Wilmette Pet Center

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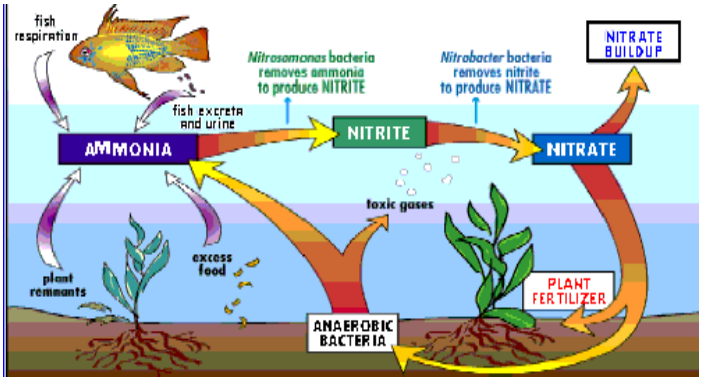
AQUARIUM MAINTENANCE:

THE NITROGEN CYCLE

All organisms, whether animal, plant, or fungus, produce organic wastes, either during their lives as products of their metabolic activity (excreta, carbon dioxide, etc.) and the shedding of dead tissue (skin cells, leaves, etc.) or through the decay of the entire life form after death. These residues are recycled in nature via biogeochemical processes, one of which is the nitrogen cycle, which also takes place within the aquarium. The successful establishment of this cycle is fundamental for the long-term health of the aquarium and its inhabitants. Fortunately, there are bacterial strains that metabolize the waste products of aquarium life into relatively harmless gases, thereby allowing the aquarium to sustain life.



It can take anywhere from thirty to forty-five days for sufficient amounts of bacteria to grow to maintain the cycle. The first of these bacteria, nitrosomonas marina breaks down the primary waste product, ammonia (NH_3) and converts it into nitrite (NO_2). Nitrosomonas should begin to appear around Day 10 of the cycling process. The nitrite level will peak at 15ppm (parts per million) around Day 20, until the second and third bacterial strains appear. Nitrospira spp. and nitrobacter further the nitrogen cycle by metabolizing nitrite and converting it into nitrate (NO_3). These bacteria should begin to make a significant impact around Day 25; when the level of nitrite should begin to fall off to less than 3ppm. As the nitrite level decreases, the nitrate level will steadily rise and once it reaches 10ppm, the aquarium has been fully cycled. There is no bacterial strain that can break down nitrate; subsequently the level of nitrate will keep rising, unless it is removed. Although plants, algae, and anaerobic bacteria may use it as nutriment, the majority will remain and must be removed by regular water changes.

The nitrogen cycle will initiate once the nitrifying bacteria have a source of ammonia. There are two ways to introduce ammonia into the aquarium, one is by introducing fish, and the other is by fishless cycling.

1) The first method consists of selecting a few "hardy" fish whose metabolic activity will provide the initial ammonia for the bacteria. Commonly used hardy fish include goldfish, platies, mollies, swordtails, guppies, zebra danios, and cichlids. These fish have a high tolerance level for the miasmic conditions, which frequent new aquariums.
2) The second technique involves the use of pure ammonium hydroxide and regular water tests. Be careful not to use ammonia with surfactants, perfumes, or colorants (read the label). Add the ammonium to the tank to obtain a reading on your ammonia test kit of 5 ppm. Record the amount of ammonium that this took, and add that amount daily until nitrite spikes. Once the nitrite is visible, cut back the daily dose of ammonium to ½ the original volume. The advantages of fishless cycling are: elimination of mortalities as no fish are subjected to fluctuating levels of toxic gases, the nitrogen cycle is established much faster (reports of anywhere from 10 days to 3 weeks), and since the amount of ammonium added is far above that generated by a few cycling fish,

3) larger bacterial colonies can develop which translates to the tank's ability to handle a heavier bioload (more fish).

In both cases weekly water quality testing is important -especially in the former – as the levels of ammonia, nitrite, or nitrate could exceed or be insufficient to properly establish the nitrogen cycle.

Another way to expedite the nitrogen cycle is to increase the supply of nitrifying bacteria. Good sources of these beneficial bacteria include: filter material, gravel, ornaments, and live plants from a preexisting aquarium since these objects already have large bacterial colonies residing on them. There are also commercial bacterial supplements (Stress Zyme, Bio-Spira, Cycle, etc.) available, which contain live bacteria to accelerate the cycle. However none of these items will help if the aquarium does not meet the bacteria's basic needs. Nitrosomonas, nitrospira, and nitrobacter require plenty of oxygen, ammonia, heat, surface areas, and low currents in order to flourish and sustain an adequate bioload.

During the fish cycling method, 10-30% water changes should be done every 4-5 days not only to avoid casualties, but also to prevent the prolonging of the cycle. It is a myth that performing water changes slows down the nitrogen cycle since the beneficial bacteria reside on the surfaces of gravel, tank walls, plants, and any other ornaments within the aquarium. In addition the pH and temperature of an aquarium factor into how often water changes are needed since ammonia is much more toxic in its unionized state (NH_3) than in its ionized state, ammonium (NH_4^+). Testing for ammonia in an aquarium actually reveals the combination of ammonium and ammonia known as Total Ammonia Nitrogen (TAN). The difference in pH with the same TAN is significant; water with a temperature of 82°F, a pH of 7.0, and a TAN of 5ppm, only has 0.3ppm of ammonia, whereas water with a temperature of 82°F, a pH of 9.0, and a TAN of 5ppm, has 2.06ppm of ammonia, a lethal level.

Once the nitrogen cycle has been established, it also must be maintained in a relative equilibrium to prevent it from crashing. Nitrogen must be added to the system (through food) and as nitrates rise, water changes must be done to keep the delicate balance. Keeping the appropriate biological load in an aquarium will also help maintain the cycle. This means not overstocking the aquarium, a ten-gallon aquarium should only house ten small fish at the most. The one-inch per gallon rule does not always apply; a ten-inch fish should not be kept in a ten-gallon tank.

Recap

The nitrogen cycle is the biological process that converts ammonia into less harmful compounds. This is done by beneficial nitrifying bacteria, which in large numbers can sustain the entire aquarium by itself. The two key elements in the nitrogen cycle are nitrifying bacteria and their source of food, ammonia, both of which are absent in a new aquarium, however in a matter of weeks there should be enough bacteria to support a large number of aquatic life. With continued assistance from the owner – in the form of water changes – the nitrogen cycle should pretty much maintain itself and the aquarium.