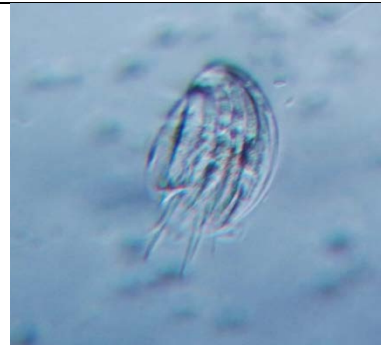
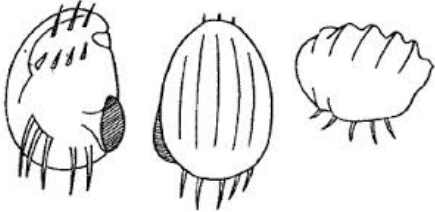

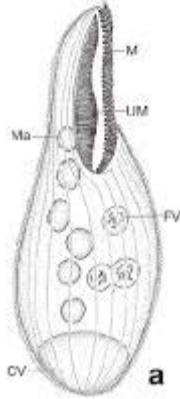

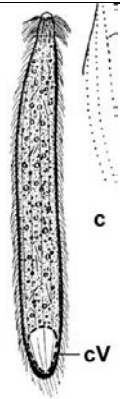

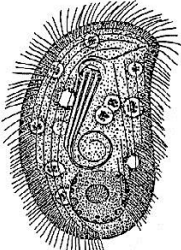



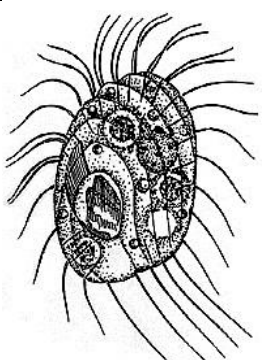
Ciliates. The ciliates are a diverse group and are very common bacterial feeders in wastewater. A few are predators. All move and feed using abundant cilia. A few (the suctorians) have tentacles for catching prey and only show cilia in the larval/reproductive stage.


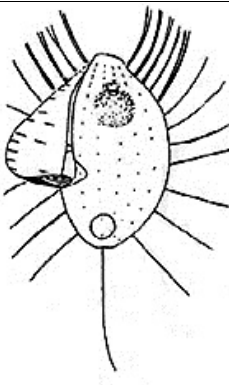
<p>Aspidisca costata (Dujardin, 1841)</p>	<p>20-45 um</p>	<p>Common</p>
		<p>Ovoid hypotrich ciliate, small- up to 45 microns long. Dorsal ridges run longitudinally and vary in shape and number (roughly 4-8).</p>

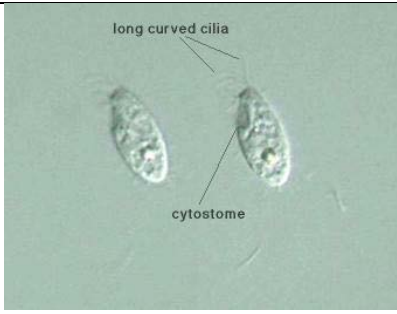
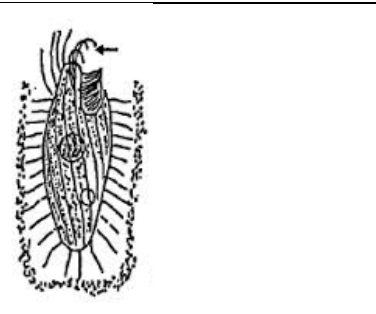
<p>Blepharisma sp. Perty, 1852</p>		<p>Uncommon</p>
		<p>Large heterotrich ciliates, often pink. Contractile vacuole terminal. Oral area very large and distinctive.</p> <p>Uncommon to rare in wastewater.</p>


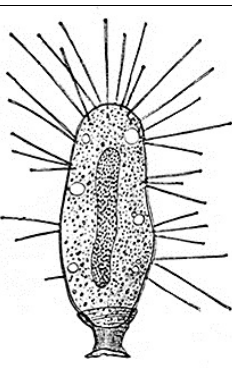
<p>Chaenea teres (Dujardin) Kent (1881)</p>	<p>60-115 um</p>	<p>Common</p>
		<p>Size is highly variable. These thin, flexible ciliates are often in masses of organic material. Note the longer cilia at the anterior end.</p>


