

# protists

volvox, euglena, amoeba, spirogyra, stentor

# Contents

## Articles

Volvox	1
Spirogyra	3
Euglena	5
Stentor (protozoa)	10

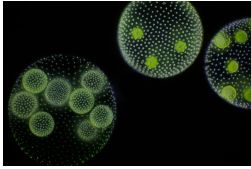
## References

Article Sources and Contributors	13
Image Sources, Licenses and Contributors	14

## Article Licenses

License	15
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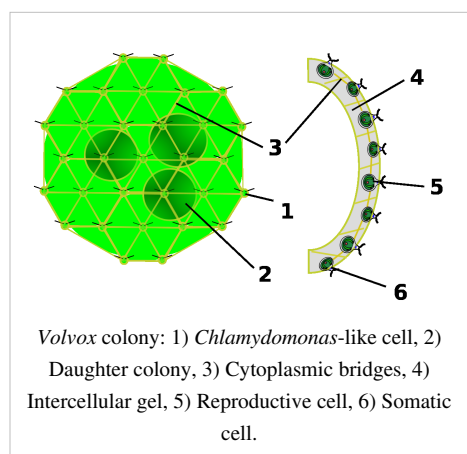
# Volvox

<i>Volvox</i>	
	
<i>Volvox sp.</i>	
Scientific classification	
Kingdom:	Plantae
Phylum:	Chlorophyta
Class:	Chlorophyceae
Order:	Volvocales
Family:	Volvocaceae
Genus:	<b><i>Volvox</i></b> L.
Species	
<i>Volvox aureus</i> <i>Volvox carteri</i> ( <i>V. nagariensis</i> ) <i>Volvox globator</i> <i>Volvox barberi</i> <i>Volvox rouseletti</i> <i>Volvox dissipatrix</i> <i>Volvox tertius</i>	

***Volvox*** is a genus of chlorophytes, a type of green algae. It forms spherical colonies of up to 50,000 cells. They live in a variety of freshwater habitats, and were first reported by Antonie van Leeuwenhoek in 1700. *Volvox* developed its colonial lifestyle 200 <sup>[1]</sup> million years ago.

## Description

*Volvox* is the most developed in a series of genera that form spherical colonies. Each mature *Volvox* colony is composed of numerous flagellate cells similar to *Chlamydomonas*, up to 50,000 in total, and embedded in the surface of a hollow sphere or coenobium containing an extracellular matrix made of a gelatinous glycoprotein. The cells swim in a coordinated fashion, with distinct anterior and posterior poles. The cells have eyespots, more developed near the anterior, which enable the colony to swim towards light. The individual algae in some species are interconnected by thin strands of cytoplasm, called protoplasmates. They are known to demonstrate some individuality and working for the good of their colony, acting like one multicellular organism. The flagellates on its outside resemble Euglena.



## Reproduction

An asexual colony includes both somatic (vegetative) cells, which do not reproduce, and *gonidia* near the posterior, which produce new colonies through repeated division. The daughter colonies are initially held within the parent coenobium and have their flagella directed inwards. Later, the parent disintegrates and the daughters invert. In sexual reproduction two types of gametes are produced. *Volvox* species can be monoecious or dioecious. Male colonies release numerous microgametes, or sperm, while in female colonies single cells enlarge to become oogametes, or eggs.

## Habitats

*Volvox* is a freshwater alga and is found in ponds and ditches, even in shallow puddles. According to Charles Joseph Chamberlain,

"The most favorable place to look for it is in the deeper ponds, lagoons, and ditches which receive an abundance of rain water. It has been said that where you find *Lemna*, you are likely to find *Volvox*; and it is true that such water is favorable, but the shading is unfavorable. Look where you find *Sphagnum*, *Vaucheria*, *Alisma*, *Equisetum fluviatile*, *Utricularia*, *Typha*, and *Chara*. Dr. Nieuwland reports that *Pandorina*, *Eudorina* and *Gonium* are commonly found in summer as constituents of the green scum on wallows in fields where pigs are kept. The flagellate, *Euglena*, is often associated with these forms."

## History

Antonie van Leeuwenhoek first reported observations of *Volvox* in 1700.

## Evolution

Ancestors of *Volvox* transitioned from single cells to form multicellular colonies at least 200 <sup>[1]</sup> million years ago, during the Triassic period. An estimate using DNA sequences from about 45 different species of *Volvox* and related species suggests that the transition from single cells to undifferentiated multicellular colonies took about 35 million years.

