REEF HOBBYIST MAGAZINE

SECOND QUARTER 2015 | VOLUME 9

FLOWER ANEMONES: BREEDING WHAT CAN'T BE FRAGGED

A UNIQUE APPROACH TO FEEDING COPPERBANDS

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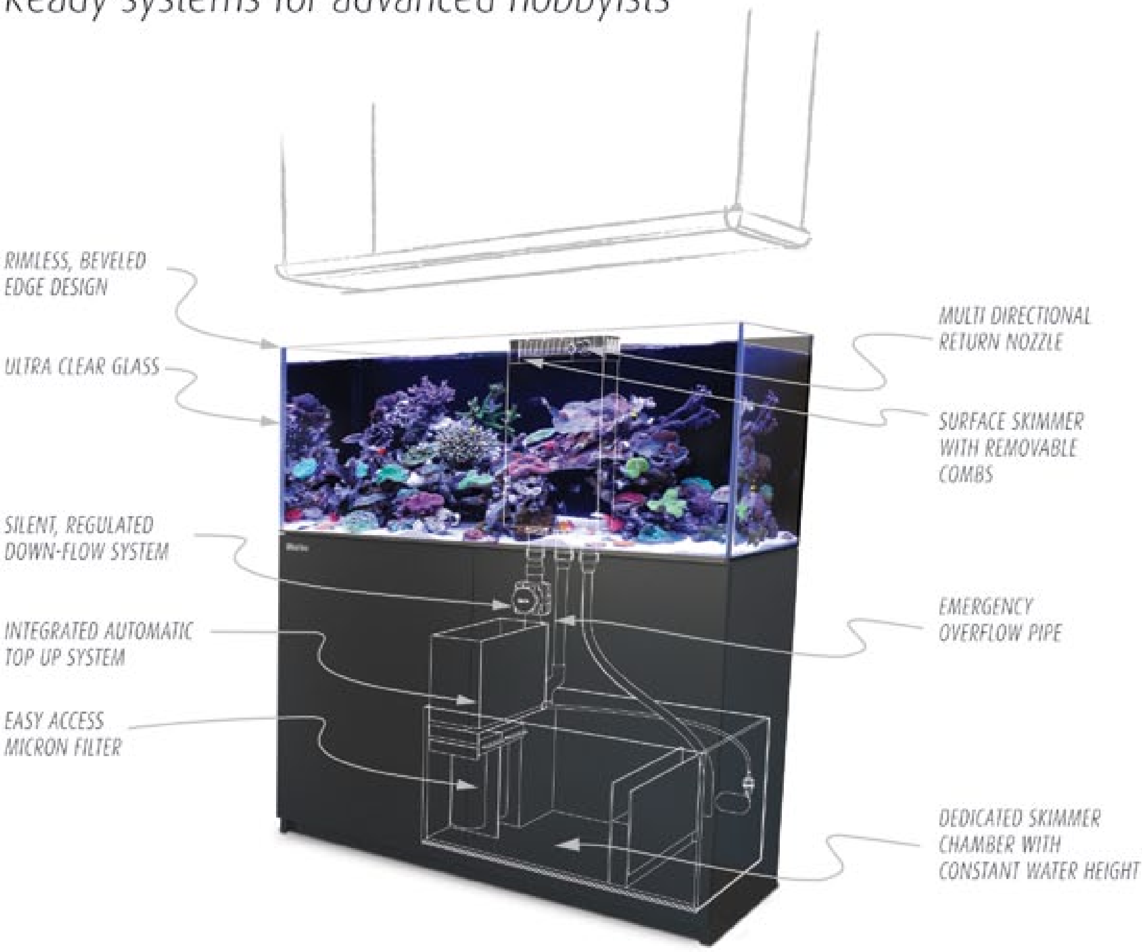

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A UNIQUE APPROACH TO FEEDING COPPERBANDS

Image by author.

ADAM MULLINS

One reason some fish species have a hard time adapting to life in our aquariums is that they are not able to feed as they would in the wild. While we can't recreate the ocean in our tanks, feeding is one activity where we can provide our fish with a more natural experience. After all, diet is a very important consideration for the long-term health of our fish, and diet and feeding go hand in hand. Many of our favorite fish are bacterial- or algal-grazing omnivores. For these fish, natural feeding stimulation can be as simple as having algae-covered rocks in your tank. More specialized feeders, such as Mandarin Gobies, often require a diet of live foods. But thanks to their relatively small size, even these specific needs can be met in a properly sized and well-established aquarium. It's not just diet that is important to consider but also overall feeding strategy (how fish acquire or hunt what they think of as food).

I recently became frustrated by the quantity of frozen *Mysis* shrimp I was putting into my tank to ensure that my Copperband Butterfly was able to get enough at each meal. It's one of the most specialized feeders in the tank and far slower and more deliberate in its feeding than my other fish. The Copperband's tankmates are mostly omnivores and readily accept everything from dry pellets to grazing blocks, while the Copperband is much fussier about what it will eat. Despite the relative overfeeding of the tank, the Copperband was always skinny and constantly pacing the glass, waiting for its next meal as if on the verge of starvation.

Every reefer knows the consequences of overfeeding: a constant battle with various alga or increased tank maintenance, or both. I would feed *Mysis* into the tank and watch the ensuing feeding frenzy, with everyone going crazy for their favorite treat, while the poor Copperband tried to get a few bites in. That's when it became quite obvious that this butterfly required a different feeding approach on my part. It is not an adept open-water feeder like its tankmates. Instead, it is a precise feeder, having to line up its shots to strike. This leaves it quite unable to compete for food with open-water masters like angels, tangs, and wrasses.

There are many things that determine the feeding strategies of fish. "The size of the jaw opening, diameter of eyes, and surface of the

The Copperband's tankmates, including this angelfish, accept various types of foods. Image by author.

Mandarin Gobies, like Copperband Butterflies, have specialized feeding needs. Image by Andrea Izzotti.

pectoral fins are essential to the understanding of the functional biology associated with foraging behavior of fish."[1] The most obvious morphological adaptation to feeding is the mouth and jaw structure, but specific visual adaptations are also important. Naturally, the eyes have evolved along with the mouthparts to correlate with the type of feeding practiced by each fish.

Other considerations when attempting to understand feeding strategy are fin size and shape, which may indicate the types of water movement found where the fish feeds. "In fish, individuals with greater stopping capability have great ability to stabilize their movement while feeding; this stabilization is achieved by having an extension of its pectoral fins, thus a greater success in capturing benthic prey."[2]

If we consider these characteristics, we can see that the Copperband is a laterally compressed fish capable of fitting into the thinnest crevices in coral reefs. It has large pectoral fins for stability in ocean currents and a mouth resembling forceps for prying food out of tubes or holes. The Copperband is a true natural

Copperbands often have trouble feeding in captivity. Image by Leonardo Stabile.

marvel of the animal world, highly specialized for its role as an elite hunter on the reef.

