A GUIDE TO HIGHER LIFE FORMS

IN BIOLOGICAL WASTEWATER TREATMENT SYSTEMS

Microlife

Why should I read this guide?

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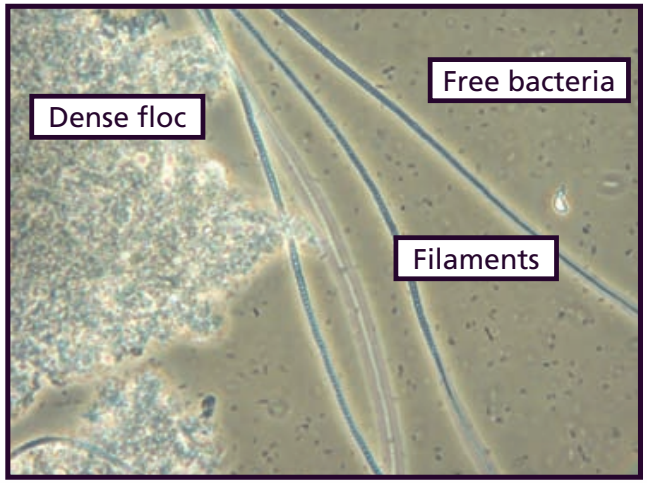
In any properly functioning biological wastewater treatment system, a hierarchy of microscopic organisms is present. These organisms include bacteria, protozoa, and metazoa. Together they are responsible for effective wastewater treatment.

Bacteria can be found as individual cells in the bulk water (free bacteria), as filaments (growing in long chains), or, ideally, as flocculated particles (or floc).

Protozoa and metazoan, also known as higher life forms, are orders of magnitude larger than bacteria and can be observed microscopically. These organisms flourish and decline in certain environmental conditions and can be found in different forms depending on their surrounding conditions. As such, the type, absense, presence, and/or form provides a basis for understanding how well the wastewater treatment plant is performing.

This guide was designed to help wastewater professionals identify higher life forms and to provide information about interpretting operational conditions based on microscopic observations. Most of the pictures in this guide were taken with an Olympus CH30 phase contrast microscope and an Olympus C-5050 digital camera with an eye-piece adaptor.



Protozoa

What are protozoa?

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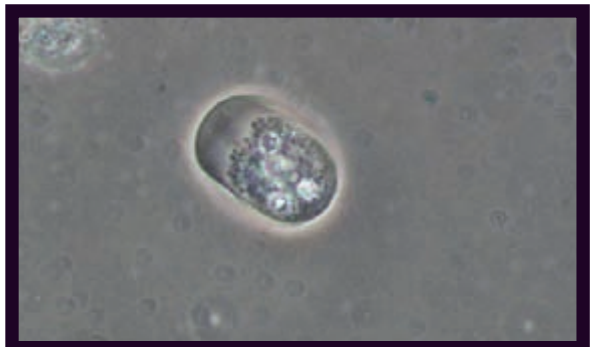
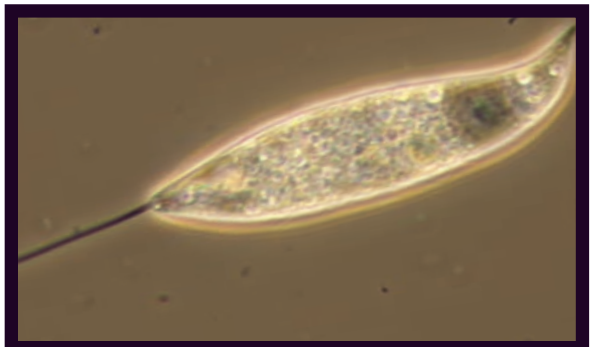
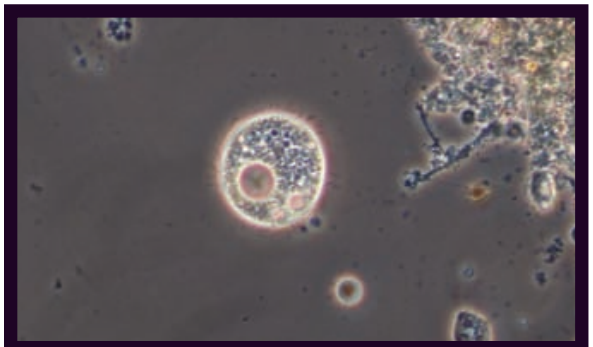
Protozoa are **single-cell organisms**. Their primary function in wastewater is the removal of non-flocculated bacteria and small floc particles. For the purpose of identifying these indicator organisms, protozoa can be broken down into the following groups:



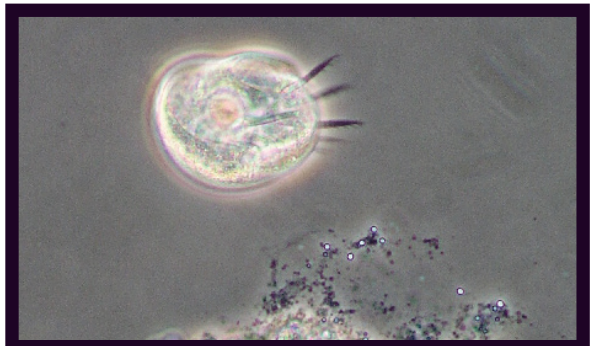
Amoeba



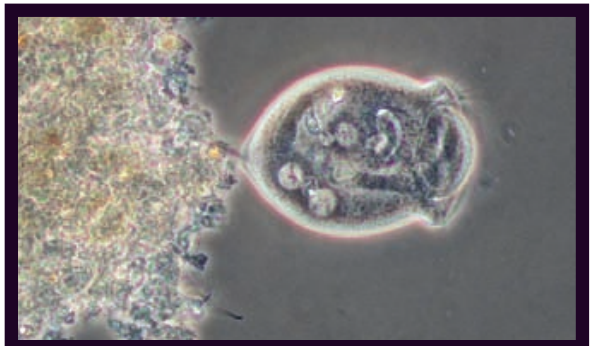
Flagellate



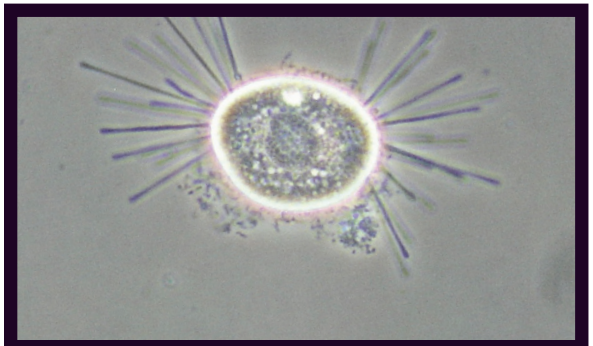
Free-swimming ciliate



Crawler ciliate



Stalk ciliate



Suctorian

Amoeba

5 to 200 um

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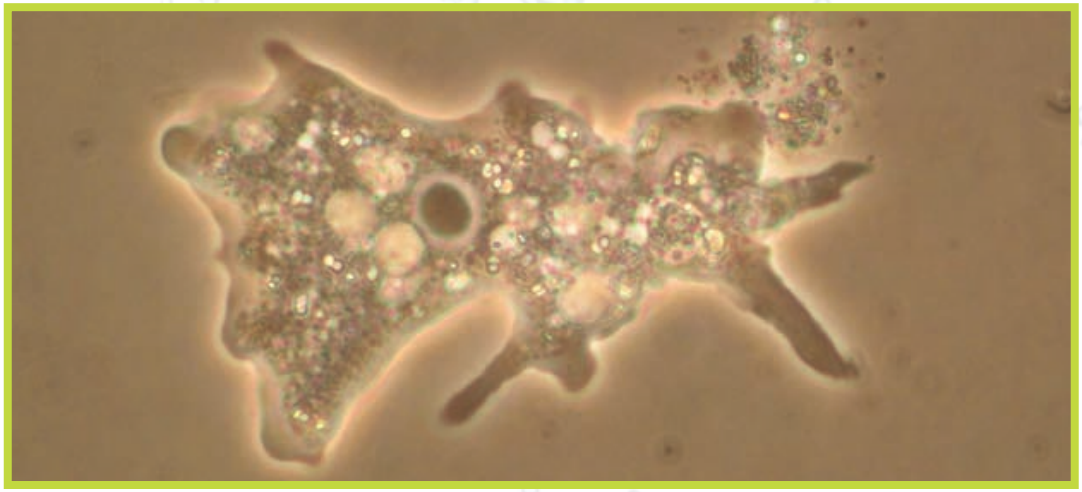
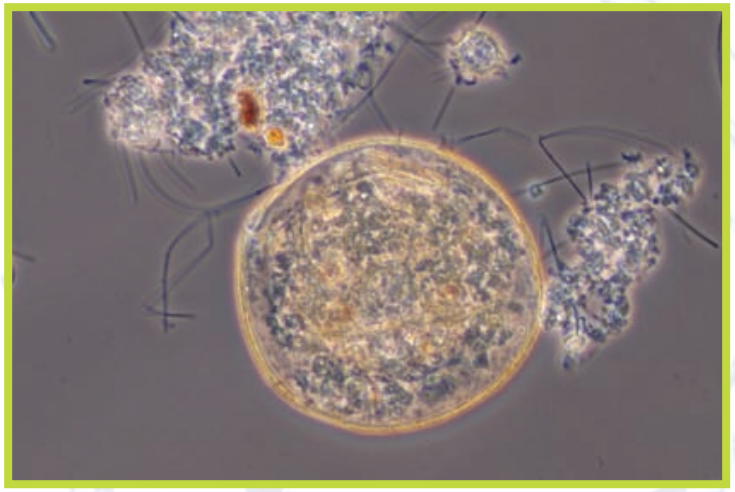
Description

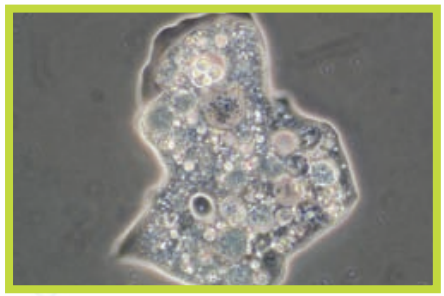
Amoeba can be found in two forms: testate (shelled) and naked. Both can survive in very low dissolved oxygen and poor water quality. The sudden absense or presence of these organisms may be an indication of a BOD loading change, recent upset, or recent recovery.

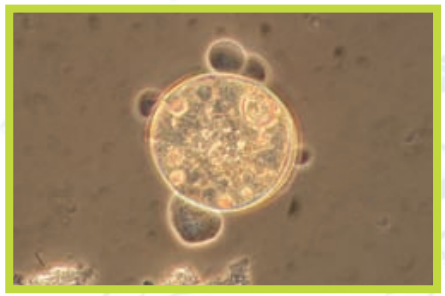
Interpretation

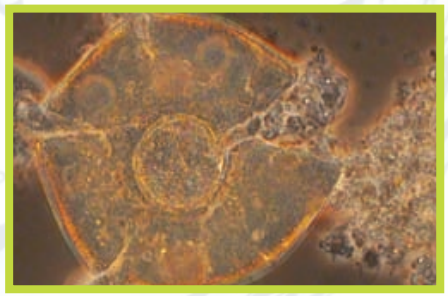
- Abundant free bacteria
- High organic loading
- Recent upset
- Wide range of dissolved oxygen











Flagellate

5 to 20 um

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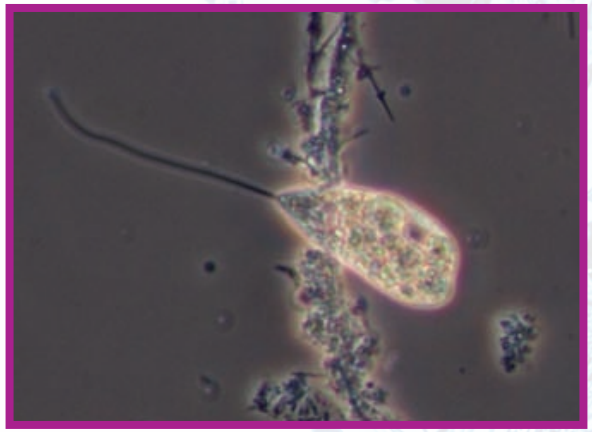
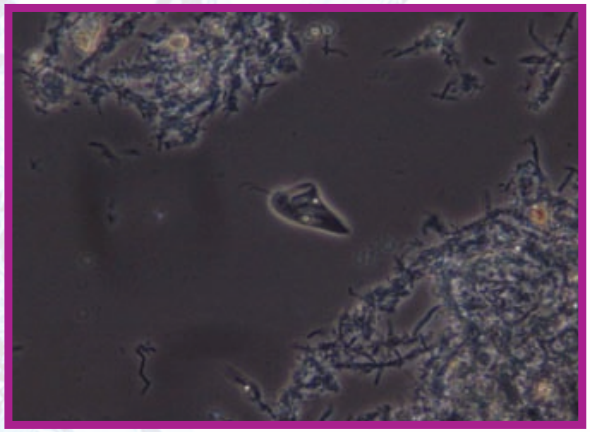
Description

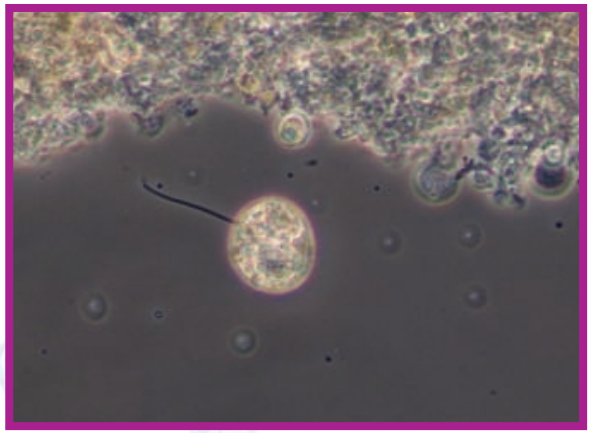
Named for their flagella, these organisms use a lot of energy for motility and feeding; therefore, they need a large amount of free bacteria in the bulk water. A sudden increase in flagellates is generally a good indication of an increase in BOD.