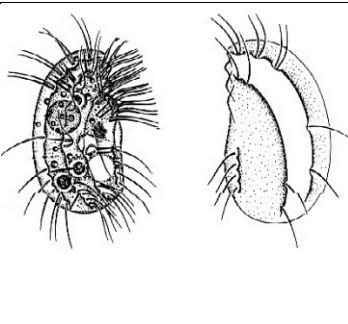
<p>Chilodonella sp Strand, 1928</p>		<p>Occasional</p>
		<p>Numerous species. Note the oral "basket" distinctive for this group (arrow). Small (40-50 um long). (Center image is Chilodonella uncinata).</p>

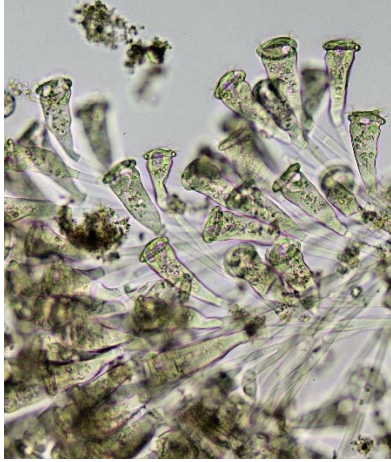
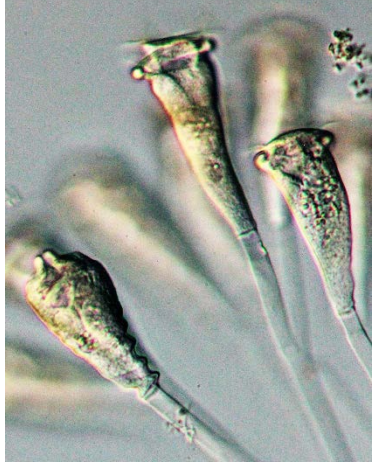

<p>Cinetochilum margaritaceum (Ehrenberg, 1831) Perty, 1849</p>		<p>Occasional</p>
		<p>Common in freshwater plankton, on surfaces and in soils and sediments. Worldwide distribution and common but only occasional in wastewater. Size range: 15-45um</p>

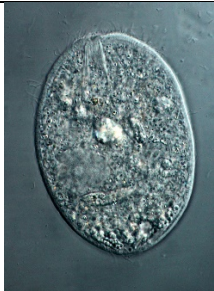
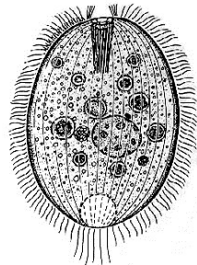
<p>Cyclidium glaucoma Müller, 1786</p>		<p>Uncommon</p>
		<p>Small scuticiliate (15 – 60 um long). Very common in freshwater. Uncommon in wastewater.</p>


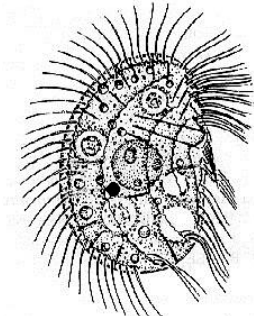
<p><i>Cyrtolophosis</i> sp Stokes, 1885</p>		<p>Uncommon</p>
		<p>Small ciliates (25-40 um long) <i>C. mucicola</i> Stokes, 1885 is common. Only one contractile vacuole subterminal; elongated cilia at anterior end; lives in dwelling-tube; cell body ellipsoid</p>



<p><i>Discophrya elongata</i> Claparède & Lachmann</p>		<p>Common</p>
		<p>Suctorian ciliate, body elongate. Stalk thick, even in width, longitudinally striate. Nucleus band-like, vertical. Considerable morphometric variation. Common but not abundant in wastewater. Approx. 200 um</p>



<p><i>Drepanomonas revoluta</i> Fresenius, 1858</p>		<p>Occasional</p>
		<p>Small, transparent ciliate, about 30 um x 15 um. Obvious furrow runs along the central axis. Seasonally abundant in wastewater.</p>


<p>Epistylis plicatilis Ehrenberg, 1831</p>		<p>Occasional to common</p>
		<p>Colonies large. Zooids 70 – 150 um. Macronucleus anterior, C-shaped. Colonies can be very large.</p> 


