As Always, Balance Is The Key

A successful reef tank must achieve a balance between the production of toxic wastes and its consumption

By Terry Siegel

Before getting to two interesting e-mail questions I received, I want to comment on an interesting marine display tank I observed in House of Finns, a pet store in Greenwich, Connecticut. The tank is a standard 55 gallon. It contains live sand, two small powerheads for circulation and one 40-watt actinic fluorescent tube for illumination. There is no traditional reef tank filtration.

The tank is filled with sponges, anemones, sea horses, banded pipefish and very healthy looking colonies of Dendronephthya and Scleronephthya soft corals. These corals are brilliantly colored and would certainly be prized by reefkeepers if it were possible to keep them alive in captivity. Most aquarists today believe the difficulty in keeping these animals centers around feeding. Peter Wilkens has had some success by stirring the gravel/sand bed daily (see The Reef Aquarium. Volume Two by J. Charles Delbeek and Julian Sprung, pages 20 to 21, for more details). Additionally, preliminary studies by scientists indicate that these corals feed on both phytoplankton and zooplankton, but that planktonic size and current may also be critical factors affecting their ability to feed.

Tom Mars, a part-time employee at House of Finns, is the one primarily responsible for maintaining the this 55-gallon tank. Tom attributes his success to an unusual feeding technique he has been using. Every day he dumps a phytoplankton "soup," along with brine shrimp nauplii, into the tank, where it is circulated by the two small powerheads. After about two to three hours the soup is completely removed by a large micronite filter. Without the use of the micronite filter the tank would become polluted.

He is also convinced that low light is essential for success with these animals. Too much light allows algae to overgrow the sponges and other animals, interfering with respiration and feeding.

We are at a stage in our hobby where some of the new frontiers will involve learning how to keep animals that have proved difficult in the past. Remember, it wasn't that long ago that reef aquarists believed corals from the genus Acropora could not be successfully kept in captivity. Today, advanced reef aquarists have to continually prune their Acropora just to keep their reef tanks from turning into a mass of calcium carbonate!

I hope other aquarists will continue to experiment with maintaining animals like Dendronephthya and Scleronephthya. If you are having success with these animals please e-mail me and I'll share it with the rest of the reefkeeping community. Now on to the letters.

Dear Mr. Terry Siegel,

To begin with, I am a great fan. I am just crazy about your 10-foot system. I would like to know more about it when you have some spare time. I really like the way you took a portion of live rock out and am planning on doing the same thing. Please give me some guidelines. My tank is going to be around 200 gallons.

Now to my main question: I have been in the hobby for three years and consider myself to be a fairly informed and intelligent person. But, there are a couple of aspects I got into an argument about. I really value your opinion and know you will be able to help.

The first area has to do with whether or not live rock removes nitrates. I say no, but other people corrected me and said yes. I believe the organisms that live on top of the rock, such as various algae, may convert it to nitrogen gas. But, is it bacteria that do this?

I have always thought the purpose of live rock was to provide a substrate for nitrification. The biological oxidation of ammonia to nitrite and then to nitrate is necessary to keep harmful substances (ammonia and nitrite) from reaching toxic concentrations. I know there are two types of bacteria that grow on the rock. The first, Nitrosomonas europaea, oxidizes ammonia to nitrite, while the second, Nitrobacter winogradskyi, oxidizes nitrite to nitrate. (Actually, although there are, in fact, two separate types of bacteria involved in the nitrification process, new research has shown that neither Nitrosomonas europaea nor Nitrobacter winogradskyi are present in saltwater environments. For more information on this new research, see the earlier "Topical Science" columns in the "Aquarium Frontiers Archive" section. —Ed.)

Then the nitrate accumulates in the tank, requiring water changes to dilute its concentration. The nitrate concentration can also be reduced by algae, live sand beds, plenums and so on. To quote Delbeek (1990), " Toxic by-products of waste such as ammonia, are oxidized by bacteria into less toxic nitrite, which is then further oxidized by other bacteria into the least toxic salt, nitrate. This nitrate then accumulates in the aquarium. This is, in essence, the basis of nitrification in the marine aquarium. Nitrate levels are then reduced by water changes, by assimilation by other organisms or by other biological processes such as denitrification, where yet more specialized bacteria act on the nitrate to convert it into nitrogen gas, which is quickly released from the water. In reef aquariums that are heavily loaded with fish or where overfeeding occurs, the production of nitrate may overcome the rock's ability to handle it and you will get a buildup of nitrate in the system."

Now, am I going crazy and do I have it all wrong? Does the bacteria on the rock also get rid of the nitrates? If so, what species of bacteria are these? I am totally lost now; I thought I knew something about it, but obviously not. I really need your opinion, because I think I am going crazy. I am sorry this is so long; I just wanted you to understand where I come from. Please help! Thank you so much,

Julia Holden

Julia, you are certainly not crazy and your questions strike at the very heart of successful reefkeeping. As I have said many times in this column, a successful reef tank must achieve a balance between the production of toxic wastes and its consumption. In this respect fish are producers, whereas photosynthetic organisms — algae and certain bacteria, for example — are consumers. Consumers are not only biological. Your protein skimmer is also a mechanical consumer.

I think your confusion is the result of not recognizing that there are two basic types of bacteria: aerobic and anaerobic. The aerobic bacteria mineralize (oxidize) ammonia into nitrates, but it requires anaerobic bacteria to reduce nitrates into nitrogen gas. Aerobic bacteria do their job only where there is sufficient free oxygen, while anaerobic bacteria thrive where free oxygen is at very low levels. Therefore, the bacteria living in deep sand beds and inside live rock, where oxygen levels are low, are anaerobic. So, your friends are correct: The anaerobes living inside your live rock help to reduce nitrates into nitrogen gas.

Does this mean you cannot eliminate some of your live rock to make your reef more esthetically pleasing or natural looking? Simply put, you can eliminate some if you can continue to maintain the balance we spoke of via other means. It might mean you will need a deeper sand bed, a better skimmer or even more photosynthetic animals. It might mean more or larger Tridacna clams, which consume ammonia and nitrates. On the other hand, it might mean fewer fish or less feeding. Remember, the key to success here is balance.