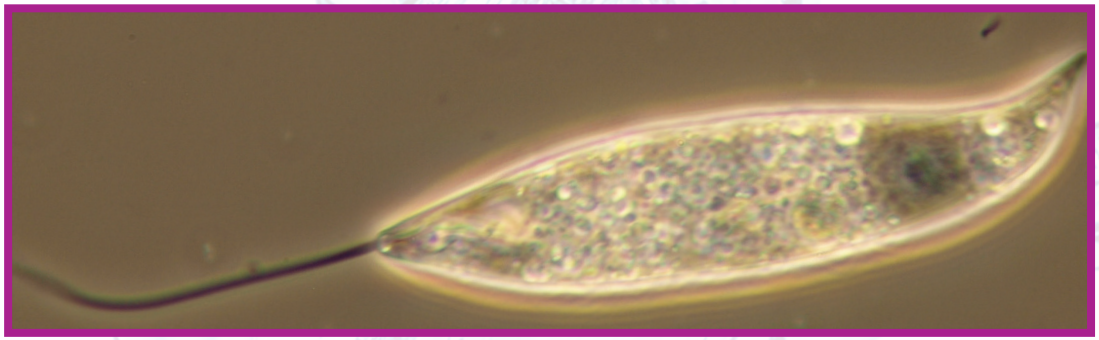
Interpretation

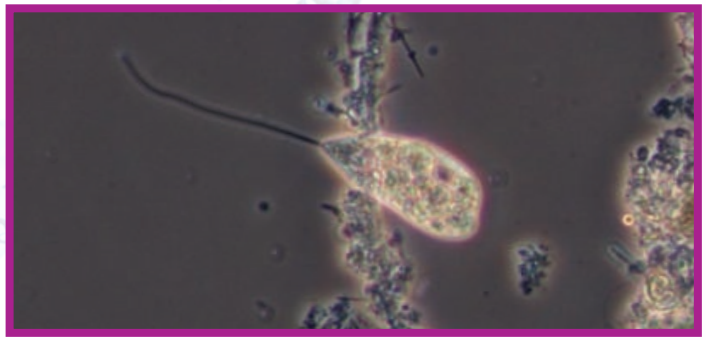
- Abundant free bacteria
- High organic loading
- Recent upset











Free-swimming ciliate

40 to 200 um

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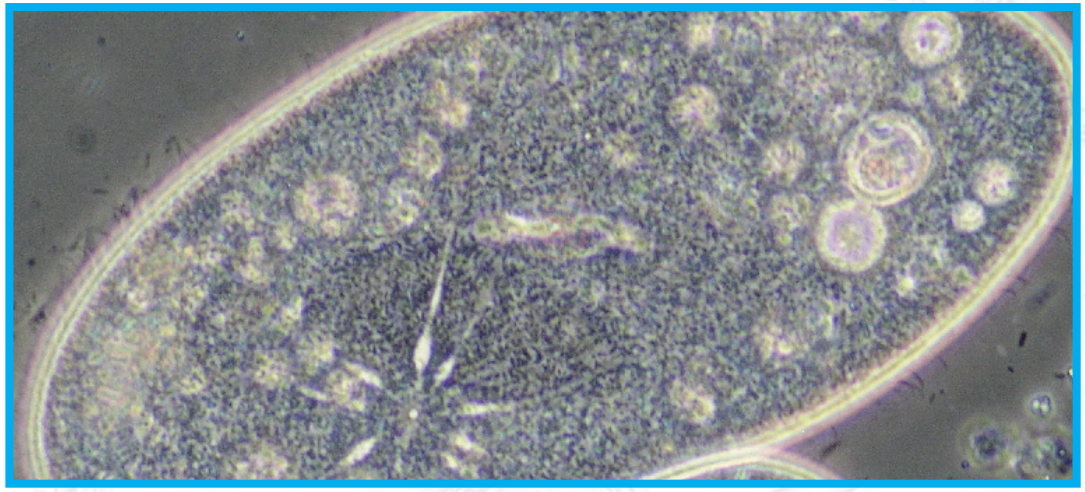
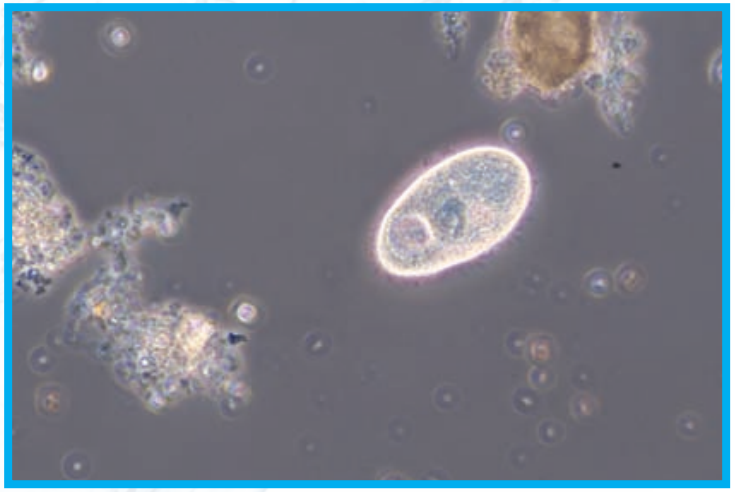
Description

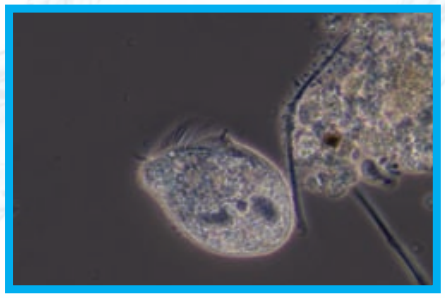
Covered entirely with hair-like cilia, ciliates are usually found in the presence of ideal floc formation and indicate satisfactory operation. Some carnivorous species can feed on smaller ciliates and flagellates.

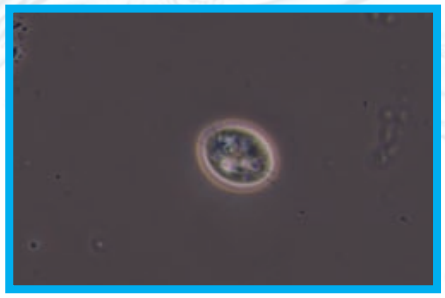
Interpretation

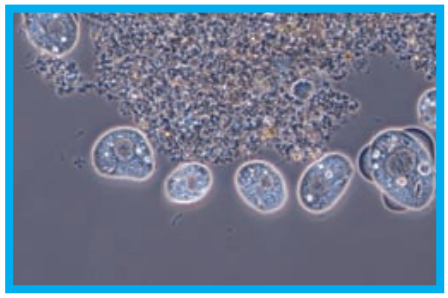
- Adequate dissolved oxygen
- Low organic loading











