Back To Nature

Natural Reef Aquarium Methodology

by Mike Paletta (Aquarium USA 2000 annual)

The reef hobby, that part of the aquarium hobby that has arguably experienced the most change, is ironically also an example of the axiom that the more things change the more they remain the same. During the past 10 years we have seen almost constant change in reefkeeping practices, and, in many instances, complete reversal of opinions as to which techniques or practices are the best. We have gone from not feeding our corals directly to feeding them, from using some type of substrate to none at all and then back again, and, finally, we have run the full gamut from using a lot of technology to little or none. It is this last change, commonly referred to as the "back to nature" or natural approach, that many hobbyists are now choosing to follow.

Advocates of natural methodologies have been around since the 1960s, when the first "reefkeeper," Lee Chin Eng, initiated many of the concepts and techniques that are fundamental to successful reefkeeping. Mr. Eng lived near the ocean in Indonesia and used many of the materials that were readily available to him from this source. "Living stones," which have come to be known as live rock, were used in his systems as the main source of biological filtration. He also used natural seawater and changed it on a regular basis.

His tanks were situated so they would receive several hours of direct sunlight each day, which kept them well illuminated. The only technology he used was a small air pump, which bubbled slowly into the tank. This provided a little water movement and kept the water better oxygenated. The inhabitants of the tank were small fish and invertebrates that Mr. Eng could readily catch in nearby lagoons and tidepools.

All things considered, Lee Chin Eng's tanks thrived. However, individuals who did not live near the ocean could not easily replicate his system, and , as a result, this first "natural system" did not gain wide acceptance.

In the early 1980s a different type of natural system was introduced. Under the direction of Dr. Walter Adey, The Smithsonian Institution (Washington, DC) introduced the "algal turf scrubber" methodology. This system was the first to try and "mimic" the natural processes on a tropical reef. The Smithsonian microcosm was modeled after reefs in the Caribbean.

The algal turf scrubber method is markedly different from most systems. It uses algae, rather then bacteria, as the main mechanism for removal of unwanted nutrients in the aquarium. Water is pumped from the main tank to a separate, shallow water tank where turf-type microalgae are cultivated on plastic screens. The tank water flows slowly across these turf algae, which allows the algae to remove nitrogen and phosphorus from the water. In more elaborate systems, a "dump bucket" is used to mimic the characteristics of waves in the turf zone in the ocean, which expedites algal growth and enhances nutrient removal.

There is strong illumination over this algal bed on a reverse daylight cycle. That is, the algal bed is illumininated when the lights in the main tank are off, and the lights on the algal bed are off when the main tank is illuminated. This is done in order to minimize the pH and oxygen fluctuations that would occur if both tanks were illuminated simultaneously.

Once the algae is established and growing the trays are removed on a regular basis and the turf algae is scrubbed off. In this way, nutrients, such as nitrogen and phosphorus, are removed from the system. The cleaned screen is then replaced and algae from the neighboring screens then recolonize it.

In a properly constructed duplication of this system, the turf scrubber tank is large enough to act as a separate refugium (tank). This refugium is inaccessible to fish and most invertebrates, and offers an area where many small marine organisms can reproduce, thus producing a natural plankton to help feed the fish and invertebrates in the main tank.

Whether or not a separate refugium is used, there is no mechanical filtration or protein skimming in this system because they would interfere with the proliferation of the natural micro-organisms (plankton). To improve the movement of plankton from the refugium or scrubber to the main tank, special "screw-type" pumps are used for transferring water between tanks. These pumps do not have the shearing type of mechanism that is common in most water pumpsit is believed that these pumps will not kill the plankton as it moves from tank to tank.

Because of the positive experiences of the Smithsonian algal turf scrubber, this system has been widely used in many public aquariums across the United States. There are also numerous hobbyists who are strong advocates as well. However, after havaing viewed the methodology at the Smithsonian, as well as the Pittsburgh Aquazoo, and having tried it myself in the late 1980s, it is my opinion that there are several flaws with this system. Although I have seen several tanks use this method with good results, I find that they are the exception rather than the rule.

The first and biggest problem I have seen with this system has to do with keeping the turf algae under control. Most algae possess one key attribute: they live to produce more algae. Trying to keep turf algae restricted to one location (i.e., the scrubber unit or refugium) is often quite difficult.
The successful algal turf scrubber systems I looked at contained a large number of herbivores, such as snails, urchins, blennies, tangs and hermit crabs. These organisms were housed in the main tank to keep the turf algae from gaining a foothold. In tanks I observed with an insufficient number of these animals the algae began to prodominate and eventually overtook the corals.

The second problem with this system is that in most instances where I have seen it used, the algae tended to color the water. That is, over time the water becomes yellow. While this problem can be reduced through the use of carbon or by doing frequent water changes, it is a constant problem. The yellow coloration is not only unsightly, but also reduces the amount of light penetrating the water to reach the corals.

Finally, this system is somewhat labor intensive. When it is functioning properly the algal mats need to be changed and scrubbed regularly. Also, if the dump bucket is used as recommended, it will require regular maintenance.

