Labs

Aquaria

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I became involved with aquaria when I first began teaching and wanted to set up some marine tanks for invertebrates. I was in the animal room washing my new aquaria with soap and water when a colleague, who kept tropical fish for many years, walked by and pointed out that what I was doing was a "no no." Jack Rudloe had introduced me to marine aquaria at the NABT meeting in Philadelphia. Because the exhibits had been canceled, he demonstrated his aquaria to small groups of teachers in his hotel room. Jack indicated that animals from Panacea are particularly tolerant of changes in temperature and salinity and were, therefore, ideal for display in classrooms by beginning marine aquarists.

A couple of months later I ordered a few animals from Rudloe. Two huge boxes of animals arrived, addressed to Sir Frederick Banting. I called Jack. He said there had been an error but that I should keep the animals since they had been in transit overnight. He sent a new shipment to Canada. The boxes contained a sea horse, some pipefish and a wide variety of organisms, perhaps 40 in all, which I placed in a newly set up 30-gallon tank. I didn't know what to do with the sea water each animal came packed in, so I put it in the tank with the synthetic sea water. The next morning I excitedly brought my colleague into the lab to see the creatures. He politely told me they would all be dead in two weeks. Amazingly, many of the animals survived the whole semester and some lived for several years. Since then, I have learned much about aquarium keeping and my colleague's comments seem very consistent with normal expectations. However, this story offers some concepts that will be helpful in thinking about proper procedures.

Soap

I had planned on calling this column "Marine Aquaria" because most of my experience has been with saltwater systems, however, the basic principles are the same in both freshwater and marine systems, so I have decided to broaden the topic. First, however, a comment about the use of soap seems in order. For years experienced practical biologists have warned of the dangers of soap and there is no doubt that organisms can be very successfully cultured in glassware that has never been exposed to detergents. Usually it is washed with warm or hot water and debris is removed mechanically with fingertips or other nontoxic scouring devices. The culturing of cells in most research laboratories is routinely done in glassware washed in strong detergents. The real question, it seems to me, is whether the system you are using can be properly washed and thoroughly rinsed. If soap residues remain that eventually contaminate living cells, there may be a problem. One normally doesn't put aquaria in glassware washers. Obviously the aquarium should be clean and free of soap or any other toxic material before trying to maintain living organisms in it.

Toxicology measurements can be made on materials used in culture systems if there is doubt. For example, plastic can be tested for toxicity by placing a piece in sea water for a period of time (usually 24 hours) and then testing the water to see if it will support sea urchin development in comparison to a control that does.

Biological Filters

In a general sense, aquaria are biological filters that maintain the normal condition of the water contained in them, whether freshwater or marine. A population of bacteria develops in the filter, which breaks down toxic wastes into simpler nontoxic products. Usually a period of time is required after the aquarium is set up to develop a population of bacteria large enough to support the number of animals ultimately expected to be kept in the system. Normally animals are gradually added to the tank during this conditioning period. Problems occur when wastes are produced faster than the bacteria can process them.

The time it takes for the biological filter to develop depends mainly on the number of bacteria initially in the system and temperature. In the example above, the sea water in which the animals were packed must have contained large numbers of these bacteria so the filter developed very quickly. Usually people who bring in collections of animals for classroom display put large demands on their aquarium filtration systems. Even after a tank has been maintained for several years, new animals are generally introduced only when large shipments are brought in at the beginning of a teaching term. The ability of the tank to support these new populations varies considerably.

Test kits are available to measure nitrogenous wastes. The ion that causes the most problems when animals are added is nitrite (NO_2^-) and its level should be measured daily after animals are added until the level returns to normal. Sometimes the system will show little or no change in nitrite values and sometimes it will change dramatically, reaching toxic levels. When this happens, animals that are sensitive (e.g. fish and cephalopods) must be moved to other tanks or the water has to be diluted with fresh sea water. Since nitrite values can sometimes be very high, draining most of the water out of the tank and replacing it with new water may still not bring the level down to normal and another dilution may be required. Fortunately, if one pays close attention to nitrite values, this does not happen

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very often. It is essential that a fresh supply of sea water be on hand during these periods. If only a few animals are replaced at a time, these problems usually do not occur.

