photos a and b) to large (photo c). Note the numerous pyrenoids in the chloroplast and the transparent area in the middle of the cell in which the nucleus is located (photos a, b and c). Photo d illustrates a vacuole at the tip of the cell containing barium or calcium sulphate crystals performing Brownian movement.

Coelastrum Nägeli

Origin: From Greek koilos, "hollow" + *astron*, "star".

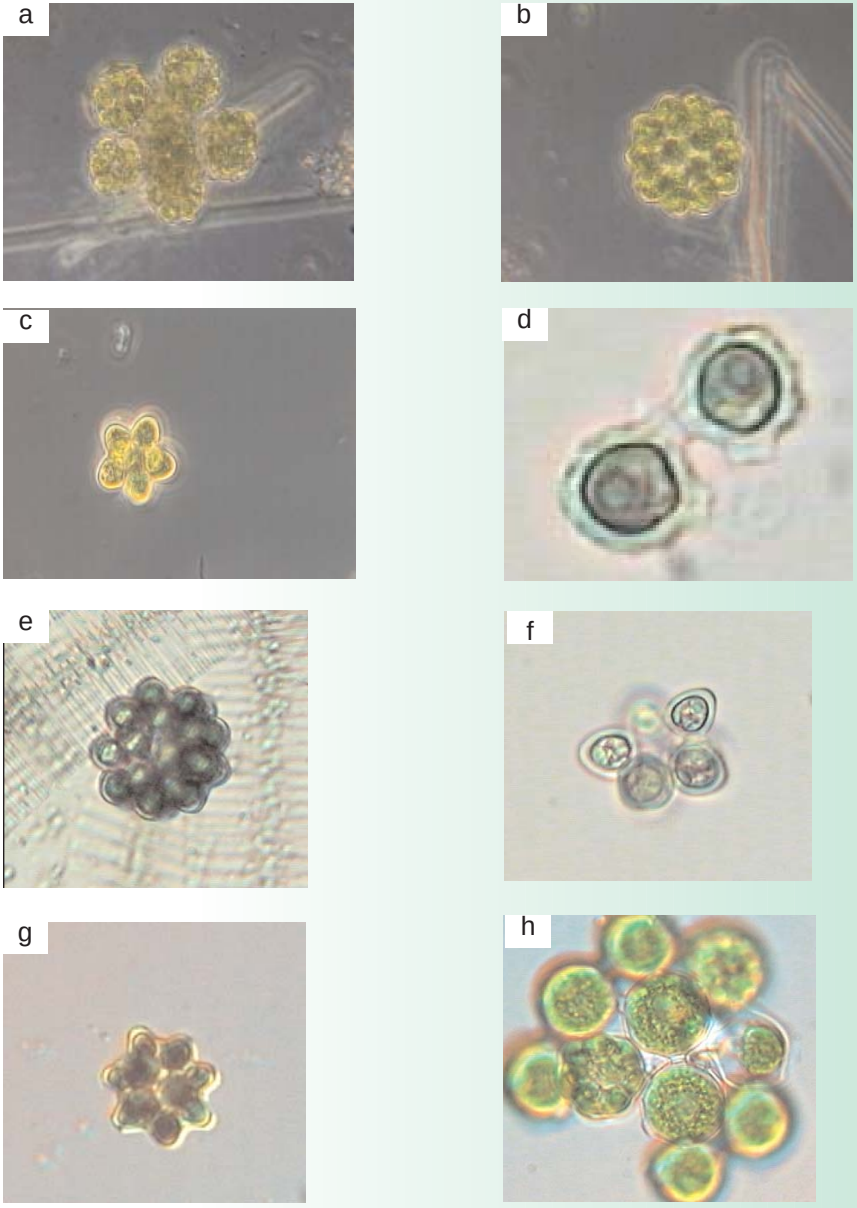
Characteristics: As the genus name suggests, cells are arranged to form a hollow colony. In some species the cells are closely associated and the hollow feature is discerned with difficulty, whereas in others the cells are clearly separated in a peripheral layer and interconnected by blunt processes or protuberances. The protuberances arise from the mucilaginous sheath surrounding each cell or from extensions of the cell walls. Colonies are spherical, pyramidal or cubical and consist of 4-32 (rarely 64 or 128) spherical, ovoid, polygonal or angular cells, with conical or globular bulges. Each cell has a single, parietal chloroplast with a single pyrenoid. The cell walls appear smooth when viewed with a light microscope, but ultrastructurally may have a wrinkled surface. No flagellated stages are present. *Coelastrum* cells reproduce asexually by the formation of daughter colonies inside any or all of the mother cells. Sexual reproduction is unknown. Species are distinguished from one another on account of cell size and shape, number of cells per colony, pattern of cell wall ornamentation and nature of wall processes.

Dimensions: Cells are 2-30 μm in diameter and colonies are up to 100 μm across.

Ecology: *Coelastrum* colonies are cosmopolitan and planktonic in freshwater habitats (ponds, lakes and slow-flowing rivers) from arctic to tropical environments. *Coelastrum* is often abundant in mesotrophic to eutrophic conditions.

Notes: Species of *Coelastrum* are generally less widespread than those of *Scenedesmus* Meyen.

Problems: None known of.



Caption: Colonies of *Coelastrum* with the cells arranged in the form of a hollow sphere. Connections between neighbouring cells are illustrated in photos d and h. Asexual reproduction, where some of the cells are busy dividing to form daughter colonies, is illustrated in photo h.

Cosmarium Corda *ex* Ralfs

Origin: From Greek *cosmarion*, "small ornament".

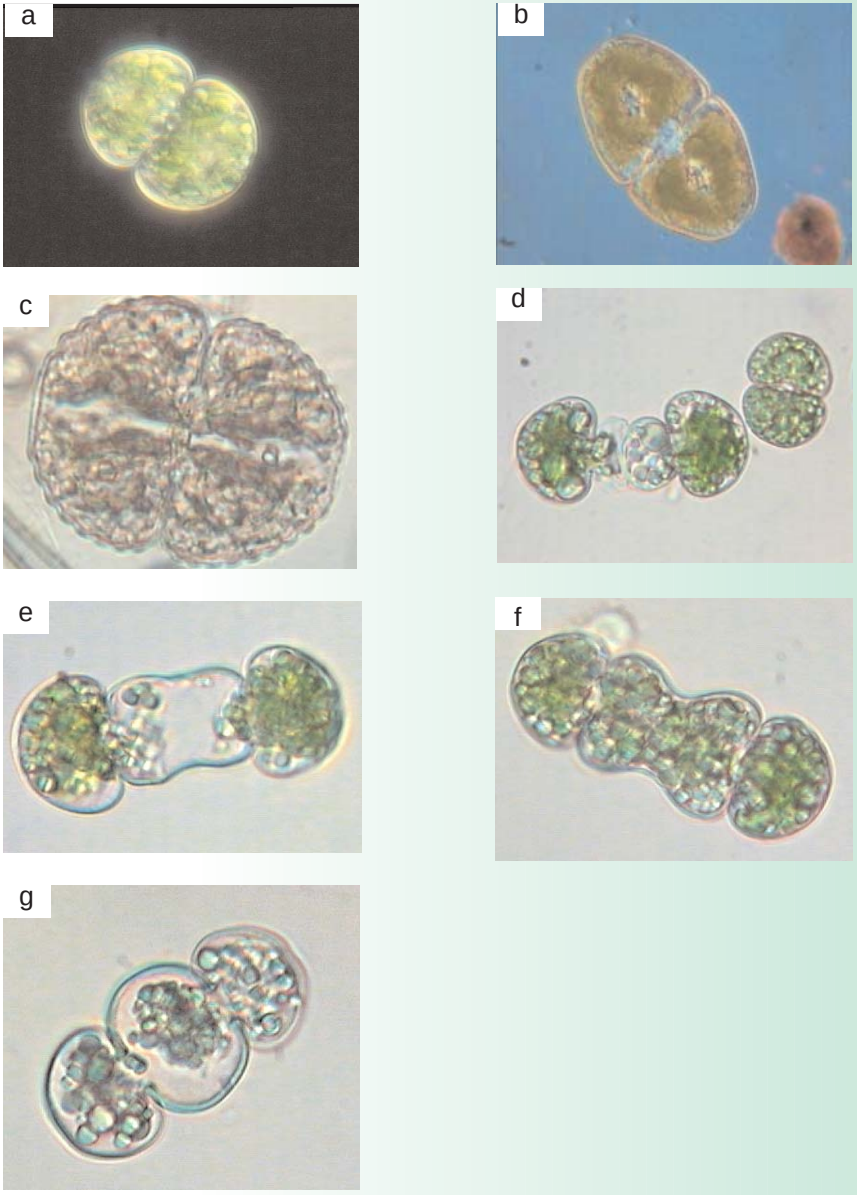
Characteristics: Although *Cosmarium* cells are solitary, they sometimes grow in the form of macroscopic gelatinous colonies. There is considerable variation in shape and size of the cells, as well as cell wall ornamentation and it is, therefore, difficult to make generalizations about their morphology. Each cell is divided into two equal semi-cells by a constriction (sinus) that may be a cleft or only a slight invagination. The semi-cells are hemi-spherical, spherical, elliptical, angular, pyramidal or kidney-shaped. Whatever the shape of the semi-cell in face view, it is usually compressed, oval or elliptical when seen in vertical view. Each semi-cell has at least one central chloroplast (usually 2 or 4) containing one to several pyrenoids. A prominent nucleus lies in the isthmus, the area between the two semi-cells. The surface of the cell walls is smooth or ornamented with fine granules (not easily seen), but no spines or apical indentations occur. The cell wall contains pores through which mucilage is secreted. The mucilage swells as it absorbs water and may play a role in the forward propulsion of the cells. Asexual reproduction takes place by cell division and sexual reproduction by conjugation.

Dimensions: Cells are 10-200 μm long and 6-140 μm wide.

Ecology: *Cosmarium* is extremely widespread and common worldwide. The cells are mostly free-floating in lakes, reservoirs, ponds and sometimes rivers, but they may also occur in attached gelatinous colonies. The genus is most common in acidic, oligotrophic, aquatic habitats, but may also occasionally be found in alkaline, eutrophic, ponds and lakes or in sub-aerial environments.

Notes: *Cosmarium* includes thousands of species, probably more than any other genus in the Chlorophyta. If there are more than two spiny projections in each semi-cell, the alga is probably *Staurastrum* (Meyen) Ralfs or *Staurodesmus* Teiling.

Problems: Mucous secretions may cause problems in water purification plants.



Caption: Single cells of *Cosmarium*, a desmid. The cell in photo a has a smooth wall, compared to the granular cell wall of the cell in photo c. In photo d a single cell is dividing, giving rise to two daughter cells (asexual reproduction). Sexual reproduction, during which a conjugation tube is formed between two cells, is illustrated in photos e, f and g.

Crucigenia Morren

Origin: From Latin *crux*, "cross" + from Greek *genos*, "descent".

Characteristics: Quadrate colonies of *Crucigenia* consist of 4 oval, triangular or rectangular cells. The cells are arranged in a cross formation and they fit tightly together along adjoining walls, often leaving a small, conspicuous, square, empty space in the centre. After cell division, cells of this genus often stay attached to each other by remnants of the mother cell wall - often two or more generations are grouped together. This results in flat, plate-like, multiple colonies, forming a compound coenobium of up to 16 cells that is embedded in a structureless, mucilaginous envelope. Besides a single nucleus, cells have a single, parietal, cup-shaped chloroplast with or without a pyrenoid. The cell walls are smooth. No motile stages occur. Daughter colonies (rotated 45° with respect to mother colony) are released by the rupturing of the motheral cell wall. Sexual reproduction is unknown. Species are differentiated by the shape of cells and the presence or absence of pyrenoids.

Dimensions: Cells are 3-15 μm long and 2-12 μm wide. Coenobia are mostly 5-31 μm in diameter.

Ecology: *Crucigenia* is cosmopolitan (except in polar and sub-polar regions) and it forms a common (but rarely abundant) member of the plankton in a variety of freshwater ecosystems, including ponds, lakes and rivers (mostly in eutrophic conditions). It can also occur on moist terrestrial surfaces.

Notes: The genus is morphologically similar to *Tetrastrum* Chodat and *Crucigeniella* Lemmermann. Unlike *Tetrastrum*, it has no spines. The principal feature for separating *Crucigenia* from the genus *Crucigeniella* Lemmermann is the position of cells within the daughter coenobium (see Komárek, 1974). Otherwise the two genera are indistinguishable, although the coenobia of *Crucigenia* are typically quadrate rather than rhomboidal or rectangular.

Problems: None known of.

Caption: *Crucigenia* colonies, each colony quadrate with four cells arranged in a cross formation. In *C. lauterbornii* (Schmidle) Schmidle the cells are oval (photo a), while they are triangular in *C. tetrapedia* (Kircher) West *et* G.S. West (photo b).

Crucigeniella Lemmermann

Origin: From Latin *crux,* "cross" + from Greek *genos*, "descent" + from Latin *ellus*, "suffix added to noun stems to form diminutives".

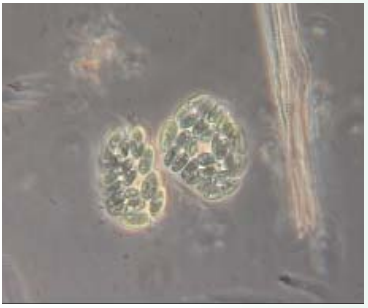
Characteristics: Rectangular colonies of *Crucigeniella* consist of 4 elongated or ovoid cells with the smooth cell walls occasionally thickened at the apices. The colonies are with or without a rectangular or rhombic internal space in the centre. After division, cells of this genus are often attached to each other by remnants of the mother cell wall and often two generations are grouped together. As in *Crucigenia*, this results in flat, plate-like, compound coenobia embedded in a mucilaginous envelope. Cells have a single nucleus and a single, parietal, cup-shaped chloroplast, usually with a pyrenoid. No motile stages occur. Daughter colonies lie in the same position as the original mother cell and are released by the rupturing of the mother cell wall. Sexual reproduction is unknown. Species are differentiated by the size and shape of the cells and details of the cell wall thickenings.

