The Sea Star

Newsletter of the Utah - Wasatch Marine Aquarium Society Founded 1995 Issue 40 April 2001

WMAS Web Site:
www.xmission.com/~mikeb/wmashome.html
Soon to be:
www.utahreefs.com

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Inside this Issue

Welcome New Members

Brad Bair
Steve Kearl
Jake Pehrson
Jax Pettey
Jon Whicker

May 3rd Meeting

The guest that has graciously accepted our invitation to visit with us in May, is enthusiastic hobbyist and Plenum expert, Bob Goemans, Ph.D.

Bob has been in the aquarium hobby for over fifty years. He was born and raised in Queens, New York, where he started with freshwater aquariums as a young child and had his first marine aquarium in 1956. At an early age he was a member of the Jamaica Aquarium Society where he became the first person in the United States to own an undergravel filter.

During the past fifty years, whether living in the United States or the Far East, Bob has maintained aquariums. He has also collected specimens for his aquariums from the South China Sea to the Caribbean.

Bob has written for Marine Fish Monthly for over fourteen years, has a monthly column in Freshwater And Marine Aquariums and has also written for Tropical Fish Hobbyist. Besides numerous current writing endeavors he has aquarium and environmental consulting businesses, having retired from General Motors as an Environmental Manager. Bob has provided question and answer sessions at new "Store Openings," spoken to aquarium societies worldwide, and even appeared in a TV hobby show for the ABC station in his home town of Tucson, Arizona. He has also provided many question and answer sessions for local school children and other interested aquarists at home and school.

Bob has never been an employee of any aquarium product company and has no allegiance to any aquarium product company. He considers himself a truly independent voice with nothing to gain but satisfaction in helping his fellow aquarists.

Golden Head Sleeper Gobies
by Chuck Earnest

The May meeting will also be the occasion to discuss nominations for

WMAS officers. We don't stand on ceremony. You may nominate yourself and cast your vote in June. All positions are open.

The current officers are:
President: Mark Peterson
Vice President: Danh Ngo
Treasurer: Rick Malin
Librarian: Cindy Jones
Secretary: Cheri Anderson
Council: Tim Weidauer
Joe Jones
Kevin Judd
Mike Blevins
Mike Howton
Diane Freedman
Kelley Johnson

Thanks Pet Shops

Thanks to the retail stores and wholesale distributors. On behalf of all hobbyists the Wasatch Marine Aquarium Society thanks you for providing livestock and supplies to the marine hobby.

Upcoming Events

June 7th

In June, Randy Olson, owner and operator of Mountain Shadow Marine, an aquarium maintenance company will introduce us to his new "high end" marine retail store in Centerville and will also discuss successful reefkeeping.

July 13th

The annual Barbecue will be held at SeaBase near Grantsville. Note that this is a Friday.

August 2nd

To be announced – open to suggestions.

September 15th

Julian Sprung and the Reef Aquarium Tour all in one Saturday!

April Meeting

The April meeting was a great one. Jim Perry presented a slide show of his 650 gallon aquarium from start to finish. It is impressive and he invites anyone to come visit. Call first to arrange the visit and he will also be happy to trade coral.

Visitors included Bryce Wilson of Pet Planet in Riverton, though Mark forgot to introduce him (Sorry Bryce). Jason Scott of Intermountain Pet Wholesalers came with some donations for the raffle, and Jake Pehrson of www.coralplanet.com made his first appearance at a WMAS meeting and donated the new club website. It is to be www.utahreefs.com. Check it out!

After the raffle, was a coral propagation demonstration. Danh, Cindy and Mark cut up a Toadstool Leather Coral, the remaining portion of which has been donated to The Living Planet Aquarium. Everyone went home with a piece of extremely hardy and very large growing leather coral. Originally cut and donated to members in 1999 by past members, Cliff and Cory Sackett, the animal was almost two feet in diameter at the club meeting when they first propagated it. The piece we cut from had grown from a ½ inch cutting to about six inches tall and eight inches across in a little over a year.

Jim Perry's 650-gallon acrylic aquarium wraps around the corner in his living room.