Anyone who has ever introduced a healthy Copperband into a reef tank, especially a tank that's been devoid of such predators, can attest to the vigor with which it scours the live rock searching out sessile invertebrates. I feel *Chelmon rostratus* is one of the most beautiful butterflies to keep in a reef aquarium, but specific feeding considerations must be kept in mind.

Returning to my personal story, since I couldn't offer my butterfly a fresh rock full of tasty treats every day to keep it sated and stimulated, I decided to make something I could regularly reload with its favorite food. This was as simple as cutting a piece of half-inch PVC pipe to 2 inches in length and capping both ends. I glued one of the end caps on and left the other removable to allow me

to load the tube with food. I then drilled numerous ¼-inch feeding holes through the tube, just big enough to fit my Copperband's mouth. I was careful to file down any rough edges on the holes to prevent unnecessary injury or scrapes to the fish.

Now it's as simple as filling the tube with food, capping it, and dropping it in the tank. When I make the next one, I'll drill fewer holes, perhaps only on one half of the tube, to help prevent food

Images by author.


The other fish watch as my Copperband uses the feeder. Image by author.

from falling out. This feeding tube could also be made with a magnet or suction-cup mount attached so that it can be affixed in any position on glass or acrylic.

With the increased availability of prepare-it-yourself, gel-type feeds, this device could also present useful options for preparing custom food mixtures, including more nutritious or vitamin-loaded pellet food for particular fish.

I've been using this feeder a few times per week, and I've noticed that my Copperband is considerably calmer and also appears to be much fatter. A focus on feeding stimulation may help calm stressed fish and alleviate nutritional maladies. And for more advanced aquarists, it may be a way to begin solving the feeding issues of more challenging species. I believe it's the responsibility of all pet owners to provide their pets with opportunities for naturalistic behavioral stimulation. I hope this article might inspire you to think outside the glass box in terms of your feeding regimen.

REFERENCE

[1,2]www.academia.edu/3891915/Trophic_ecology_of_abundant_reef_fish_in_a_remote_oceanic_island_Coupling_diet_and_feeding_morphology_at_the_Juan_Fernandez_Archipelago_Chile

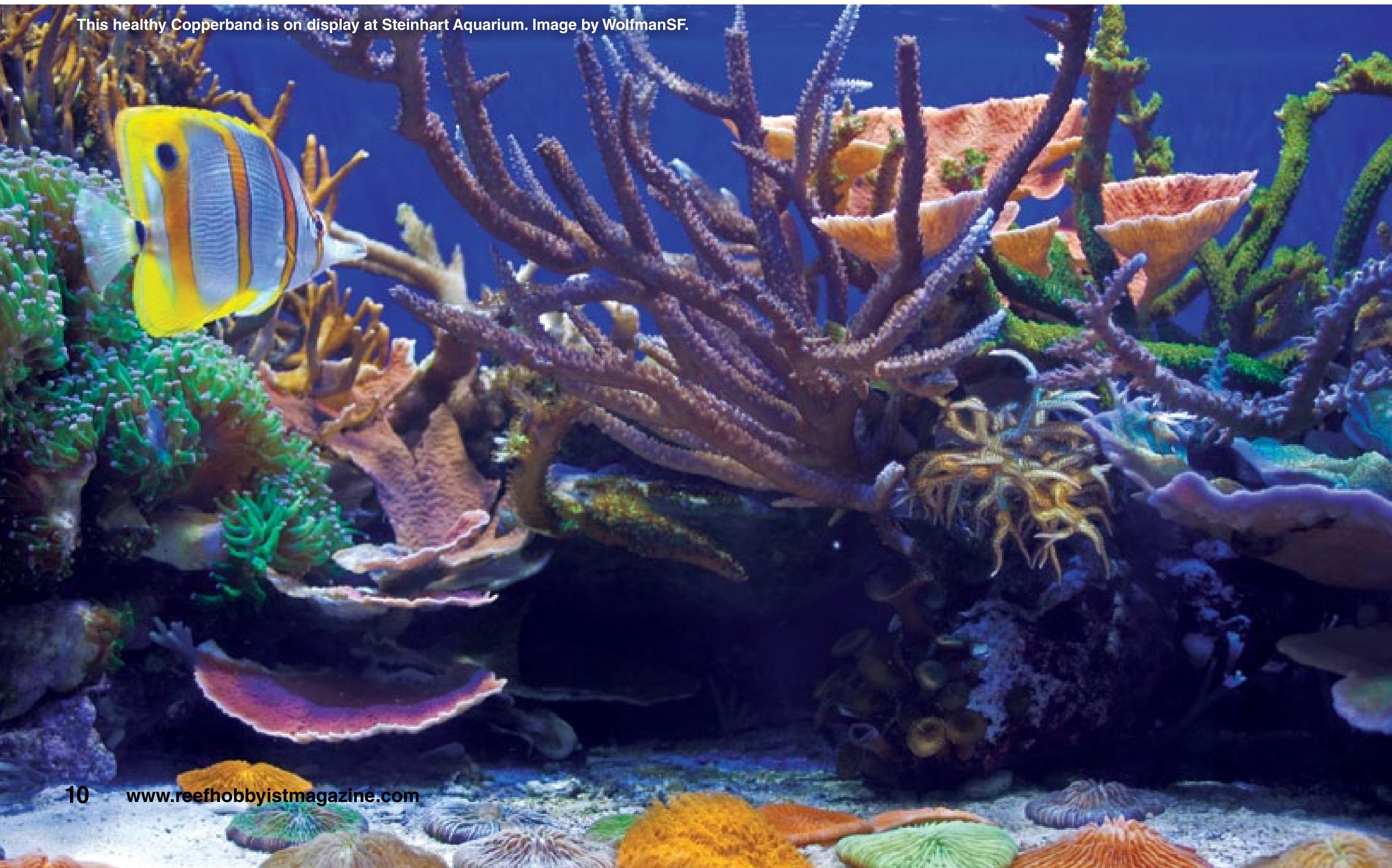

This healthy Copperband is on display at Steinhart Aquarium. Image by WolfmanSF.

Image by João Ribeiro.

JORGE MACHADO DE SOUSA

A CORAL MATERNITY PART 2

A VICTIM OF MY OWN SUCCESS

INTRODUCTION

I had the pleasure of publishing an article titled “A Coral Maternity: The Early Years” in the Q4 2014 issue of this magazine in which I chronicled the genesis of my coral farm up through about three years ago.