Dimensions: Cells are 4-15 μm long and 2-8 μm wide. Rectangular coenobia are 8-24 μm long and 6-22 μm wide.

Ecology: *Crucigeniella* are probably cosmopolitan and mostly planktonic in a wide range of freshwater habitats (ponds, lakes and slow-flowing rivers).

Notes: See remarks under *Crucigenia* Morren. *Crucigeniella rectangularis* (Nägeli) Komárek is probably the most frequently encountered and widely distributed species in South Africa. A basionym for this species is *Crucigenia rectangularis* (Nägeli) Gay.

Problems: None known of.



Caption: Rectangular colonies of *Crucigeniella rectangularis* (Nägeli) Komárek that closely resemble the colonies of *Crucigenia*. The most obvious difference between *Crucigeniella* and *Crucigenia* is the position of cells within the daughter coenobium.

Dictyosphaerium Nägeli

Origin: From Greek *diktyon*, "net" + *sphaira*, "sphere" or "ball".

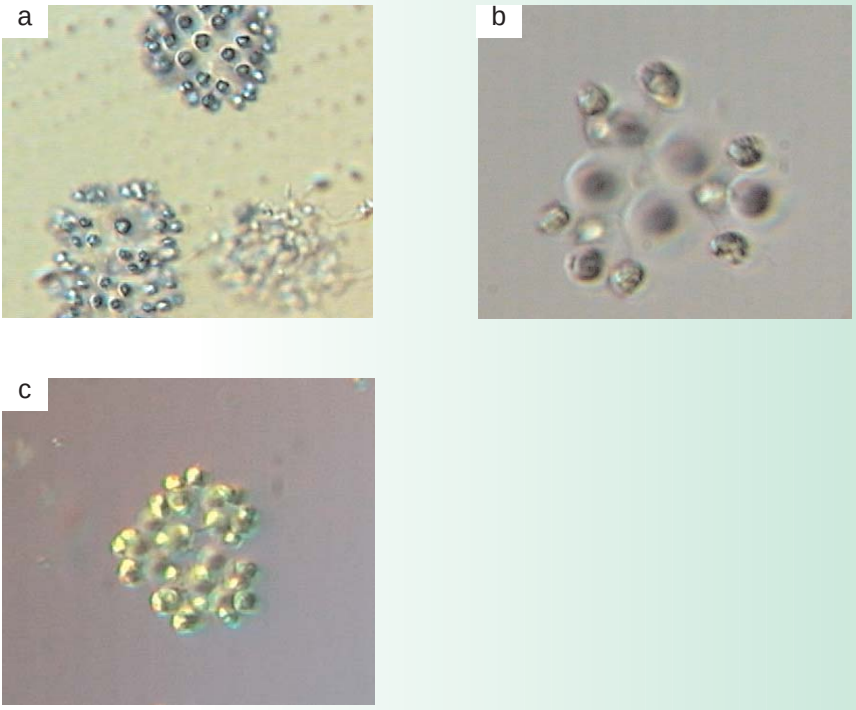
Characteristics: *Dictyosphaerium* occurs in round to irregular colonies, consisting of 4 to 64 cells that are embedded in clear mucilage (that is difficult to observe). Clusters of four cells are connected by fine, branching threads (remnants of old mother cell walls) that are often barely visible. Individual cells are equal in size and round, ovoid to cylindrical, spindle-shaped or kidney-shaped. The cells are uninucleate and each cell contains one or two parietal, cup-shaped chloroplasts, each with a pyrenoid. The cell walls are usually smooth and spines are absent. Asexual reproduction is by means of autospore formation. Sexual reproduction is only reported in one species. Many characters are used to separate species, e.g. cell shape, cell arrangement and number of cells forming a colony.

Dimensions: Cells are 1-10 μm in diameter. Colonies are 10-100 μm in diameter.

Ecology: *Dictyosphaerium* is widespread and abundant, sometimes dominating the phytoplankton community. Colonies are generally free-floating in freshwater environments, such as semi-permanent pools, ponds, lakes and slow-flowing rivers. *Dictyosphaerium* is often responsible for green water blooms in eutrophic reservoirs and fishponds. It can also be found in hard- and soft water lakes, in acid bogs and a few species may occur on soil.

Notes: The size of the colony and cellular dimensions are known to vary, depending upon environmental conditions. Cell form is also age-dependent, with young cells being elongate or narrowly oval and adult cells usually broadly rounded, ovoid or spherical. It is, therefore, necessary to examine colonies of different ages to follow changes in cell shape when using it as the principal character for distinguishing species.

Problems: None known of, although it may form blooms.



Caption: *Dictyosphaerium* colonies of variable size. Note the remnants of mother cell walls between the individual cells (photo b).

Eremosphaera DeBary

Origin: From Greek *eremos*, "solitary" + *sphaira*, "ball".

Characteristics: Although cells are usually solitary, they may appear in clusters of 2 to 4 enclosed by the old, mother-cell wall. The solitary cells are spherical, sub-spherical or ellipsoidal with or without a conspicuous mucilaginous envelope. Numerous discoid chloroplasts lie along the periphery immediately within the wall, or they are arranged in strands of cytoplasm radiating from the cell centre to the periphery. Each chloroplast contains one to three pyrenoids often surrounded by starch grains. The cell wall is smooth, thick and layered. A single, large nucleus is suspended in the centre of the cell by numerous strands of cytoplasm extending through a large central vacuole. Asexual reproduction is by division of the protoplast into two or four autospores that are liberated by rupturing of the parent-cell wall. Oogamous sexual reproduction is known only in one species. Zygotes produce thickened walls. Species are distinguished based on cell size and shape, presence of wall spicules (one species) and details of chloroplast morphology.

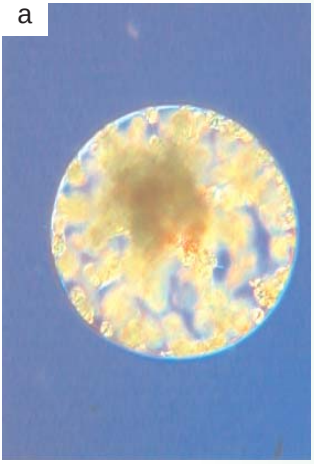
Dimensions: Cells are 30-200 μm in diameter.

Ecology: *Eremosphaera* is cosmopolitan and can be found free-floating or lying among mixtures of algae and aquatic macrophytes in shallow water. *Eremosphaera* is so often restricted to soft water habitats that it may be used as an index organism for acid conditions in which the pH is 6.0 to 6.8. It is a common component of habitats in which desmids predominate, and there is some evidence that high organic acid content of the water results in huge *Eremosphaera* cells.

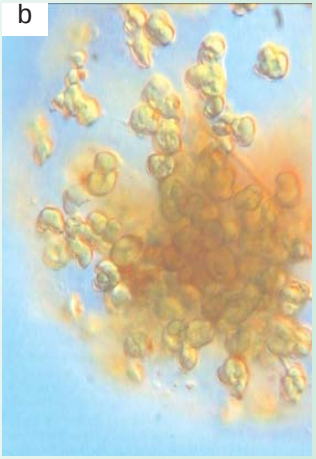
Notes: This is one of the largest spherical cells encountered among unicellular algae.

Problems: None known of.

a



b



Caption: Large, solitary, spherical cells of *Eremosphaera* generally occur, together with desmids, in soft water bodies. Note the numerous chloroplasts arranged in radiating strands of cytoplasm (photo a).

Euastrum Ehrenberg *ex* Ralfs

Origin: From Greek *eu*, "good" or “true”+ *astron*, "star".

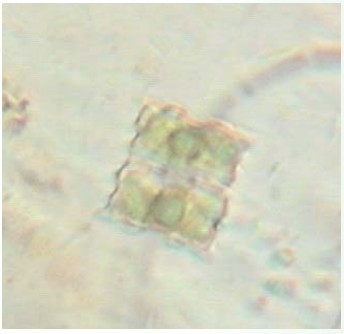
Characteristics: Cells of *Euastrum* are solitary, usually longer than broad, with a deep median constriction (sinus), forming two distinct semi-cells. The semi-cells are oval, elliptical or pyramid-shaped and distinctly compressed when viewed from the side. The poles of the cells mostly have a median incision, which is often deep, but sometimes hardly evident to almost absent. The cell walls may be smooth or have ornamentations, such as warts, granules, and spines or, according to species, may have definite mucilage pores. In most taxa the semi-cells have lobed margins. Each semi-cell has one chloroplast containing one or more pyrenoids. The nucleus is located in the isthmus. Asexual reproduction takes place by cell division and sexual reproduction by conjugation. There are numerous species of this desmid, varying greatly in size, shape and type of cell wall ornamentation. Most of the species can, however, be identified readily by the polar incision and by the protrusions or swellings on the face of the semi-cell.

Dimensions: Cells are 10-200 μm long and 10-100 μm wide.

Ecology: Most species prefer acidic habitats such as peaty pools and boggy places, although some species can be found in alkaline waters. Cells are also common in nutrient-poor (oligotrophic) ponds and lakes.

Notes: Important taxonomic characters (such as cell wall ornamentation) are best observed in cells without contents.

Problems: None known of.



Caption: *Euastrum*, a desmid closely related to *Cosmarium*, but with a cleft at the cell apices. Note the pyrenoid in each semi-cell.

Eudorina Ehrenberg *ex* Ralfs

Origin: From Greek *eu*, "good, true or primitive" + *dorina*, derived from *Pandorina*.

Characteristics: Free-swimming spherical to ellipsoidal colonies, in which 16, 32 or 64 spherical or ovoid cells are inclosed within a gelatinous envelope. The cells are approximately the same size and they are arranged some distance from one another in a single layer (mostly in distinct transverse tier-like rows). They are not as closely adherent as those of *Pandorina* Bory de Saint-Vincent. Each cell is *Chlamydomonas*-like and has two equal flagella, an eyespot, two small contractile vacuoles at the base of the flagella, and a massive cup-shaped chloroplast with one (basal) or multiple pyrenoids. The eyspots of anterior cells (according to direction of swimming) are often larger than in posterior cells. Reproduction is asexual by the formation of autocolonies (daughter colonies) or sexual by anisogamy.

Dimensions: Cells are 5-15(-25) μm in diameter and colonies are 60-200 μm across.

Ecology: *Eudorina* is cosmopolitan in freshwater and frequently occurs in lakes, ponds and puddles, ditches and slow-flowing rivers. Colonies are also frequently found on clay or calcareous soils associated with nutrient enrichment. Dense growths have been reported during summer, spring and autumn.

Notes: The genus *Eudorina* initially only included the most common species, *E. elegans* Ehrenberg; later seven more species were described. Unlike cells of *Pandorina* those of *Eudorina* are spherical or slightly oval and they are evenly spaced (show a tiered arrangement) in a mucilaginous matrix leaving a gap at the centre. Cells of *Pandorina* are densely packed and closely appressed to one another and there is no hollow in the centre of the colony. In *Eudorina* the two flagella of each cell arise wider apart than in *Gonium* Müller and pass through two short tubes at the surface of the colony.

Problems: None known of, although it may form blooms.

Caption: *Eudorina elegans* Ehrenberg with spherical cells evenly spaced within the colony. Note the spaces between individual cells (unlike cells of *Pandorina* that are tightly compressed) and the two flagella visible in the marginal cells.

Golenkinia Chodat

Origin: Named after M. Golenkin, a Russian phycologist.

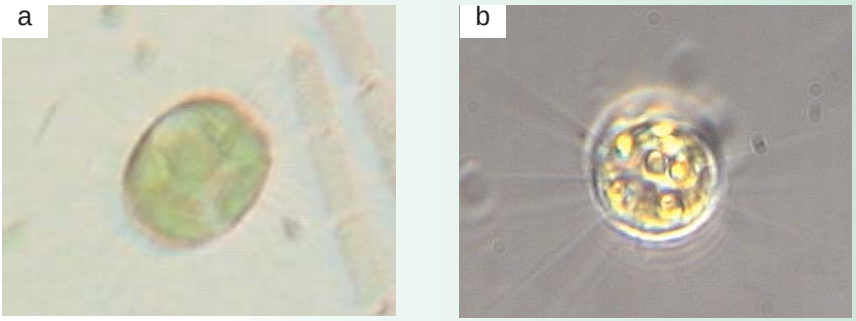
Characteristics: *Golenkinia* cells are solitary, but occasionally form false colonies by the interlocking of spines or when failing to separate immediately after division. Cells are spherical and covered with numerous long, radiating spines that are regularly distributed. Each cell has a cup-shaped, green chloroplast containing a cup-shaped pyrenoid with a distinct starch sheath surrounding it. Cells are uninucleate, with smooth cell walls. A very thin (barely visible) to thick mucilaginous envelope sometimes surrounds the cell and the base of the spines. During asexual reproduction non-motile autospores or motile, flagellated zoospores are formed. *Golenkinia* can also reproduce sexually.

Dimensions: Cells are 7-20 μm in diameter. Spines are 6-65 μm long.

Ecology: *Golenkinia* is strictly planktonic in freshwater habitats such as ponds, lakes and slow-flowing reaches of rivers.

Notes: Recent work suggests that differences between *Golenkinia* and *Golenkiniopsis* Korschikoff are not clearly defined. In general, the two genera are separated by the shape of the pyrenoid (cup-shaped in *Golenkinia* and spherical in *Golenkiniopsis*), the structure of the spines (thickened at the base in *Golenkiniopsis,* while no thickenings occur in *Golenkinia*) and the thickness of the cell walls (*Golenkinia* with thick walls, whereas *Golenkiniopsis* is thin-walled). *Micractinium* Fresenius differs from *Golenkinia* in that it is usually colonial.

Problems: None known of.



