

Select Aquatics of Erie, CO.

A Practical Understanding: Maintaining Water Quality

Only in the past 20 years has the nitrogen cycle process that occurs in our aquariums become well documented. In the early 1990s, the basic identification of the bacteria involved was found to be incorrect, further demonstrating that aquarists have had to depend upon their own experience to achieve the best results in their tanks. Published information, if it could be found, was of little value.

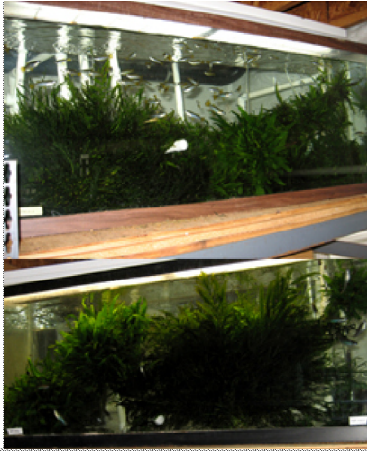
What many of us know as the “nitrogen cycle”, and what is referred to in pet-fish texts is encountered when first setting up an aquarium, as if it were some brief and temporary issue. We are all familiar with “new tank syndrome”, where fish in a fresh, dechlorinated aquarium will not thrive for long, because the nitrifying bacteria have not yet had an opportunity to populate, and are unable to process the waste produced. Once the bacterial levels are up, the tank is said to be “cycled”. Once a tank has been running healthfully for a few months, it is said to be “seasoned”. At this point most of us consider a tank to be “mature” and don’t think of the nitrogen cycle again, other than when cleaning the tank and filter occasionally.

But many of our aquariums seem to exist at the whim of some unknown hand. Fish get sick, other fish seem to die for no reason. Or worse, a tank is set up to breed a particular species, and after many months or even years they appear to thrive, but do not breed. Or fish are obtained from someone else that looked great, but three generations later your fish never grow to as large or look as nice as the original fish. All this comes down to water quality. And that comes down to how closely and effectively we are able to maintain our tank. Effective means simpler, cleaner, with an awareness of what the bacteria in a tank can handle, based on its history, the fish currently in it, and the organic load going in and coming out of the aquarium.

This essay will attempt to address nitrogen cycle issues that arise in fully seasoned tanks. Problems that arise can quickly cause disease, as well as fish that do not thrive or refuse to breed, and fry that grow out stunted and undernourished.

Fish are very adaptable, and hardier commercial varieties found in pet shops can survive in conditions considered impossible for the wild caught species now available in the hobby. Many of these new species come from genera that have not been kept in captivity, requiring a special concern for water quality issues, and many have done well when fresh approaches to fishkeeping are tried. Keeping these new fish, some yet to be formally identified, then breed them, has sometimes proven difficult without considering changes to the way our aquariums are kept. These changes have led to tanks that are easier to maintain, fundamentally cleaner, simpler and with closer attention paid to fewer variables. This is all toward optimum water quality, a minimum amount of effort, affordability and what is best for the fish.

Fish have a certain amount of energy to expend toward growth, breeding, dealing with stress, fighting off disease, etc. When a fish has been kept in a clean, disease free environment, its energy and reserves go into growth and breeding, as opposed to a fish living in a setting where, for example, fending off disease is commonplace. As a result, the fish in the cleaner environment will become larger, breed more frequently, show better color, etc. than the fish in the less clean environment.



When a tank is not stressed by excess organic waste, the plants also reflect the healthy conditions. These are Bolbitis fern and Java fern in 55 gallon tanks.



When raising the fish that breed for you, clean conditions allow for fish with good size and color. These are Xiph. alvarezii

New Tank Syndrome and how to avoid it:

A fresh body of water when fish are introduced and fed daily will generally “crash”- in that the organic waste in the tank will overwhelm the available bacteria in about 15 days. At that point the water will become cloudy, and a “bloom” of bacterial activity will deplete the oxygen in the aquarium. The fish will be seen gasping for air at the surface, and soon the fish will die. This is avoided in two ways- the first is to introduce seasoned, aged aquarium water to your newly filled, dechlorinated tank. This will “seed” the new tank with the nitrifying bacteria needed to maintain water quality. Introduce new fish very slowly, and allow the tank to cycle by being careful not to overfeed, and keep the number of fish in the tank to a minimum for the first couple weeks.

The second way to cycle a new tank is to be sure to do 10% water changes about every other day for the first 2-3 weeks, while allowing the nitrifying bacteria to build up. Also keep the number of fish in the tank to a minimum and be careful not to overfeed.