The next "natural system" that has been widely used is the Jaubert system. It was developed by Dr. Jean Jaubert of the Monaco Aquarium, and has been used in the U.S. during the past six years. This system is the simplest design of all the natural systems, and, unlike all the other methods, filtration occurs within the display tank itself it doesn't usually require a sump or other separate tank to house the filtration components. Instead, the Jaubert system uses two filtration components live sand and a plenum to produce the desired effect of reducing nutrients.

The Jaubert method is much more difficult to explain than it is to set up. Basically, a plate, not unlike an undergravel filter plate, is placed on the bottom of the tank, on top of which a thick layer of live sand is spread. Live rock is place on top of this thick sand layer so that not more than 20 percent of the sand is covered.

Over time, the lower layers of the sand will contain less oxygen and eventually become low in oxygen (anoxic), but not totally without oxygen (anaerobic) the sand will still contain about 1 part per million (ppm) oxygen. In this low oxygen environment, certain bacteria that can only survive in this type of environment will develop. They are capable of converting nitrate into nitrogen gas, which will then bubble out of the system.

In order for all of this to occur, natural microfauna need to be present to keep the sand stirred up. Similarly, the system also needs to contain large sand-sifting organisms, like hermit crabs and gobies, to reduce the likelihood of the sand compacting and becoming anaerobic.

While this system is rather simple and easy to set up, many aquarists who have tried it have not followed the guidelines devised by Dr. Jaubert precisely and have run into problems. Only when thes guidelines are strictly adhered to can any success be achieved.

One of the biggest problems is getting the "right" live sand. The live sand typically available is too fine, and, more importantly, it rarely contains any of the valuable burrowing organisms that are necessary to make the system work. As a result, nutrients accumulate in the sand that eventually cause microalgae to overgrow everything.

Another factor limiting the success of this system is that when it is set up no more than 20 to 25 percent of the tank's bottom should be covered by live rock. Otherwise, too much of the live sand will be compacted under the rock and burrowing orangisms will not be able to keep the sand clean. This will also result in algae overgrowth.

Most hobbyists, myself included, tend to overcrowd our tanks with corals and fish. When viewing videotapes of tanks that correctly use the Jaubert system, it is readily apparent that these tanks contain far fewer organisms than most of our tanks do. This, no doubt, plays some role in why these tanks are successful.

Finally, some aquarists believe that tanks that successfully use the Jaubert system are at least partially "open." That is, they receive a continuous drip of natural seawater. In fact, many claim that this is why these tanks are successful. Being a strong advocate of partial water changes, I have seen how replacing even a small amount of tank water on a regular basis can yield positive results.

Another unique"natural system" that has been recently described is the sponge filtration method presented by Steve Tyree at the Marine Conference of North America in 1998. In this system, sponges on the live rock, rather than algae, bacteria or protein skimming, are used to remove waste products. Mr. Tyree hypothesized that the natural ability of the sponges to extract suspended material from the water can also be used to break down waste materials, such as uneaten food, feces and so on, before it is mineralized. Phosphate and other byproducts that would normally be released into the water would be used directly by the sponges to grow.

This method of filtration requires a sump that is filled with live rock. Over time, sponges begin to grow between the spaces in the rock, so that eventually virtually all of the free space is filled with sponges. As water from the overflow passes through the sponges the material suspended in the water is consumed by them.

In theory, this is a rather elegant system. However, because it is relatively new, there are still many questions to be answered. First, what do you do in the interim, before a sufficient supply of sponges has developed? What happens to the waste products not consumed by the sponges? Finally, most sponges produce waste of their own. What happens to this? Time will tell.

The last "natural system" to be discussed is one that I have been experimenting with for the last two years. Because of space constraints, I will briefly describe how the system works and give a brief evaluation of what I have seen to date.

This method is called the "Ecosystem filtration system," which was developed by Leng Sy. Basically, it is an advanced hybrid of both the Jaubert and algal turf scrubber methods, with some interesting innovations. Water flows down from the display tank into a specially designed sump. It flows first into a chamber that contains bioballs, which act as a mechanical filter and break up any large particulate matter, as well as any air bubbles.

The water then flows from this chamber into the main filtration chamber, which is comprised of two parts. The top portion contains a large bed of Caulerpa algae, generally Caulerpa taxifolia.. The Caulerpa rests on an approximately 2-inch layer of Leng Sy's patented "miracle mud." The water then flows from this chamber over an overflow and into a final empty chamber, from which it is pumped back into the main tank.

In spite of the fact that this system seems so simple, it has produced some rather interesting results. When I initally set this system up I was quite skeptical. Because my two other tanks are maintained using the Berlin method, I was quite sure that the Ecosystem method would not be able to live up to the results I was experiencing in the Berlin tanks. Now, after two years, the method has exceeded even my wildest expectations.

Not only has it maintained optimal water quality in my "stressed" tanks (by stressed I mean that they contain 42 fish and over 40 invertabrate colonies), but, in fact, it has sustained an environment in which the corals have grown faster than in my other systems. Amazingly, it has done this while maintaining a nitrate level of less than 1 ppm and a phosphate level of less than 0.1 ppm. Equally impressive is the fact that four different species of fish have spawned in this system to date. Because of the success of this method, I am currently in the process of enlarging my present system, as well as converting at least one of my other tanks over to this method.