Caption: Solitary cells of *Golenkinia* with long radiating spines.

Kirchneriella Schmidle

Origin: Named after E.O.O. von Kirchner.

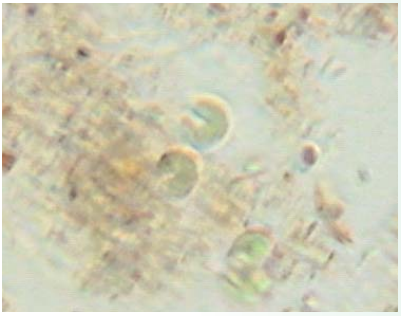
Characteristics: *Kirchneriella* cells occur in spherical, ovoid or irregularly shaped colonies surrounded by a, sometimes indistinct, mucilage sheath. Each colony consists of up to 16 arcuate or crescent-shaped cells. The cells are often so strongly curved that the rounded ends almost touch. Each cell is filled with a parietal chloroplast that contains one or more pyrenoids. The cells are uninucleate and surrounded by smooth cell walls. No flagellated stages occur. Asexual reproduction occurs by the formation of non-motile autospores, while sexual reproduction is unknown. Species within this genus are differentiated by cell size and shape, particularly the degree of curvature.

Dimensions: Cells are generally 6-30 μm long and 1-12 μm wide.

Ecology: *Kirchneriella* is virtually cosmopolitan in tropical and temperate freshwater, where it is widely distributed. It usually occurs as members of the open water plankton.

Notes: *Kirchneriella* should be compared with *Selenastrum* Reinsch. In *Kirchneriella* the colonies do not consist of a fixed number of cells, while the colonies of *Selenastrum* have a fixed cell number (known as coenobia). According to John *et al*. (2002) a genus *Kirchneria* was established by Hindák (1988) to accommodate those *Kirchneriella* species without pyrenoids. Hindák (1988) was unaware, at the time, that the generic name *Kirchneria* had been used for both a fossil plant and a living member of the family Leguminosae. After having been informed of these earlier names, Hindák (1990) proposed replacing *Kirchneria* with *Pseudokirchneriella* Hindák. There is, however, considerable doubt to the justification for separating genera on the presence or absence of a pyrenoid, especially if based on light microscope observations alone (John *et al*. 2002). The genus *Pseudokirchneriella* is, therefore, sometimes used for *Kirchneriella* species without pyrenoids (John *et al*. 2002).

Problems: None known of.



Caption: Strongly curved (C-shaped) cells of a *Kirchneriella* colony**.**

Lagerheimia Chodat (= *Chodatella* Lemmermann)

Origin: *Lagerheimia* named after N.G. von de Lagerheim; *Chodatella* named after R.H. Chodat.

Characteristics: Unicellular organisms with spherical, ovoid or ellipsoid cells with rounded apices. Cells bear long, needle-like spines confined to the poles, or to the poles and the equator. Spines may be straight or curved and they are equal to, or longer than (most usual case), the cell length. There are 1-4 chloroplasts per cell, each with one pyrenoid. The cell wall is smooth. Asexual reproduction takes place by autospore formation. Species are differentiated on the basis of cell shape and arrangement of spines.

Dimensions: Cells 2-30 μm long and 5-20 μm wide. Spines are mostly 6-60 μm long.

Ecology: Planktonic and widely distributed in ponds, in lakes (more frequently in shallow than deep lakes) and in slow-flowing rivers.

Notes: *Lagerheimia* is comparable to *Oocystis* Braun in size and shape, but can be distinguished from it by the presence of the spines. The presence or absence of a basal thickening of the spines is no longer considered a character of any taxonomic significance. It was formerly the principal character used for separating *Lagerheimia* from *Chodatella.* Other characters used include the number of spines (cells with two spines arising at each pole was classified as *Lagerheimia,* while cells with 3-8 spines arising from each pole was formerly placed in the genus *Chodatella*). The names of several *Chodatella* species were recently transformed to the genus *Lagerheimia,* and *Chodatella* is now reduced to synonymy under *Lagerheimia* (Hindák, 1983).

Problems: None known of.

a

b

c

Caption: Elliptical cells of *Lagerheimia* with spines clearly visible. Note that the spines may be restricted to the poles (photos b and c) or they may be located sub-apical and equatorial (photo a).

Micractinium Fresenius

Origin: From Greek *mikros* "small" + *actin,* "ray".

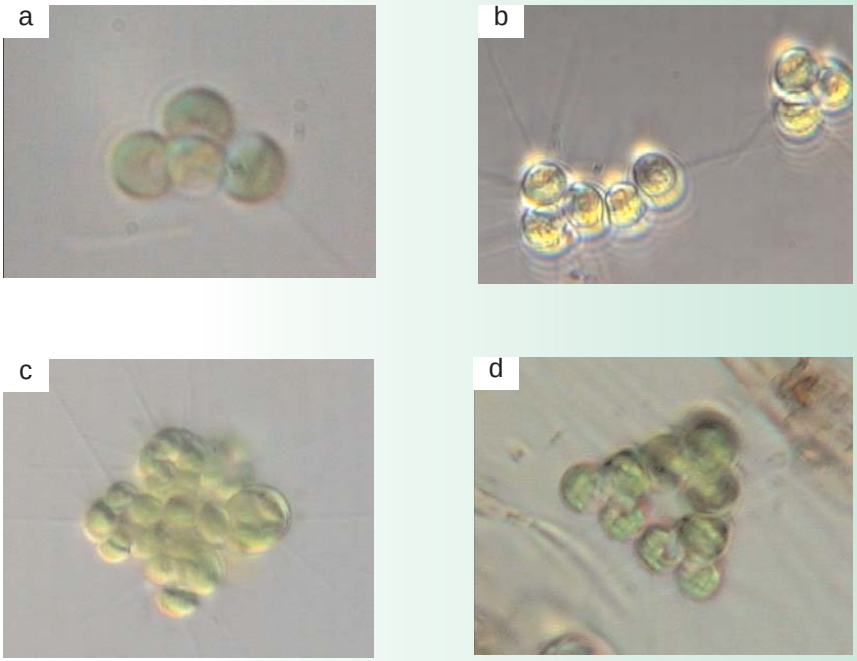
Characteristics: Colonies are triangular to pyramidal consisting of a cluster of 4 (mostly) to 64 spherical or broadly ellipsoidal cells. Each cell usually bears 1-8 (sometimes up to 18) long, tapering spines that may be up to ten times the length of the cell. The spines are evident, thin and needle-like. The interlocking of spines often causes colonies to occur united and in this way large, compound colonies of 128 or more cells may be formed. Each cell contains a single, cup-shaped chloroplast with one pyrenoid. The cell walls are thin and smooth. Asexual reproduction is by the formation of autospores. Sexual reproduction is known from only one species.

Dimensions: Cells are 3-10 μm in diameter. Spines are 10-35 μm long.

Ecology: Free-floating colonies of *Micractinium* occur frequently (sometimes abundantly) in standing waters of ponds and lakes, but are also occasionally observed in rivers. They are particularly common in eutrophic waters.

Notes: Sometimes pyramidal colonies, with the outer free wall of the cells bearing a single, stout long spine, are placed in the genus *Errerella* Conrad, but more often *Errerella* is included within the genus *Micractinium.*

Problems: None known of.



Caption: *Micractinium* may be in the form of single colonies (photos a and b) or colonies may be attached to one another by the interlocking of spines (photo c). A pyramidal colony, that can be regarded as *Micractinium* or *Errerella*, is shown in photo d. Note the cells bearing long, needle-like spines.

Micrasterias Agardh *ex* Ralfs

Origin: From Greek *micros*, "small" + *aster*, "star".

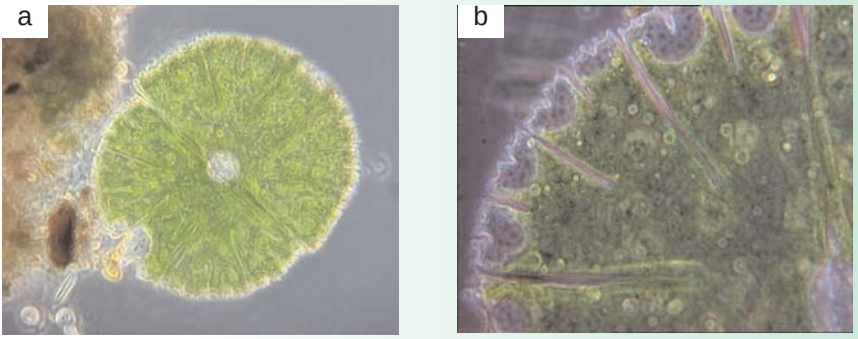
Characteristics: According to John et al. (2002) *Micrasterias* includes the most striking of all desmids, if not all plant and animal cells. With the exception of one filamentous species, all members of this genus are unicellular. Cells are very compressed, flat and circular to oval in outline. Some species look like flattened disks, and others are so highly incised that they look like stars, as the generic name indicates. Each cell is composed of two semi-cells, separated from each other by a deep median constriction. The edges of each semi-cell are variously incised, resulting in the division of each semi-cells into lobes which are usually further subdivided. An odd number of lobes are present in each semi-cell, the middle polar one usually well differentiated from the others. The lateral lobes are usually once, twice, or three times divided into secondary lobelets. Each semi-cell contains a single chloroplast that extends into lobes of the cell. The chloroplast contain numerous, evenly distributed pyrenoids. The nucleus lies in the isthmus between the two semi-cells. The cell wall is usually smooth, although some species have rows of marginal spines or spines over the entire wall. Asexual reproduction is by cell division and new semi-cell formation typical of *Cosmarium*-type desmids. Sexual reproduction takes place through the process of conjugation, and gametes fuse in the conjugation tube (when present). Zygospores are usually spherical with spines that are sometimes forked. Although there is considerable variation in shape from species to species, all are distinctly differentiated into polar and lateral lobes.

Dimensions: Cells are up to 400 μm long and 60-200 μm wide.

Ecology: *Micrasterias* occurs free floating in soft or acidic water of lakes and reservoirs. It is rarely present in abundance. Sometimes they are present around the margins of nutrient-poor lakes where they are often attached to submerged macrophytes.

Notes: There is no clear distinction between *Micrasterias* and *Euastrum*, and placement of a few taxa is arbitrary.

Problems: None known of.



Caption: *Micrasterias*, a beautiful desmid genus closely related to *Cosmarium*, but with lobed semi-cells (photos a and b). The nucleus is located in the transparent area in the middle of the cell (photo a).

Monoraphidium Komárková-Legnerová

Origin: From Greek *monõsis* "single" + *raphidos,* "needle" or "pin".

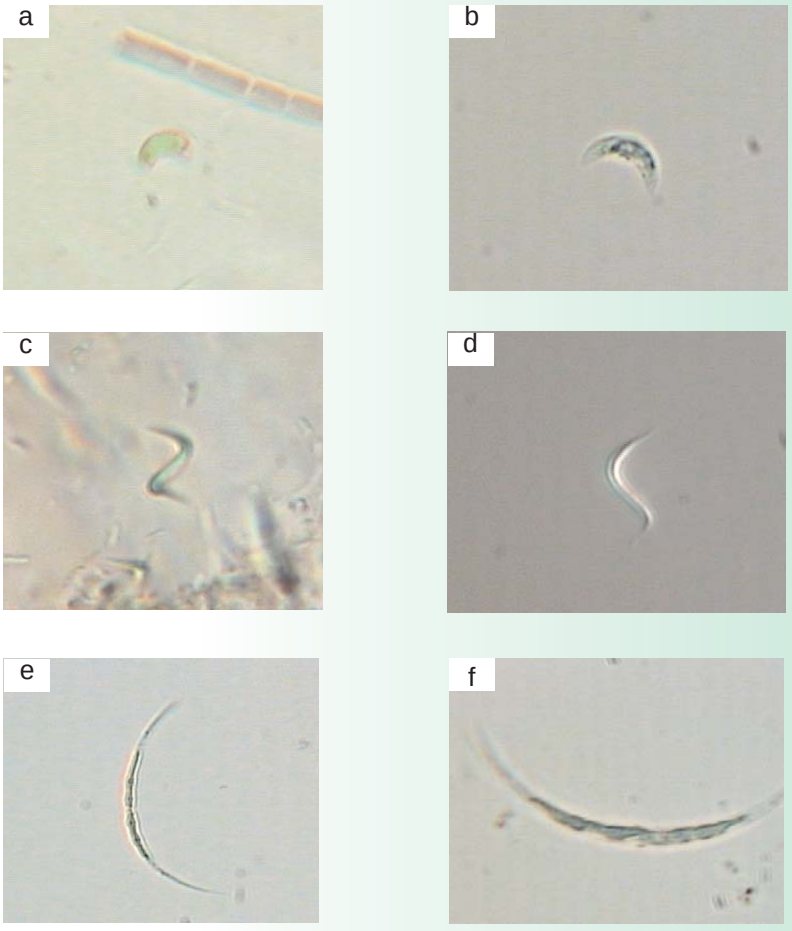
Characteristics: *Monoraphidium* cells are not embedded in mucilage to form colonies, but occur as solitary cells. The cells are needle- or sickle- or spindle-shaped, straight, curved, sigmoidal or spirally twisted, often with both ends equally pointed or curved. Each cell has a single chloroplast that almost fills the cell and usually a pyrenoid is not visible when examined with a light microscope (when present, the pyrenoid is without a starch envelope). The cells are uninucleate with thin smooth cell walls not surrounded by mucilage. The cells do not possess flagella. Asexual reproduction takes place by the formation of autospores. Sexual reproduction is unknown. Species are distinguished from each other based on cell shape, size and characters associated with cell curvature.

Dimensions: Cells 2-182 μm long and 1-8 μm wide.

Ecology: *Monoraphidium* is free-living or associated with aquatic macrophytes or other submerged surfaces in still or slow-flowing freshwater. *Monoraphidium* is particularly common under eutrophic conditions. It may also occur in soil.