Calcium Reactors

By Jim Perry

I frequently get email questions about my aquarium and reefkeeping in general, and it seems like the number-one topic these days is calcium reactors. So, I figured I would write an article for the Sea Star to answer a number of these questions and give a general overview of calcium reactors, and their advantages and disadvantages (yes, there are both!). I won't try to get too detailed or scientific, since clearly one could write an entire book on this topic.

What is a calcium reactor? - A calcium reactor is also called a "kalkreaktor" (after the German term) or "limestone reactor" which is a more literal translation of the German term, and a more accurate description. The device is essentially a means to dissolve calcium carbonate into your aquarium, to replenish the calcium as well as the alkalinity consumed by coral and other creatures in the reef. All reefs suffer from a gradual decline in alkalinity (or buffer capacity) as the animals excrete complex organic compounds and acids into the system. These acids consume the buffer by binding with carbonates. If not replenished, the carbonate buffer system will eventually become exhausted and your pH will drop. Similarly, calcium is consumed by all coral to varying degrees, but especially stony corals. These corals consume large amounts of calcium from the water to build their skeletons. (For more information about pH and the carbonate buffering system in your reef, refer to a good reef book such as “The Reef Aquarium” by Sprung and Delbeek.)

Maintaining chemistry- Reefkeepers use any of several methods to replenish the calcium and alkalinity in the aquarium. Some reefs have very low consumption rates because they lack stony corals; these aquaria can likely maintain calcium and alkalinity simply with water changes. Most reefs however, require some additional calcium and alkalinity supplementation, since large, frequent water changes are generally not a good solution. Some of these supplementation methods I do not recommend, because over time they create ionic imbalance in your water chemistry. An example of this is calcium chloride and buffer additions. While this is a quick and inexpensive way to boost the calcium and/or alkalinity level in your tank with no short-term ill effects, it is a poor choice to use on a consistent basis. The constant addition of chloride ions will eventually build up and upset the ionic balance. The three most common methods, (which will not upset the water chemistry long term) are kalkwasser additions, balanced two-part supplements such as B-Ionic from ESV, and calcium reactors. This article describes the calcium reactor method.


The Knop-C has outside plumbing.

How does it work? - The calcium reactor is essentially a chamber full of aragonite, through which you continuously circulate water with a small pump, which dissolves the aragonite and adds both calcium and alkalinity to the water in the reactor. You then have water from your aquarium continually exchanged with the water in the reactor, at a very slow rate (typically a drip). Sounds simple, no? Of course, there’s a catch. At the pH of saltwater the aragonite will not dissolve. If it did, our sand beds would also dissolve, and we’d have no use for a calcium reactor!

In order to get the aragonite to dissolve, we must acidify the reactor water, dropping the pH from normal seawater levels (around 8.2) to 6.5 or lower. To accomplish this, we simply slowly add CO_2. This dissolution is described by the following chemical reaction:

$$\mathbf{CaCO_3 + CO_2 + H_20 \leftrightarrow Ca(HCO_3)_2}$$

For those of you rusty on your high-school chemistry, this simply shows an equilibrium reaction, in which calcium carbonate, carbon dioxide, and water combine to form calcium hydrogen carbonate. As all equilibrium reactions, the reaction is reversible; it will go back and forth as driven by other chemical factors such as the pH.

The water in the reactor, at an ideal pH of 6.5 (completely saturated with CO2), dissolves enough of the aragonite media to bring the alkalinity in the reactor output (effluent) to 35-40 dKH, much higher than the desired 7-10 dKH in our aquaria! The calcium levels are similarly sky-high, a condition which cannot exist chemically at the pH of the aquarium because the calcium would precipitate out of solution. The slow drip of the effluent from the reactor to the aquarium is sufficient to bring both the calcium and alkalinity up to wonderful levels in the aquarium (I get about 10 dKH, and 450 ppm calcium on a tank with lots of stony corals). The drip from the reactor to the tank must be very slow; the slow drip lets the calcium and alkalinity dissipate in the aquarium water without coming out of solution at the higher pH. Besides, the very low pH and high dissolved CO_2 levels in the reactor water would be lethal in the aquarium! While you may expect your pH to drop slightly when using a reactor, a slow drip minimizes this effect. I also drip my reactor effluent into the input of my protein skimmer, which should allow the excess CO_2 plenty of opportunity to be released as the water is so highly aerated. My pH drops as low as 8.0 in the morning, and reaches 8.3 by evening with lights on.