Crawler ciliate

20 to 100 um

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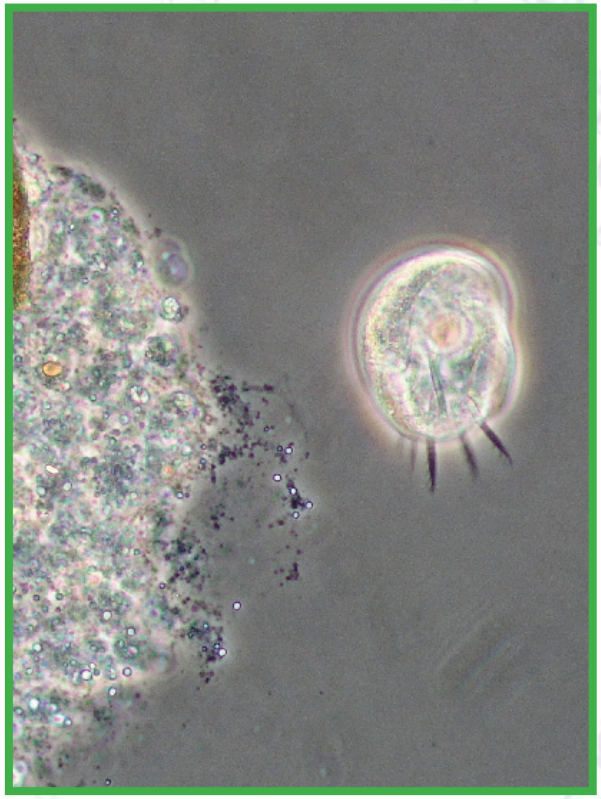
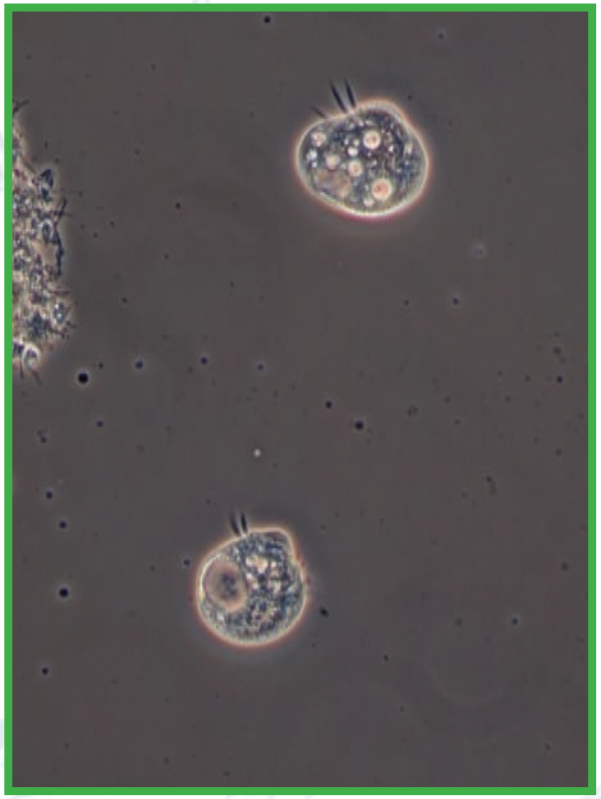
Description

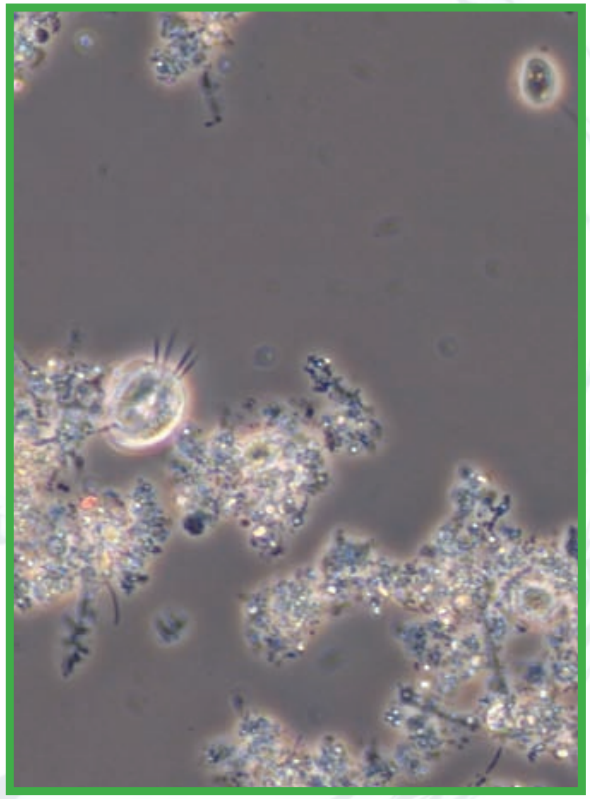
These organisms are generally associated with a stabilized biomass and well-run systems. Most species possess cirri, which are bundled cilia and allow the organism to crawl over and around the floc.

Interpretation

- Bacterial floc present
- Low organic loading
- Lower ammonia







Stalk ciliate

30 to 80 um

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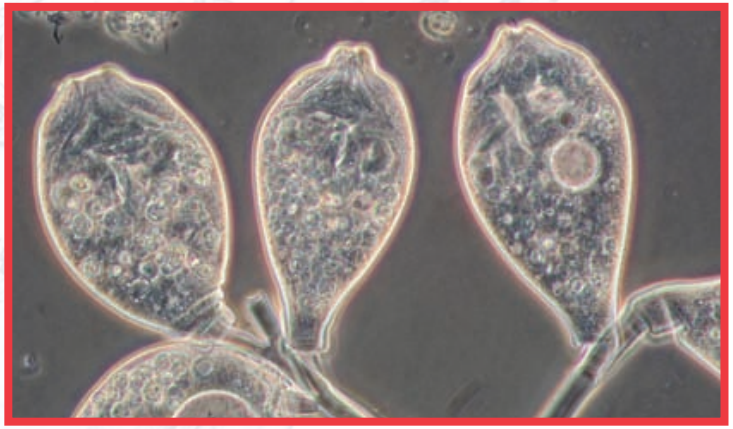
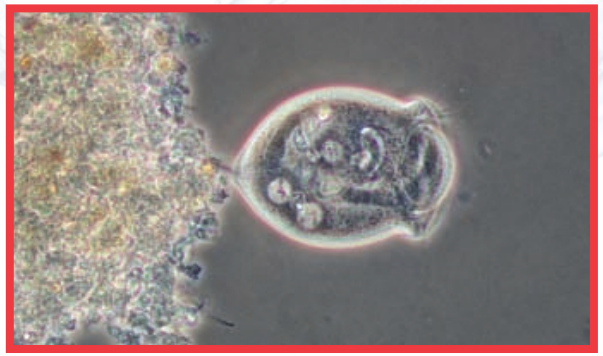
Description

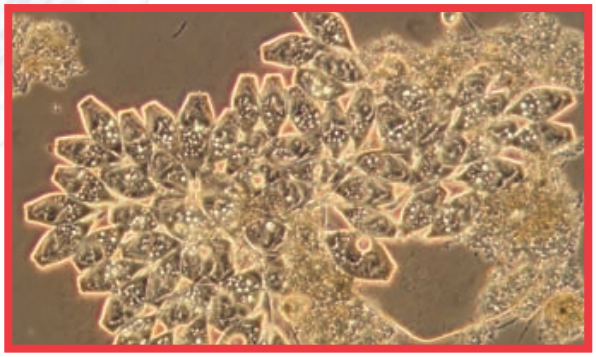
Stalk ciliates can be either colonial or single, and are indicators of stablized biomass and well-run systems. The longer the stalk, the older the organism. Some species will separate from the stalk during an upset or changing environmental conditions.