Notes: The genus *Monoraphidium* is segregated from *Ankistrodesmus* Corda based on its unicellular nature, and the seriate development of autospores. *Monoraphidium* species in which the pyrenoids are visible with the light microscope have been transferred to the genus *Keratococcus* Pascher. Sometimes the genus *Selenastrum* Reinsch is used as a synonym for *Monoraphidium.*

Problems: None known of.



Caption: Solitary cells of different *Monoraphidium* species. Cells resemble the cells of *Kirchneriella*, but never occur in colonies. Cells of *Monoraphidium* range from small (photos a and b) to large (photos e and f).

Oedogonium Link

Origin: From Greek *oidos,* "swelling" + *gonos,* "offspring".

Characteristics: *Oedogonium* is an unbranched, filamentous green alga, consisting of a single layer of cells. The filaments are often attached by a basal holdfast cell, but they can also occasionally be found free-floating. Individual cells of the filament are usually cylindrical and are sometimes wider at one end than the other. *Oedogonium* is easily identified by distinctive rings (up to 20) at the apical (wider) ends of certain cells, which arise as a consequence of cell division - each cellular division creates a new ring on the cell. In some filaments, a long spike is carried on the apical cell. The shape of the apical cell and the basal holdfast cell is often distinctive. Vegetative cells are uninucleate, highly vacuolate and contain a parietal, net-like chloroplast with several pyrenoids. The cell walls are very hard. *Oedogonium* reproduces asexually by fragmentation, cell division (forming rings) or zoospore formation or sexually. Species are identified and differentiated when in the reproductive condition by the size, shape, and location of the gametangia, and variations in patterns on the zygote wall.

Dimensions: Species differ markedly in cell size with diameters ranging from 4-54 μm, commonly 14-30 μm. The mean cell diameter is, however, an unreliable guide to species discrimination as filaments vary in width from one end to the other.

Ecology: *Oedogonium* is common in freshwater habitats worldwide, with the greatest abundance of species in temperate and sub-tropical regions. Only a few species are found in brackish water. Filaments are attached by the basal holdfast cell to rocks in shallow, still or slow-moving water, wood or aquatic plants or they are free-floating. When free-floating, they form dense pale-green, yellow-green or cream-coloured masses near or on the surface of the water (especially when nutrients are readily available). Often these masses are so dense that, if left to dry by the evaporation of water, they may form what is known as "algal paper". *Oedogonium* filaments are often covered with epiphytic diatoms or other microalgae as a result of the hard cell walls that make them an ideal substrate.

Notes: *Oedogonium* is easy to distinguish from other unbranched, filamentous algae by the rings left after cell division. Sometimes a number of cells must be observed to find these rings and they can be seen by careful focussing under favourable lighting. Species identification is only possible with fertile organisms present (not always common).

Problems: *Oedogonium* may form blooms (floating mats) under high nutrient concentrations and clog irrigation canals when growth on the concrete surfaces becomes excessive. However, *Oedogonium* is much more easily controlled by copper treatments than other mat-forming green algae.

Caption: An unbranched filament of *Oedogonium*. Note the rings (a result of cell division) on the right hand side of the filament - they are very important characteristics used in the identification of this genus.

Oocystis Braun

Origin: From Greek *oon*, "egg" + *kystis,* "bladder".

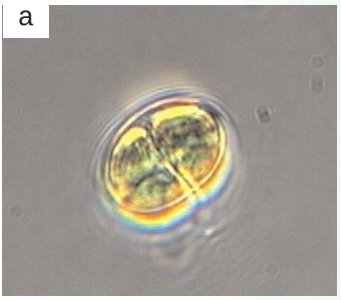
Characteristics: Cells are either solitary or arranged in oval to ellipsoidal colonies of 2-16 (sometimes 32 or 64) cells enclosed by the mother cell wall from the previous generation. Two to three generations of mother cell walls may be enclosed in the original mother cell wall, which enlarges so that it often appears as a gelatinous sheath. The cell body is broad ellipsoidal or oval to lemon-shaped with both ends slightly pointed. Cells have one to many chloroplasts with or without pyrenoids. The cell wall is thick and smooth, sometimes with polar thickenings. Asexual reproduction is by the formation of autospores that are released by the rupturing of the mother cell wall. Sexual reproduction and flagellated stages are unknown. Species are differentiated by cell size and form, the presence or absence and degree of thickenings at the poles, and by the number of chloroplasts and pyrenoids.

Dimensions: Cells are 12-50 μm long and 7-46 μm wide. Colonies are up to 77 μm in diameter.

Ecology: *Oocystis* is widespread and common. *Oocystis* is planktonic, predominantly in freshwater. Cells are common in pools, ditches, lakes and slow rivers, but can also occur in soil.

Notes: Hindák (1988) transferred those species of *Oocystis* not known to possess pyrenoids to the genus *Oocystella* Lemmermann.

Problems: None known of.



Caption: Oocystis in the form of solitary cells (photos a and b) or colonies (photos c,d and e). When the mother cell wall ruptures, the individual cells will be released (photo d).

Pandorina Bory de Saint-Vincent

Origin: From Greek "*Pandora",* a mythological women.

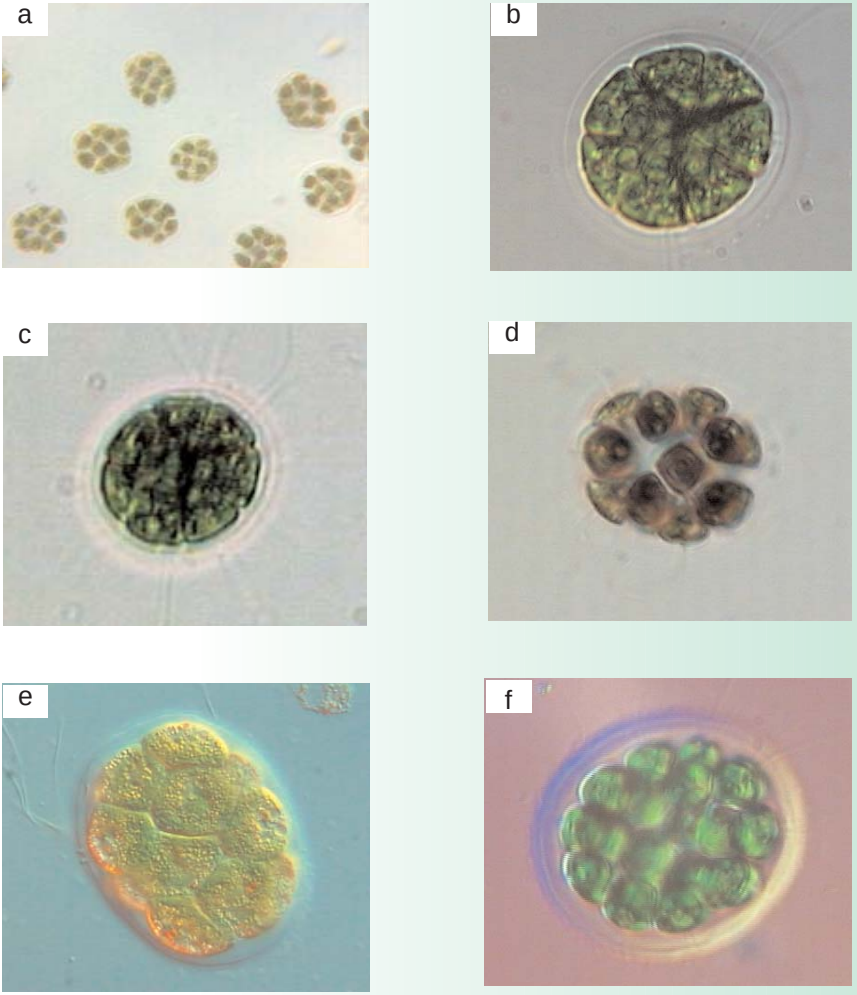
Characteristics: Colonies of *Pandorina* are oval, ellipsoidal or spherical with 8-32 densely packed cells so that there is no hollow at the centre of the colony. The cells are ovoid or slightly narrowed at one end to appear pear-shaped. The cells have flattened sides where they touch one another and slightly flattened apices. Outside the cells is a broad zone of clear mucilage through which the flagella protrude. Each cell has two flagella, two contractile vacuoles, an eyespot (eyespots of anterior cells are larger than those of posterior cells), and a large cup-shaped chloroplast with at least one pyrenoid. Colonies move through the water with a tumbling motion. Each cell can undergo cleavage to form daughter colonies that are exact replicas of the mother colony. *Pandorina* can also undergo sexual reproduction.

Dimensions: Cells are 8-20 μm long. Colonies are usually up to 100 μm in diameter.

Ecology: *Pandorina* inhabits a variety of freshwater environments around the world and is common in standing bodies of water (such as puddles, ponds and lakes) and slow-flowing rivers.

Notes: *Pandorina* differs from *Eudorina* Ehrenberg *ex* Ralfs in that the cells fit closely together without a large central space. The most common species is *P. morum* (Muller) Bory.

Problems: *Pandorina* growths can be difficult to control and are relatively tolerant to copper treatments. When present in large numbers, this alga gives the water a fishy odour.



Caption: Colonies of *Pandorina*, consisting of triangular, tightly-compressed cells kept together by mucous (clearly visible in photo f). Note the two flagella arising from each cell (photo c).

Pediastrum Meyen

Origin: From Greek *pedion,* "flat or plain" + *astron,* "star".

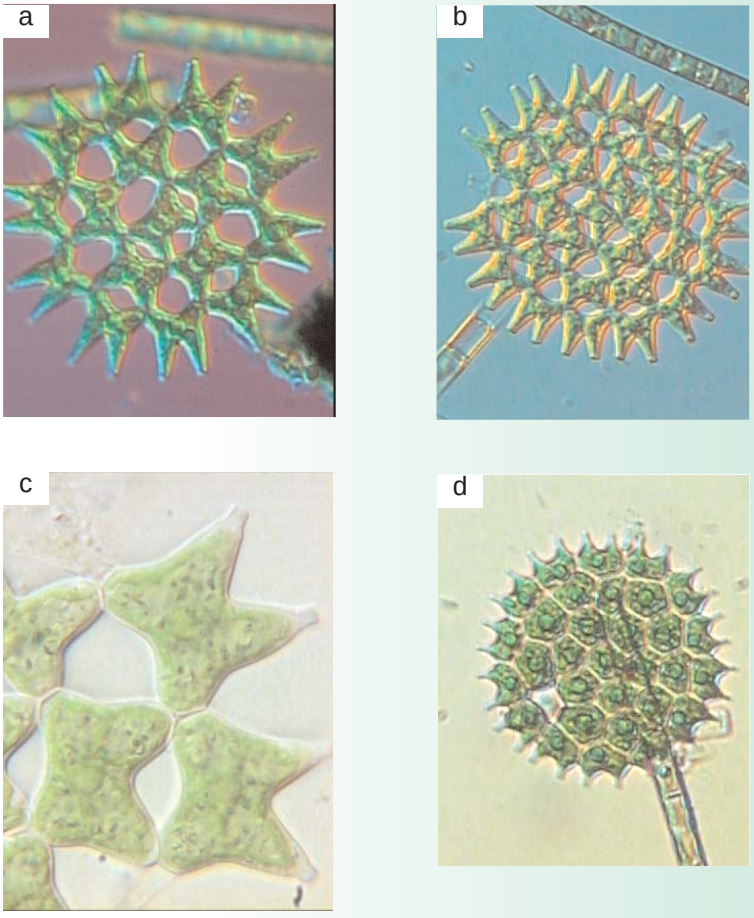
Characteristics: *Pediastrum* forms flat disc-shaped, oval to circular colonies, consisting of 4-64 (sometimes 128) cells. The colony is one cell-layer thick and if there are more than 16 cells, the cells tend to be arranged in concentric rings in a star-like pattern. Cells of *Pediastrum* are highly variable in shape - the cells at the margin differ in shape from those within the colony. The interior cells are typically polyhedral with four to many sides, while the peripheral cells are similar or with 1, 2 or sometimes 4 horn-like lobes or projections. These horn-like projections improve buoyancy in the water column and help to prevent predation. Cells of the colony are contiguous or the colony is perforate. The cells contain a parietal chloroplast with one pyrenoid. Cells are non-motile and multinucleate. The cells walls are smooth, finely reticulated or highly granulated, wrinkled or notched. The cell walls are highly resistant to decay and often persist for some time after the contents have died. Asexual reproduction is by zoospore and autocolony formation. Sexual reproduction is infrequently reported. Cell size and shape (particularly the numbers of projections of peripheral cells) and colony morphology are very important characteristics for species identification. In addition, the presence or absence of perforations and ornamentation of the cell wall should be considered for taxonomic contemplation.

Dimensions: The cells are 8-32 μm in diameter. Colonies can be large (up to 200 μm in diameter).

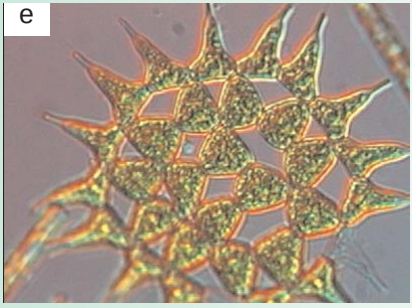
Ecology: *Pediastrum* is widespread and common in most standing (swamps, bogs, ditches, ponds, lakes) and slow-flowing freshwaters, and occasionally forms blooms especially in nutrient-rich environments. Colonies are free-floating, often among plants or other algae.

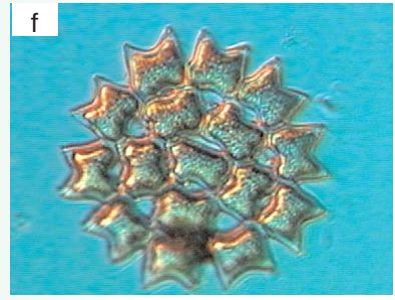
Notes: Common species include *P. simplex* Meyen (marginal cells are single lobed), *P. duplex* Meyen (marginal cells are bilobed with distinct gaps between the inner cells), *P. boryanum* Menegh. (marginal cells are bilobed without gaps between individual cells) and *P. tetras* Ralfs (small colonies with only 2, 4 or 8 angular cells per colony, each cell divided into two lobes by a narrow central incision). All the above species are common and widely distributed. *Euastropsis* Lagerheim is similar to *Pediastrum,* but its colonies consist of only 2 cells.