Running a reactor - When you initially set up a reactor, you simply adjust the bubble rate of the CO_2 and the drip rate of the effluent until you minimize excess CO_2 (visible as bubbles in the media) and achieve a pH at or below 6.5 in the reactor effluent. 6.5 is theoretically the CO_2 saturation point, although most reactors run with a slight pressure inside, letting you dissolve a bit more CO_2 and get just below 6.5 pH. You can adjust the CO_2 bubble rate and the effluent drip rate to get your calcium and alkalinity levels where you want them in your aquarium. Dripping faster than the minimal required rate will only waste your CO_2 and aragonite, since you quickly reach a point at which your aquarium's calcium and alkalinity simply cannot go any higher. And, the faster you drip, the more CO_2 you must add to keep the pH at 6.5. Never let the pH in the reactor go above 6.5; the aragonite will not dissolve fast enough. Even a slight increase above 6.5 pH results in a substantial decrease in the calcium and alkalinity level of the reactor effluent. This is a common mistake – when your aquarium calcium levels are not going high enough, you will think you should increase the drip rate from your reactor! This is often the wrong thing since increasing the drip rate means less CO_2 gets dissolved in the water and the effluent pH rises, putting even less calcium and alkalinity into your aquarium! Measure the effluent pH to ensure you get the most for each drip! You can increase the drip rate only if you can also increase the CO_2 rate so that the pH remains low enough, and the effluent has an alkalinity of around 40 dKH. This brings up another point – get a reactor rated for an aquarium bigger than you have. The additional cost is very small, since the only difference is the size of the media chamber – more aragonite in the reactor. Everything else is the same. You can drip a larger reactor more slowly, but if you have an undersized reactor, you have a hard time upgrading!

Korallin reactor has everything in one.

Cost - The initial cost of a commercially built reactor is initially very high. They typically cost several hundred dollars for the reactor, and the CO_2 tank and regulator can cost over a hundred dollars. Luckily, the DIY (do it yourself) engineer can build one for much, much less. You can also get CO_2 tanks and a regulator at any welding supply store. Of course, buying two-part supplements is expensive as well, especially in the long-haul, and kalkwasser is not free either. My reactor pays for itself in less than a year compared to two-part supplements. Kalkwasser alone won't work for me because of the high rate of calcium use in my reef. I've seen several good plans for DIY reactors on the internet. Beware, not all reactors are created equal! Look for plans that someone has actually built and can vouch for. Despite the apparently simple design, there are subtleties that make a big difference. For example, I have used both the Knop and Korallin commercially-made reactors (see the pictures in this article). While both did the job, the Korallin is a substantially better design. It is easier to set up, adjust, and maintain than the Knop. The Knop had a tendency to develop a CO_2 bubble that would grow large enough to stop the circulation pump by starving the input for water! Even going the DIY route, I expect it will cost between $100 and $200 to build your own reactor and get the CO_2 equipment.

amazing coral growth in Jim's tank

Maintenance - Once you have your reactor up and going, there is very little work required to make it do its magic. Periodically you have to change the aragonite media, and refill the CO_2 tank. I replace media about once per year, and my 20 lb. CO_2 tank (about 2 feet high) lasts over two years on my 650 gallon tank. With a smaller aquarium you can of course get a much smaller CO_2 tank and still refill it only yearly or so. Rather than use normal aragonite reef sand for media, I recommend using commercially available reactor media. The grains are optimally sized for use in a reactor, and the media is lower in impurities, which becomes an issue when you are dissolving it all into your aquarium. I've tried both, and the special reactor media works better than plain aragonite sand. For my large tank, I spend about $20 per year in media, and average another $20 annually to refill the CO_2 tank.

