The Ecosystem Aquarium Revisited

More information on the ecosystem aquarium filtration method.

By Mike Paletta

Diagram of the Ecosystem Aquarium Filter Box. One way I judge how an article has been received is by how many letters or phone calls I get about it. Judging by the number of requests for more information on the Ecosystem Aquarium Filtration method, developed by Leng Sy, that I have received since writing articles in both Aquarium Fish Magazine (November 1997) and SeaScope (Fall 1997), I really struck a nerve. There are probably a number of reasons for this, but perhaps the biggest is the simplicity of the system itself and the little amount of maintenance that is required.
I have experimented with virtually every system available, with my goal being to achieve the most successful reef tank possible with the least of amount of work to maintain it. Like most reefkeepers, I would rather spend my time looking at my tank than working on it. For this reason, the Ecosystem Aquarium method is quite appealing. It produces a successful tank that needs much less equipment to set it up and less effort to maintain it relative to most of the systems I have seen. For this reason I took another trip to Southern California to assess how well the system was working at the six month mark.

For those of you not familiar with the Ecosystem Aquarium method, more detailed accounts can be found in the references mentioned above. But, let me try and bring everyone up to speed here with a brief description of how the system works. Like most methods of reef filtration this method starts off in a similar manner. Water is drawn off the top of the tank via an overflow box, where it flows into the sump. But, it is at this point that the heart of the Ecosystem method kicks in. The tank water first flows into a narrow chamber that contains bioballs. The bioballs are submerged, not dry, and they act primarily to break up any large pieces of detritus, as well as to dissipate any large air bubbles that are caused by the water splashing down. The water then flows out through two outlet slots near the bottom of a partition and into the main filtration chamber.

This central chamber is where all of the filtration occurs, and it contains two separate components that work synergistically with each other. In the bottom of this chamber, and running from front to back, are four 2-inch high partitions. Leng's special "mud" substrate rests within these partitions. This mud is the crucial component that Leng has been working on over the last six years. The mud itself is not inert — it is full of worms, copepods, nematodes and so on from the live rock, which have now populated it. Leng said that over the years he had tried numerous types of mud, but that the formulation he is now using seems to be the crucial element in the system. He feels that this media performs many functions, which I will elaborate on below.

Resting on the mud in this chamber is a large bed of Caulerpa sertuloides. I know many of you reading this know of my general disdain for algae in the reef tank, and my opinion that algal turf scrubbers are not the optimal method for filtering a closed reef system. The reason for these opinions is that in the past when algal scrubbers were used for filtering reef tanks, I have seen several problems invariably arise. First, turf algae has a tendency to overgrow the tank as it moves from the scrubber to the tank itself over time. Second, in most tanks using algal turf scrubbers that I observed, the algae released yellowing compounds into the water that not only reduced the passage of light, but also seemed to produce negative effects on the corals, particularly small-polyped scleractinian (SPS) corals.

In addition, on some tanks I have seen that use this type of filtration system, the pH of the tank fluctuated widely between night and day because of the algae releasing or consuming CO2. For this reason, many new algal filtration systems recommend lighting the algal tank in a reverse manner from when the main tank is illuminated.

Also, in some tanks with high algal loads the algae outcompete the corals for some of the trace elements present. Finally, in most turf scrubber systems it is necessary to frequently remove the algae in order to rid the tank of excess nutrients, an endeavor that is often labor and time intensive.

Despite all these negatives regarding algal filtration, I am positive about the Ecosystem method, for several reasons. First, the algae in this system is illuminated 24 hours per day by four flourescent tubes — the lights never go off above the sump. This has caused some interesting results.

The wild pH fluctuations that I have seen on other systems do not ocur in this system. The pH bottoms out at 8.2 one hour prior to the lights being turned on for the main tank, and it rises to a maximum of 8.4 one hour prior to the light in the main tank going off at night. Also, after several years of growth in each system, the Caulerpa in the filters has never

crashed and gone into sexual production. As a result, none of it has found its way into Leng's main tank, which has been a problem in some other algae filtration systems. This may also be a function of the species of Caulerpa he has chosen — Caulerpa sertuloides.

Even more interesting than the things I've mentioned so far, however, is seeing how crystal clear the water is. In many reef tanks I've seen that contained even small amounts of algae, the water would become yellow over time. However, in Leng's tanks the water is crystal clear. Again, this may be a result of the 24-hour light cycle, because by not having a dark cycle the production of gelvin (yellowing compounds) — which is thought to be a product of the chloroplasts of the algae breaking down at night and being released into the water — may be prevented. Lastly, for reasons still unclear to me, this algae has never outgrown the filter and thus never needed to be harvested or removed. From what I've seen, there is little maintenance involved in running this system.

