Ammonia, Nitrite, Nitrate

The Fish Vet

NITROGEN CYCLE

The conversion of ammonia (the major excretory product of fish) to nitrate is termed the “Nitrogen Cycle”.

Nitrifying bacteria grow slowly and may take between 2-6 weeks in freshwater to develop sufficient numbers to adequately filter the water. This time is called the “conditioning period”. An established, well balanced aquarium should have no ammonia or nitrite.

In the natural environment, the end product (nitrate) will be incorporated into plants/algae. However, in the aquarium, this will accumulate in fish tanks unless it is removed by partial water changes.

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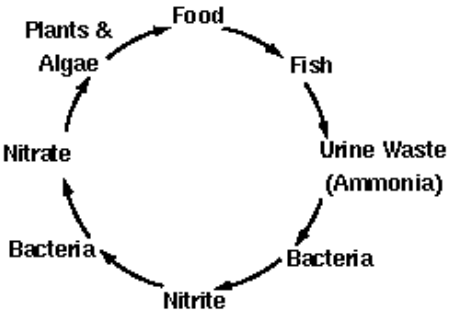

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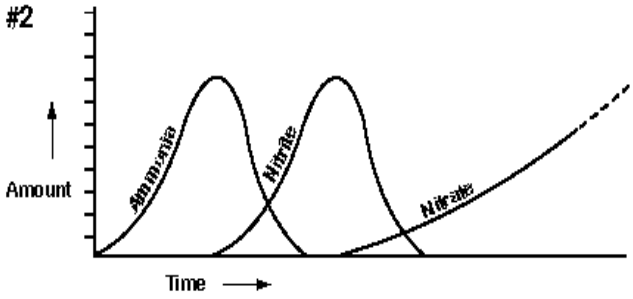

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This “Nitrogen Cycle” takes significantly longer to establish in the marine aquaria. In fact, the time it takes may be up to double. A way to speed up the process is to set up the tank as a freshwater system (without fish or plants) and seed with ammonium chloride. Once the filter is conditioned, convert this set-up to marine by increasing the salinity by 10ppt/day until the desired SG is reached.

Ammonia

Ammonia (NH_3) is produced by fish respiration and by the decomposition of waste products (excessive organic matter and excessive feeding). It can be present as two forms: highly soluble toxic unionised ammonia (NH_3), or the less dangerous ammonium ion (NH_4^+). The synonym for the unionised ammonia if free ammonia (FA).

Ammonia is a strong cell poison and can cause damage to the gills at levels as small as 0.25ppm. Clinical signs include (but are not limited to) increased mucus production, red or bleeding gills, darkening of body colouration, 'gasp' for air at the surface, increased respiration rate.

The levels of free ammonia can be influenced by pH, temperature and salinity. However, the pH of water is the most important factor that determines the ratio of NH_3 and NH_4^+. When the pH is high, more of the ammonia is in its toxic form. Toxic ammonia will increase exponentially with increasing pH levels and temperature. Water test kits usually measure total ammonia nitrogen (TAN) and come with a chart so that you can determine whether toxic levels of ammonia (TA) is present. Most aquarium test kits are not suitable for diagnosis of low levels of ammonia, especially for investigation of production fish facilities.

Best treatment is an immediate large partial water change (25-50%).

Nitrite

Nitrite (NO_2^-) is generated through the oxidation of ammonia by nitrifying bacteria. Elevated levels often occur during the early stages of setting up new aquariums and is in the process of undergoing the 'cycling' process. Full biological establishment of a new aquarium will commonly take approximately one month (double this time in marine set-ups). When an aquarium is fully established, no ammonia and nitrite should be present. A sudden spike in the nitrite usually means there is an imbalance in the system. This could stem from something as simple as washing the biological filter media too thoroughly. Nitrobacter are not as adherent as nitrosomonas and may be washed away. This means that the ammonia can continue to be converted to nitrite, but the rate of conversion of nitrite to nitrate will be much reduced and hence the nitrite spike.

Nitrite causes the formation of methaemoglobin in the blood and causes respiratory compromise as it blocks oxygen uptake by the blood (similar to carbon monoxide poisoning in mammals). Treatment is by adding 1ppt NaCl (Cl^- will competitively inhibit NO_2^- uptake by the gill epithelium) or methylene blue and large partial water changes (25-50%). Vitamin C will also help. The filtration system should be checked. Nitrification process stops at pH <5. Nitrite is more toxic in soft water and at higher temperatures and marine fish and juveniles are most sensitive. Nitrite may also become more toxic with drops in salinity (makes perfect sense since treatment is by the addition of salt).

Nitrite levels and their consequences

0-0.2mg/L is ideal

>0.5mg/L is harmful

>1.6mg/L is lethal

Nitrate

Elevated nitrate (NO_3^-) levels create considerable stress to fish and reduces their capacity to resist disease. Nitrate is the final by-product of organic and inorganic decay. In the natural environment, nitrate is removed through organic usage, however, in the closed system, nitrate will accumulate if not removed. Thus, high levels indicate pollution from prolonged waste build-up and partial water change is necessary.

Nitrate limits for:

Freshwater: 110ppm

Marine fish: 40ppm

Marine invertebrates: 15-20ppm

For more detailed information contact **The Fish Vet**

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