Disadvantages - I'm a big fan of calcium reactors (could you tell?), but there are disadvantages:

- Initial cost is pretty high. Even if you Do It Yourself (DIY) it can be a daunting proposition.
- Increased CO_2 in your aquarium - This can encourage algae to grow. Unfortunately, if your dominant algae species is something other than zooxanthellae (like hair algae, perhaps) it may add to the problem. In tanks run "on the edge" with high nutrient levels, the additional CO_2 may push things "over the edge".
- Lower pH – the greater CO_2 can lower the pH of your system, which can have other secondary consequences. In extreme cases, you may need to balance the pH drop with kalkwasser additions or something. My tank drops to 8.0 in the morning unless I add kalkwasser.
- Yet another unsightly thing – For those with significant others who are not so sympathetic to the reef obsession, yet another strange looking piece of equipment doesn't win any points.

Advantages - Here are the most significant advantages:

- High impact – you can add a lot of calcium and alkalinity, much more than you can with kalkwasser.
- Labor savings – unlike dosing kalkwasser, or adding two-part solutions, the reactor keeps working like the energizer bunny without any real help from you.
- Cost savings – believe it or not, in some tanks (especially large ones) the reactor actually saves you money over the long term.

- Increased CO_2 – also listed as a disadvantage above, this can be a great thing. It actually increases the buffer capacity of your aquarium. Also, zooxanthellae are algae too, and so long as this is the dominant algae species your corals will really thrive. Some caulerpa, perhaps, could be great too.
- Cool-ness – Many reefkeepers, like me, are in this hobby partly because you can tweak and tinker with things. The reactor is yet another cool thing to observe, measure, tweak, and feel good about, especially if you build it yourself!

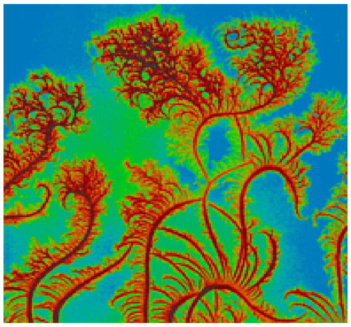
Those of you who have had your curiosity sparked by this article, feel free to give me a call sometime and come by and see my calcium reactor in action. I'd also be happy to answer any questions you may have. You may reach me at jperry@10fold.com. Also, you can check out the discussion of the "Lobbekke reactor" in *The Modern Coral Reef Aquarium*, *volume I*, by Nilson and Fossa, which gives a bit more detail on the chemistry involved.

Bacteria – the Good and the Bad

Last month the Sea Star had articles about bacteria and yet it seems that the little ones should not be underestimated. Following is a condensed article found in www.bacreriamuseum.org . We need to understand the role of bacteria, if we are to understand filtration and ecological balance in aquaria.

Bacteria are simple organisms that consist of one cell. They are among the smallest living things. Most bacteria measure from 0.3 to 2.0 *microns* in diameter and can be seen only through a microscope. One micron equals 0.001 millimeter or 1/25,400 inch.

Bacteria exist almost everywhere. There are thousands of kinds of bacteria, most of which are harmless to human beings. Large numbers of bacteria live in the human body but cause no harm. Some species cause diseases, but many others are helpful.



Bacteria colonies can look beautiful

Helpful bacteria - Certain kinds of bacteria live in the intestines of human beings and other animals. These bacteria help in digestion and in destroying harmful organisms. Intestinal bacteria also produce some vitamins needed by the body. Bacteria in soil and water play a vital role in recycling carbon, nitrogen, sulfur, and other chemical elements used by living things. Many bacteria help *decompose* (break down) dead organisms and animal wastes into chemical elements. Other bacteria help change chemical elements into forms that can be used by plants and animals. For example, certain kinds of bacteria convert nitrogen in the air and soil into nitrogen compounds that can be used by plants. A chemical process called *fermentation,* used in making *antibiotic* drugs, industrial chemicals, cheese, soy sauce, and many other foods, is caused by various bacteria. Sewage treatment plants use bacteria to purify water. Bacteria are also used in making some drugs.