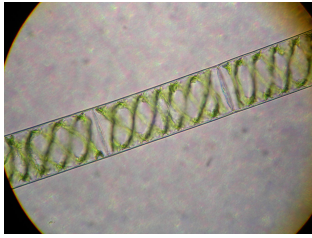
## References

[1] <http://toolsserver.org/~verisimilus/Timeline/Timeline.php?Ma=200>

## External links

- Guiry, M.D.; Guiry, G.M. (2008). "'**Volvox**'" ([http://www.algaebase.org/search/genus/detail/?genus\\_id=43497](http://www.algaebase.org/search/genus/detail/?genus_id=43497)). *AlgaeBase*. World-wide electronic publication, National University of Ireland, Galway.
- *Volvox* description with pictures (<http://protist.i.hosei.ac.jp/pdb/Images/Chlorophyta/Volvox/index.html>) from a Hosei University website
- YouTube videos of *Volvox*:
  - Life cycle and inversion (<http://www.youtube.com/watch?v=fqEHbJbuMYA>)
  - Waltzing *Volvox* (<http://www.youtube.com/watch?v=V6Yg2BQy82w>)
  - Spinning *Volvox* (<http://www.youtube.com/watch?v=w8O4OolGcPg>)
- *Volvox*, one of the 7 Wonders of the Micro World (<http://www.microscopy-uk.org.uk/mag/artdec03/volvox.html>) by Wim van Egmond, from Microscopy-UK
- *Volvox carteri* (<http://www.metamicrobe.com/volvox/>) at MetaMicrobe.com, with modes of reproduction, brief facts

# Spirogyra

<i>Spirogyra</i>	
	
Scientific classification	
Domain:	Eukaryote
(unranked):	Archaeplastida
Kingdom:	Protista
(unranked):	Streptophyta
Phylum:	Charophyta
Class:	Zygnematophyceae
Order:	Zygnematales
Family:	Zygnemataceae
Genus:	<i>Spirogyra</i> Link in C. G. Nees

*Spirogyra* is a genus of filamentous green algae of the order Zygnematales, named for the helical or spiral arrangement of the chloroplasts that is diagnostic of the genus. It is commonly found in freshwater areas, and there are more than 400 species of *Spirogyra* in the world. *Spirogyra* measures approximately 10 to 100µm in width and may stretch centimeters long.

## General characteristics

*Spirogyra* is unbranched with cells connected end to end in long male reproductive system filaments. This genus of green algae undergoes a haploid-dominant life cycle. The cell wall has two layers: the outer wall is composed of pectin that dissolves in water to make the filament slimy to touch while the inner wall is of cellulose. The cytoplasm forms a thin lining between the cell wall and the large vacuole it surrounds. Chloroplasts are embedded in the peripheral cytoplasm; their numbers are variable (as few as one). The chloroplasts are ribbon shaped, serrated or scalloped, and spirally arranged, resulting in the prominent and characteristic green spiral on each filament. Each chloroplast contains several pyrenoids, centers for the production of starches, appearing as small round bodies.

*Spirogyra* is very common in relatively clean eutrophic water, developing slimy filamentous green masses. In spring *Spirogyra* grows under water, but when there is enough sunlight and warmth they produce large amounts of oxygen, adhering as bubbles between the tangled filaments. The filamentous masses come to the surface and become visible as slimy green mats. *Mougeotia* and *Zygnema* are often found tangled together.

## Reproduction

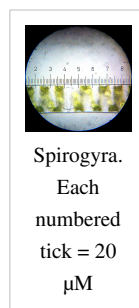
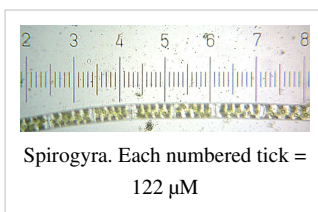
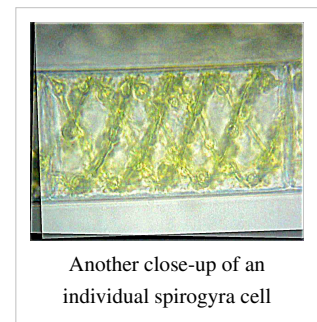
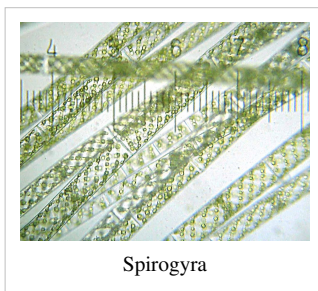
*Spirogyra* can reproduce both sexually and rarely asexually. In vegetative reproduction, fragmentation takes place, and *Spirogyra* simply undergoes the intercalary mitosis to form new filaments.