A little background on Aquarium Cleanliness

Starting, nurturing but then ignoring the nitrogen cycle often gets aquarists into trouble, and is a source of confusion or uncertainty for even the most advanced hobbyists. Some amount of experience helps to best recognize when there is a problem, and then deal with it effectively before you lose any fish.

For many years aquariums were kept with a thick layer of gravel over an undergravel filter that bubbled away, without concern for the amount of waste pulled into the gravel that had collected over time, stressing the fish and constantly challenging their immune systems. This resulted in shorter lifespans, and fish that did not attain their full size or coloration. Most aquarists saw an undergravel filter as nearly maintenance free, entirely unaware of the long term issues created by keeping organic waste within the aquarium.

Diseases such as fin rot, fungal infections, internal and external bacterial infections can all often be traced back to poor water quality, which tie directly to a loss of control over the balance between the waste going into a tank, and the nitrifying bacteria's ability to process that waste.

These undergravel filters also set up a see-saw of husbandry, where water quality fluctuated wildly at each cleaning, and occasional long periods of poor water quality was the norm. I have kept aquariums this way in the past, where a thorough cleaning a couple times a year was seen as adequate aquarium care.

In large fishrooms of over 100 tanks, the aquarist must know accurately how each tank is filtered, what is kept in it, the amount of food and other wastes going into it, the organic load / stocking level of the tank- which changes daily as the fish grow- and where the line is when the bacteria present in any specific tank can no longer handle the waste produced in that tank. This considers the type of filtration being used, the water change schedule, amount of live plants and the manual cleaning of tanks being done. When providing for the maximum health of the fish, you must also be aware that each species has its own natural tolerance for ammonia and nitrate- some can handle low levels, some cannot.

This essay is how to develop an awareness of the organic load going into a tank, and its relation to the other factors working to keep the water quality at its best for the fish, as well as things that can be done to improve the bacterial activity toward a more consistent, healthier tank.

With this mindset, particularly in a larger fishroom, this approach works towards consistency, few variables to consider when things go wrong, and the best health, growth, color and breeding from your fish.

Starting with a cycled tank, fish acclimate to their water, and the bacterial level in the water adjusts to the organic load being produced in that tank.

Many of the final "rules" you will set for yourself will come from your own experience. How heavily stocked should a 30 gallon tank be with a box filter, thin layer (1 stone thick) of gravel over half the tank bottom, weekly 50% water changes, a few small live plants, lights, and a temperature of 75 degrees? The old books used to say "an inch per gallon", but three 10 inch Oscars could never go into that 30 gallon aquarium, yet I could put 30-40 inches of young plecostomuses in that 30 gallon tank. (Though for only a shorttime- a few weeks- as they will all be growing, and will gradually produce more waste than the bacteria in the tank can handle.

When in doubt, always go fewer fish, and whenever possible, keep stocking levels lower. Over time, as you make the best choices when setting up a tank, you must get to know the maturity of the tank water, the type and amount of fish to be kept, what and how much they will eat, and the amount of water movement, aeration, and type of filtration.

Some species are 'dirtier' than others in that they give off more waste, requiring that the bottom of the tank must be siphoned every few days for the same number of fish to be kept. Each species handles water quality, oxygen levels and crowding differently based on how they impact the nitrifying bacteria through the waste they produce.

When breeding and raising fish in larger numbers, the creation of a bacterial bloom by overestimating what the tank's nitrogen cycle can handle happens often. In fact, a cloudiness of the water in a tank is often the first sign that the fish have outgrown the capacity of the bacteria in that tank to process the waste being produced. Immediate action is then taken to save the tank before the fish expire. Learning how to prevent this from happening means understanding how healthy the nitrogen cycle is in your tank (s).

The organic load consists of:

The size of the fish in the aquarium- This will dictate the number and type of fish kept.

The number of fish in the aquarium- The fewer the fish, the less waste.

The metabolism of the fish- High oxygenation fish with active metabolisms produce more waste and are more sensitive to poor conditions. Sluggish, less active fish can tolerate slightly higher density and lower water quality. Some fish produce a lot of waste and cannot be kept at the density of other species.

What the fish are fed- High protein dry foods, vegetable dry foods, live or frozen foods all decay and pollute in slightly different ways. Even when the majority of the food is eaten, its effect on the water quality can be substantial, while many foods do not pollute the water at all.

How much they are being fed- The frequency and amount of food fed at each feeding needs to be considered, keeping an eye toward getting the maximum amount of food into the fish as possible while maintaining water quality. Dry, frozen or live foods all break down in the water differently.

Frequency of changing filters- A wad of dirty filter material is the same sitting in a filter where the water in the aquarium is running through it, or sitting in the middle of the aquarium. Most filter mediums need to be changed at least monthly.