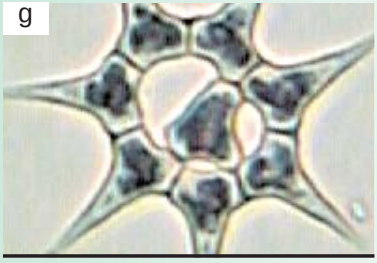
Problems: May form blooms.

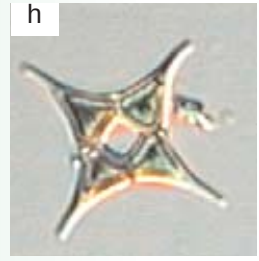


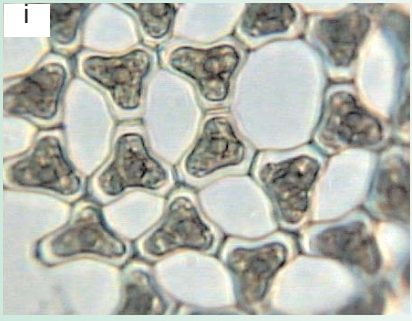
Caption: *Pediastrum* colonies belonging to *P. simplex* (photos a - d)

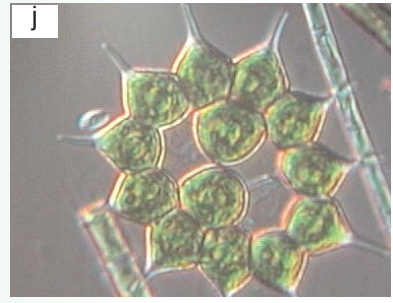




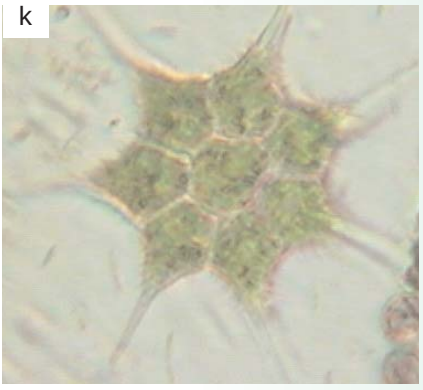


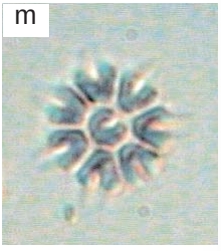






Caption: *Pediastrum* colonies belonging to *P. simplex* (photos e-j)





Caption: Pediastrum colonies belonging to several species, e.g. *P. simplex* (photos k and l) and *P. tetras* (photo m).

Scenedesmus Meyen

Origin: From Latin *skene,* "tent or awning" + *desmos,* "bond".

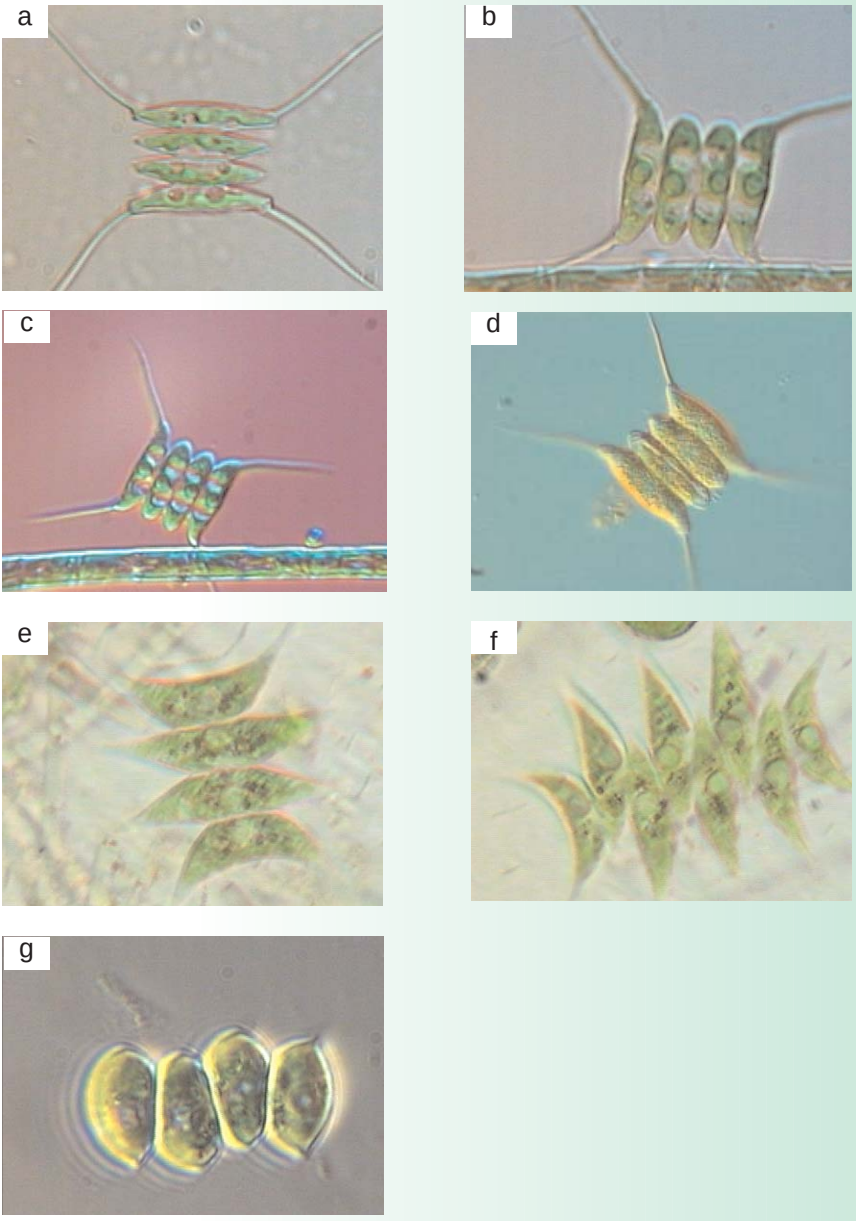
Characteristics: In this genus the elongated cylindrical cells are joined side by side to form flat, rectangular, plate-like colonies of 2, 4, 8, 16 (or rarely 32) cells. The cells may be arranged linearly or zigzag in a single or double row. Occasionally *Scenedesmus* cells occur solitary, especially when cultured. Cells are oval, fusiform or crescent-shaped with rounded or pointed ends. The terminal cells of many species have spines protruding from their outer corners, with the other cells having smooth walls, spines, teeth or ridges. The spines make the colonies more buoyant and may deter predation. Colonies are non-motile, with each cell containing a single nucleus and a single parietal, plate-like chloroplast with a single pyrenoid. The cell walls are resistant to decay and thus contribute to the formation of fossil fuel deposits and visible fossil records. The usual method of reproduction is asexual by autospores, forming a daughter colony inside each cell. Sexual reproduction is reported, but is apparently extremely rare. Species are distinguished by the number, arrangement and size of cells and the ornamentation pattern on the cell wall (spines, ribs, granulation, etc.).

Dimensions: The cells are mostly 5-30 μm long and 2-10 μm wide. Spines (if present) may be up to 200 μm in length.

Ecology: *Scenedesmus* is a very common and sometimes abundant genus found in the plankton of freshwater ponds, lakes and rivers (rarely in brackish habitats). It is reported worldwide in all climates, but prefers eutrophic to hypertrophic waters with slight acidity and low salinity. *Scenedesmus* can also grow on damp soil. Besides being widely distributed in nature, *Scenedesmus* cells appear frequently in laboratory aquaria, colouring the water green. Like many other algae, *Scenedesmus* is an important primary producer and food source for higher trophic levels. *Scenedesmus* is a common bio-indicator of physical and chemical changes in environmental conditions. The genus is commonly used to detect the presence of nutrients or toxins resulting from anthropogenic inputs to aquatic systems.

Notes: Single celled stages often look like species of *Lagerheimia* Chodat (*Chodatella*) and can cause much nomenclatural confusion.

Problems: Although growth may be dense in nutrient-rich waters, it is not typically considered a nuisance.



Caption: *Scenedesmus* colonies consisting of four or eight cells. Different species are distinguished by the number, arrangement, size and shape of the cells. Note the clearly visible pyrenoids in photos b, e and f.

Spirogyra Link

Origin: From Greek *speira,* "coil" + *gyros,* "twisted".

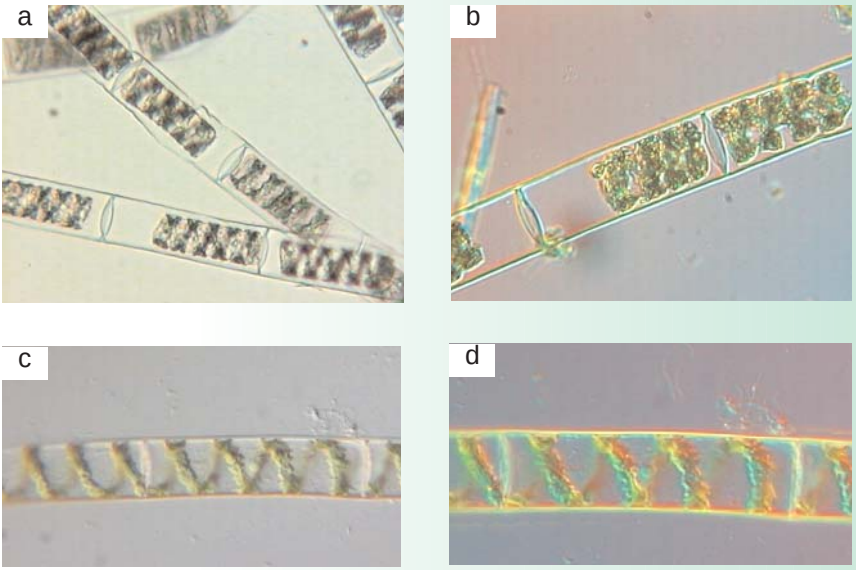
Characteristics: The long, unbranched filaments of *Spirogyra* are straight, one cell-layer thick, and slimy to touch as a result of an outer coating of mucilage. Cells are cylindrical and longer than broad with firm cell walls. Each cell contains one or more (as many as 16) spiralled, ribbon-shaped, parietal chloroplasts, with numerous disc-shaped pyrenoids. The edge of the chloroplast may be ruffled. The chloroplasts render the cells a bright grass-green colour - *Spirogyra* is sometimes referred to as "green silky-strand algae". The nucleus is located in the centre of the cell and is suspended from strands of cytoplasm stretching from the cell periphery. A large central vacuole is present. No flagellated stages are present in the life cycle. Asexual reproduction by fragmentation and the formation of akinetes and aplanospores. Sexual reproduction is by conjugation, which may be scalariform (ladder-like between two filaments) or lateral (between two adjacent cells in the same filament). Species are differentiated by a combination of vegetative characters (size and shape of cells, number of chloroplasts, etc.) and reproductive details, mostly in reference to the morphology of the zygospore and its wall markings. Identification of species can be difficult.

Dimensions: Cells are up to 200 μm long and 10-150 μm wide, depending upon the species.

Ecology: *Spirogyra* is widespread in all freshwater habitats. It is most common in standing water (e.g. shallow ponds, ditches and amongst vegetation at the edges of large lakes), but also frequently occurs in running streams of neutral or low pH. The filaments are usually found as free-floating masses and it often forms extensive blooms in freshwater ponds. The filaments are also frequently attached to a substrate.

Notes: Under favourable conditions *Spirogyra* forms green clouds of filaments below the surface of the water and it usually appears as floating yellowish-brown mats when entering the reproductive state.

Problems: Blooms can impart a grassy odour to the water, block canals and clog filters, especially at water treatment facilities.



Caption: Unbranched filaments of *Spirogyra*. Note the spirally twisted chloroplast and the nucleus in the centre of the cell (photo d).

Staurastrum Meyen *ex* Ralfs

Origin: From Greek *stauron,* "cross" + *astron,* "star".

Characteristics: There is a great variation in size, shape and ornamentation within this genus. Each cell is divided into two semi-cells by a deep incision, the sinus. In front view semi-cells may be elliptical to semi-circular, triangular, quadrangular to polygonal. In apical view the cells are usually triangular with the angles produced into multiple hollow projections (usually 2-12). Projections may be absent (cell angles rounded or truncate) or range from short and stumpy (giving the cell a polygonal appearance) to long, arm-like structures often covered in warts or spines. The cells with longer projections can achieve greater buoyancy in the water column and are often planktonic. In some species the arm-like projections are in one plane only (horizontal extensions of the semi-cell), in others they may occur in different planes. Cell walls have pores and extrusion from pores (especially in planktonic species) results in cells enclosed within a wide mucilage envelope. Each semi-cell usually has a large, lobed chloroplast with a single large pyrenoid in its centre, but this can vary among species. The nucleus is located in the isthmus between the two semi-cells. The cell walls may be smooth or ornamented, and contain compounds that make them resistant to decay (remains have been found in lake sediments thousands of years old). Asexual reproduction occurs by cell division and new semi-cell formation. Sexual reproduction, by conjugation, is known for many species. Species of *Staurastrum* are mainly distinguished by differences in the cell wall patterns and the number, size and arrangement of projections.