Sexual Reproduction is of two types:

1. Scalariform conjugation requires association of two different filaments lined side by side either partially or throughout their length. One cell each from opposite lined filaments emits tubular protuberances known as conjugation tubes, which elongate and fuse, to make a passage called the conjugation canal. The cytoplasm of the cell acting as the male travels through this tube and fuses with the female cytoplasm, and the gametes fuse to form a zygospore.
2. In lateral conjugation, gametes are formed in a single filament. Two adjoining cells near the common transverse wall give out protuberances known as conjugation tubes, which further form the conjugation canal upon contact. The male cytoplasm migrates through the conjugation canal, fusing with the female. The rest of the process proceeds as in scalariform conjugation.

The essential difference is that scalariform conjugation occurs between two filaments and lateral conjugation occurs between two adjacent cells on the same filament.


## Gallery



## References

- *Spirogyra* at microscopy-uk.org.uk (<http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/artjan99/gyra.html>)
- John Whitton, B.A. and Brook, A.J. (editors) 2002. *The Freshwater Algal Flora of the British Isles*. Cambridge University Press, Cambridge. ISBN 0-521-77051-3.

# Euglena

<i>Euglena</i>	
	
Scientific classification	
Domain:	Eukaryota
Kingdom:	Excavata
Superphylum:	Discoba
Phylum:	Euglenozoa
Class:	Euglenoidea
Order:	Euglenales
Family:	Euglenaceae
Genus:	<i><b>Euglena</b></i> Ehrenberg, 1830

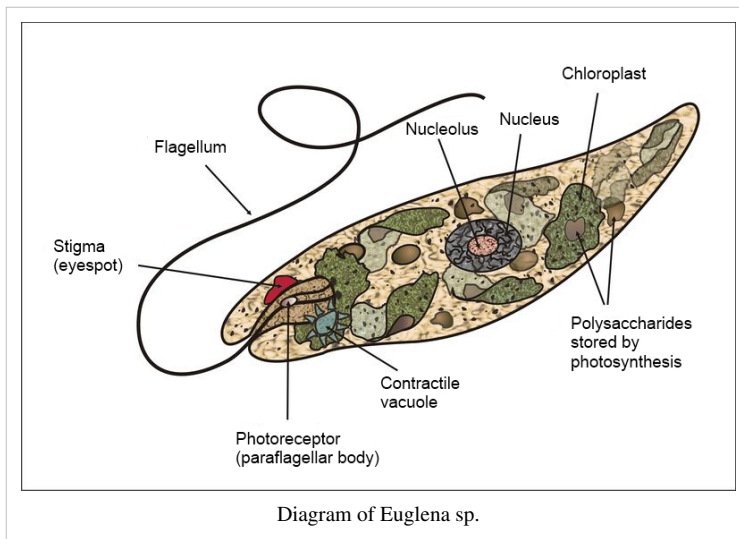
*Euglena* is a genus of unicellular flagellate protists. It is the best known and most widely studied member of the phylum Euglenozoa, a diverse group containing some 44 genera and at least 800 species. Species of *Euglena* are found in fresh and salt waters. They are often abundant in quiet, inland waters, where they may bloom in numbers sufficient to color the surface of ponds and ditches green (*E. viridis*) or red (*E. sanguinea*).

The species *Euglena gracilis*, has been used extensively in the laboratory as a model organism.

Most species of *Euglena* have photosynthesizing chloroplasts within the body of the cell, which enable them to feed by autotrophy, like plants. However, they can also take nourishment heterotrophically, like animals. Since *Euglena* have features of both animals and plants, early taxonomists, working within the Linnaean two-kingdom system of biological classification, found them difficult to classify. It was the question of where to put such "unclassifiable" creatures that prompted Ernst Haeckel to add a third kingdom to the *Animale* and *Vegetabile* of Linnaeus: the Kingdom Protista.