Box filters- the best choice for simplicity, low cost, effectiveness and cleanliness.



A perfect basic tank ready for more fish and plants. This 29 gallon tank has box filters, a gravel filter and a single layer of gravel lightly over the tank bottom.

Filtration consists of:

The Size of the Aquarium- The larger the aquarium, the more forgiving the aquarium is going to be when an overload of organics occurs. A 2 inch dead fish in a 55 gallon aquarium is not going to cause a biological problem, however, in a 10 gallon, particularly if the tank is already to capacity it certainly can.

The type of filtration you will be using- Using a filter that removes particulate matter from the aquarium in combination with a layer of ¼ inch pea gravel over half the aquarium bottom is best. Filters that keep the particulate matter in the aquarium must be used with manual removal of particulate matter and possibly heavier water changes. (undergravel filters, sponge filters)

The amount of nitrifying bacteria colonizing area – If you are using the gravel method mentioned above, a wet/dry filter or sponge filter to supplement other filtration.

The frequency and amount of water changes- Most fish do well with their water being changed a minimum of 20% a week to a maximum of about 20% a day. Before using an automatic water changing system, I found 20% twice a week to be a good amount for the livebearers I was keeping.

The amount of aeration- Aeration is very important for the stimulation of bacterial growth and best for most fish.

The amount of lighting- Lighting also stimulates bacterial growth and encourages assists plants etc. to assist filtration.

Whether you are using live plants- An essential addition to a well filtered, healthy aquarium.

When determining whether a fish will do well in a particular aquarium, keep in mind that fish do best in the circumstances they have become accustomed. For example, you keep a fish in fairly clean, consistent conditions, and then give some of your fish go to someone else, who may not maintain the same level of consistent water quality. That person's fish may do fine, but your fish may find the circumstances too difficult and not thrive, even though the ammonia and nitrate levels in the tank were within a normal range.

An awareness of the organic load in your tank is important with the goal of keeping it within what the bacteria can handle, as much as possible. You need to know the balance between the waste going in, the amount of nitrifying bacteria, and the amount of filtration being used. The debris that can be seen will break down, releasing ammonia that takes effort from the fish to accommodate. Also consider that the main source of waste is that which cannot be seen, given off by the fish through routine 24/7 respiration, which needs to be added to the equation.

When a tank is running well, and the nitrogen cycle is well established, a number of factors will be present.

- The aquarium water will be crystal clear.
- Fish will be swimming at their appropriate levels in the aquarium. (not predominantly near the surface or at the bottom)

if they normally would not.)

- The fish are out and confident, and not hiding or cowering in the plants.
- Other creatures- snails, etc. are also out and about.
- The water does not become cloudy after a feeding, and the fish are ready to eat eagerly when the food is presented.
- The fish swim with fins extended and color is good. The fins are clear and fluid in motion, eyes are clear and alert.

When there is a problem, one or more of these factors may be present.

- The water is at all cloudy
- The water has a slight yellow or brown tinge to it, and wood or other substances are not responsible.
- A foaming may appear at the water line, and there may be an increase in water tension at the surface of the aquarium.
- The fish may have their fins clamped or held restricted, their color may also be darker or lighter (washed out) than normal.
- The fish's fins or eyes may be cloudy, their behavior is slowed or lethargic.
- The fish are breathing at the surface or cowering near the bottom.
- A cloudy film may form on the glass, or brown or green algae may appear.

If nothing is done, fin rot, fungal infections and sudden deaths will begin to appear within 1-3 days.

Immediate fixes when problems are seen-

- Change 50% of the water. Use clean, aged aquarium water from another disease free tank if at all possible. Otherwise use the dechlorinated water used in any other water change.
- Remove the filter medium and rinse well in clean, aged aquarium water- if possible, do not discard at this time. You will need the bacteria to help get the tank back on its feet, and changing the filter medium with a 50% water change may be too jarring for the fish. Replace the filter medium as you would next time around when the tank is stable.
- Clean up the bottom of the tank, looking for any collections of debris. Thoroughly siphon gravel with a gravel cleaner if necessary. Wipe the glass.
- Be sure a light is on and working over the aquarium. Light stimulates bacterial growth, plant growth, etc. and improves the overall health of the aquarium.
- You may want to add a medicinal dose of salt (1 tablespoon of salt to 5 gallons of water) to the tank to assist the fish to overcome their clamped fins, etc.

