July 2017

The Wastewater Insight

Environmental Leverage INC.

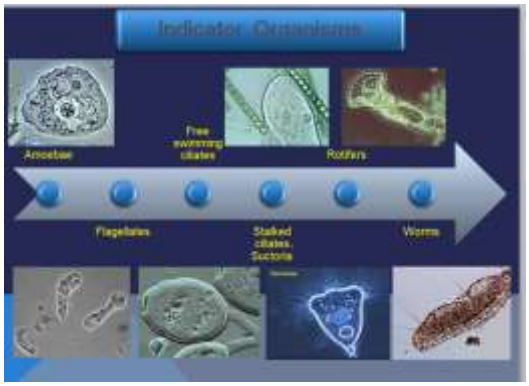
Turning Liabilities into Leverage

What are the higher life forms?

I always hear the term higher life forms? What exactly does that mean. What are the higher life forms. How do I use that information to correlate it all together to make a process change at my wastewater plant?

A daily microscopic analysis should be performed at every wastewater treatment plant. It is the number one tool to evaluate how well you are running your wastewater plant or "Bug factory"

In addition to the single cell bacteria your biomass will contain other microorganisms. These organisms are collectively referred to as higher life forms or indicator organisms. They are advanced organisms beyond just bacteria. As the system matures or stabilizes the type and relative abundance of the higher life forms will change. By monitoring the higher life form population, you can draw numerous conclusions regarding the overall health of a particular system. Higher life form distribution tends to be very plant specific. What looks normal in one plant may not be normal for another. Your plant may be designed only as a pretreatment facility, so it may only have a young system with free swimmers or flagellates. A typical municipality with activated sludge may get rotifers and worms. Learn what the organisms are in relation to your own facility and it becomes easier to make minor process changes and make the facility run more efficiently.



Higher Life forms or Indicator organisms indicate how well you are beating the time and numbers game. Do you have sufficient bacteria in your system to handle the incoming BOD loading?

They are the last to come and the first to leave during upset conditions. First in your system after your bacteria, you will develop Amoebae. As you get a little older in your system, you may start to develop flagellates. Free swimming ciliates are the next type of indicator organisms. All of these still indicate you have a pretty young to medium sludge age to some extent. We will go over each separately in more detail. Stalked ciliates and Suctorian come next. Rotifers are next in the line of sludge age and indicator organisms. Worms are the last in the line of typical higher life forms present in wastewater. And no, higher life forms do not morph. An amoeba does not change into a rotifer ever.

Let's take a closer look at each of the categories and how they correlate to your sludge age in your system.

Amoebae are single celled microorganisms. Amoebae are motile by pseudopodia, also known as "false feet". Amoebae are divided into two different types, testate and naked. Testate amoebae are those that have shells (or tests) and naked amoebae do not have shells. The shells can be proteinaceous or siliceous shells. A naked amoeba might make you think of the movie "The Blob" as they can slowly spread out their protoplasm in any direction. They eat by engulfing their food. They range in size from 10-200 µm. Amoebae tolerate low D.O. environments. When Amoebae are dominant, this indicates a young sludge age or a recent high BOD loading High F/M conditions are present. This is an Arcella. They are usually easy to spot since they can sometimes look like a donut! They can sometimes indicate the presence of heavy metal salts.

Amoebae are found in many different types of wastewater, including activated sludge and trickling filters and lagoons. Amoebae grow well on particulate organic matter and are able to tolerate low DO

We started this month out with a new **Mystery Bug of the month!**

Check out our website for more photos of our new mystery bug!!!!

EnvironmentalLeverage.com

environments. Testate amoebae are often found in lightly loaded plants or in plants where nitrification occurs. They are usually found in young sludge ages but they can be found at any age if all of a sudden a high BOD loading has occurred. They can be found during plant start-ups or often following upsets. They can be used as an indicator for a process control tool to cut back wasting, increase a thicker RAS short term or use bioaugmentation if limited by hydraulic capabilities.