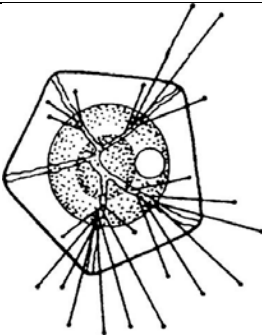
<p>Holophrya sp. Ehrenberg, 1831</p>		<p>Occasional</p>
		<p>Ovoid to round body shape. Cells about 35-40 um long (sometimes larger). These images are for Holophrya simplex.</p>


<p>Leptopharynx costatus (Trichopelma) Mermod 1914</p>		<p>Occasional</p>
		<p>Typically 20-50 μm long, 20-30 μm wide. Specimens in wastewater are larger (up to 100 um) and may be a new species.</p>



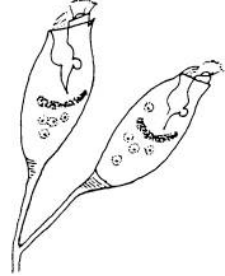
<p>Litonotus fasciola (Ehrenberg, 1838) Wrzesnioski, 1870</p>		<p>Occasional</p>
		<p>Two macronuclei. Cells up about 100 um long.</p>


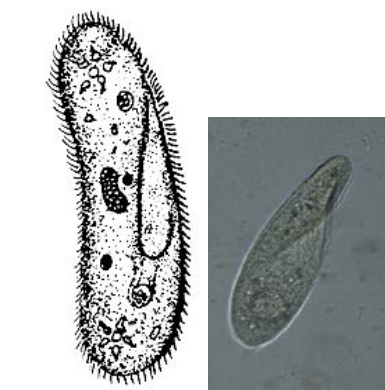
<p>Litonotus fusidens Kahl, 1926</p>		<p>Occasional</p>
		<p>Similar to L. fasciola but with prominent fused cilia on the "neck" of the cells. Sometimes very abundant. Cells about 100 um long.</p>


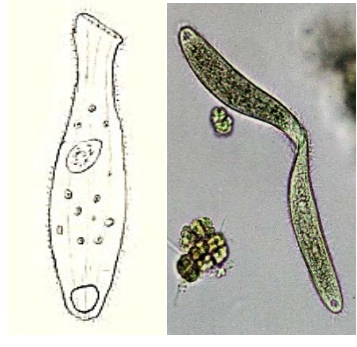
<p>Loxophyllum sp. Dujardin, 1841</p>		<p>Common</p>
		<p>Up to 120 um long. Very flexible. In side view, ridges and valleys obvious and oriented lengthwise.</p>


<p>Metacineta sp Bütschli 1889</p>		<p>Occasional</p>
		<p>Cells 35-100 um in diameter. Some species in this genus have stalks. Uncommon to occasional in wastewater.</p>

<p>Microthorax sp (c.f. sulcatum) Engelmann, 1862</p>		<p>Occasional</p>
		<p>Small ciliates (20-30 um x 15-25 um). Cyrtos (feeding tube) in the rear half of the cell.</p>

<p>Opercularia (c.f. coarctata) Goldfuss, 1820</p>		<p>Occasional to common</p>
		<p>Large colonies. Colony branched clearly notched from colony growth. Individual zooids are 40-50 um long.</p> 

<p>Paramecium sp (complex) Müller, 1773</p>		<p>Frequent but never in large numbers</p>
		<p>Large group of large ciliates common in enriched systems. Image is <i>P. polycaryum</i> but has some similarity to <i>P. caudatum</i> which often has a pointed posterior. Note the deep oral groove. Cells 150-300 um.</p>

<p>Spathidium spathula Dujardin, 1841</p>		<p>Occasional</p>
		<p>Predatory ciliate with spade-like anterior end. Contractile vacuole terminal. 85 – 200 um. Images in second panel include conjugating cells.</p>

<p>Tokophrya sp Bütschli</p>		<p>Common</p>
		<p>Suctorian ciliate (the tentacles can attach to prey). Large forms may be encountered. Similar to Acineta.</p>