Here, I present a roundup of the latest developments in the project and a brief update on my installations as they currently stand.

A BIT OF HISTORY

Since the age of 18, I have had a passion for maintaining reef aquariums. In the beginning of my addiction to the hobby, I loved watching corals grow, becoming ever larger colonies in my tanks. After a few years, I started to focus on the propagation of corals and the subsequent tracking of their growth over time.

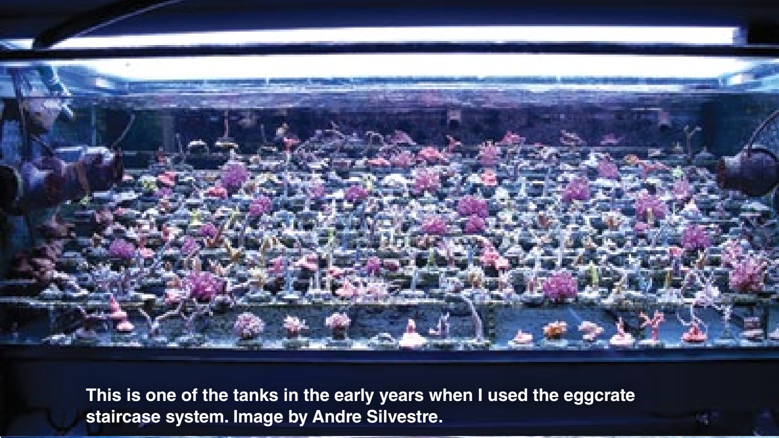
In 2006, I began fragging corals in my frag tank (named Coral Maternity). The corals were arranged on staircases constructed of eggcrate, and on these racks, I mounted thousands of frags, representing many generations of corals.

Seeing so many racks full of frags gave me a huge sense of accomplishment and pride in what this project had achieved. The smaller the coral fragments with which I started, the more satisfying the grow-out, and this is where I began devoting a significant part of my time.

FRAG EXCESS IN CORAL MATERNITY

Corals, when provided with correct lighting and environmental parameters (water quality, flow, etc.), tend to grow at a steady rate. If we have dozens of frags exhibiting good growth rates and we continue to produce frags from previously produced frags, in a relatively short time, dozens of frags will become hundreds, and hundreds will become thousands.

As a result, my frags filled all available rack space in the 6,000-liter Coral Maternity in a few short years.



This is one of the tanks in the early years when I used the eggcrate staircase system. Image by Andre Silvestre.

Flame Angel. Image by João Ribeiro.

Large clams and coral colonies. Image by João Ribeiro.

Copperband Butterfly. Image by João Ribeiro.

CONSEQUENCES OF EXCESS FRAGS

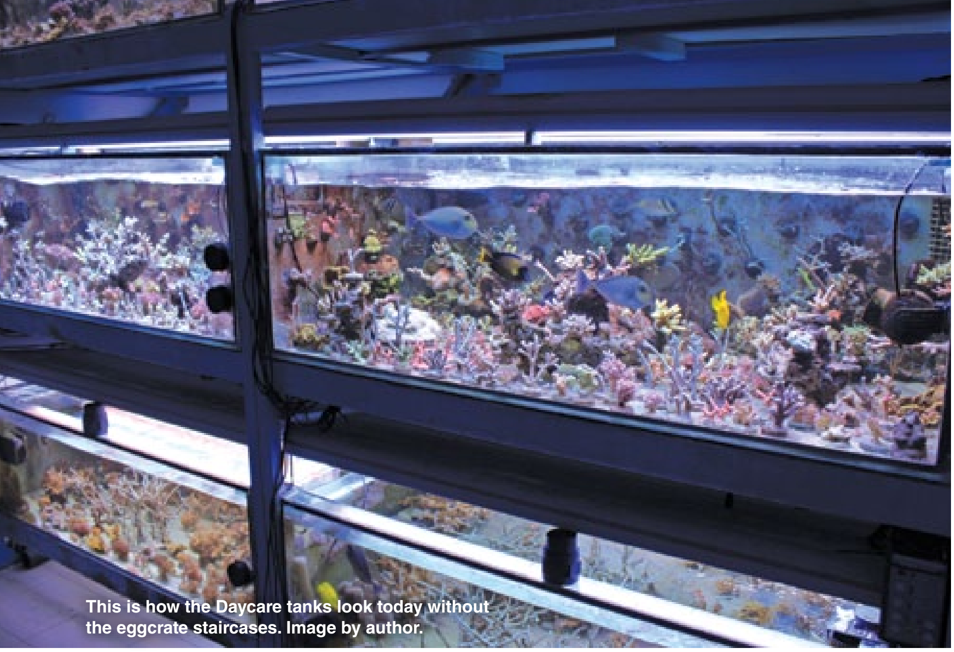
Fish and other clean-up crew members, useful in maintaining aquariums, lost the ability to access the space surrounding the corals to do their work of controlling the growth of algae and other pests.

With water flow restricted between corals, dead zones were created in the system. Organic sediment and waste accumulated in these areas, which then became ideal growth sites for dinoflagellates, cyanobacteria, and other opportunists. These interlopers can colonize quickly and be very difficult to remove. The corals also had difficulty getting the necessary nutrients for their survival and were unable to rid themselves of metabolic waste.

And last but not least, the close proximity of the frags resulted in coral warfare. The growing corals ended up causing injuries to one another.

REMOVAL OF EGGCRATE STAIRCASES

While the use of eggcrate staircases was effective in the beginning of the project when the frags were smaller, these staircases began to create problems as the corals grew out. They promoted sediment retention on their horizontal steps. The ever-increasing density of rapidly growing corals further facilitated the accumulation of sediment and organic matter on the plugs of frags, which led to coral damage. The staircases also made access to the tank bottom difficult and made vacuuming clean the tank's bottom nearly impossible.



This is how the Daycare tanks look today without the eggcrate staircases. Image by author.

So to eliminate the problems created by the use of eggcrate staircases, I decided to remove them altogether. The coral frags were placed directly on the gravel at the bottom of the tank in rows, grouped by species.

CORAL POPULATION FOR THE SPACE AVAILABLE

Eventually, it became imperative to significantly reduce the population of frags in Coral Maternity. In 2013, I began to offer free corals to anyone who visited the coral farm. I also created a website that advertised corals for sale with the goal of supplying the market with frags and aquarium equipment in order to generate some financial support for the maintenance of Coral Maternity. I had developed all my work since 2006 without sponsorship by any individual or collective entity, but once the financial crisis hit Portugal in 2011, it became difficult to maintain this project without reaching out for help.

By reducing my out-of-pocket expenses for the current Coral Maternity, I was able to start a new phase of the project: Coral Maternity II.