Flagellates are single-celled protists with one or more flagella; whip-like organelles often used for propulsion. The flagella is used for movement through the liquid. Some flagellates live as colonial entities, while others function as a single cell. Flagellates can be plant or animal-like. Plant-like Flagellates contain chlorophyll and are autotrophic. Animal-like Flagellates are colorless heterotrophs. Many times flagellates are overlooked and must be viewed at 400x. If Flagellates are dominant, this means a young sludge, high F/M or low MCRT.

Like their relatives the amoebae, flagellates are usually present when there are large amounts of soluble food available (high F/M or high BOD). They are found during start up when the sludge is young or after an upset, but will quickly predominate over the amoebae because they are more efficient feeders. They are often found in trickling filter, oxidation ditch, ponds, lagoons and activated sludge. Flagellates are one of the few protozoan forms present in sludge that are strongly loaded. Their presence may indicate high soluble BOD levels. Flagellates usually are present in very large numbers during initial start- up of a wastewater treatment plant, during recovery from a toxic discharge to the treatment plant, or at low D.O. levels. If flagellates are present as the dominant protozoan group, this could indicate an unstable wastewater environment and a sludge biomass that is very young.

The Ciliates are more complex organisms than the amoebae and flagellates. Free swimming ciliates are covered with cilia, hair-like projections, which are uniform and aligned in rows. The ciliates move and capture food by means of the cilia. The anterior portion of the ciliate is the oral region, which is also covered with cilia. Free swimming ciliates range in size from 20-400 µm and have two kinds of nuclei. Sexual reproduction is by conjugation.

Free-swimmers swim faster due to more cilia than flagellates, so they can compete better for food. Crawling ciliates have cilia mainly on the lower surface of their bodies that make them appear to be legs. They may look like lady bugs crawling around on the floc structures. Ciliates feed on bacteria not on dissolved organics. While bacteria and flagellates compete for dissolved organics, ciliates compete with other ciliates and rotifers for bacteria. They are usually an indicator of good quality sludge. They are typically found in young to medium age sludge.

Free swimming ciliates or crawling ciliates are found in various types of water, including freshwater and wastewater. Free swimming ciliates are important because they work with the bacteria. They feed on the bacteria and thus help to clarify the effluent. These can be found during most sludge ages but are dominant during the middle sludge ages.

Some types commonly found in wastewater are Paramecium, Litonotus, and Coleps. Common types of crawling ciliates found in wastewater are the Genus: Aspidisca and Euplotes.

Stalked ciliates are a type of protozoa that can be branched or unbranched. Stalked ciliates are usually sessile. Stalked ciliates are "inverted bell-shaped bodies mounted on a stalk which is attached to a substratum." A key identification feature is the presence of cilia (minute hair-like projections) on the oral region of the organism.

Cilia is used for locomotion and feeding. The stalked ciliates create a vortex in the water and capture single celled bacteria. Stalked ciliates can be solitary or colonial. They can be branched or unbranched. Stalked ciliates when dominant are typical indicators of good quality sludge age. Notice if there is heavy attached growth on the stalks. This is a good sign. That means your system has been stable for a long time. The stalks have probably come and gone many times around the system in the RAS so that bacteria are even growing on the stalk.

Stalked ciliates may be found during most sludge ages, but are dominant during middle sludge ages. Stalked ciliates are found in large numbers when the bacterial population and dissolved oxygen concentration of the treatment process are high, the wastewater environment is stable and a mature floc structure has developed. Stalked ciliates usually indicate a stable wastewater environment and a healthy biomass. Vorticella is a type of stalked ciliate. When performing microscopic analyses and doing your counts per field, always “count” each head on the stalks. For example, if this were a field, you would count three when performing your biomass analyses.