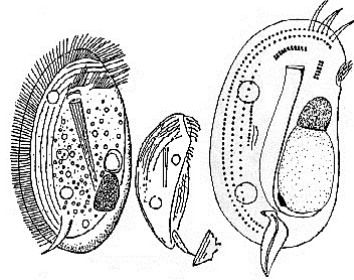






<p>Trochilia minuta (Roux, 1899) Kahl, 1931</p>		<p>Occasional</p>
		<p>Small bacterivorous ciliate with a distinctive “foot”.</p>
<p>Uronema sp Dujardin, 1841</p>		<p>Uncommon</p>
		<p>Small scuticociliates similar to Cyclidium and Pleuronema (see second panel). Neither of these is common in wastewater.</p>
<p>Vorticella microstoma Ehrenberg, 1830</p>		<p>Common</p>
	 	<p>Frequent and common small peritrich ciliate (the cilia are around the anterior end and create a feeding current). Mostly solitary. Small (30-80 µm)</p>
<p>Vorticella sp Linnaeus, 1767</p>		<p>Occasional</p>
		<p>Similar in size to V. microstoma but with longer body and less constricted anterior end. There are many species of Vorticella. Specimens become distorted under low oxygen conditions.</p>

Image sources

Aspidisca costata – L: <https://es.wikipedia.org/wiki/Hypotrichia> , C: <https://aspidisca.livejournal.com/40869.html>

Blepharisma sp- L: <http://www.plingfactory.de>, C: Kueppers, C et al., Revista Mexicana de Biodiversidad 80: 581-592, 2009

Chaenea teres – L: original, C: https://taxonomic.aad.gov.au/keys/ciliate/key/Antarctic%20Marine%20Ciliates/Media/Html/Chaenea_teres.htm

Chilodonella sp L: <http://protist.i.hosei.ac.jp/PDB/Images/Ciliophora/Chilodonella/index.html> , C: <http://ciliateguide.myspecies.info/file/169>

Cinetochilum margaritaceum – L: , C: <http://ciliateguide.myspecies.info/file/170>

Cyclidium glaucoma – L: original, C: <http://ciliateguide.myspecies.info/file-colorboxed/185>

Cyrtolophosis sp. – L: http://protist.i.hosei.ac.jp/PDB/Images/Ciliophora/Cyrtolophosis/sp_1b.html , C: <http://www.microbehunter.com>

Discophrya elongata– L: original, C: <http://ciliateguide.myspecies.info/file/200>

Drepanomonas revolute – L: <http://www.photomacrography.net/> , C: <http://ciliateguide.myspecies.info/>

Epistylis plicatilis – L,C: original

Holophrya sp

Leptopharynx – L: original, C: <http://ciliateguide.myspecies.info/file/260> .

Litonotus fasciola

Litonotus fusidens – L, C: original

Loxophyllum sp – L: original

Metacineta sp – L: original

Microthorax sp. – L: <http://protist.i.hosei.ac.jp/PDB4/PCD2911/htmls/57.html>

Opercularia sp – L C: original, R: http://web.tiscali.it/ifts/protozoi_ciliati_sessili_i.htm

Paramecium caudata – L:

Spathidium sp – L: original

Tokophrya sp. – L: original


Trochilia minuta L: <https://www.flickr.com/photos/microagua/3346715727/> , C: <http://ciliateguide.myspecies.info/file-colorboxed/439>

Uronema sp


Vorticella microstoma – L: original, C: <http://protist.i.hosei.ac.jp/PDB/PCD2003/htmls/57.html> and <http://ciliateguide.myspecies.info/file-colorboxed/479>

Vorticella sp – L: original



Amoebae (Samples contain several different kinds of amoebae. These include so-called “naked” amoebae with various kinds of pseudopods but no test [shell] or other structures, testate amoebae with various kinds of shells, and heliozoan amoebae (sun-like) with radiating pseudopods.)


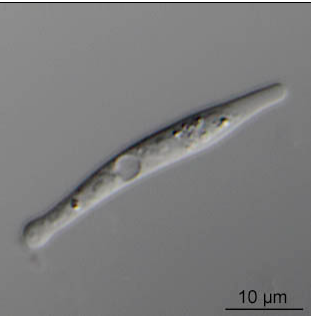
<p>Arcella sp Ehrenberg, 1832</p>		<p>Occasional</p>
		<p>Common freshwater testate amoeba. The pseudopods are rounded. Tests range from light yellow to reddish-brown. Tests frequent but tests with living cells are not.</p>


<p>Arcella cf discoides Ehrenberg, 1843</p>		<p>Occasional</p>
		<p>Tests are more transparent, especially in developing specimens.</p>