Interpretation

- Bacterial floc present
- Low organic loading
- Adequate dissolved oxygen







Suctorian

30 to 200 um

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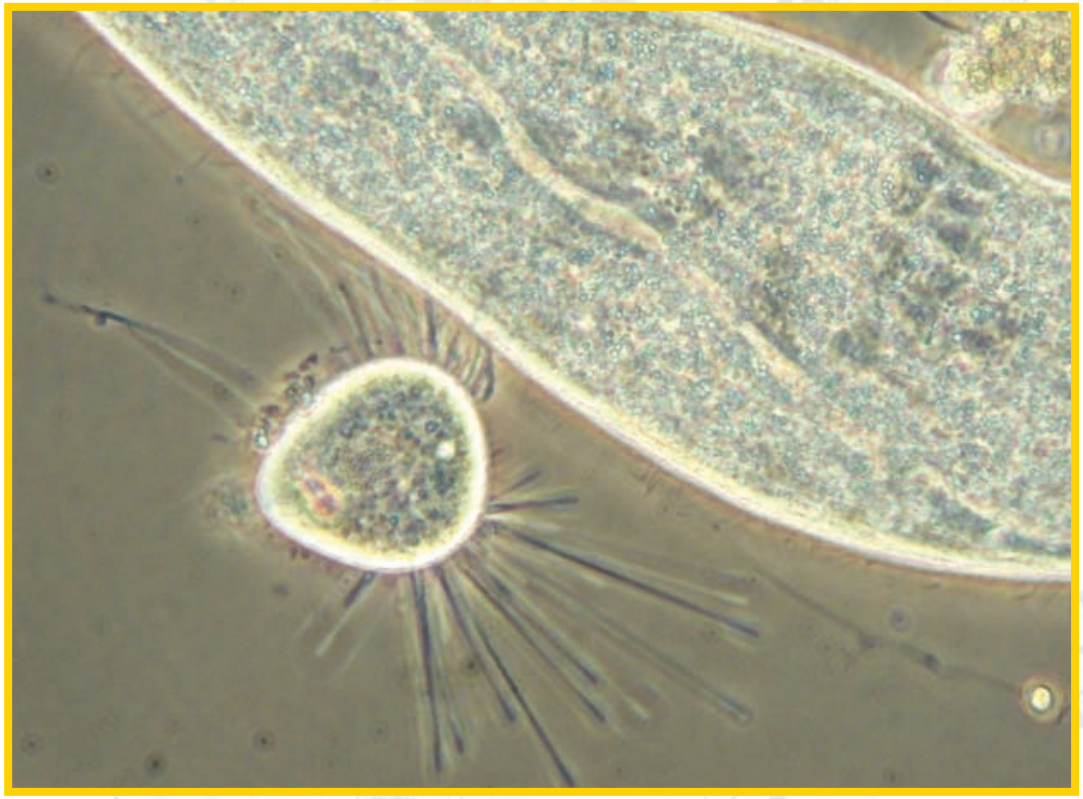
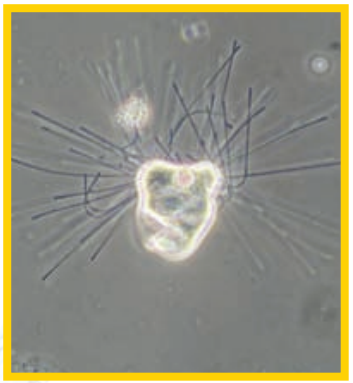
Description

Suctorians are found in various shapes and sizes and can be observed with or without a stalk. They are typically seen in a stable biomass with sufficient dissolved oxygen and low ammonia, and are especially common in nitrifying plants.

Interpretation

- Low organic loading and ammonia
- Adequate dissolved oxygen





Metazoa

What are metazoa?

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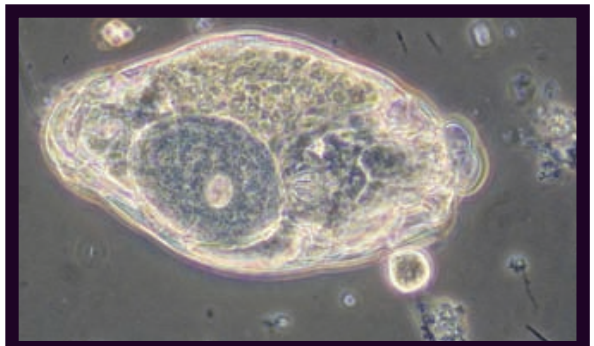
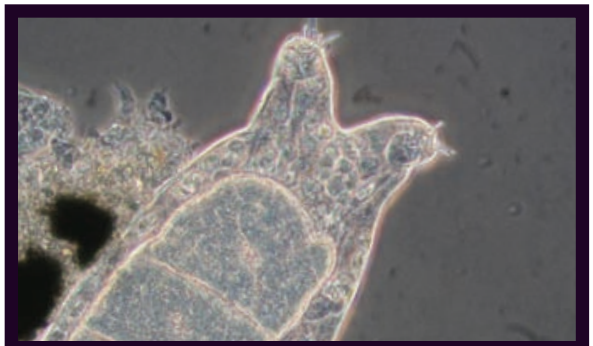
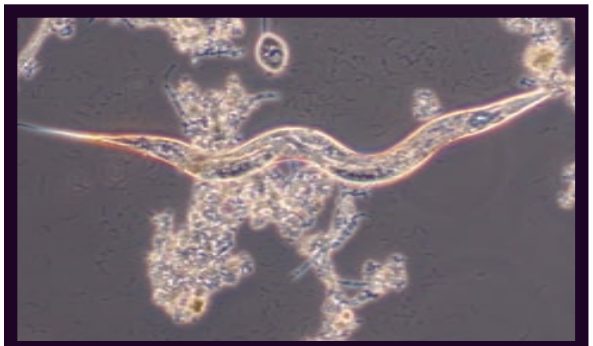
Metazoa are **multi-cellular organisms**. Typically found in systems with longer sludge ages, metazoa have little to do with the removal of organic material. Though their contribution to treating wastewater is small, they are good indicators of treatment conditions—especially in the form of the following organisms:



Rotifer



Tardigrade "water bear"