Bacterial cells resemble the cells of other living things in many ways, and so scientists study bacteria to learn about more complex organisms. For example, the study of bacteria has helped researchers understand how certain characteristics are inherited. Most types of bacteria reproduce quickly. This rapid reproduction enables scientists to grow large quantities for research.

Harmful bacteria - Harmful bacteria prevent the body from functioning properly by destroying healthy cells. Bacteria that usually live harmlessly in the body may cause infections when a person's resistance to disease is low. For example, if bacteria in the throat reproduce faster than the body can dispose of them, a person may get a sore throat. Bacteria also cause diseases in other animals and in plants.

Protection against harmful bacteria - Many bacteria live on the skin and in the mouth, intestines, and breathing passages. But the rest of the body tissues are normally free of bacteria. The skin, and the membranes that line the digestive and respiratory systems, prevent most harmful bacteria from entering the rest of the body. When harmful bacteria do enter the body, white blood cells surround and attack them. Also, the blood produces *antibodies,* substances that kill or weaken the invaders. Bacteria produced *toxins* are neutralized by certain antibodies called *antitoxins.* Sometimes the body cannot make its own antitoxins fast enough. In such cases, a physician may inject an antitoxin from an animal, such as a horse or rabbit, or from another person.

Dead or weakened bacteria are used in making drugs called *vaccines,* which can prevent the diseases caused by those species of bacteria. Vaccines are injected into the body, causing the blood to produce antibodies that attack the bacteria. Some vaccines protect the body from infection for several years or longer.

Antibiotics are made from microorganisms that inhabit the air, soil, and water. Antibiotics can kill or weaken disease-causing bacteria. However, extensive use of antibiotics may encourage the spread of bacteria resistant to the drugs. The drugs then become ineffective.

Chemicals called *antiseptics* are used to prevent bacteria from growing on living tissues. Other chemicals, known as *disinfectants,* are used to destroy bacteria in water and on such items as clothing and utensils. Bacteria can also be killed by heat, and so heat is often used to sterilize food and utensils.

Where bacteria live - Bacteria live almost everywhere, even in places where other forms of life cannot survive. The air, water, and upper layers of soil contain many bacteria. Bacteria are always present in the digestive and respiratory systems and on the skin of all animals.

Certain bacteria, called *aerobes,* require oxygen to live, but others, known as *anaerobes,* can survive without it. Some anaerobes can exist either with or without oxygen. Other anaerobes cannot live with even a trace of oxygen in their environment.

Some bacteria protect themselves against a lack of food, oxygen, or water by forming a new, thicker cell membrane inside the old one. The cell material surrounding the new membrane dies. The remaining organism becomes inactive and is called a *bacterial spore.* Bacterial spores may live for decades or even longer because they can resist extremely high or low temperatures and other harsh conditions. If food, oxygen, and water again become available, the spores change back into active bacteria.

How bacteria move - Bacteria are carried long distances by air and water currents. Clothing, utensils, and other objects also carry bacteria. Various kinds of bacteria have *flagella* (thin hairs) that enable them to swim. Some species that lack flagella move by wriggling.

Clown in green, yes green, Sinularia
By Shane Heil

How bacteria obtain food - Most kinds of bacteria, called *heterotrophic bacteria,* feed on other organisms. Some species, known as *autotrophic bacteria,* manufacture their own food. For example, *photosynthetic bacteria* (that red slime) make food from carbon dioxide, light, and water.

Certain bacteria may be autotrophic or heterotrophic, depending on the food available. The majority of heterotrophic bacteria feed on dead organisms. Others are parasites. Some parasitic bacteria cause little or no harm to the host organism, but others cause diseases.

How bacteria reproduce - Most bacteria reproduce *asexually*--that is, each cell simply divides into two identical cells by a process called *binary fission.* Most bacteria also reproduce quickly, and some species double their number every 20 minutes. If one of these cells were given enough food, over a billion bacteria would be produced in 10 hours. Industrial and laboratory processes often produce such enormous numbers of bacteria. In nature, bacteria lack an adequate food supply to maintain such a high rate of reproduction.

And now you know enough to pass the test on bacteria at the May 3rd meeting! ☺

Rick Malin's beautiful Reef