There are 3 types of filtration commonly found in aquariums. Not all three are needed in all aquariums, and bacterial filtration is nearly always present, but possibly not in adequate amounts. The three types are mechanical filtration (anything that mechanically removes particulate waste by collecting it in some type of medium), Chemical filtration (such as when charcoal is used) and biological filtration. This primarily involves the work of nitrifying bacteria that occurs in any aquarium after it has been running for a few days. The amount of this bacteria can be manipulated, as it forms on every surface within the aquarium. The effect of live plants is also substantial, and is also a form of biological filtration.

You can run a tank that is kept "too clean" for some fish. When this occurs, it has come about when heavy water changes (even of degassed water- water that had been allowed to sit for a couple days) and heavy mechanical filtration created what appeared to be a clean environment. However, with the limia nigrofasciata and others, they did not survive, or did poorly when exposed to those conditions. An effort is made to routinely remove any mulm that can easily be seen, and rinsing the gravel in only clean aquarium water- but generally there is no need to remove it. Rinsing the gravel in tap water would kill the colonized bacteria.

Most types of modern aquarium filters will do an adequate job, with the exception of the undergravel filters that should be avoided. The filters that best support a healthy nitrogen cycle are those that remove the detritus from the aquarium, inhibit collection of mulm or areas within the tank where debris can collect, and provide the appropriate amount of quiet or disruption in the tank that you are seeking that is best for the fish. As livebearers, catfish and some cichlids are bred at this fishroom, aeration generated

filtration is preferred. This also means that all of the filters run from a central blower, requiring no additional power for individual tank filters.

We use the old style 4 inch round box filters with marbles for weight and polyester floss as the filter medium with a central blower.

Each tank here is on an automatic water changing system that changes 15% of the water daily. A weekly water change is usually adequate.

Essentially, there are 6 factors when setting up a tank to consider so that the bacterial activity and filtration going on within the tank is adequate for the species of fish you are keeping, the number of fish, what you are feeding, and what you wish to do with the fish in the tank- grow them out, breed them, etc.

1. The amount of waste going into the tank- This includes the number of fish, the size of the fish, the types and amounts of food that are fed, and other decorations in the tank that may reduce the overall amount of water and interrupt the flow of water through the tank. You do not want a setup that creates areas where debris collects, or where anaerobic areas can develop unless you are willing to go in and routinely clean those areas. Many aquarium setups contain these spots where air does not get to, which can release hydrogen sulfide- a toxic gas, and the "rotten egg" smell noticed when cleaning particularly dirty aquariums. There are always things to do, so I try to plan for the cleanest setup such that the required work is quick, accessible and infrequent.

Higher protein foods can be fed more frequently in smaller quantities when the water is found to cloud up, or it appears the amount of biological filtration is not adequate, as it can tend to be responsible for bacterial bloom problems.

2. The ability of the fish to handle less than ideal conditions- The fish you are introducing will always do best in a clean, cycled aquarium. Keep in mind, particularly with rare, expensive or possibly wild fish that a slightly dirty tank- even when ammonia and nitrate measurements are outside of toxic levels, the new fish may have some difficulty before they adjust, and some fish may simply expire. Keeping your fish in environments where your awareness of the tank's consistent health is where it should be will nearly eliminate unexpected surprises.

The potential for the tank health to deteriorate is always present as time passes- Tanks are dynamic environments. Fish grow, they produce young that demand more from the environment, and a change in one fish's health in a community could easily and quickly affect the health of every other fish in the tank. The ability of the ongoing filtration in the tank must be frequently observed, and changes made as necessary.

You cannot always predict how a fish will respond to a certain environment, but a fish accustomed to a crowded tank or less than ideal conditions will always do well in a cleaner environment. A fish kept in clean conditions, however, may not adapt if conditions they are introduced to are not to their liking.

3. The bacterial needs of the fish- An effort through water changes and quality mechanical filtration alone to provide filtration can be too unnatural for some fish, and a component of biological filtration must be provided.

The thin layer of gravel over about half of the bottom of the tank is good, but mulm and debris must be seen clearly, so that it can be easily cleaned up with a siphon, or as I prefer, a turkey baster. A layer of gravel up to about ½ inch that can be cleaned regularly can also be used. However, a layer beyond a few stones deep will attract and collect organic waste that will then build up within the aquarium if the entire bottom is not cleaned regularly (at least weekly).

4. The type of mechanical filtration used- Any mechanical filter must remove as much particulate matter from the aquarium as possible, and be easy to access and clean. Allowing filter medium to become filthy within the filter box is the same as putting the dirty filter medium directly into the aquarium. The medium minimizes the surface area of the debris so that ammonia is not released as easily into the aquarium, but a quantity of filter medium collecting dirt as it should must be changed at least monthly.