Another ion, nitrate NO_3^-, gradually increases in concentration. Many marine aquarium manuals suggest that a 25 percent water change is necessary each month to reduce nitrate concentration and replace trace elements. Most marine aquarium keepers maintain fish rather than invertebrates and often treat their tanks with copper to eliminate fish diseases. Copper is fatal to many invertebrates and microorganisms that live in the tank. In a tank where copper is not used and, instead, a wide variety of microscopic plants and animals thrive, water quality seems to be much higher. In these conditions water replacement does not appear to be as necessary since nitrate is utilized by plants.

pH

Among freshwater aquarium keepers, one seldom hears any discussion of nitrite levels. This may be because freshwater aquarists don't normally put the same kinds of loads on their systems or that freshwater organisms are more tolerant of such changes, but frankly, it is not clear to me why it's less of a problem. What one does hear discussed is the measurement of pH. Acid-base balance in freshwater aquaria can be a problem because the gravel used does not have the buffering capacity of the substrates commonly used in marine systems.

Dolomite is the usual substrate recommended for sea water systems and can be expensive. A less expensive material, the calcite sold by feed stores for chickens, seems to work very well. If the pH in a marine tank drops, the gravel has become covered with proteinaceous material. The gravel should be stirred to rub off the coating and expose the buffer. Nitrite level should be measured at this time because it sometimes increases dramatically when wastes are released from the undergravel filter during stirring. Many people put a Diatom filter on the tank during stirring to remove the debris that is also released. If the pH is not corrected, most of the gravel should be replaced. Because I have used calcite instead of dolomite, I have had little problem with pH. Apparently the calcite is more soluble and does not lose it buffering capacity as readily as dolomite.

Evaporation

When evaporation occurs in freshwater or marine tanks, the water level is brought back to normal by adding fresh or distilled water. Some people simply inscribe a water line on their tanks and add water on a weekly or monthly basis. The most common problem resulting from evaporation is that siphons stop and pumps run without water, sometimes overheating. For that reason, many people have discovered the advantage of a canister-type power filter, e.g., the Eheim power filter, which takes in water near the bottom of the tank. This problem is also avoided with the use of undergravel filters, although circulation of water via the air-lift tubes decreases as the water level drops and will eventually stop. Air pumps, particularly the vibrator type, often lose their ability to pump at original capacity in a short time. Many labs have compressed air and if an in line filter with a pressure control and trap is used, e.g. one manufactured by Balston, a reliable source of air is continuously available.

The salts left by evaporation are much more of a problem with marine aquaria than with freshwater systems. Large amounts of salt can accumulate unless efforts are made to reduce evaporation. The best solution I have found is to place a rim around the edge of the tank on which a glass cover can be set. A small hole in the glass cover is necessary to allow air to escape. The cover and edges still need to be cleaned occasionally and the salt returned to the tank. Because salt water is an electrolyte, serious electrical hazards can develop. If the aquarium is near electrical outlets, salt can accumulate on plugs which can result in a mild shock. Electrical fixtures commonly sold with aquaria do not have grounded plugs and usually are not rapid-start so they cannot be used with a timer. Consequently, it is better to fasten a grounded, rapid-start fixture above the aquarium. For example, if the aquarium is on a bench with cabinets attached to the wall above, use ground fault interrupters with their electrical systems to protect against shock hazards. This is a good safety measure, but may cause other problems. If a ground fault occurs, pumps can be turned off and animals can die of lack of oxygen, and sometimes because of refrigeration. The problem is only resolved when the ground fault is identified. Because salt mist can produce a ground fault almost anywhere, it can sometimes be exasperating to find the problem. The electrical hazard may be over-exaggerated. I once saw a light fixture, the aquarium type that is barely supported by the sides of the tank, fall, while it was on, into a saltwater tank with fish in it. Nothing happened, no James Bond scenario of electrocution. The fixture was unplugged, removed from the tank, cleaned and put back in use.