Nematode

Rotifer

40 to 2,000 um

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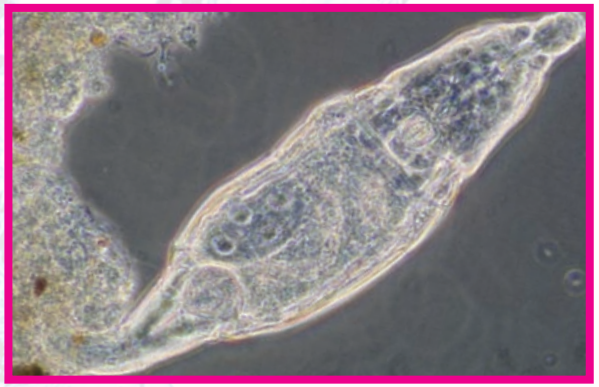
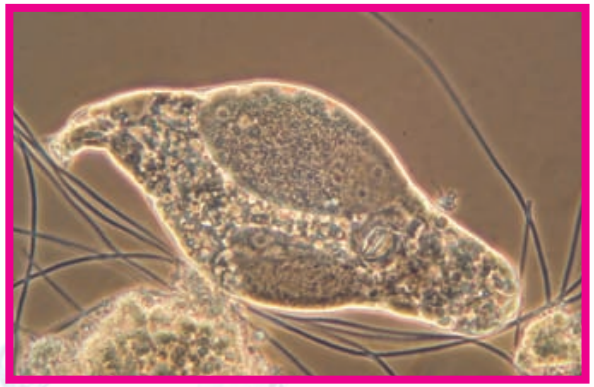
Description

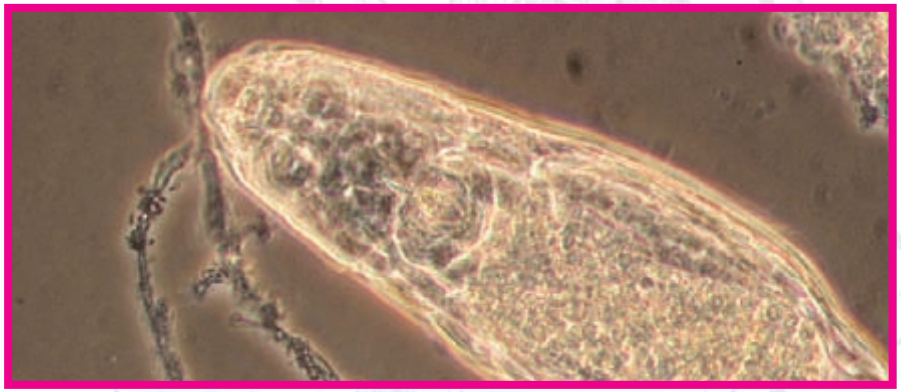
Commonly found in systems with sufficient aeration, there are a few species that can survive in anaerobic conditions for short time periods. Most survive in neutral pH, are very sensitive to chlorine, and indicate a relatively healthy biomass.

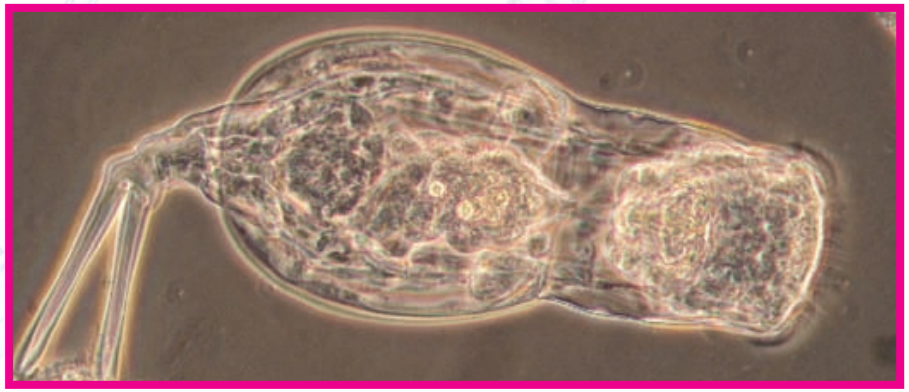
Interpretation

- Low organic loading
- Adequate dissolved oxygen
- Ammonia < 5 mg/L









Tardigrade ("water bear")

200 to 1,200 um

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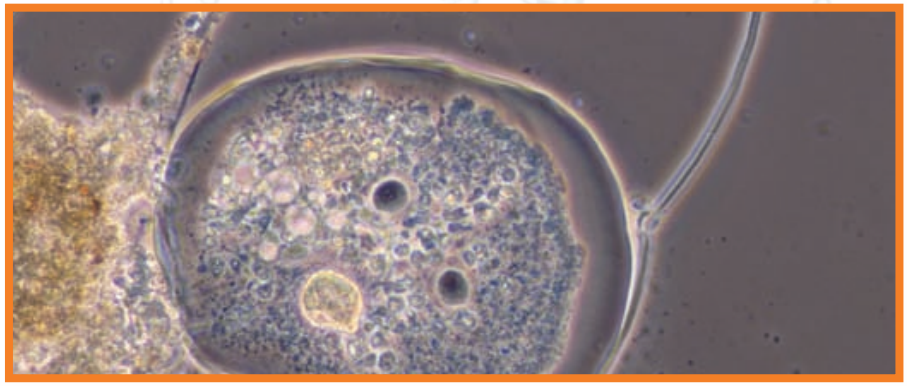
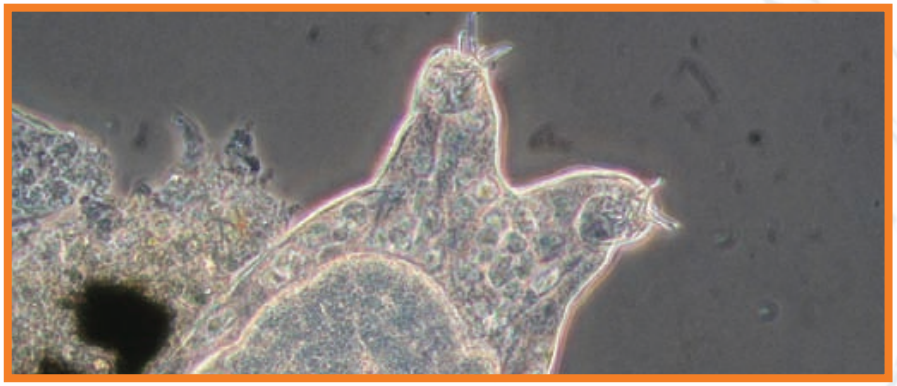
Description

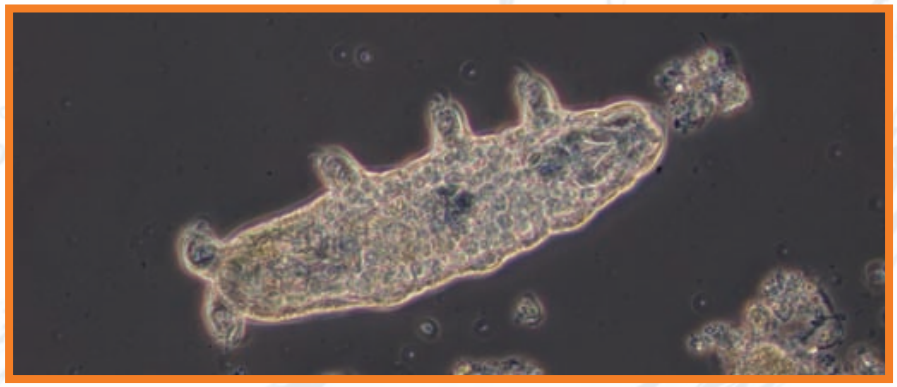
Some species feed on plants and others on smaller metazoans. They are commonly found in ideal conditions and are usually indicative of a very stable biomass.