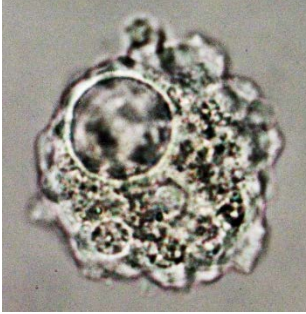
<p>Choanocystis (Acanthocystis) aculeata Penard, 1904 emend. Siemensma & Roijackers, 1988</p>		<p>Uncommon</p>
		<p>Small heliozoan amoebae, mostly 25-40 μm in diameter. Scales are silica.</p>



<p>Cochliopodium sp Hertwig & Lesser, 1874</p>		<p>Occasional</p>
		<p>Amoebae with a protein “test” or shell. Normally with many small, finger-like pseudopods. Center image is a side view of a fixed specimen showing protein test and long pseudopods.</p>

<p>Euglypha sp. Dujardin, 1841</p>		<p>Occasional (tests frequent but tests with living cells are not)</p>
		<p>Testate amoebae with shells made of overlapping plates. Pseudopods are very slender and long. Some species have spines on some plates (shown in the center image).</p>

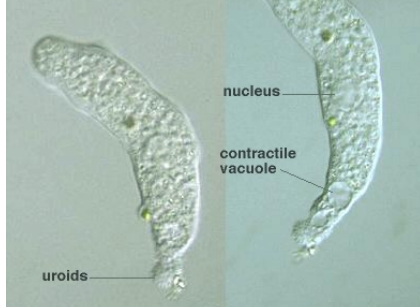
<p>Hartmanella sp (sm) aka Vermamoeba sp. Cavalier-Smith and Smirnov, 2011</p>		<p>Common (but small)</p>
		<p>Small, worm-like amoebae. Some taxonomists have suggested a new name, Vermamoeba.</p>

<p>Naegleria sp. cf gruberi (Schardinger, 1899) Wilson, 1916</p>		<p>Uncommon</p>
		<p>Small amoebae with eruptive pseudopods. There is a flagellated stage. Some species (N. fowleri) are associated with diseases, but these amoebae are common in freshwater and occasional in wastewater.</p>

<p>Pellita sp Smirnov and Kudryavtsev, 2005</p>		<p>Common</p>
		<p>Unusual amoeba fairly common in wastewater. Central image is a "floating" form showing some rectangular pseudopods. Left image is the moving amoeba showing refractile granules in main pseudopod.</p>

<p>Pelomyxa sp Greeff, 1874</p>		<p>Occasional</p>
		

<p>Thecamoeba sp Fromentel, 1874</p>		<p>Uncommon</p>
		

<p>Trichamoeba sp Fromentel, 1874</p>		<p>Uncommon</p>
		

<p>Vannella sp Bovee, 1965</p>		<p>Uncommon</p>
		<p>Fan-shaped amoebae. Occasional in wastewater. Distinguish from Pellita. Floating forms also star-like (center).</p>

Image sources

Arcella sp. – Original

Arcella discoides - Original

Choanocystis (Acanthocystis) – L: Original, C: <http://protist.i.hosei.ac.jp>

Cochliopodium sp - Original

Euglypha sp. – L: original, C: original

Hartmanella sp. – L: original, C: Siemensma, F. J., Microworld, world of amoeboid organisms. <https://www.arcella.nl>.

Mayorella sp – L: original, C: original

Naegleria cf. gruberi (sm limax) -

Pellita sp – L: original, C: original (identification: Kudryavtsev, pers. comm.)


Pelomyxa sp – L: original, C: <http://www.science-guy.com>


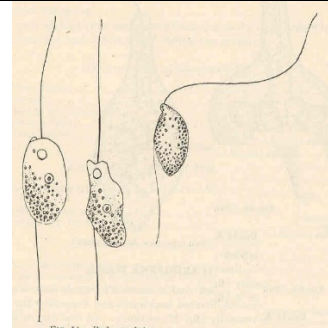
Thecamoeba sp. – L: original, C: original

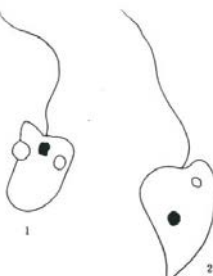
Trichamoeba sp. – <http://protist.i.hosei.ac.jp>



Vannella sp. - L: Siemensma, F. J., Microworld, world of amoeboid organisms. <https://www.arcella.nl>, C: original

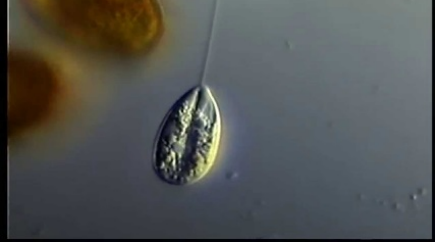

Flagellates. The flagellates are a diverse group with a large size range. They are often considered indicators of upset in waste water, especially when numbers of small flagellates are high. Many have two flagella, and several are related to species with chlorophyll and other pigments.