## Form and function

When feeding as a heterotroph, the *Euglena* surrounds a particle of food and consumes it by phagocytosis. When there is sufficient sunlight for it to feed by phototrophy, it uses chloroplasts containing the pigments Chlorophyll a and Chlorophyll b to produce sugars by photosynthesis. *Euglena's* chloroplasts are surrounded by three membranes, while those of plants and the green algae (among which earlier taxonomists often placed *Euglena*) have only two membranes. This fact has been taken as morphological evidence that *Euglena's* chloroplasts evolved from a eukaryotic green alga. Thus, the intriguing similarities between *Euglena* and the plants would have arisen not because of kinship but because of a secondary endosymbiosis. Molecular phylogenetic analysis has lent support to this hypothesis, and it is now generally accepted.



*Euglena* chloroplasts contain pyrenoids, used in the synthesis of paramylon, a form of starch energy storage enabling *Euglena* to survive periods of light deprivation. The presence of pyrenoids is used as an identifying feature of the genus, separating it from other Euglenoids, such as *Lepocinclis* and *Phacus*.

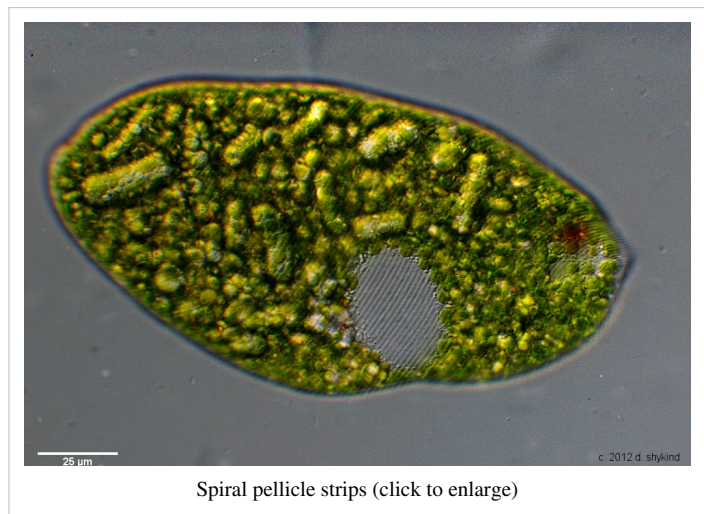
All Euglenoids have two flagella rooted in basal bodies located in a small reservoir at the front of the cell. In *Euglena*, one flagellum is very short, and does not protrude from the cell, while the other is relatively long, and often easily visible with

light microscopy. In some species, the longer, emergent flagellum is used to help the organism swim.

Like other Euglenoids, *Euglena* possess a red eyespot, an organelle composed of carotenoid pigment granules. The red spot itself is not thought to be photosensitive. Rather, it filters the sunlight that falls on a light-detecting structure at the base of the flagellum (a swelling, known as the paraflagellar body), allowing only certain wavelengths of light to reach it. As the cell rotates with respect to the light source, the eyespot partially blocks the source, permitting the *Euglena* to find the light and move toward it (a process known as phototaxis).

*Euglena* lacks a cell wall. Instead, it has a pellicle made up of a protein layer supported by a substructure of microtubules, arranged in strips spiraling around the cell. The action of these pellicle strips sliding over one another gives *Euglena* its exceptional flexibility and contractility.

In low moisture conditions, or when food is scarce, *Euglena* forms a protective wall around itself and lies dormant as a resting cyst until environmental conditions improve.



## Reproduction

*Euglena* reproduce asexually through binary fission, a form of cell division. Reproduction begins with the mitosis of the cell nucleus, followed by the division of the cell itself. *Euglena* divide longitudinally, beginning at the front end of the cell, with the duplication of flagellar processes, gullet and stigma. Presently, a cleavage forms in the anterior, and a V-shaped bifurcation gradually moves toward the posterior, until the two halves are entirely separated.

Reports of sexual conjugation are rare, and have not been substantiated.



## Historical background and early classification



*Cercaria viridis* (= *E. viridis*) from O.F. Müller's *Animalcula Infusoria*

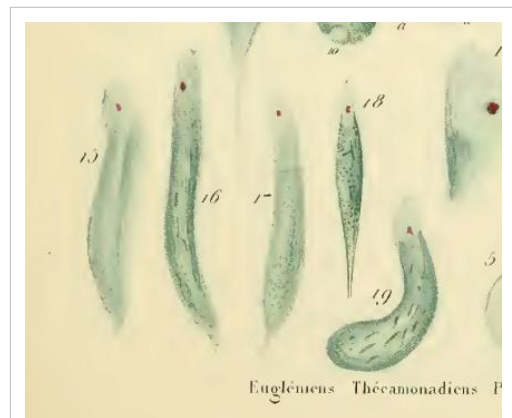
Species of *Euglena* were among the first protists to be seen under the microscope.