Interpretation

- Low organic loading
- Long sludge age
- Adequate dissolved oxygen







Nematode

400 to 5,000 um

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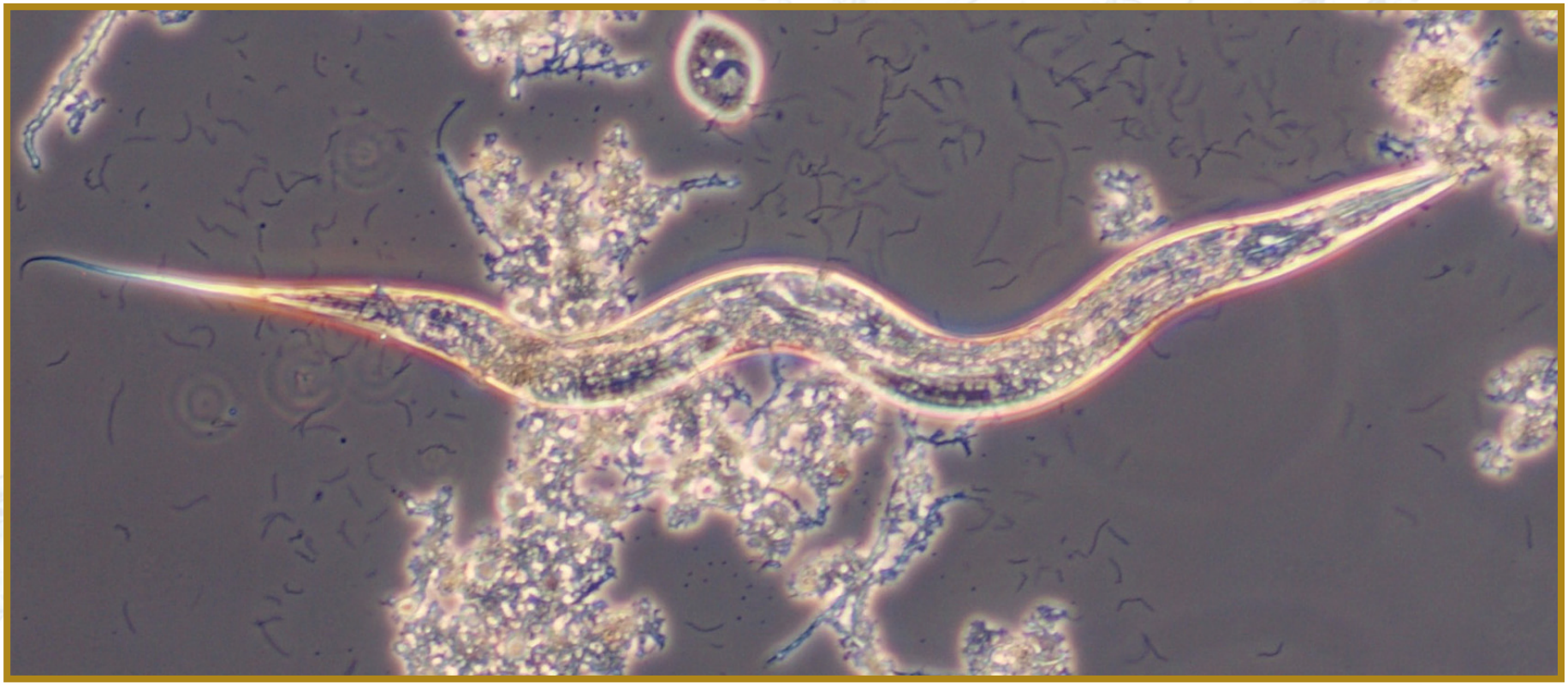
Description

They aid the floc with oxygen utilization. They are commonly found in healthy attached growth systems and are indicative of poor operating conditions if they are found in activated sludge systems.

Interpretation

- Low dissolved oxygen
- Long sludge age



Others

Non-indicative higher lifeforms

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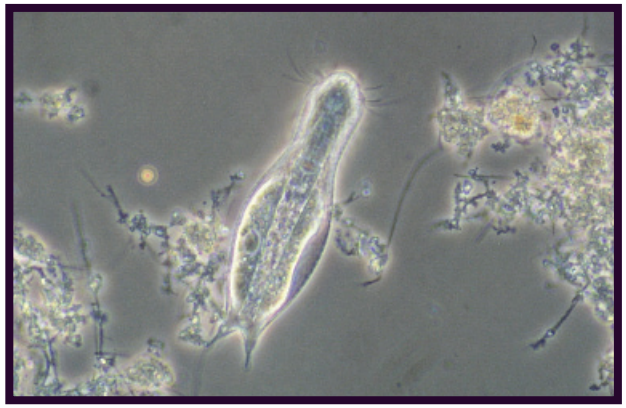
There are a number of other higher lifeforms—both protozoa and metazoa—that are not good indicators of treatment issues, including:

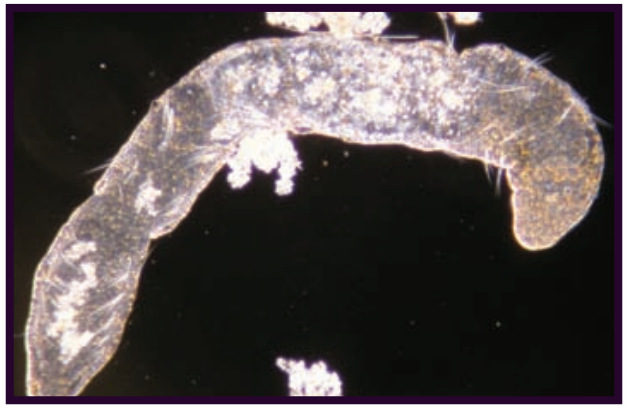
Gastrotrich

Commonly confused with rotifers.



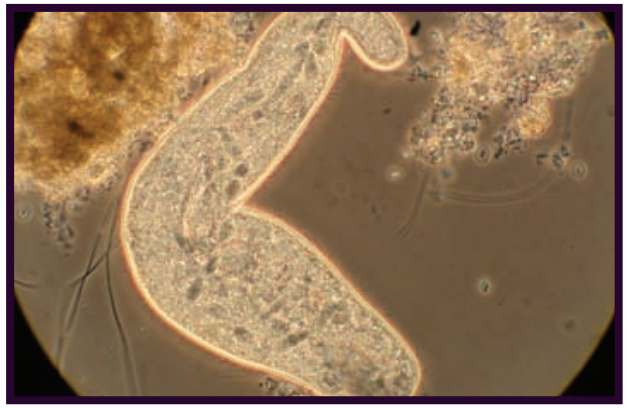
Aeleosoma worm

Also known as a "bristle worm."