<p>Anisonema sp. Dujardin 1841</p>		<p>Occasional</p>
		<p>These small, colorless flagellates have a training (keel) flagellum. They are not common in wastewater but are occasionally found. Several species. Feeds on bacteria.</p>

<p>Bodo sp Ehrenberg, 1832</p>		<p>Common</p>
	 <p><small>FIG. 14.—Bodo ovalatus.</small></p>	<p>There are many different kinds of these very small flagellates. They are very common, often numerous. Feeds on bacteria.</p>

<p>Oikomonas sp Kent, 1880</p>		<p>Occasional</p>
		<p>Small, flexible flagellates. Feeds on bacteria.</p>

<p>Peranema trichophorum (Ehrenberg) F.Stein 1859</p>		<p>Occasional</p>
		<p>Large, flexible flagellates occasionally in moderate numbers. Two flagella, second very short and near anterior next to the longer flagellum. Feeds on bacteria.</p>

<p>Petalomonas sp (Dujardin) Stein 1859</p>		<p>Occasional to common</p>
		<p>A few species found in wastewater. Two flagella of differing lengths. The longer flagellum flicks back and forth at the anterior end. Bodies mostly inflexible. Some species have clear ridges on the body surface. Feeds on bacteria.</p>



<p>Salpingoeca sp H.J.Clark, 1866</p>		<p>Occasional</p>
		<p>Occasional. Very small, collared flagellates. The “collar” is actually composed of small rods (microvilli) that cannot be resolved in the light microscope. Attached to other fibers or filaments. Feeds on bacteria.</p>

Image sources

Anisonema sp. – <http://www.discoverlife.org/>

Bodo sp. – L: http://protist.i.hosei.ac.jp/pdb/images/Mastigophora/Bodo/sp_5b2.html , C: <http://www.wikiwand.com/en/Bodo> (excavate)

Oikomonas – C: <http://www.munhwaenv.co.kr/water/Oicomonas.htm>

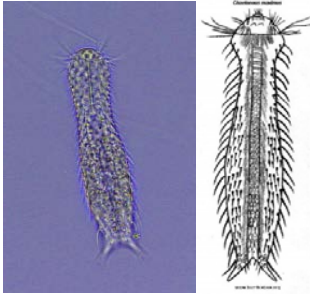



Peranema trichophorum – L: original, C:


<http://www.plingfactory.de/Science/Atlas/Kennkarten%20Algen/Euglenophyceae/source/Peranema%20trichophorum.html>

Petalomonas – L: Francisco Pujante Capilla, <https://www.youtube.com/watch?v=uJRD1eNbc6I> , C: Flickr, <https://www.flickr.com/photos/microagua/38686789075>

Salpingoeca - <http://www.dayel.com/choanoflagellates/>

Other common taxa. A few other (multicellular) organisms are common in wastewater. These include gastrotrichs, rotifers, and occasional nematode worms and annelid worms.

<p>Gastrotrichs</p> 	<p><i>Chaetonotus</i></p> <p>Mostly less than 1mm (1000 um) in length. Gastrotrichs live in the watery spaces between grains of sand in loose sediments, in surface detritus, and on aquatic plants; a few are planktonic.</p> <p>Common in wastewater.</p>
<p>Rotifers</p> <p><i>Philodina</i> (common, but not in large numbers)</p> 	<p>Bdelloid rotifers similar to <i>Philodina</i> Common.</p> 
<p><i>Monostyla/Lecane</i> Common.</p> 	<p>Case building rotifers and rotifers similar to <i>Monostyla</i> are common in wastewater.</p>

<p>Worms</p>	<p>These worms are occasional to frequent in wastewater but not in large numbers.</p>
<p>Nematode</p> 	<p>Annelid worm (<i>Aelosoma</i>)</p> 