CREATING REEF LAYOUTS IN THE DAYCARE TANKS

The existing amount of frags in Coral Maternity has been significantly reduced since the day the website went online.

I removed all the existing gravel at the bottom of the Daycare tanks to minimize the sediment accumulation there. The coral frags were placed at the bottom of the tanks and also affixed to live rock retired from the sump. Many SPS frags have also been attached to the rear and side glass panes in order to save space and create a unique effect as the corals grow toward the light.

LIGHTING AND FILTRATION CHANGES

In Maternity, the two Infinity Sfiligoi Vision plasma lights were removed because one of them had problems with its dimmer. The previously retired T5 lighting was reinstalled.

This is a full-tank shot of one of the Daycare tanks. Image by João Ribeiro.

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Many SPS frags were attached to the rear and side glass panes. Image by author.

In Nursery, the T5s were replaced by LEDs except for one fixture (2 × 80-watt tubes) in the rear that remains.

In the Recently Glued Frags tank, a CT Lite Smart 90-watt LED replaced an 85-watt LED of the same brand when its LED module failed.

In my sump, I decided to remove the zeolite reactors and discontinue the use of bio-pellets. The system was running with very low nutrients already, possibly due to the mangroves that have huge root systems and have been growing for nearly 2 decades. All other original filtration equipment remains.

INTERNAL CIRCULATION CHANGES

Only Maternity and Nursery are still using Polario pumps for water movement. These pumps were removed from the remaining tanks because they were too noisy. All Tunze Waveboxes were also removed, but for aesthetic reasons.

EQUIPMENT AND TECHNIQUE CHANGES

After switching from the Balling Light method to the use of a calcium reactor, I switched back to the Balling Light method but with a Deltec PF 1001 calcium reactor filled with 35 kg of Aqua Crown media enriched with magnesium. Its effluent is routed to the Deltec AP903 skimmers to degas CO_2. The Deltec PF 1370 calcium reactor is out of service because it was damaged.

T5s were reinstalled in Maternity after the plasma lights were removed due to a problem with a dimmer. Image by João Ribeiro.

FISH AND INVERTEBRATES

About 8 months ago, Coral Maternity suffered a general power failure for 21 consecutive hours due to excessive humidity inside the facility. The SMS module associated with the Profilux could not send messages to warn me because the SIM card was damaged. All existing fish and non-coral invertebrates in Maternity died.

I believe the fish and invertebrates in Maternity died due to the high density of corals compared to the water volume. With the power failure and resulting lack of water movement, the corals consumed oxygen and released carbon dioxide into the tank for a long period of time. The corals were able to survive in an oxygen-starved environment, but other invertebrates and fish could not tolerate a situation like this. Fish, corals, and other invertebrates living in every other tank survived and did not suffer any negative consequences.

FINAL THOUGHTS

Anything we can do to promote the reproduction of corals in captivity or in the wild, with a focus on sustainability and preservation of the hobby, should be done. Assuming that motto, I have been developing Coral Maternity near Lisbon, Portugal, since 2006. And so I continue.

It was a great honor for me to have been invited to collaborate in two issues and share my story in *Reef Hobbyist Magazine*.

THE HAZARDS AND REWARDS OF TRANSITIONING TO A LARGER SYSTEM

HENRY RAFAEL
Images by author

One issue we sometimes have to face in this hobby is what to do when our corals have grown and there is no room left to add more. You have to make a decision to either sell/give away some of your corals or expand your aquarium, and neither of these paths are easy. If you choose the former option, surely you will feel nostalgia for your corals. If you choose to transition to a larger aquarium, then you must do everything you can to prepare for a number of potential problems you might face. The decision to expand always puts both your fish and your corals at risk unless you have enough space inside your house to maintain two systems at the same time. If so, you could wait for the new aquarium to cycle before you move everything over. I didn't have that option. So, I started to plan for expansion.

Months prior, I knew that this moment would eventually come. My understanding of the fact that different types of corals preferred different types of environments led me to envision an upgrade that consisted of three display tanks. They would all share the same filtration system, but each would have different levels of light and water flow.

While my small polyp stonies (SPS) were quite happy with strong currents and bright lighting, my large polyp stonies (LPS) preferred gentle currents and moderate lighting. My zoas and polyps, sometimes seemingly even more difficult to keep than my SPS, preferred strong currents, but only some of them thrived in bright lighting.

My goal then was to make the first display SPS-dominated, the second one LPS-dominated, and the third aquarium a haven for zoanthids and polyps. With these ideas in mind, I had plenty of planning and preparation ahead of me. The total system volume of all three displays and the shared filtration (sump) would be approximately 300 gallons.

Montipora setosa


Clavularia sp.

The upgrade began in the early morning hours of June 28, 2014, with the set-up of the first new display. I started by moving the corals from my old display into the tank that would eventually function as my new sump. It already contained 75 gallons of water that was brought in from a nearby beach and would complete the total volume of water that the new system would ultimately hold. After nearly 18 hours, I had the new SPS display up and running but still not plumbed into the new sump. I waited for the water in the display to clear up before transferring the corals. At that point, my corals had already spent 24 hours in the new sump. As I finally began moving the corals, I noticed my first casualties; a couple of *Acropora* had died. A couple more were not looking too good, so I knew that I had to speed up the transfer. Finally, on the evening of June 29, nearly 33 hours after I started, the upgrade with the first display of three was finally complete.

About 90% of the first phase of the upgrade had gone as planned. Now it was time to wait and see how the fish and corals would do. The sand from the previous setup was used, and an additional 75


Green plating monti

War Coral

Fungia sp.

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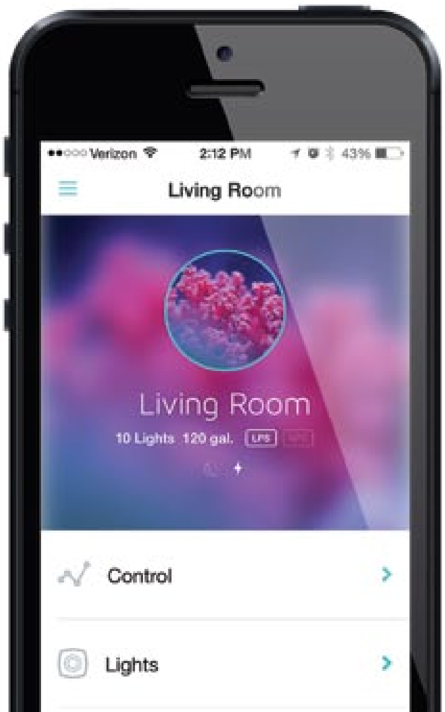

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pounds was added. I also added an additional 50 pounds of live rock in order to improve the natural filtration.