In 1674, in a letter to the Royal Society, the Dutch pioneer of microscopy Antoni van Leeuwenhoek wrote that he had collected water samples from an inland lake, in which he found "animalcules" that were "green in the middle, and before and behind white." Clifford Dobell regards it as "almost certain" that these were *Euglena viridis*, whose "peculiar arrangement of chromatophores...gives the flagellate this appearance at low magnification."

Twenty-two years later, John Harris published a brief series of "Microscopical Observations" reporting that he had examined "a small Drop of the Green Surface of some Puddle-Water" and found it to be "altogether composed of Animals of several Shapes and Magnitudes." Among them, were "oval creatures whose middle part was of a Grass Green, but each end Clear and Transparent," which "would contract and dilate themselves, tumble over and over many times together, and then shoot away like Fishes."

In 1786, O.F. Müller gave a more complete description of the organism, which he named *Cercaria viridis*, noting its distinctive color and changeable body shape. Müller also provided a series of illustrations, accurately depicting the undulating, contractile movements (or metaboly) of *Euglena's* body.

In 1830, C. G. Ehrenberg renamed Müller's *Cercaria Euglena viridis*, and placed it, in keeping with the short-lived system of classification he invented, among the Polygastrica in the family Astasiaea: multi-stomached creatures with no alimentary canal, variable body shape but no pseudopods or lorica.<sup>[1]</sup> By making use of the newly invented achromatic microscope, Ehrenberg was able to see *Euglena's* eyespot, which he correctly identified as a "rudimentary eye" (although he reasoned, wrongly, that this meant the creature also had a nervous system). This feature was incorporated into Ehrenberg's name for the new genus, constructed from the Greek roots "eu-" (well, good) and glēnē (eyeball, socket of joint).



*Euglena* from Félix Dujardin's *Histoire Naturelle des Zoophytes*

Ehrenberg did not notice *Euglena's* flagella, however. The first to publish a record of this feature was Félix Dujardin, who added "filament flagelliforme" to the descriptive criteria of the genus in 1841. Subsequently, the class Flagellata (Cohn, 1853) was created for creatures, like *Euglena*, possessing one or more flagella. While "Flagellata" has fallen from use as a taxon, the notion of using flagella as a phylogenetic criterion remains vigorous.

## Recent phylogeny and classification



In 1881, Georg Klebs made a primary taxonomical distinction between green and colorless flagellate organisms, separating the photosynthesizing Euglenoids from those that live by phagotrophy. The latter (colorless, shape-changing unflagellates) were divided among the Astasiaceae and the Peranemaceae, while flexible green Euglenoids were generally assigned to the genus *Euglena*.

As early as 1935, it was recognized that this was an artificial grouping, however convenient. In 1948, Pringsheim affirmed

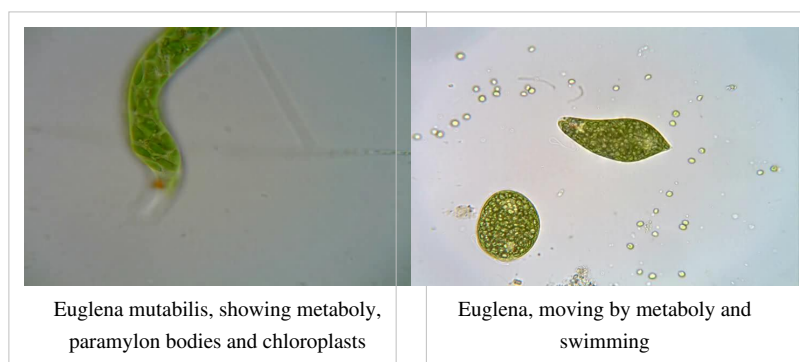
that the distinction between green and colorless flagellates had no taxonomical justification, although he acknowledged its practical appeal. He proposed something of a compromise, placing colorless, saprotrophic Euglenoids in the genus *Astasia*, while allowing some colorless Euglenoids to share a genus with their photosynthesizing cousins, provided they had structural features that proved common ancestry. Among the green Euglenoids themselves, Pringsheim recognized the close kinship of some species of *Phacus* and *Lepocinclis* with some species of *Euglena*.