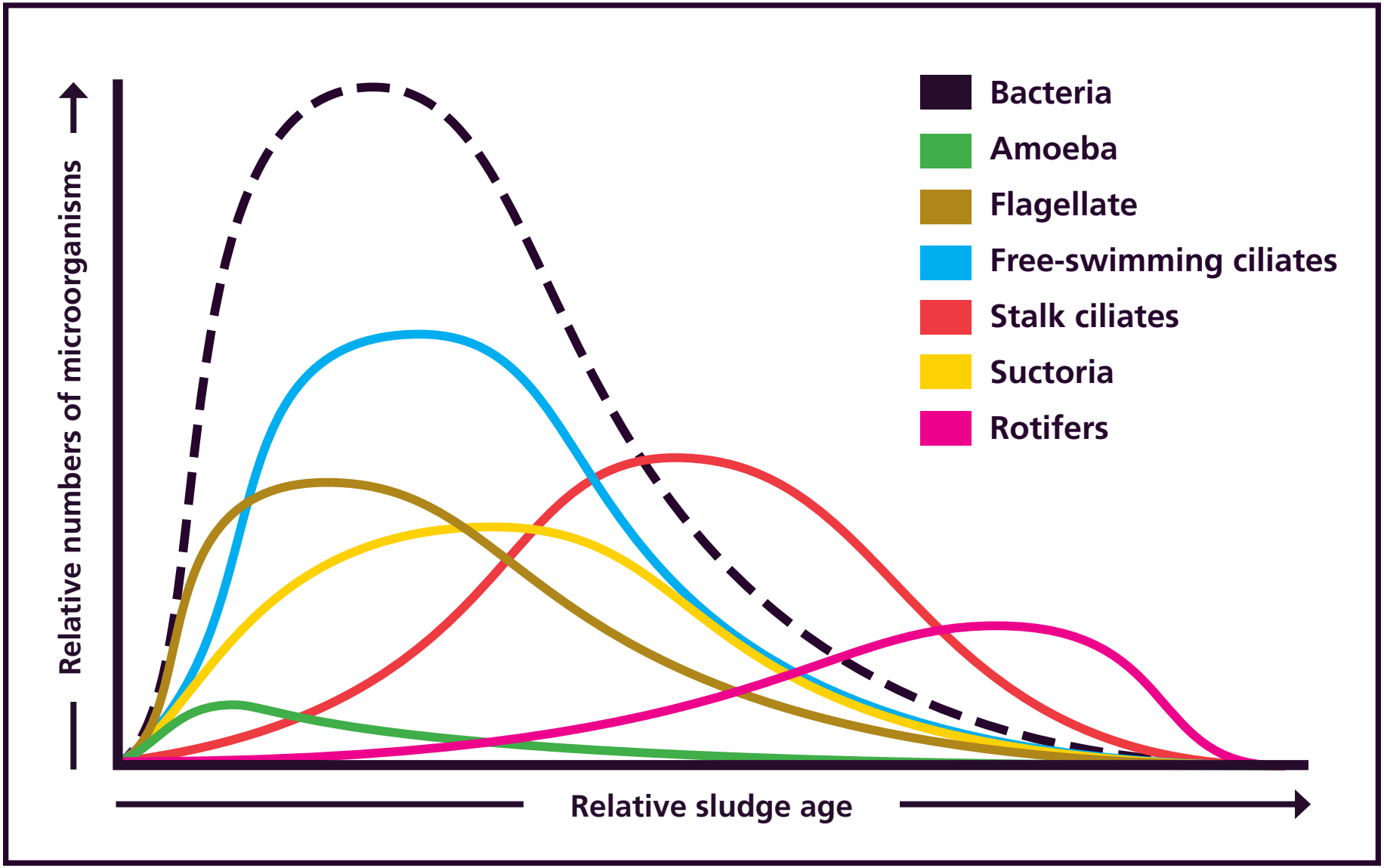
Spirostomum

This organism is a carnivore ciliate.



Relative growth

Microorganisms stabilizing an organic waste



Tips and Tricks

Utilizing your microscope effectively

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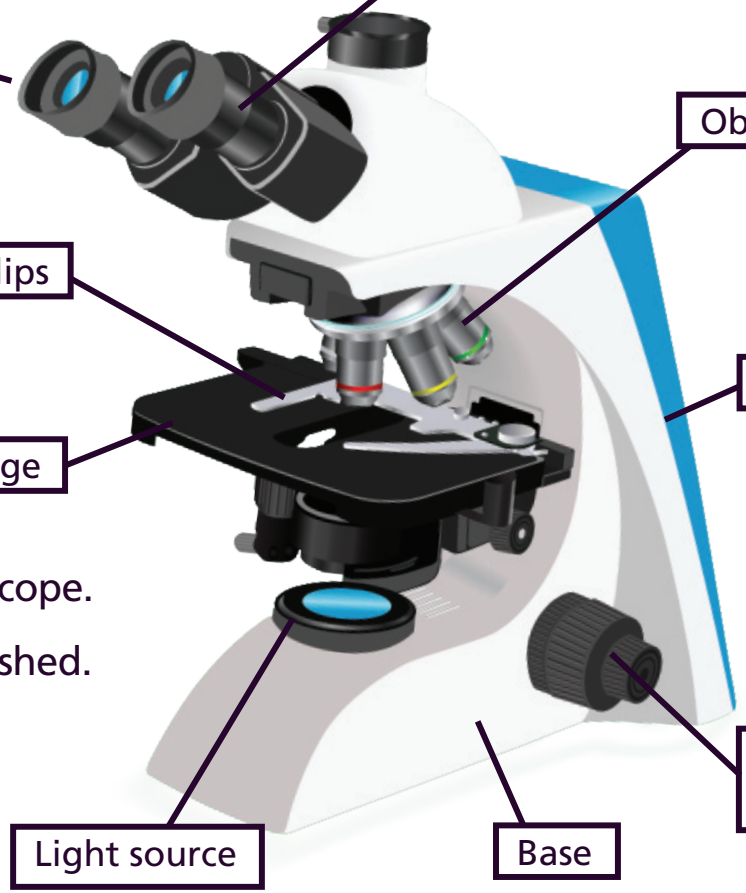
1. Grip slides and coverslips by edges.
2. Do not re-use slides and coverslips.
3. Cover scope when not in use.
4. Keep scope away from vibrations.
5. Turn light down when not in use.
6. Use lens paper only on eyepieces and objectives.
7. Phase condenser must be centered with objectives.
8. You can seal coverslips with clear nail polish.
9. Higher magnification means smaller field of view.
10. Samples will dry quickly with intense light.
11. Must have phase objectives for phase contrast microscope.
12. If using oil, wipe lens clean with lens paper when finished.
13. Only 100x objective uses oil immersion (most scopes).
14. Condenser setting should match objective.
15. Read microscope manual for specific instructions.



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With over 700 products used in 130 countries, Novozymes' bioinnovations improve industrial performance and safeguard the world's resources by offering superior and sustainable solutions for tomorrow's ever-changing marketplace.

For assistance with analyzing your microbial community or to find out how Novozymes' biotechnology can help improve your system, contact us:

wastewater@novozymes.com • www.novozymes.com/wastewater • @NZB_Wastewater