During the first 15 days, everything functioned as planned. I had a few algae outbreaks that were easily controlled. Then, cyanobacteria began to appear, and some of the parameters began to soar. I decided to go to the beach to get water for a large water change. After doing the water change, the algae outbreak persisted. I felt as if the sand bed didn't perform as I had hoped, and despite the mechanical filtration working correctly, the algae wouldn't give in. It took 3 months of daily attention to finally stabilize the aquarium, but not without some additional casualties. I lost a lot of corals, but what hurt most was the loss of some of my most prized acans.

It has been over 9 months since the first display was connected to the new sump. Seven months ago, I installed aquarium number two and joined it to the main aquarium's filtration system. The system is very stable now, though on a couple of occasions, I've tried to rebuild the aquascapes, which still don't suit me. I hope that this project is complete by the end of 2015 and that all three displays will be well established.

Ultra-green polyps

We tend to think that since we have some reefing experience, we can control our aquariums through an understanding and application of standard reefing practices and techniques. This upgrade taught me that nature and the path that our aquariums take are unpredictable.

Changing my system did result in several very positive outcomes. Today, my SPS are growing at an accelerated pace, and my *Montipora* have very quickly doubled in size. The *Acropora* are mostly frags, but I hope they grow into colonies soon. I look forward to the continued growth of my corals so that I can have another opportunity to share my passion for fish and corals with the readers of *Reef Hobbyist Magazine.*

Purple and green monti

These SPS are now very healthy and growing rapidly in the SPS-dominated tank.


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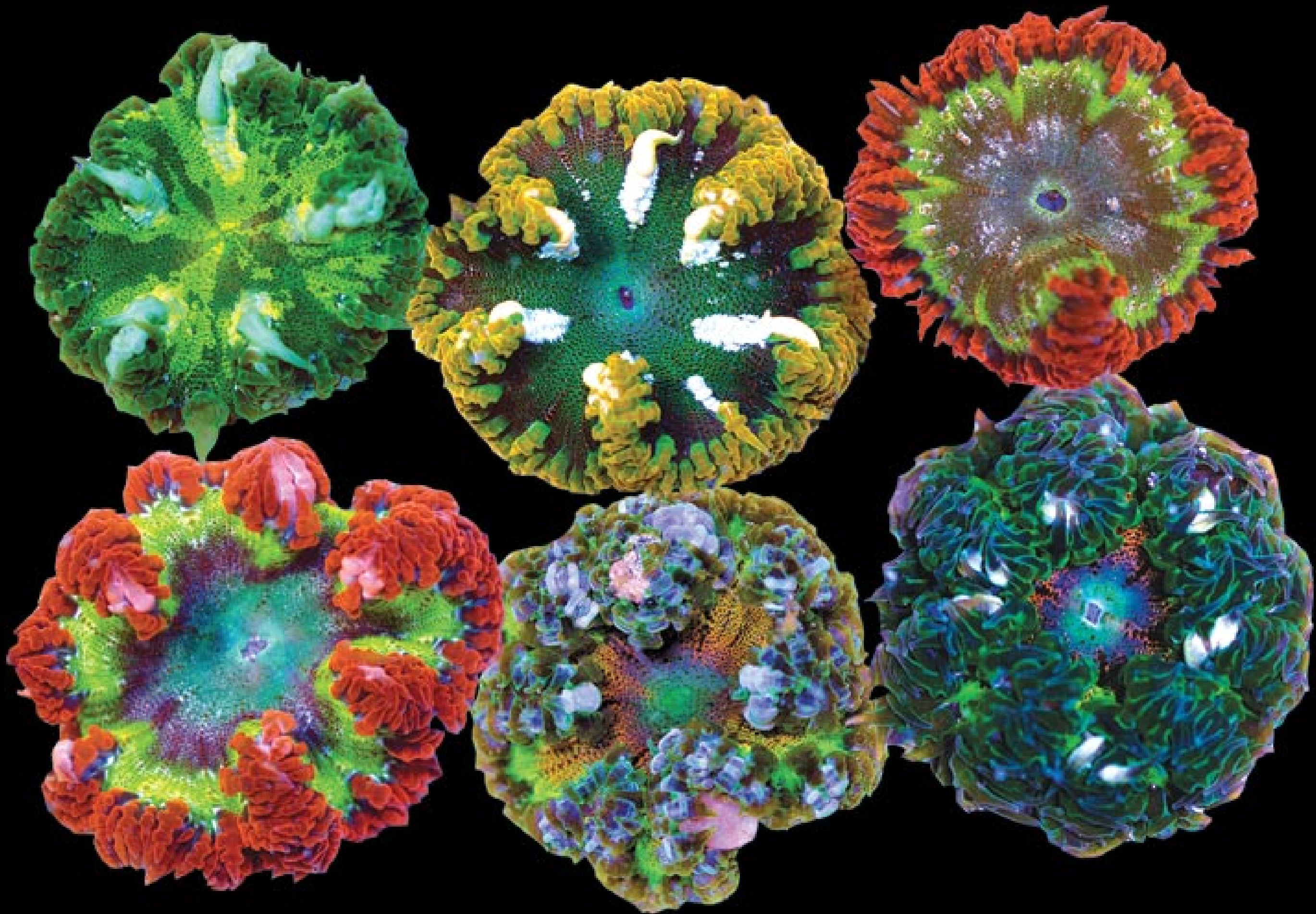

MIGUEL TOLOSA

Flower Anemones (*Epicystis crucifer*)

BREEDING WHAT CAN'T BE FRAGGED

Over the past year, Flower Anemones (*Epicystis crucifer*) have begun appearing in a stunning variety of different colors from several vendors, but they still remain fairly off the radar for most hobbyists. On the surface, Flower Anemones are a great tank anemone with only a mild sting. They can survive in a variety of lighting conditions and respond well to being put into a PVC end cap and positioned as desired. These anemones move very little in general, grow slowly, and get along well with other reef inhabitants. They don't usually host clownfish and are considered reef-safe since most fish will just ignore them. While some reports have Flower Anemones growing up to 10 inches wide, the vast majority I've seen have stopped growing at about 4 to 6 inches and take a long time to get there. My largest one is a little over 4 inches wide at just under 4 years of age, and my other two of the same age are only 3 inches wide.

The only reason Flower Anemones are not spreading like wildfire throughout the hobby like most other new and rare anemones is as simple as it is frustrating: They can't be fragged. As we have learned from the failed attempts of some adventurous hobbyists, it turns out that trying to split an *Epicystis crucifer* in half only results in two halves of a dead anemone. The reason for this is that *Epicystis crucifer* is a brooding spawner, meaning the male spawns gametes into the water column that are absorbed by the female who carries (broods) the fertilized eggs, which become baby anemones. This is in contrast to the majority of corals and anemones that are broadcast spawners wherein parent animals release both eggs and sperm, with the eggs being fertilized in the water column before settling on a surface to grow. So here we have a new addition to the hobby that seems like it can only be appreciated but not shared. This makes it less appealing to those who prefer tank-bred

This is my red anemone with pink tentacles. Image by author.