The idea of classifying the Euglenoids by their manner of nourishment was finally abandoned in the 1950s, when A. Hollande published a major revision of the phylum, grouping organisms by shared structural features, such as the number and type of flagella. If any doubt remained, it was dispelled in 1994, when genetic analysis of the non-photosynthesizing Euglenoid *Astasia longa* confirmed that this organism retains sequences of DNA inherited from an ancestor that must have had functioning chloroplasts.

In 1997, a morphological and molecular study of the Euglenozoa, put *Euglena gracilis* in close kinship with the species *Khawkinea quartana*, with *Peranema trichophorum* basal to both. Two years later, a molecular analysis showed that *Euglena gracilis* was, in fact, more closely related to *Astasia longa* than to certain other species recognized as *Euglena*. Furthermore, the venerable *Euglena viridis* was found to be genetically closer to *Khawkinea quartana* than to the other species of *Euglena* studied.

Recognizing the polyphyletic nature of the genus *Euglena*, Marin et al. (2003) have revised it to include certain members traditionally placed in *Astasia* and *Khawkinea*.

## Video gallery



<http://www.youtube.com/watch?v=jl0TzaWUQWk&feature=endscreen>


## References

[1] Ehrenberg, C. Organisation, Systematik und geographisches Verhältnifs der Infusionsthierchen. Vol. II. Berlin, 1830. pp 58-9 ([http://books.google.com.ar/books?id=RBtJAAAAcAAJ&source=gbs\\_similarbooks](http://books.google.com.ar/books?id=RBtJAAAAcAAJ&source=gbs_similarbooks))

## External links

- The Euglenoid Project (<http://euglena.msu.edu/>)
- Tree of Life web project: Euglenida (<http://tolweb.org/Euglenida/97461>)
- Protist Images: Euglena (<http://protist.i.hosei.ac.jp/PDB/Images/Mastigophora/Euglena/>)
- Euglena at Droplet - Microscopy of the Protozoa (<http://www.pirx.com/droplet/gallery/euglena.html>)
- Images and taxonomy (<http://starcentral.mbl.edu/microscope/portal.php?pagetitle=assetfactsheet&imageid=23340>)
- Constantopoulos, George; Bloch, Konrad (1967). "Effect of Light Intensity on the Lipid Composition of *Euglena gracilis*" (<http://www.jbc.org/content/242/15/3538.short>). *The Journal of Biological Chemistry* **242** (15): 3538–42.

# Stentor (protozoa)

<i>Stentor</i>	
	
<i>Stentor roeseli</i>	
Scientific classification	
Domain:	Eukarya
Kingdom:	Chromalveolata
Superphylum:	Alveolata
Phylum:	Ciliophora
Class:	Heterotrichea
Order:	Heterotrichida
Family:	Stentoridae
Genus:	<i>Stentor</i> Oken, 1815
Species	
<ul style="list-style-type: none"> <li>• <i>Stentor amethystinus</i></li> <li>• <i>Stentor araucanus</i></li> <li>• <i>Stentor baicalius</i> (syn. <i>Stentor pygmaeus</i>)</li> <li>• <i>Stentor barretti</i></li> <li>• <i>Stentor caudatus</i></li> <li>• <i>Stentor coeruleus</i></li> <li>• <i>Stentor cornutus</i></li> <li>• <i>Stentor elegans</i></li> <li>• <i>Stentor fuliginosus</i></li> <li>• <i>Stentor igneus</i></li> <li>• <i>Stentor introversus</i></li> <li>• <i>Stentor katashimai</i></li> <li>• <i>Stentor loricatus</i></li> <li>• <i>Stentor magnus</i></li> <li>• <i>Stentor muelleri</i> (syn. <i>Stentor felici</i>)</li> <li>• <i>Stentor multiformis</i> (syn. <i>Stentor gallinulus</i>, =<i>S. nanus</i>)</li> <li>• <i>Stentor multimicronucleatus</i></li> <li>• <i>Stentor niger</i></li> <li>• <i>Stentor polymorphus</i> (syn. <i>Stentor pediculatus</i>)</li> <li>• <i>Stentor pyriformis</i></li> <li>• <i>Stentor roeseli</i></li> </ul>	