Once the water passes through the Caulerpa it flows over a partition, through slots near the bottom of a second partition and into a chamber containing bioballs, where it is pumped into the main tank. These last bioballs act to prohibit any

Caulerpa from being drawn into the pump and fed into the main tank. The amount of water flowing through the filter is approximately three times the volume of the tank per hour.

All this may not sound like anything revolutionay, but upon seeing the tank and the corals, and also the fish, I do indeed feel that this methodology for successful reef husbandry has merit. In particular, not only are the corals thriving, but the fish are as well. In this system all of the fish have colors as vibrant as the day they were collected, even though many of the tank's inhabitants have now been in the system for six years or longer. In addition, this system has demonstrated an ability to reduce and even eliminate ongoing lateral line disease in some fish, and to restore the coloration in other fish that have faded over time. I will discuss this at the end of this article.

Besides the overall health of the inhabitants in the system, there are some other advantages to this method as well. In terms of maintenance, Leng's tank requires less than just about any other system I have seen. The tanks contain no substrate in order to easily remove the detritius that settles out during the week. Once a week Leng siphons out 10 gallons of water to remove as much detritus that has accumulated as possible. To further reduce the detritus buildup, the current in these tanks is quite strong. In the 400-gallon SPS tank there are powerheads and circulation pumps producing more than 4000 gallons of circulation per hour, which keeps detritus in suspension so that it can find its way to the filter. No doubt this strong water movement also helps to explain why the corals are growing so exuberantly, and polyp extension is so great. In his 120-gallon soft coral tank the water circualtion is approximately 1500 gallons per hour.

Other than removing detritus weekly the only other maintenance that is performed on this system is the addition of calcium in the form of calcium hydroxide and buffer. These are added to maintain calcium above 400 parts per million (ppm) and alkalinity above 2.5 milliequivalents. Other than that, this system virtually runs itself. To date, neither iodine or strontium have been added, and this has not produced any deleterious effects on the corals. Combining the Caulerpa with the mud has also produced a system in which virtually no microalgae-inducing nutrients are present. During a two-month testing period, ammonia, nitrite and nitrate were tested daily and remained a 0 ppm, while phosphate showed only a trace at 0.1 ppm.

Needless to say, this system raises a lot of questions. The most common is, "what's in the mud?" I would love to tell you, but Leng has patented this compound, and the entire system for that matter. Also, I don't really know. What I can tell you, however, is that the mud itself is not a homogenous mixture. In fact, it seems to have three distinct components. There is a large-particled calcareous portion, a sandy component and a light, silty component that seems to "float" around the other two. Also, upon viewing the sumps on Leng's tanks I noticed that the mud seemed thicker than when I saw it six months ago. Leng said that this was indeed so. The mud usually increase in depth by at least a ½-inch per year. Therefore, one other function of the sump is to act as a settling chamber because much of the detritus that remains in suspension settles here.

Other aspects of the system that stick in my mind include the large amount of growth that occurred in the inhabitants of the tank, especially in the SPS corals. In fact, on my trip six months ago, Leng and I split two fragments of different corals. While these corals have doubled in size in my tank, in Leng's tank the growth rate was even greater. Part of the reason for this may be the large quantity of calcium that Leng adds to his SPS tank. When I previously visited Leng, all that I knew was that his tank parameters for alkalinity and calcium were quite reasonable — I did not know how much of anything he was adding to keep these levels. Leng adds 1 rounded tablespoon of calcium hydroxide and 1 teaspoon of buffer to his 400-gallon tank daily. These compounds are mixed together and allowed to drip into the tank slowly over the course of the day. These quantities equal approximately 50 grams of calcium hydroxide per week and 20 grams of buffer. Interestingly, neither calcium nor buffer are supplemented in the soft coral tank. The only additional calcium that gets into this tank is

what occurs during the weekly 5-gallon water change.

Another interesting observation of these tanks is that, despite these differing calcium supplementation schedules, the rock in the soft coral tank is covered in coralline algae, while the rock in the SPS tank has none. Because both tanks began with the same rock and have approximately the same amount of light a possible explanation could be that in the SPS tank, in spite of the large addition of calcium, the SPS corals are outcompeting the algae for available calcium.