Suctorians are similar to stalked ciliates only instead of hairs, they have a rigid set of tentacles or hollow tubes extending from the cell body. They use these to spear their prey such as free swimming ciliates and flagellates. Suctorian are usually sessile and usually representative of a good quality sludge age. They can be colonial but usually are solitary.

The **Rotifers** are the most abundant macro invertebrates found in the activated sludge process. Rotifers can be found in many different shapes and sizes. Important structural characteristics used to classify rotifers are body shape (sac, spherical or worm), size, jaw, number of gonads, foot development, number of toes and protective covering. Most rotifers are colorless, except for the eyespot. However, ingested food may sometimes give the organism the appearance of having color.

Rotifers are characterized by the possession of a ciliated area or a funnel-shaped structure at the anterior end that may look like rotating wheels and a specialized pharynx that is part of many pieces that act as jaws. The mouth opening of the rotifer is surrounded by two bands of cilia. The beating of the cilia creates water current for locomotion and food

gathering. They can feed on stabilized floc.

Rotifers move by swimming freely or crawling. Rotifers are able to consume both microbes and particulate matter. Like protozoa, these microorganisms are strict aerobes and are more sensitive to toxic conditions than bacteria. Rotifers are found only in a very stable activated-sludge environment and are highly sensitive to high BOD loadings and toxic shocks.

Rotifers range in size from 40 to 500 µm and have an average life span of 6 to 45 days. Rotifers are found in low F/M, high MCRT or high MLSS. Rotifers can reduce turbidity and BOD, control slime growth that can lead to anaerobic conditions by grazing on sludge and increasing oxygen penetration.

Free-living **Nematodes** are non-segmented, terrestrial macro invertebrates. This means that they have no backbone or invertebrate. They often they may look segmented due to the thickening of the cuticle or epidermis. Their bodies are cylindrical with tapering ends. Nematodes range in size from 0.5 to 3.0 mm in length to 0.02 to 0.05 mm in width. Aquatic earthworms have setae along the body, which allows them to tunnel through the floc particles, ingesting chunks of bacterial floc. They can be very common in old activated sludge.

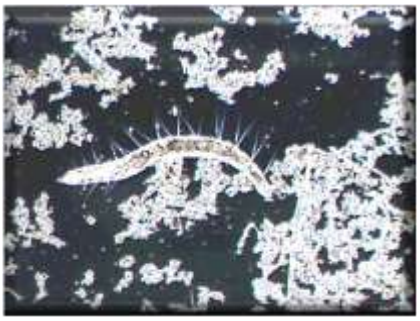
Nematodes also secrete a sticky substance in order to anchor themselves to a substrate (media) or floc particles so that they can feed without interference by currents or turbulence. A lack of nematode activity or dead and hollow nematodes can be one of the bio-indicators of a toxic condition that may be developing in the treatment process.

Worms indicate a very old sludge age, high MLSS, low F/M or high MCRT. Burrowing permits oxygen diffusion to floc structures, promoting microbial activity. They can crop bacterial populations and recycle nutrients. Nematodes or Bristle worms are common types found in wastewater.

Nematodes are often observed in higher MCRT systems or where the sludge is older. They thrive in aerobic wastewater treatment processes when the DO concentrations are high and bacterial food is abundant. They are present in large numbers in secondary wastewater effluent, trickling bio-filters or rotating biological contactors (RBC's) where an older biofilm develops. They are usually the last to come (as far as age) and the first to go (as far as increases in toxicity or BOD loading) from an "indicator organism" standpoint.

Bristle worms usually indicate high nitrates

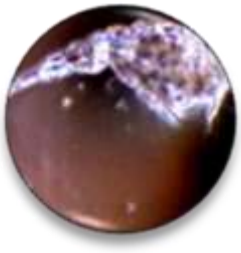
Non-biting midges



Spiked worms

There are many **macroinvertebrates** associated with a seriously older sludge.