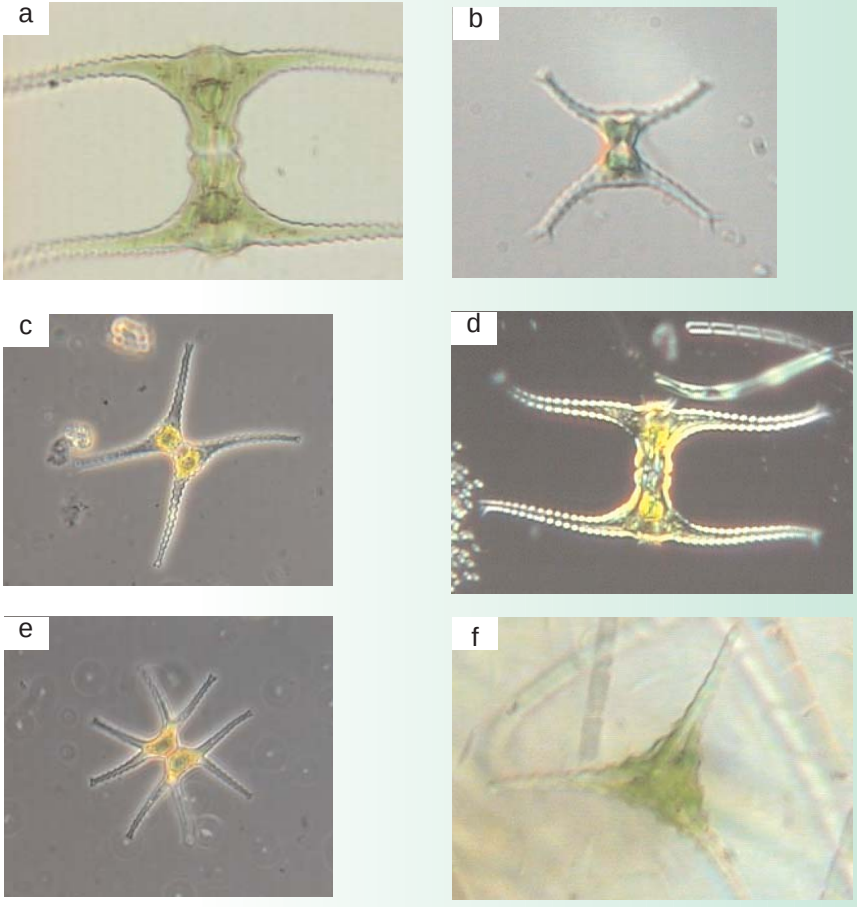
Dimensions: The cells are usually 15-120 μm long and 10-100 μm wide (excluding processes).

Ecology: *Staurastrum* is widespread and extremely diverse. Although the genus is most commonly found in the sediments or periphyton of acidic, oligotrophic lakes, ponds and swamps, they can occur in all freshwaters, including eutrophic conditions. Some species are planktonic and they often have long processes that aid in buoyancy. At least two *Staurastrum* species are regarded as reliable indicators of eutrophic, alkaline waters, while many others are used as bio-indicators of oligotrophic, mildly acidic waters.

Notes: *Staurastrum* is the desmid genus with the greatest range of morphologies. Because of this and the complexity of form within the genus, several attempts have been made to divide it into several genera.

So far only smooth walled species with a single spine (or thickened cell wall) at each angle have been assigned to the genus *Staurodesmus* Teiling. Many species appear like *Cosmarium* Corda *ex* Ralfs when seen in front view and one must focus carefully to see the arms or lobes of the semi-cell extending towards or away from the observer.

Problems: Blooms of *Staurastrum* have created odour problems in drinking water supplies. The odour is described as grassy.



Caption: Different views of *Staurastrum* spp. Photo f shows an apical view, in which the semi-cells look triangular. The spike-like projections (often with forked ends; photo b) increase the surface area and improve the algae's ability to float. Note the single pyrenoid in each semi-cell (photo a).

Stigeoclonium Kützing

Origin: From Latin *stigeus,* "tattooer" + from Greek *klonion,* "small twig".

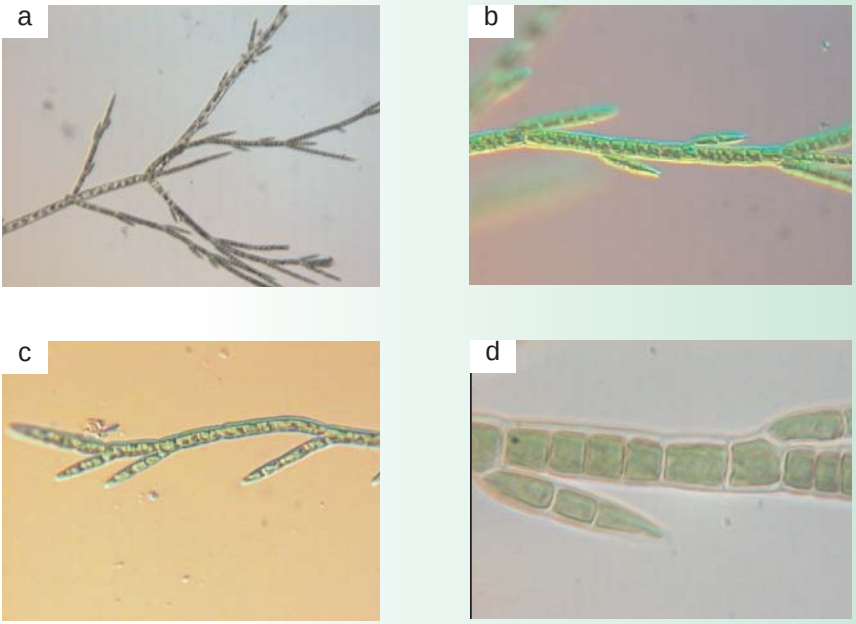
Characteristics: The morphology of *Stigeoclonium* is highly variable. In general, *Stigeoclonium* filaments are prostrate and attached to the substrate by means of a basal cell, which may develop into an extensive disc. Branches may arise regularly or irregularly and grow upright, sometimes producing a macroscopically visibly system of erect filaments. The erect filaments have tapering terminal cells with long, multicellular hairs. The filaments are uniseriate (one cell-layer thick). The cells are cylindrical or rounded with thin or thick walls, containing a single nucleus and one to several plate-like, parietal chloroplasts, each with at least one pyrenoid. Reproduction is asexual by the formation of zoospores, or sexual. There are several species differentiated by size, plan of branching, and by the general morphology of the thallus as a whole.

Dimensions: Cells of the filament are 8-25 μm wide and 2 to 5 times as long as broad.

Ecology: *Stigeoclonium* is a common freshwater genus growing on a wide range of different surfaces. It is usually found as attached tufts or mats on submerged rocks or aquatic plants, mostly in fast-moving rivers and streams (it can, however, also be found in standing waters). It is sometimes abundant in polluted waters such as the outflow of sewage treatment plants, and it is tolerant of heavy metals. The genus typically forms mats in colder waters and is part of the periphytic community.

Notes: *Stigeoclonium* is a common weed species in urban creeks, and although capable of clogging irrigation canals, it is usually less problematic than *Cladophora* Kützing. The filaments are more slimy to touch than *Cladophora* but less so than *Spirogyra* Link.

Problems: *Stigeoclonium* is known to clog irrigation canals by growing abundantly on the concrete linings.



Caption: Branched filaments of *Stigeoclonium* consisting of a single cell layer. These filaments often produce a macroscopically visible system of erect filaments. Note the tapering terminal cell in photo d.

Tetraedron Kützing

Origin: From Greek *tetra*- "four" + *hedra* "seat, base."

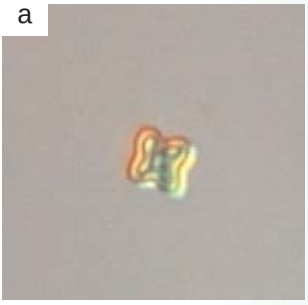
Characteristics: *Tetraedron* cells are solitary, flat or slightly twisted and free-floating. Cells are generally small and angular. In apical view the cells appear 3-, 4- or 5 sided (triangular, pyramidal or polygonal). The angles may be blunt or rounded, sometimes terminating in a papilla-like wall thickening or spine. Each uninucleate cell contains a single chloroplast with one to many pyrenoids. The cell wall is relatively thin and finely granulated when observed by means of light microscopy. Asexual reproduction is by autospore formation and sexual reproduction is unknown. Species are distinguished based on details of cell size and shape.

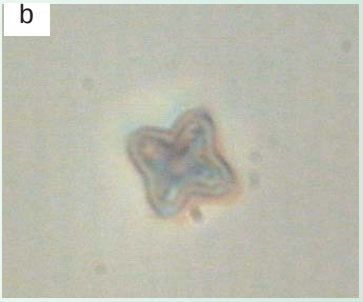
Dimensions: Cells are 5-25 μm in diameter.

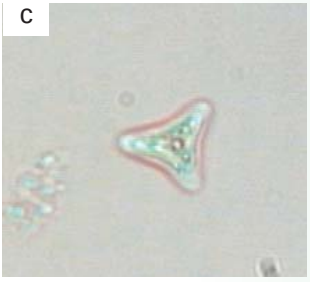
Ecology: Common, but rarely abundant, in freshwater plankton. *Tetraedron* is found free-floating in ponds, lakes and slow rivers or it can be associated with bottom sediments or aquatic macrophytes.

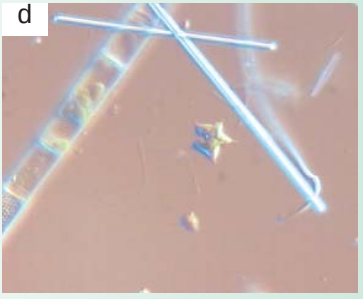
Notes: Morphologically they cannot be differentiated in a key from the genus *Polyedriopsis* Schmidle. The latter genus groups those species that reproduce by zoospores, whereas *Tetraedron* reproduces by non-motile autospores. The most common species include *T. minimum* (Braun) Hansgirg (cells 4-sided with concave sides and rounded angles containing small papillae), *T. regulare* Kützing (cells 4-sided, corners caped with a short, blunt spine) and *T. caudatum* (Corda) Hansgirg (cells 5 sided with rounded angles each bearing a distinct short spine - the young cells are more deeply indented, but here one side is always much deeper than the others).

Problems: None known of.









Caption: Small, solitary cells of various *Tetraedron* species e.g. *T. minimum* (photos a and b), *T. mediocris* (photo c) and *T. caudatum* (photo d).

Tetrastrum Chodat

Origin: From Greek *tetra,* "four" + *strumosus,* "swollen".

Characteristics: The colony is four-celled and flat, with a small, central opening. Cells are oval, heart-shaped or triangular as a result of mutual compression. Each cell usually bears one to four slender spines or warts on the outer free wall (sometimes absent). Uninucleate cells contain one to four plate-like chloroplasts, with or without pyrenoids. When viewed by means of light microscopy the cell walls appear smooth. No flagellated stages are present. Asexual reproduction is by autospore formation and sexual reproduction is unknown. Species are distinguished based on details of cell size and shape, spine morphology and presence/absence of pyrenoids.

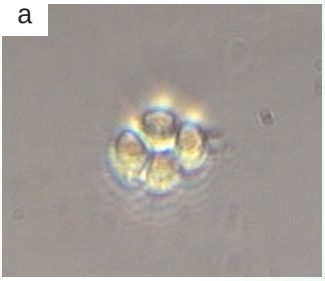
Dimensions: Cells are 2-12 μm across (excluding spines).

Ecology: Commonly found in the phytoplankton of freshwater such as ponds, lakes and slow-flowing rivers. *Tetrastrum* favours eutrophic conditions.

Notes: *Tetrastrum* resembles some species of *Crucigenia* Morren, but differs in having spines (often only small) and in not producing compound colonies of more than one generation. Species with wall granulations or warts as observed with a light microscope should be assigned to *Pseudostaurastrum* Chodat. The most common species is probably *T. staurogeniaeforme* (Schroeder) Lemmermann, which occurs in the plankton, but is not usually abundant.

Problems: None known of.

a



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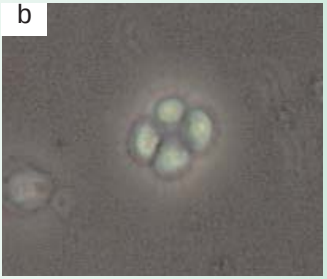


c

Caption: Colonies of *Tetrastrum*, each consisting of four cells with a small opening in the middle. Each cell has a rounded external wall bearing spines (photos a and b).

Treubaria Bernard *emend.* Reymond

Origin: Uncertain.

Characteristics: *Treubaria* is a unicellular, planktonic alga with elongate-triangular, tetrahedral, polyhedral to almost spherical cells. The cell has three to five angles, each angle bearing a pointed, hollow, conical spine, sometimes with very a broad base. Cells are uni- or multinucleate and there are one or several plate-like chloroplasts, each with 1 to 4 pyrenoids (depending on age). The cell walls are smooth. Asexual reproduction takes place by autospore formation. Sexual reproduction is unknown. Species are distinguished based on protoplast shape as well as length, number and morphology of the spines.

Dimensions: Cells are 5-22 μm in diameter. Spines are 6-83 μm long.

Ecology: *Treubaria* is cosmopolitan and usually planktonic in freshwater. Cells may, more rarely, be associated with submerged surfaces and periphyton in standing water or the slow-flowing reaches of very nutrient-rich rivers.

Notes: *Treubaria* cells are similar to *Tetraedron* Kützing in the pyramidal or polyhedral shapes, but in *Tetraedron* the spines are relatively short or reduced to papilla at the tips of the lobes.

Problems: None known of.

Caption: A dead cell of *Treubaria*, with prominent spines clearly visible.

Volvox Linnaeus

Origin: From Latin *volvo*, "to roll".