Here is my green anemone with pink tentacles. Image by author.

Image by Cultivated Reef.

organisms or who like to trade and sell pieces of their collections. Hopefully, this article can help change things.

Approximately 2 years ago in late April, I received a beautiful Flower Anemone that promptly died after spitting out about two dozen ⅛- to ¼-inch transparent babies. Only five survived, likely due to the fact that the anemone had released them prematurely after a transit that was too stressful for the pregnant mother. Out of those five, a mostly gray one was sold, a pink one was given to a friend, and I ended up keeping three. Only one of those three was the same color as the mother. The second one was red but had inherited a few patches of the mother's pink tentacle coloration, and the last anemone had big pink dots running down the center and a green mouth. Raising these tiny anemones gave me an opportunity to study their growth and eventual reproduction. As a result, I can offer a template on how to successfully propagate them at home.

After the mother anemone died, I started backtracking to figure out when the last likely spawning might have been. I guessed that it was during the March equinox when many corals are known to spawn. Sure enough, after a year of watching my tiny anemones do nothing but grow slowly, I saw two of them begin spawning. They spawned fairly consistently four times a year: during the March and September equinoxes (around March 20 and September 22) and the June and December solstices (around June 21 and December 21). In the wild, this makes sense and is similar to how many different species propagate, but in my tank with no moonlight and a fixed light cycle, it was a bit of a mystery. Either way, after several spawning events, I still had no babies; I wanted a squadron of these anemones!

I had two small spawning anemones that had topped out at around 3 inches wide as of a year ago and one that was 4 inches wide with great color that did nothing but continue growing. At that point, I was fairly sure that I had two small male anemones and a larger female one, and when May rolled around, I began feeding them Fauna Marin LPS pellets every other day. In this case, feeding

This is the 4-inch wide anemone that I thought was female. Image by author.

pellet food is immensely better for your water quality than feeding frozen food that can leach excess nutrients into your water.

Sure enough, the male (smaller) anemones began spawning into the water column right around the June solstice. Each spawning event took place in the evening around 7 p.m. I would turn off the return pump during this time (approximately 1 hour) to keep the gametes from being filtered out of the water, although I was concerned about the temperature fluctuation. I also put the tank's powerhead on feeding mode and took far too many of what ended up being unpublishable, blurry photos.

For 2 months, nothing happened. Then in late

August, the larger anemone spit out three half-inch baby anemones. Two were nicely colored with pink tentacles, and one was completely brown. It was apparent that these anemones carry a lot of genetic color variation and there was no telling what colors offspring will be. Either way, I was thrilled to have finally found a way to propagate these anemones in captivity.

They did need to be moved from the surfaces on which they initially attached, but *Epicystis crucifer* is surprisingly easy to relocate if you time it properly. The trick is to wait until it is on the move itself, which new anemones seem to be fairly frequently. Then, with a little help, it will pop right off of the rock. The anemone's foot inflates for movement, which prevents it from

This baby anemone with pink tentacles is one of three born in August. Image by author.

Two baby anemones have settled on the bottom rock. Image by Cherry Corals.

clamping down. This is a great way to move the anemone into a PVC end cap in order to relocate the animal to a preferred position on the sandbed.

I had managed to repeat this breeding process for the September equinox with the same formula of feeding Fauna Marin LPS pellets every other day for a month in advance. This time, I was able to increase the anemone "litter" size to eight by fine tuning some of the details. The key changes were to turn off all of the flow in the tank and use a turkey baster or feeder tube to collect the gametes from the males. Once collected, I laid them directly on top of the female anemone. This greatly increases the chances of multiple

Image by AquaSD.

Image by AquaSD.

Images by AquaSD.

fertilizations without having the gametes diluted throughout the tank. Gestation time was approximately 2 to 3 months following spawning for the production of healthy, well-colored babies.

If you would like to try breeding Flower Anemones at home, I would recommend picking up several individuals to increase the odds of getting both males and females. From personal correspondence with friends who keep these anemones, it seems that the growth rate of males is significantly slower than that of females, and males tend to stay around 3 to 4 inches. Females grow faster and have tentacles that look fuller once the anemone grows to 4 inches or more. However, I've only been able to study a few dozen anemones thus far, so in my mind, these dimorphic characteristics aren't set in stone just yet. Being that it only takes 2 to 3 months from spawning to babies, and with the high prices some of these anemones are fetching, I have found it a worthwhile investment of my time for the return. I plan to collect a few dozen more in order to increase the genetic diversity in my tank. As the red anemone with pink tentacles shows, Flower Anemones can end up with some surprising color combinations.

At the end of the day, we are just starting to learn how to propagate these incredible anemones, so this is more of a guideline than an exact recipe. A lot of things need to be working at the same time to succeed in breeding these animals, but it's this kind of challenge that can make our reef tanks continually exciting. If you want a project that is as interesting as it is rewarding and fun, or if like me you just want to try something new and different, then breeding *Epicystis crucifer* might be right up your alley.

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Feed The Frenzy

Image by Witold Krasowski

HOW EFFICIENT IS YOUR LIGHT?

TULLIO DELL AQUILA

Aquarium lighting is a complex and highly technical subject. The differences between types of lighting, and even different lighting systems of the same type, are difficult to assess without at least a basic understanding of the physics involved. I have spent nearly two decades focusing on the importance of proper lighting paradigms for aquarium and aquaculture use and am often called upon to help people make lighting decisions for their tanks or exhibits. In this article, I hope you'll find some information that's useful in evaluating your current or future lighting choices.

A common question I often hear regarding aquarium lighting is, "What's the wattage?" I get this question regarding LEDs, as well as other lighting platforms such as T5s and metal halides. Our hobby has historically used radiometric power (watts) to roughly indicate the light output of aquarium lighting products. As we will see, simply comparing wattage tells us little about how efficiently a light system might perform.

First of all, the efficiency of lighting has increased over time. In the '80s and '90s, 4–5 watts per gallon was the minimum amount of light recommended for a reef aquarium or biotope that would house species requiring intense light. Many of the lamps available at that time were not specifically designed for photosynthetic organisms, and supplemental lighting in the blue region was usually needed to help promote growth and color. This was the beginning of reef aquarium and actinic lighting.

Since then, lighting has come a long way. Today, T5-HOs, metal halides, and LEDs typically produce up to 100 lumens per watt and are designed to give photosynthetic organisms both the intensity and spectral output they need. But the efficiency of the bulb or LED is just part of the story.