Water Bear



Ostracod

Daphnia

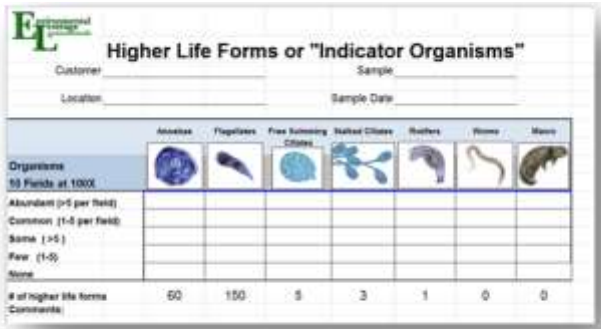
Copepod

Water mites

Usually a system has to be very old, or have solids build-up somewhere.

What is the Higher Life Form or "Indicator Organism" Sheet?

The Higher Life Forms Worksheet shows the number and types of higher life forms found in the wastewater sample. It is usually performed under the microscope at 100x. An average of 10 fields is used to determine the number and types of life forms. The purpose of recording the number of higher life forms is to determine the health and age of the system. Typically, the organisms represent only 5% of the biomass. These organisms are exactly what they are called-Indicator organisms. They are usually the last to come and the first to go in a system if it is not running properly. They usually correlate to the plant performance. They can indicate if the sludge is young, old or medium aged. They can sometimes indicate if there had been a recent slug of high BOD loading.


Higher Life Forms or "Indicator Organisms"

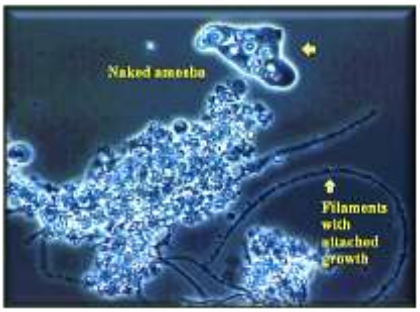
Customer _____ Sample _____

Location _____ Sample Date _____

Organisms 10 Fields at 100X	Amoebae	Flagellates	Free Swimming Ciliates	Stalked Ciliates	Rotifers	Worms	Misc
Abundant (>5 per field)							
Common (1-5 per field)							
Some (>5)							
Few (1-5)							
None							
# of higher life forms	60	150	5	3	1	0	0

Comments: _____

Some things that may be noted on your sheet:



1. Loss of all higher life forms can indicate a recent high BOD loading or toxic shock.

2. Many rotifers and nematodes usually indicate an older sludge age unless the system is a fixed film type.

3. Increase in amoeba and flagellates from normal numbers of higher life forms can indicate a change to a younger sludge (lower MLSS), high F/M ratios or BOD loading.

4. Suctorians are usually excellent indicators of good BOD removal.

5. Many stalked ciliates can be an indication of middle aged sludge.

6. Fungi or yeast can indicate low pH, fermentative conditions or severe phosphorous deficiency. Sometimes if present with high numbers of Thiothrix, it can indicate septic conditions in midstream clarifiers or process units that feed into the aeration section of the wastewater treatment plant.

7. Tetrads can indicate a nutrient deficiency, usually nitrogen. These cause high levels of TSS and require lots of polymer in final clarifier.

8. The presence of spirillum or spirochaetes usually indicates septicity. The presence of high organic acids or low DO is usually associated with septicity. Again, check your clarifier for holding solids too long.

9. Hyphomicrobium looks like "beans on a stalk". They are an indication that denitrification is going on or septicity is present.

10. The presence of heavy metals can result in dispersed growth of floc structures. Check to see if Arcella are present.

11. Zooglea is extremely large, non-motile bacteria. The bacteria staining are usually Gram negative and Neisser negative. No sulfur granules are present. They can be "fingered or amorphous". Zooglea has the presence of excessive amounts of polysaccharide coating. Zooglea grows usually as "amorphous" clumps or "fingered" like a tree. They can indicate low pH. This bacteria is usually found in environments where there is a high F/M ratio where the soluble organic compounds are readily bio-degradable. Often present in selector systems in activated sludge. Also an indication of nutrient deficiency (N or P).