Plants

Many aquarium plants are available for freshwater aquaria and grow very well with normal aquarium lighting. In fact, the problem is often one of overgrowth. This is not so with marine systems in which plants can be grown but seem to require much more light. The use of large amounts of supplemental light using halide lamps is, reportedly, quite successful. These lamps produce a considerable amount of heat, however, and must be kept at a distance that does not allow the water to reach undesirable temperatures. Recently, a number of plant growth supplements have come on the market that also seem to encourage plant growth. I have had some success growing Caulerpa in tanks where the top of the tank was completely covered with sunlight simulating fluorescent lights (Vita lites). However, the best growth has been in tanks next to a window, where they receive large amounts of natural sunlight.

Animals destroy aquascaping in aquaria in the same way they disturb terraria. Consequently, a number of approaches have been tried to produce more permanent features. Plastic plants and shaped volcanic rock are two widely used materials. The Seattle aquarium has used latex casts of natural rocks and surfaces to aquascape its tanks. Because they have an open system which brings in water from the ocean, they had hoped that larvae would settle on these surfaces and produce natural looking tanks. It worked very well but is expensive. I saw no reason why the styrofoam surfaces used in terraria would not work in aquaria, and aquascaped a large tank. The obvious problem is that styrofoam floats. This I solved by gluing the sculptured styrofoam with silicone to heavy glass plates that could fit into the tank. The bottom of the plate I buried in the gravel and held down the top by the rim of the aquarium. The surface looked quite natural and soon became covered with algae and a variety of invertebrates.

Sources of Animals

There seem to be two separate types of suppliers who do not get involved with each other. One is a small group of suppliers who deal mainly with research and teaching institutions and the other is the pet industry. The cost of animals from these sources varies greatly among companies and also for different kinds of organisms. For some kinds of organisms, there are only a few suppliers. Gulf Specimen Company, for example, is the only supplier I know of that can obtain warm water ctenophores and jellyfish. They also can supply a wide variety of animals but many are often small and not as colorful as those supplied by most other scientific supply companies. The pet industry, on the other hand, brings in many large, colorful animals. Unfortunately, the price of these animals is very high in most local pet stores. However, if you purchase animals from pet wholesalers, the cost is about the same as from scientific suppliers. Larger cities usually will have a wholesaler who brings in tropical fish for pet stores. A wide variety of freshwater organisms also are available from wholesalers. Often some of the animals are of more interest to biology teachers than to pet people. Recently, for example, it has been possible to buy aquatic caecilians at low prices. Sometimes pet stores and wholesalers will rent organisms at low cost. I once rented marine organisms from a large wholesaler in Chicago for 10 percent of wholesale cost. Each week I went in and selected a variety of animals as we surveyed the animal kingdom. It worked very well and I lost only one animal, an eel that crawled out of the tank.

If animals are purchased locally, they are normally transferred to a new tank after the plastic bag has been floated long enough for the water temperature to adjust to that of the new tank. The bag is opened and the water allowed to mix slowly as the animal is released. However, if the animals have been in shipment for a day or more, there is some controversy about what is best. Some argue that the shipping water is so harmful to the animal that it is best to remove the animal from the water quickly and either dump, or lift the animal with a net, into the new tank. The shipping water is then discarded. Others argue that the animal has to be adjusted gradually to the new tank by dripping new water into the shipping water until it is diluted at least two-fold. Both procedures work some of the time; i.e. animals are still lost with either method. Some animals seem to be more sensitive to these changes than others. I have decided to use the drip method, however, time and space don't always allow one to use it on every animal, e.g. when you have a shipment of a hundred assorted animals plus a hundred sea urchins that arrives at midnight.

Local resource persons can be of tremendous help here too. The source of calcite I spoke of earlier came from a local fish enthusiast, and I've met some very experienced aquarists who have had to solve the same problems I have. Animals can often be traded or shared. Write me about your experiences with aquaria. The first letter I received about this column pointed out the difficulty of writing good lab questions, ones that relate directly to the lab experience. I'll talk about that next time.