Undergravel filters were invented 60 years ago as one of the first filters that made aquarium keeping easy. Unless the gravel above the filter plate is cleaned regularly, undergravel type filters are always to be avoided.

5. The provision of surface area for nitrifying bacteria without contributing to the organic load in the tank- By increasing the amount of surface area within the tank, you can increase the amount of nitrifying bacteria and thus the ability of the tank to assimilate waste. Generally, gravel will serve that function, but when used in any depth, it also collects debris and enables the deterioration of water quality. By using larger ¼ inch pea gravel in a single layer across the bottom of an aquarium, mentioned above, the biological filtration provided seems to be adequate.

Other standard options include the addition of a wet/dry filter that runs the water over plastic bio-balls, cut to enhance surface area, or creating with a 1-2 qt. cup and an uplift tube, a gravel filter that simply pulls the water through the gravel, and needs to be changed about every 8 weeks.

6. The water change and cleaning schedule being done on the tank- Water changes and the cleaning schedule, if possible, should not be your primary defense against the aquarium's need for maintenance, or as a substitute for the type of filtration, air and setup you really need that is best for the fish. Try to set up the tank with the filtration, nitrifying surface area, tank density and feeding schedule so that disasters are not just a couple mistakes or a missed water change away.

The quality of the water deteriorates in a number of ways, most due to the inevitable buildup of organic material that happens in most aquariums. There are ways during the initial setup to create a tank where you are always aware of what is going on, that organic buildup stays at a minimum, and you can be confident that the fish experience the best odds of a consistent, healthy environment.



A Homemade Gravel filter made to specifically boost biological filtration. These work best with a 1/4" sifted pea gravel to provide maximum water flow. These need to be cleaned every 2 months.



A hang-on-the-side Magnum canister filter for quick resolution of water cloudiness issues.



A fishroom like this isn't for everyone. This is a look at the automatic water change system and air lines behind two of the 14 racks at Select Aquatics.

Special Filtration circumstances-

Breeding sucker catfish:

We are breeding bristlenose plecos here that eat fresh, canned green beans. A 40 gallon tank, containing about 100 plecos will go through 1/3 – 1/2 can of green beans a day. Adult breeders in a 55 gallon breeding tank will eat 1/3 can a day, but to breed, they require clear water of high quality. In the grow out pleco tanks the amount of waste produced by the fish is clear, and siphoning away the waste must be done daily. Without extra measures, any of the pleco tanks would be heavily clouded by evening after a morning feeding, and the fish would likely be dead due to oxygen deprivation by the next morning. The nitrifying bacteria in each pleco tank is likely at its maximum density, and the cycle process is working very well, but more must be done.

A group of magnum 250 hang-on-the-side canister filters is used with micron filters to remove the fine particulate matter given off by the beans as they eat. The surface area provided by the small fibrous bean matter easily creates a bacterial bloom, depleting the oxygen in the tank if not removed. Catfish require especially clean water to breed, yet with the plecos large amounts of plant material is fed. By using the micron filters, which all clog within 24 hours, organic waste going into the tank is brought down to a level where the natural nitrifying bacteria can keep up, in combination with the aeration and filtration of the box filters also in the aquarium.

Raising fry:

Young livebearer fry must be raised in separate containers or tanks where they can be seen, fed and maintained easily. Often, 2 gallon "critter keeper" containers are used, and they work well for the first few days when being raised on brine shrimp. Because brine shrimp fouls water quickly, light feedings followed by 50% water changes 1-3x per day are required, with the presence of an airstone.

With larger numbers of other types of fry, large amounts of food such as vinegar eels and microworms are generally fed, both

that will foul the water as they die, requiring heavy water changes (at least 50%) after every feeding.

New fry are especially sensitive to the buildup of ammonia, which causes the water to become cloudy, and large water changes (of only clean, seasoned aquarium water) must be done multiple times a day.

Mechanical filtration will suck young into the filter, and I have found that 50% water changes after every feeding for the first couple weeks pretty much removes the need for a filter. Airstones are always provided. Once the young are large enough for brine shrimp, they are raised up and divided up into tanks where standard care can take over.

Another solution used by many fishkeepers is the use of sponge filters, especially for small fry as they can feed from the sponge material on microorganisms that are collected there. These work well, but are not used here as the debris still stays in the tank, and the filters deteriorate relatively quickly. Many aquarists use them routinely with much success.

The goal is a room of tanks where disease never visits, all the fish are healthy and robust and breeding at their maximum. Everything is organized, clean and if anything, boring. The best you can hope for is that others will feel that way about your room. Like a juggler with balls in the air, you must know what is really going on behind the scenes, from the fish's point of view.

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