EFFICIENCY

When a light source like a bulb or LED is evaluated, the data produced is based on ideal laboratory conditions. These idealized conditions do not take into account the fixture (or luminaire in techspeak). Once the light source is installed in a fixture, the original lab data is no longer representative. The performance of the light source is now heavily dependent on the optical design and thermal management of the fixture, not to mention the ballast and other electronics used for its operation. Particularly with LEDs, poor thermal management is one of the leading causes of premature

DEFINITIONS

luminous flux
1. the rate of transmission of luminous (visible) energy; expressed in lumens

radiant flux
1. the rate of transmission of radiant (including IR, UV, and visible) energy; expressed in watts

luminous efficacy
1. the quotient of the luminous flux (visible light) of a source and its corresponding radiant flux K (total radiant energy)
2. the quotient of the luminous flux of a source and the power it consumes; measured in lumens per watt

luminous efficiency
1. the perceived brightness of light as a ratio of the total luminous flux to total radiant flux of the source

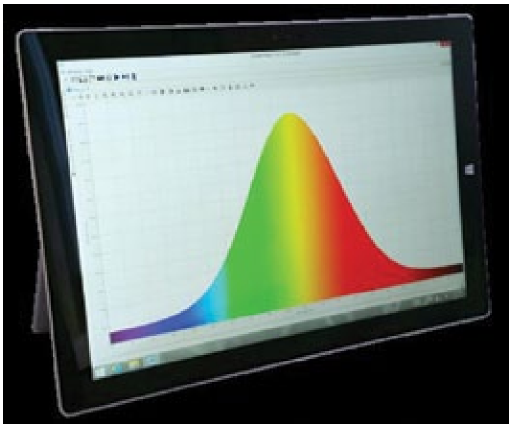
failure. The overall design and efficiency of the fixture will determine the amount of light produced versus the amount of energy lost.

A simple rule of thumb is that the hotter a lighting system runs, the less efficient it is. Heat equals loss of light energy, whether this heat is produced by the diode/bulb itself, excess heat from the ballast and controls, or even from light becoming trapped in the fixture. A well-designed fixture will passively dissipate most of its heat through thermally conductive heat sinks that comprise or are incorporated into the fixture.

Fans help fixtures dissipate heat faster, but I consider fans to be like cold remedies. They help alleviate the symptoms (heat) but do not eliminate the cause(s) of the problem. Should a fan fail, particularly on a higher-wattage fixture constructed without attention to passive thermal management, the results are usually catastrophic.

The quality of LEDs used, thermal and optical design, and build materials can also vary greatly, so it is important to rely on a trusted supplier when purchasing any aquarium lighting system. Depending on the light fixture, as much as 75% of the radiant energy it produces is emitted in the form of ultraviolet radiation, infrared radiation, and heat. Ballasts, power supplies, and even LED drivers, which also contribute to this loss, are given what is known as a power factor. This power factor is a measure of electrical efficiency and is always less than 1 (which equates to 100% efficiency). This factor accounts for the amount of energy lost during the conversion from electrical input at the wall plug to the device or lamp itself.

To arrive at the optical output of a device, take the wattage or power consumption and multiply it by the power factor(s) of the



The reading from a spectrometer displays measurements of available energy at specific wavelengths. Image by Ocean Optics.

lighting system. Then multiply that number by the luminous efficacy of the light source.

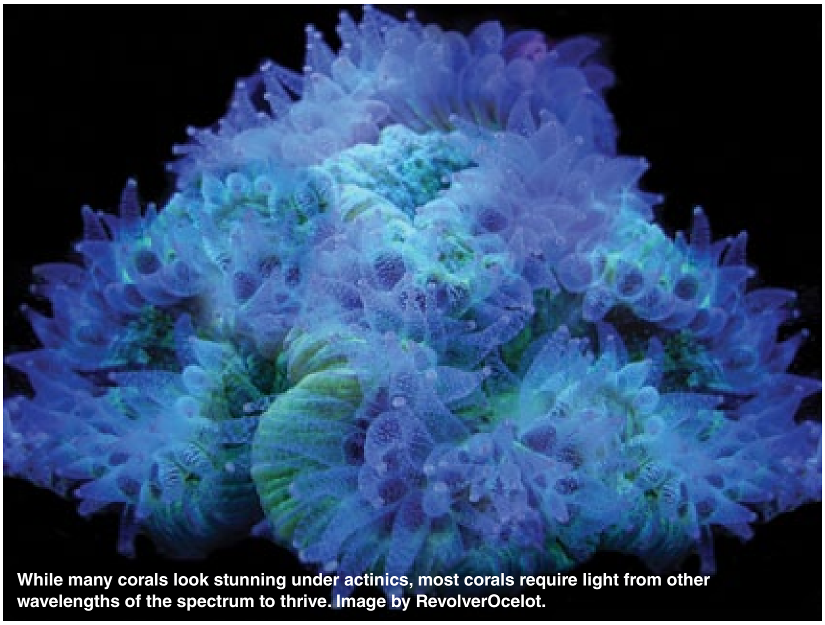
MEASURING LIGHT

I would like to note here that the only tried and true way of measuring the appropriateness of a light source for any photosynthetic application is with the use of a spectrometer. I regularly use an Ocean Optics USB modular series spectrometer as a reference tool when testing batches of lamps or LED boards. Spectrometers allow you to determine spatial distribution across a light source's spectral output and provide accurate measurements of available energy at specific wavelengths. Unfortunately, spectrometers are usually very expensive and simply not practical for general aquarium use.

Another more common approach is to utilize a simple light meter, often used in photography, to measure lumens or foot candles. The visible light output of any light source is usually expressed in luminous flux, or lumens. In short, the performance of any light source, depending on application, is gauged by luminous efficacy, not by wattage. Luminous efficacy is the quotient of total luminous flux emitted and the total power consumed (lm/w). By comparing luminous efficacy, not only can we compare the relative luminous efficiency of different types of lighting, we can rank any light source in simple terms of lumens of output per watt. Now that we've discussed the total amount of light produced versus the watts consumed, we can further narrow our analysis to photosynthetic spectra.

A common method of measuring lighting for reef tanks is with the use of a PAR (photosynthetically active radiation) meter. The problem with relying solely on PAR values to judge reef or planted aquaria lighting is that they still do not give us a complete picture of the distribution of usable light produced. PAR readings only tell us how much photosynthetically active radiation is available in total. This can lead to some confusion. While a light source may appear to produce a lot of light (apparent brightness) and a high PAR value, it can still lack the necessary amounts of spectral energies at specific wavelengths to meet the requirements of photosynthetic corals, invertebrates, or plants.