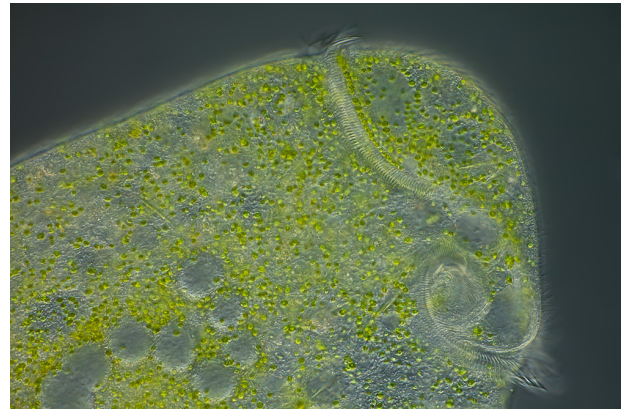
*Stentor*, sometimes called **trumpet animalcules**, are a genus of filter-feeding, heterotrophic ciliate protists, representative of the heterotrichs. They are usually horn-shaped, and reaching lengths of 2 millimeters, they are among the biggest known unicellular organisms.

## Appearance and characteristics

The body, or cortex, is generally horn-shaped, hence the association with the Greek herald and the former name "trumpet animalcule", with a ring of prominent cilia around the anterior "bell" that sweep in food and aid in swimming. Some reach several millimeters in length, making them among the largest single celled organisms. *Stentor* can come in different colors. For example, *S. coeruleus* can appear blue due to the presence of Stentorin, a natural pigment. As in many freshwater protozoans, *Stentor* has a contractile vacuole. Because the concentration of salt inside the cell and in the surrounding freshwater is different, *Stentor* must store water that enters it by osmosis and then discharge it from the vacuole. They can regenerate, and small fragments can grow into full organisms. Each cell has one (often elongated) macronucleus and several micronuclei.



*Stentor polymorphus* with algal symbionts



*Stentor polymorphus* with algal symbionts

## Ecology

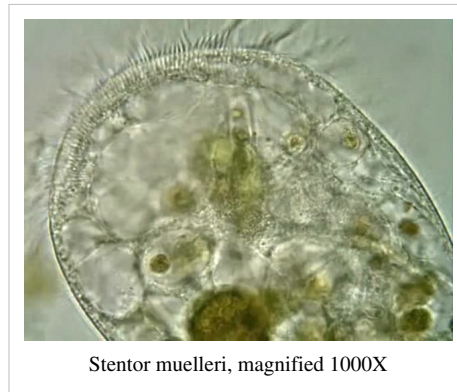
These protists are common worldwide in freshwater lakes and streams, only *S. multiformis* has been recorded from marine, freshwater and even terrestrial biotopes. They are usually attached to algal filaments or detritus. Some *Stentor* species, such as *S. polymorphus*, can live symbiotically with certain species of green algae (*Chlorella*). After being ingested, the algae live on while their host absorbs nutrients produced, whereas the algae, in turn, absorb and feed on the *Stentor's* metabolic wastes. *Stentors* react to outside disturbances by contracting into a ball. Resting cysts are known from a few species.<sup>[1]</sup>

## Systematics

The genus contains over twenty described species, including:<sup>[2][3]</sup>

The type species of the genus is *Stentor muelleri* Ehrenberg, 1831. According to recent molecular analyses, the genus seems to be monophyletic, and related to the genus *Blepharisma*.<sup>[4]</sup>

## Video gallery



Stentor muelleri, magnified 1000X

## References

- [1] Tartar, V. (1961). The biology of Stentor. Pergamon Press, New York
- [2] Kumazawa, H. (2002) Notes on the taxonomy of Stentor Oken (Protozoa, Ciliophora) and a description of a new species. J. Plankton Res. 2002 24: 69-75;
- [3] Foissner, W. and Wölfl, S. (1994) Revision of the genus Stentor Oken (Protozoa: Ciliophora) and description of *S. araucanus* nov. spec. from South American lakes. J. Plankton Res., 16, 255–289
- [4] Gong, Y-Ch. et al. (2007) Molecular Phylogeny of Stentor (Ciliophora: Heterotrichea) Based on Small Subunit Ribosomal RNA Sequences. J. Eukaryot. Microbiol., 54(1), pp. 45–48

## External links

- Stentor (<http://www.microscopy-uk.org.uk/mag/indexmag.html?http://www.microscopy-uk.org.uk/mag/art98/stent.html>)

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