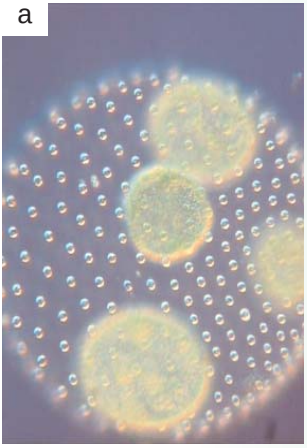
Characteristics: Because of its large size, free-swimming *Volvox* colonies can usually be seen with the unaided eye. The hollow, spherical to ovoid colonies contain a peripheral layer of approximately 500 to 50 000 biflagellate *Chlamydomonas*-like cells, each surrounded by a mucilaginous envelope. Cells are approximately equidistant, spherical, ovoid or star-shaped, each with two equal flagella, an eyespot, two contractile vacuoles at the base of the two flagella, and a cup-shaped chloroplast with single pyrenoid. Cytoplasmic strands between cells are thick, thin or absent (species dependent). During asexual reproduction, one to several daughter colonies is formed within the interior of the sphere by repeated division of special gonidial cells. Daughter colonies are released by rupturing of the parental colony surface. Sexual reproduction is oogamous and mature colonies may contain several, much enlarged egg cells and packets of motile sperm. Species may be monoecious or dioecious. The zygote is thick-walled - the wall may be smooth, or it may bear external decorations such as spines and warts.

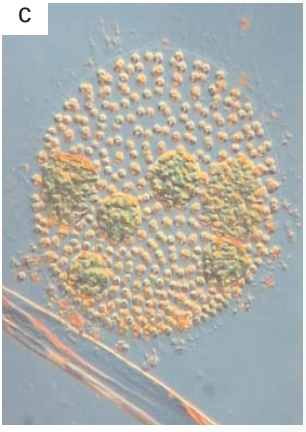
Dimensions: Cells are mostly 4-8 μm in diameter while colonies are usually 0.5-1.5 mm in diameter.

Ecology: *Volvox* is widespread and common in freshwater, especially those rich in nitrogenous matter. Colonies are free-swimming in ditches, lakes, ponds or other bodies of still or slow flowing water, especially during late summer. *Volvox* often over winter on the bottom of the waterbody in the form of zygotes.

Notes: *Volvox* is the largest free-swimming, colonial Chlorophyte and it is frequently accompanied by *Eudorina* and *Pleodorina* Shaw in water bodies. Because *Volvox* colonies are a millimetre or more in diameter, their movements can be followed when large populations are present - in a dish it can be seen that they move towards the light, provided it is not too bright.

Problems: An excess of nitrogen encourages the growth of *Volvox* and may cause “blooms” during the summer months. When this occurs in the shallow ponds at fish hatcheries, large numbers of *Volvox* cause damage to the gills of young fish. When present in large numbers *Volvox* gives water a fishy odour.





Caption: Large colonies of *Volvox*, with daughter colonies visible on the inside of the mother colonies (photos a, b and c). Photo d shows higher magnification of the individual cells each having two flagella.

GLOSSARY

Accessory pigment: A pigment capable of capturing radiant energy and transferring it to chlorophyll-*a*.

Acid water: Water with a pH value below 7.

Adnate: Tightly joined or affixed to a particular substratum.

Akinete: Thick-walled non-motile resting spore formed by transformation of a vegetative cell; in blue-green algae, with a thick wall and usually considerably larger than the vegetative cells. Considered to be storage structures that can survive in sediments for many years.

Alga (pl. algae): A commonly used term for primitive chlorophyll-containing, mainly aquatic eukaryotic organisms, lacking true roots, stems and leaves.

Alkaline: Having a pH greater than 7.

Alkalinity: A measure of the acid-neutralising capacity of water, and as such, it is also an indication of the base content. Ions which commonly contribute to the alkalinity of water are bicarbonate (HCO_3^-) and carbonate (CO_3^{-2}), and at higher pH values, hydroxide (OH^-).

Alveolus (pl. alveoli): Elongate chambers in the surface of the valve. The top surface of these is composed of punctae or similar structures, which may only be resolvable under the electron microscope.

Amorphous: Having no definite form or distinct shape.

Anterior: The forward end, toward the top or the front plane of the body.

Anthropogenic: Caused by human activities, often referring to disturbances to ecological systems, such as acidic precipitation.

Apex (pl. apices): End or tip of the cell.

Apical: Situated at the apex (tip) of any cell, structure or organ.

Aplanospore: An ontogenetically potential zoospore that has omitted the motile period.

Araphid: Diatom valve with no true raphe slit, valve may however be ornamented with a pseudoraphe

Arcuate: Arched-, bow- or crescent shaped; strongly curved (2-dimensional term).

Areola (pl. areolae): Chamber-forming perforations, rounded to angular in cross-section, in the valve wall of diatoms. They are closed either on the outside, or inside, by a velum.

Asexual reproduction: Reproduction which does not involve formation and fusion of gametes, and which may be by binary fission, budding, asexual spore formation or vegetative propagation, resulting in progeny with an identical genetic constitution to the parent and to each other.

Autocolony: A colony, that is a miniature of the parental colony, formed during asexual reproduction of coenobia.

Autospore: A non-motile spore resembling the parent cell

Autotrophic: "Self-feeding"; able to synthesise, by the process of photosynthesis, organic compounds from inorganic substrates, using either sunlight or chemical energy sources.

Axial area: In pennate diatoms this is an areolae-free zone on either side of the apical axis.

Basal: Located at the base or point of origin of a thallus or filament.

Basionym: Original name of a taxon, now used in a new combination.

Benthos, benthic: Bottom-dwelling; non-planktonic; attached to, or resting on, the substrate.

Bilateral symmetry: Having two sides symmetrical about one median axis only, so that one side is a mirror image of the other.

Binary fission: A form of asexual reproduction whereby a cell divides into two daughter cells after DNA replication nuclear division.

Bio-indicator: Organisms or groups of organisms, which relate to biochemical, cytological, physiological, ethological or ecological variables, and enable the characterisation of the state of an ecosystem or ecocomplex. Subsequently they enable the observations of changes in time and/or space of these characteristics and facilitate the differentiation between human and/or natural causes of these changes.

Biraphid: Diatom frustule ornamented by a true raphe on each of the two valves.

Bloom: Massive or conspicuous growth of algae which visibly discolours the water, typically planktonic and often forming surface scums; often a large percentage of the total cells are one of a few species.

Bog: Wet spongy ground of decomposing vegetation; has poorer drainage than a swamp.

Bow-shaped: Curved.

Brackish: Water that contains an increased and usually variable dissolved salt (sodium chloride) content, that is, however, less than that in seawater.

Brownian movement/motion: Random motion of small (about 1 μm) solid particles suspended in a colloidal solution, due to their bombardment by molecules of the solution.

Budding: Method of asexual reproduction in which new individuals develop as outgrowths of the parent organism and may eventually be set free.

Calcareous: Composed of or containing calcium carbonate or calcite.

Capitate: Enlarged or swollen at the tip.

Carcinogenic: Causing, or tending to cause, cancer in humans or animals.

Carotenoid: A group of widely distributed orange, yellow, red or brown fat-soluble pigments.

Cell: The basic structural and functional unit of all organisms; Cells may exist as independent units of life or may form colonies or tissues as in higher plants and animals.

Cell division: The process by which a cell divides to form daughter cells

Cell membrane: A thin membrane around the cytoplasm of a cell that controls passage of substances in and out of the cell. Also known as the plasma membrane or plasmalemma.

Cell wall: Typical rigid external structure enclosing the cell membrane (not in animal cells though); may consist of cellulose, silica, pectin, or other materials in algae.

Cellulose: A linear polysaccharide made up of glucose residues joined by ß-1,4-linkages, the most abundant organic compound in the biosphere, comprising the bulk of algal cell walls, where it occurs as cellulose microfibrils.

Chelate: A heterocyclic compound having a metal ion attached by coordinate bonds to at least two non-metal ions.

Chlorophyll-*a*: A primary photosynthetic pigment and light receptor in algae and higher plants.

Chlorophyll-*b*: A secondary photosynthetic pigment present in higher plants, green algae, prochlorophytes, and euglenophytes.

Chlorophyll-*c*: A secondary class of photosynthetic pigment which occurs in chrysophytes, synurophytes, diatoms, cryptophytes, tribophytes, dinoflagellates and brown algae; includes two components (both forms not found in all algal groups) termed c_1 and c_2, each of which has several different absorption peaks.

Chloroplast: Double-membrane bounded organelle in eukaryotic algae containing chlorophyll and other pigments; if the green colour is masked by chlorophyll, the older literature sometimes used the term chromatophore.

Chrysolaminarin: A polysaccharide storage product,ß -1,3-linked glucan; occurs in several algal groups, including chrysophytes and diatoms. Also termed leucosin.

Cigar-shaped: Shaped like a cigar, i.e. rod-like, but tapering at each end.

Cingulum: In dinoflagellates, a transverse groove that encircles the cell (usually) and holds the transverse flagellum in place. In diatoms, the girdle region of the frustule, connecting the epivalve and hypovalve.

Circumneutral: Having a pH of approximately 7.

Clathrate: Lattice-like with irregular perforations or openings.

Clavate: Club-shaped, growing gradually thicker toward the top (3-dimensional term).

Cleavage: Mitotic divisions resulting in the splitting of a single cell.

Coenobium (pl. coenobia): Colony in which the cell number is fixed at the time of formation and not augmented subsequently; a colony has a definite form and organisation, behaves as an individual and reproduces to form daughter coenobia.

Collar: A narrow neck around the flagellum opening in a lorica.

Colonial: Living in colonies.

Colony (pl. colonies): Group of individual cells enclosed within a common mucilaginous sheath or joined together by cytoplasmic strands or parent cell walls.

Conductivity: A measure of the resistance of a solution to electric flow.

Conical: Relating to, or resembling a cone i.e. tapering to a fine point.

Conjugation: Sexual reproduction between cells that connect together, with the entire cytoplasm from one cell fusing with that of the other, resulting in a zygospore.

Contiguous: Touching each other at the edges, but not actually united.

Contractile vacuole: Small vesicle found in the cytoplasm of many freshwater algae, which expels surplus fluid.

Cosmopolitan: World-wide distribution.

Costa (pl. costae): Longitudinal (transapical) thickening of the valve.

Costate: Possessig transapical ribs.

Creek: A natural stream of water smaller than a river (and often a tributary of a river).

Crescent-shaped: In the form of an arc, resembling the curved shape of the moon in its first or last quarters (a narrow, curved shape tapering at the ends to form a wider or cylindrical mid-region).

Cross wall: See septum.

Culture: Algae grown in a laboratory in a solution which is made of the basic nutrients required for growth.

Cup-shaped: A nearly complete folded plate (as a chloroplast) open at one position to form a cup.

Cylindrical: Elongate with parallel lateral margins when viewed from any direction, as in a cylinder or tube (3-dimensional term).

Cyst: Resting spore, usually thick-walled.

Daughter cells: Cells derived from a parent by a mitotic division.

Daughter colony: Small colony within a mother cell or mother colony.

Debris: The remains of something that has been destroyed or broken up.

Dermatitis: Inflammation of the surface of the skin.

Desmid: Unicellular or filamentous freshwater green alga whose cells are typically almost divided in two by a constriction of the cell wall.

Diatom: A yellow-brown algae belonging to the division Bacillariophyta; most are unicellular and have a cell wall consisting of two halves (valves) composed of silica.

Diatomaceous earth: A light soil consisting of deposits of siliceous diatom remains and often used as a filtering material.

Discoid: Having a flat, circular shape; disc-shaped.

Ditch: Any small natural waterway.

Dorsiventrally flattened: In dinoflagellates, flattened in cross section of the cell, equivalent to laterally flattened or flattened in side view in other flagellate groups (e.g. chrysophytes).

Ecology: The interrelationships between organisms and their environment and each other; the study of these interrelationships.

Ecosystem: All the plants and living creatures in a particular area considered together with their physical environment.

Ejectisome: Projectile-like structure that is discharged from the cell; may serve as an escape mechanism or direct defence against other organisms.

Ellipsoidal: A three-dimensional term for a structure appearing elliptical in side view, i.e. an elongated structure with convex lateral margins and rounded, narrowed ends; watermelon-shaped.

Elliptical: Rounded, like an egg (2-dimensionale term).

Endosymbiont, endosymbiotic: Symbiosis in which one partner (the endosymbiont) lives inside the cells of the other, e.g. photosynthetic cyanobacteria living in the cells of non-photosynthetic dinoflagellates (i.e. they live endosymbiotic).

Endosymbiosis: A symbiotic relationship between two organisms in which one of the two organisms (the endosymbiont) lives inside the body of the other one (the host).

Enriched: Loaded with nutrients, particular nitrogen and phosphorus.

Epipelon: Algal community living in or on the surface of sediments in shallow waters where light penetrates.

Epiphyte, epiphytic: Growing on another plant (including another alga), but does not parasitise on it.

Epitheca: In dinoflagellates, the portion of the cell anterior to the cingulum; in diatoms, the larger and older half of the frustule, also known as the epivalve.

Equator: Imaginary line halfway between the opposite poles of the cell.

Eukaryotic: Organisms with distinct membrane-bounded organelles, such as the nucleus, mitochondria and/or chloroplasts.

Eutrophic: Literally, well nourished; water bodies that have high levels of dissolved nutrients (especially N and P) and high levels of organic production.

Eutrophication: Process of becoming eutrophic by an increase in nutrients in a body of water. Natural eutrophication is a gradual process, but human activities may greatly accelerate the process.

Eyespot: Granular organelle, or a cluster of granules, usually red or orange, frequently present in flagellated cells; it functions in different ways in different groups of algae, but either directly or indirectly permits the cell to perceive the direction of light.

Fascicles: Stria bundled together in sectors on the valve surface.

Fertile: Capable of reproducing.

Fibulae (carinal dots): Support in the form of a silica strut, bridging the raphe-bearing keel on the inner side of the valve in many diatom species with a canal raphe. The fibulae can end in one or more transapical striae, and be either solid, tubular or be flattened.

Filament: Cells united or arranged in one or more rows to form a chain or thread; in blue-green bacteria often used interchangeably with the term "trichome" in forms which do not have a sheath; in those forms with a sheath, it refers to the trichome and its investing sheath.