Another possibility for why the corals are growing so fast is the availability of food in the form of plankton. After closely observing a water sample, it was clear that some plankton is present in the water. Because no skimming is used, this may allow some of the plankton to survive. However, as preveiously noted, the mud is teeming with life, so obviously some of the offspring from this life is making its way into the tank.

Another hypothesis has also been postulated. Because the Caulerpa is not growing fast and does not need to be harvested, the corals are doing well because the water contains a great deal of nutrients that are helping to fuel the coral's growth. This may be true for the soft corals, which have been shown in some instances to prefer water that contains more nutrients. However, from everything I have read, SPS corals seem to do best in cleaner, well-oxygenated water. Leng's explanation for why his SPS tank is doing so well is that the Caulerpa is only necessary to remove the nutrients that are maintained at low levels due to the weekly water change. This water change is not simply removing water from the top of the tank and replacing it, but rather, Leng is meticulous in removing as much detritus as possible — which is a considerable amount — during the water change. By doing this Leng feels that he is removing the nutrient sink of phosphate and nitrate that otherwise would accumulate in this system and eventually lead to algae overgrowth. While I may have underemphasized this is in previous articles, Leng made it a point for me to stress the importance of this.

Leng has also pointed out that in some applications, the mud may have a downside. Leng told me that last year he had a problem with rapid tissue necrosis and that it was very difficult to control. Because of the presence of the mud, Leng thought it may have acted as a reservoir for the bacteria. To combat this problem Leng has added an ultraviolet (UV) sterilizer to prevent bacteria in the mud from being reintroduced into the SPS tank. It should be noted that no UV sterilizer is present on the soft coral tank, and there has never been a problem in this tank.

I have now had my own Ecosystem Aquarium tank running for two months, and the system is working as I had expected. My 90-gallon tank is a mixed tank that contains both hard and soft corals (to test the system as best as I can), as well as a large population of fish. For the first two weeks after adding the mud to the sump there was some slime algae on the live rock, but this has since disappearred. At that time I added the Caulerpa and it has been growing ever since. I should add that I "cheated" when I set up this system in that I used cured live rock. I did this in order to try and get the system up as quickly as possible. In discussions with Leng it is apparent that when "fresh" live rock is added it may initially overwhelm the system if a large amount of die-off occurs. Therefore, in order to properly cure the rock it may be necessary to use a skimmer during this early phase. I should note that the Caulerpa I added was beginning to show signs of dying when I initially placed it in the mud. I weighed it down using small pieces of live rock, and after a few days it had all recovered.

The last aspect of Leng's system I would like to mention is that it also boasts one of the healthiest assortment of fish I have seen. Leng's tanks are not restricted in terms of the types of fish they house either. His SPS tank has a flamingi tang, three purple tangs, a squirrellfish and numerous other large fish, while his soft coral tank contains three black tangs among its inhabitants. Also, equally impressive is his fish-only tank, which houses numerous adult angelfish, butterflies and tangs. This tank uses live rock for decoration and, once again, the only filtration used is the Ecosystem Aquarium filter. Needless to say, all of the fish in this fish tank were healthy, so this system may also be useful in fish-only applications.

When looking at this system in all of its various applications, the question arises as to why does this system work. I have discussed this in depth with Tom Frakes, and we have come up with the following hypothesis. To begin with, the major flaw of algae scrubber systems is that when the algae take nitrates out of the water, they convert them along with CO2 into organics that color the water and inhibit the growth of the corals. The plenum-type systems seem to work better. When properly set up, they remove the organics from the water to provide a food source for the bacteria present in the anoxic bed, while at the same time converting nitrate into nitrogen gas. Unfortunately, in most of our tanks, we cover too much of the substrate with rock, so this prevents the system from reaching its full potential. In Leng's system, because of the close proximity of the algae to the special substrate, the nitrate and organics are efficiently removed.

The key, however, seems to be in the compounds in the mud. These seem critical for the growth of the Caulerpa. In fact, Leng has told me that the current mud is his fourth attempt at a substrate with the proper characteristics over the past seven years.

I realize that it is still too early to proclaim this system as the be all and end all system. As we have learned far too often

in the past, a methodology is not fully tested until it has been run on a tank for at least two years. However, after viewing Leng's tanks, which have been set up longer than this, there is a strong possibility that this system may work in the long term. Because my own tank has only been in operation for two months, we will have to wait and see. Until more people try this system, however, and discuss its merits and shortfalls, I'm afraid that I will still constantly be asked, "What's in the mud?"