Microscopic analyses of any biological system should be a critical component of any ongoing daily monitor and control programs. Lab sheets to correlate health of the system, any changes in floc structures, higher life forms, filamentous identification, polysaccharide coating of the bacteria and suspended solids can be determined by using a microscope and examining the biomass. This is a tool that can help not only show exactly what the health of the system is at a given time, but can also help predict which direction the plant is headed if used daily. It is a tool that can also help prevent critical upsets, or be used as an early warning. In the cases of filamentous problems, staining and identification of the filamentous can help with troubleshooting and help avoid costly chemical consumption.

Well, I do not know how to do that myself, what can I do? . . . You can always send in a sample to our lab for an analysis. We have created past newsletters as well as training on each of these types of higher life forms. Check out our main website for our monthly newsletter as well as our Bug of the Month to help you identify the different species in each category. We do have training CD's as well as our new Elearning if you need to learn more. www.WastewaterElearning.com. Always feel free to contact our office if you have questions.

2017 Class Schedule

We still have some spots open in our upcoming hands on Training classes

New locations to make it easier to travel to. If you cannot travel, we also now have more courses on our ELearning.

Washington, California, Alaska and Iowa

All of these courses have been pre-approved for CEU credits

Some of these courses have limited sizes, so reserve your spot now.

July

California- East of San Francisco

July 13th & 14th, Thurs. & Fri., 2017

8am - 4:30pm both days

2 Day Biological Wastewater Treatment Seminar

GVI Training Facility
5711 Griffith Ave.
Livingston, CA 95334 USA

August

Alaska- Anchorage

August 9th & 10th, Wed. & Thurs., 2017

8am - 4:30pm both days

2 Day Biological Wastewater Treatment Seminar

AWWU Eagle River Wastewater Plant
15524 Artillery Road
Eagle River, AK 99577 USA

September

Iowa- Quad Cities

Sept. 13th & 14th, Wed. & Thurs., 2017

8am - 4:30pm both days

2 Day Biological Wastewater Treatment Seminar

QC Analytical Services Training Center
1798 Iowa Drive
LeClaire, Iowa 52753 USA

Please check our website or email us for a registration form. Please let us know if you would like to host a class in your area.

New Training development- Check out our new wastewater ELearning classroom.

Now you can take classes from the comfort of your own office. Online classes save money, travel time and expenses as well as the fact that you can learn at your own pace. You can go ahead and set up a free account and take the few virtual demo. Then you are ready to choose your classes form our list currently or as the new ones come up and go online. We already rolled out the first set of training classes. Stay tuned for more information on upcoming classes. . . .

We will continually be adding new courses to the ELearning. Let us know if you have a special topic you would like to see covered.

https://www.wastewaterelearning.com/elearning/index.php

These courses have been pre-approved for Wastewater CEU's in Alaska, California, Connecticut, Idaho, Indiana, Maine, Massachusetts, Nevada, New York, North Carolina, Tennessee, Vermont, Washington and West Virginia. Some states do not require pre-approval. If you need these approved for your state, please contact our office.

These courses are eligible for CEU's, Contact Hours or PDH (Professional development hour) in Alabama, Arizona, Maryland, Virginia and more to come. Now approved in Canada for Nova Scotia and Saskatchewan.

Coming soon, Nitrification/Denitrification and Clarifier

Filamentous ID the Easy Way in the Fall

Did you guess what this was? This is Fungi. Usually this is present when the pH is below 7. Check your digesters as well. Oftentimes pH is overlooked there. Low pH and fungi can lead to false fecal coliform counts on your biosolids tests.

June 2017- Fungi

Check out our website for more photos of our new mystery bug!!!!

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