Film: Thin layer of cells or filaments on surfaces such as rocks or sediments.

Fission: A mode of division in which cells cleave, thereby dividing into 2 equal daughter cells.

Flagellate: Non-phyletic term for protists that possess one or more flagella.

Flagellated: The condition of possessing one or more flagella.

Flagellum (pl. flagella): A long whip-like or feathery structure, used for locomotion through a liquid medium. Borne either singly or in groups by the cells of many bacteria and unicellular eukaryotic cells and by the motile male gametes of many eukarotic organisms. Bacterial and eukaryotic flagella differ in internal structure and mechanism of action.

Fragmentation: Formation of new individuals from segments arising by the break-up of parental ones.

Freshwater: Water lacking a significant salt content.

Frustule: The complete silicified cell-wall of a diatom, consisting of the epi- and hypotheca plus assossiated girdle bands.

Fucoxanthin: Brown-coloured carotenoid pigment produced by members of the golden-pigmented algae (e.g. chrysophytes, dinoflagellates and diatoms); acts as an accessory pigment in photosynthesis.

Fultoportula: Hollow processes on the outside of the valve (Thalassiosiraceae), normally as a marginal ring.; tubuli (tubes) with 2-5 closely associated structures ("satellite pores") that penetrate the valve wall. They can be arranged in a marginal ring and/or otherwise arranged on the valve surface. Their organisation and number (including their presence and absence) are held as important taxonomic characters.

Fusiform: Spindle-shaped, elongate, broad in middle and tapering gradually to acute or broadly rounded apices (3-dimensional term).

Gametangium (pl. gametangia): Structure producing gametes.

Gamete: A cell with a haploid chromosome complement, potentially capable of fusing with or fertilising a compatible cell to form a zygote in the process of sexual reproduction.

Gas vacuole: In blue-green bacteria, a grouping of gas vesicles in the cell which are visible under the light microscope.

Gas vesicle: In blue-green bacteria, the minute hollow, cylindrical, gas-filled structure in the gas vacuole. It confers ability for gas vacuoles to float; only visible with the electron microscope.

Gelatinous: Jelly-like.

Genus (pl. genera): Taxonomic group of closely related species, similar and related genera being grouped into families.

Girdle: A band or belt, usually median; part of the structure just within the wall, and lateral in the cell, which holds the valves of diatoms together.

Girdle-view: A lateral or side view of a diatom, showing the overlapping of the two sections of the frustule.

Gliding: Type of movement shown by various microorganisms which requires contact with a surface, but not involving flagella or cilia; it occurs in many blue-green bacteria, diatoms, desmids and also some green algal filaments.

Globose, globular: Having the shape of a sphere or ball.

Glycoprotein: Protein with attached carbohydrates, often in wall or external gelatinous coatings.

Granular, granulated: As if composed of minute grains.

Gullet: A depression in the anterior region of some euglenoids, chrysophytes, cryptomonads, and other flagellates in the area where the flagellum(-a) emerges.

Habitat: The type of environment in which an organism or group normally lives or occurs.

Haploid: Having one set of chromosomes representing the basic genetic complement of the species, usually desinated n.

Hard water: Water containing large concentrations of alkaline earth elements, such as calcium and usually also magnesium ions, usually derived from drainage of calcareous deposits.

Heavy metal: Metal with a high relative atomic mass, such as lead and mercury.

Hepatotoxin: Poison acting on the liver.

Heterocyst: In blue-green bacteria, a rounded, thick-walled, seemingly empty cell in which nitrogen fixation takes place; found at intervals in filaments.

Heteropolar: Asymmetric polarity.

Heterotroph: An organism utilising organic sources of carbon, nitrogen, etc. using either sunlight or a chemical energy source.

Heterotrophic: Requiring organic compounds of carbon and nitrogen for nourishment.

Heterotrophy: Mode of heterotrophic nutrition.

Heterovalvar: One valve differing from the other valve, usually with respect to the raphe slit, i.e. one valve will possess a true valve and the other no raphe or a pseudoraphe.

Holdfast cell: Cell modified to attach or hold something in place.

Hormogonium (pl. hormogonia): In filamentous blue-green bacteria, a means of vegetative reproduction (and dispersal) formed via fragmentation of the trichome, forming distinct segments that are often motile (gliding).

Humus: Black organic material of complex composition which is the end product of the microbial breakdown of plant or animal residues in the soil.

Hyaline: Description of un-perforated parts of the diatom valve, i.e. those parts lacking puncta (opposite: perforated).

Hypertrophic: Waters grossly enriched with plant nutrients.

Hypotheca: In dinoflagellates, the portion of the cell posterior to the cingulum; in diatoms the smaller and younger half of the frustule, also known as the hypovalve.

Intercalary: Inserted between cells of a filament or trichome, rather than at the ends or laterally.

Interfascicular costa: The areolate and alveolate area between the transapical costae.

Isobilateral: A form of bilateral symmetry where a structure is devisable in two planes at right angles.

Isopolar: With similar poles.

Isthmus: In some desmids narrow equatorial part between two semi-cells.

Kidney-shaped: Bean-shape resembling the shape of kidney.

Labiate process (rimoportulae): A tube or similarly shaped perforation in the cell wall. Its inner opening is formed into an elongated slit, often surrounded by lip-shaped structures (centric and araphid diatoms).

Lake: A body of (usually fresh) water surrounded by land.

Lanceolate: Lance-shaped; long and narrow, with almost parallel margins but tapering towards the apex (2-dimensional term).

Lateral: Towards the side.

Lemon-shaped: Oval, with both ends slightly pointed.

Life cycle: The various phases that an individual passes through from origin to maturity and reproduction.

Linear: Narrow and several times longer than wide, with parallel sides.

Lobate: Having or resembling a lobe or lobes.

Lorica: In euglenophytes, chrysophytes and some green algae, a shell-like structure in which the organism lies. The shape varies, but there is always an opening at one end. Sometimes there is a collar through which a flagellum passes.

Macroalga: Multicellular alga, visible without magnification.

Macrophyte: Term used for all plants visible to the naked eye, not just macroalgae.

Macroscopic: Visible to the unaided eye; discernible without magnification.

Marine: Relating to the sea (ocean).

Marsh: An area of low land that is wet because water cannot drain away from it.

Mats: Thicker and firmer than films; they usually include distinctly sheathed organisms and are formed especially by significant growths of blue-green bacteria or some filamentous green algae.

Mesotrophic: Intermediate nutrient status, between oligotrophic and nutrient-rich, eutrophic water.

Metaboly, metabolic: In euglenoids, motility and flexibility in the pellicle (outer cell covering) without the aid of a flagellum.

Microalga: Small, unicellular alga, visible only under a microscope.

Micron, micrometer (*µ*m): Unit of measurement (= 0.001 mm); microscopy measurements are usually expressed in micrometers.

Microscopic: Discernible only with magnification by a microscope.

Morphology: The form or shape of a cell or organism.

Mother cell: Cell which divides to form daughter cells.

Motile: Capable of movement.

Mucilage: General term for colloidal material consisting of complex polysaccharides and frequently forming a protective coat, enveloping individual algal cells and especially groups of cells; the limitation of desiccation in aerial or sub-aerial environments is one of various important roles.

Mucilaginous: Containing or composed of mucilage.

Mucous: Slimy material consisting of water, the glycoprotein "mucin" and salts.

Multicellular: Many-celled.

Multinucleate: With several or many nuclei.

Naked: Cell not covered by a cell wall, only a cell membrane.

Naviculoid: Boat shaped.

Needle-like: Tapering at both ends.

Neurotoxin: Poison acting on the nervous system.

Niche: The conditions in which a species can live successfully.

Nitrogen fixation: The process whereby atmospheric, elemental nitrogen is reduced to ammonia by some blue-green bacteria and bacteria.

Non-motile: Not capable of movement.

Oligotrophic: Used to describe a waterbody low in nutrients, especially nitrogen and phosphorus.

Ontogenetically: Relating to the origin and development of individual organisms.

Organelle: A specialized part of a cell; analogous to an organ.

Oscillating: To move repeatedly and regularly from one position to the other and back again.

Osmotrophic: Any heterotrophic organism that absorbs organic substances in solution.

Oval, Ovate: Slightly elongate egg-shaped figure, with one pole broader than the other (2-dimensional terms).

Ovoid: Egg-shaped, rounded with one pole broader than the other (3-dimensional term).

Palmelloid stages: Stage in the life history of flagellated algae where cells become non-motile and divide to form a mass of cells embedded in an amorphous mucilage.

Papilla (pl. papillae): A small conical projection or protuberance on the cell wall.

Paramylon: Storage compound in euglenoids and other algae; a polymer of many b-1, 3-linked glucans organised in a membrane-bound crystalline structure; appears as distinct rods or disks under the light microscope.

Parasitic: The process whereby an organism derives its food from a living organism of another species (the host).

Parietal: Adjacent to or lying just inside the cell wall, usually used with reference to the position of the chloroplast.

Peat: Type of soil formed by partly decomposed plant material in anaerobic waterlogged conditions.

Pellicle: In euglenophytes, the flexible proteinaceous outer layer of the cytoplasm consisting of overlapping strips immediately internal to the cytoplasmic membrane. In Cryptophyta, a cell covering of proteinaceous plates internal to the cell membrane.

Periphery, peripheral: A position along the edge or boundary.

Periphyton, periphytic: Algae and other organisms growing attached to any submerged surface.

Phagotroph: Any heterotrophic organism that ingests live or dead food particles.

Photoactic: Attracted to moderate, but not intense light levels.

Photosynthesis: The synthesis of carbohydrate from carbon dioxide as a carbon source and water as a hydrogen donor with the release of oxygen as a waste product, using light energy trapped by the green pigment, chlorophyll inside chloroplasts.

Photosynthetic: Capable of performing photosynthesis.

Phycobilin; phycobiliproteins: Pigment found in blue-green bacteria, rhodophytes, a few cryptomonads and organisms containing cyanelles.

Phycobilisome: One of a number of small particles present on the thylacoids of cyanobacteria.

Phycocyanin: Blue phycobiliprotein pigment of all blue-green bacteria (other than prochlorophytes), cyanelles, some rhodophytes and some cryptophytes.

References

Brook, A.J. & Johnson, L.R. (2002). Order Zygnemales. In: *The Freshwater Algal Flora of the British Isles. An identification guide to freshwater and terrestrial algae.* (John, D.M., Whitton, B.A. & Brook, A.J. Eds), pp. 479-593. Cambridge: Cambridge University Press.

Deflandre, G. (1930). *Strombomonas* nouveau genere d'euglénacées (*Trachelomonas* Ehr. pro parte). Archiv für Protistenkunde, 69:551-614.

Downing TG and Van Ginkel CE (2002) Cyanobacterial monitoring 1990 - 2000: evaluation of SA data. Report No 1288/1/03 to the Water Research Commission. Pretoria. ISBN 1-77005-012-6.

Harding WR and Paxton BR (2001) Cyanobacteria in South Africa: A review. Report No TT153/01 to the Water Research Commission. Pretoria. ISBN 1 86845 7745.

Hindák, F. (1983). Review of the genus Latgerheimia Chod. incl. Chodatella Lemm. (Chlorococcales, Chlorophyceae). Schweizerische Zeitschrift für Hydrologie, 45:372-387.

Hindák, F. (1988). Studies on the Chlorococcal algae (Chlorophyceae). IV. Biologicke Práce, 34:1-264.

Hindák, F. (1990). Studies on the Chlorococcal algae (Chlorophyceae). V. Biologicke Práce, 36:1-277.

Javornický (2001). Freshwater Rhodomonads (Cryptophyceae). Algological Studies 102: 93-116.

John, D.M., Whitton, B.A. & Brook, A.J. (2002). *The Freshwater Algal Flora of the British Isles. An identification guide to freshwater and terrestrial algae.* Cambridge: Cambridge University Press.

John, D.M. & Tsarenko, P.M. (2002). Order Chlorococcales. In: *The Freshwater Algal Flora of the British Isles. An identification guide to freshwater and terrestrial algae.* (John, D.M., Whitton, B.A. & Brook, A.J. Eds), pp. 327-409. Cambridge: Cambridge University Press.

Komárek, J. (1974). The morphology and taxonomy of crucigenoid algae (Scendesmaceae, Chlorococcales) Archiv für Protistenkunde 116:1-74.

Nudelman M.A., Lombardo, R., Conforti, V. (1998). Comparative analysis of envelopes of *Trachelomonas argentinensis* (Euglenophyta) from different aquatic environments in South America. Algolocial Studies 89: 97-105.

Van Ginkel CE and Conradie B (2001) Potentially toxic algal incident in the Orange River, Northern Cape, 2000. Internal Report No. N/D801/12/DEQ/0800. Resource Quality

Van Ginkel, C.E.; Hohls, B.C.; Belcher, A.; Vermaak, E. & Gerber, A. (2001a) *Assessment of the Trophic Status Project.* Internal Report No. N/000/00/DEQ/1799. Resource Quality Services (Institute for Water Quality Studies). Department of Water Affairs and Forestry. Pretoria.

Van Ginkel, C.E., Hohls, B.C. & Vermaak, E. (2001b) A *Ceratium hirundinella* (O.F. Müller) bloom in Hartbeespoort Dam, South Africa. Water SA, 27 (2), 269-276.

World Health Organization (1999) *Toxic cyanobacteria in water. A guide to their public health consequences, monitoring and management.* Edited by Chorus I and Bartram J. E&FN Spon. London. ISBN 0-419-23930-8.

Sources:

Belcher, H. & Swale, E. (1976). A beginner's guide to Freshwater Algae. Her Majesty's Stationery Office (HMSO). ISBN 0 11 881393 5.

Belcher, H. & Swale, E. (1979). An illustrated guide to River Phytoplankton. Her Majesty's Stationery Office (HMSO). ISBN 0 11 886602 8.

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