A good example of why a PAR value doesn't tell the whole story is found in the high pressure sodium (HPS) lamp often used for street lights and horticulture. On a one to one basis, the PAR value produced by HPS lamps is actually equal to or greater



While many corals look stunning under actinics, most corals require light from other wavelengths of the spectrum to thrive. Image by RevolverOcelot.

than metal halide lamps, T5-HOs, and even LEDs. If you take a PAR meter and measure an HPS lamp, you would think that it was the greatest thing since sliced bread. Unfortunately, due to its deficiencies in the blue spectral range, it's not a lamp anyone would want to use by itself for most reef tanks.

The other problem with a PAR meter is that it does not measure all light sources accurately. If you call Apogee, a popular manufacturer of PAR meters, they will tell you that there is actually a correction factor you need to consider when measuring light with a PAR meter. This is due to calibration issues, types of sensors and filters used, error factors, and overall variations in quality. These issues apply to any PAR meter or light measurement device. When considering the purchase of a light meter, it is important to do some research in order to weigh cost versus performance. All quality light meters have error factors and require regular maintenance and calibration.

When discussing other terms used in regard to lighting performance, such as lumens, CRI (color rendering index), and even Kelvin, it's important to remember that these measurements were originally based on human-eye response. While the human eye can perceive approximately one million color variations, it in no way compares to the sensitivity of photosynthetic organisms and their needs for specific spectral energies in order to thrive. So, while your aquarium or reef may look great under certain lights, it's more important to pay attention to the very specific lighting needs of its inhabitants. Remember that it's your responsibility as a conscientious reefer to educate yourself in the science underlying our hobby. Then you can provide the best conditions for your animals and ensure you make wise equipment choices.


view of side 1

KIEN'S MIXED-REEF PENINSULA

KIEN TRAN
Images by author

Before I turned my 90-gallon system into a mixed-reef tank, it was a fish- and softies-only tank for a long time. I was actually quite content with just my fish for a while and never really thought too much about stony corals. Then it happened. In the spring of 2007, my family and I went on vacation to Maui where we had lots of opportunities to snorkel. I think we must have gone snorkeling at every site on Maui. That is when I fell in love with stony corals. Sure, it wasn't the Great Barrier Reef, but it was still quite amazing. When we returned from this vacation, I decided to make a small lighting upgrade and try my hand at keeping stony corals. Needless to say, like that marlin I caught in Maui, I was hooked. After covering every open inch of rock space with frags and colonies of LPS and SPS corals, I decided that my 90-gallon tank was no longer sufficient, so I started planning the upgrade of my entire system. Yeah, I got the bug.

Like every system upgrade, this was the perfect opportunity to apply all those lessons learned as well as gleefully repeat old mistakes. Surely, the sump won't overflow a second time in the exact same manner right? Right? I set out with a laundry list of key goals that I wanted to achieve. There were quite a few items on the list, but here is what I considered the big three. First, get the biggest tank that my budget, room, and time could comfortably manage. Next, get the right hardware for the job. How many times have we bought a piece of hardware only to find it woefully inadequate? Last but not least, focus on the aquascape. During the build-out process, the aquascaping was always on my mind. I've had rockslides in the past, and I hate rearranging rocks. I envisioned a very open aquascape with plenty of room under and over the rocks for fish to swim. I didn't want to stack rocks, so I researched the use of acrylic rods and zip ties to secure the structure. With all of these goals in mind, I was ready to open a new chapter (and my wallet—ouch!).

SYSTEM

The main system consists of a 150-gallon tank (72 in. × 24 in. × 20 in.), which is filtered by a 45-gallon sump underneath. The main tank is eurobraced with an external overflow box at one end.


The display functions as a room divider.


Acrylic rods and zip ties were used to build the aquascape.

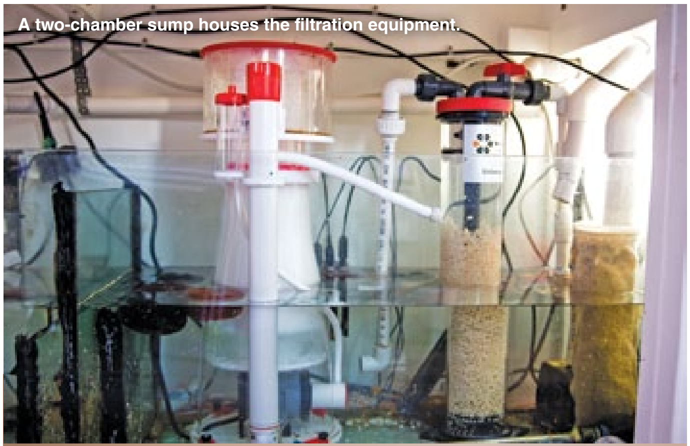

view of side 2

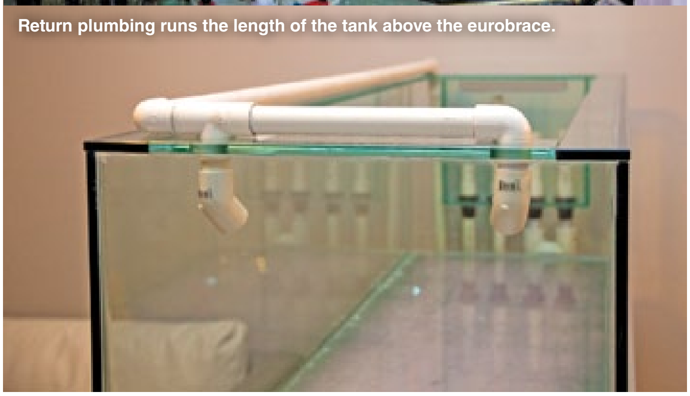
The overflow box houses three 1-inch drain pipes. This overflow employs the Herbie System for noise dampening. Two standpipes are merged to form the main overflow, and the third acts as the emergency drain. The return plumbing consists of a 1-inch pipe that runs from the return section of the sump up and over the top of the tank. This then runs the length of the tank and drops into holes that are drilled through the eurobrace at the opposite end from the overflow.

The sump is a two-chamber design that houses a skimmer, thermometer, heaters, reactors, and probes. The two sections are separated by three baffles that function as a bubble trap. The main chamber houses the skimmer and bio-pellet reactor while the secondary chamber houses the return pump.

The tank sits on a wooden DIY stand made from 2 by 6s. It was primed, sealed, and painted white with water-resistant paint and does a great job of repelling water. The 2 by 6s are skinned with white Ikea cabinet door panels on three sides, which are simply held in place by magnets. The stand is topped with a pre-fabricated Ikea countertop.


Door panels are held in place by magnets.


A two-chamber sump houses the filtration equipment.

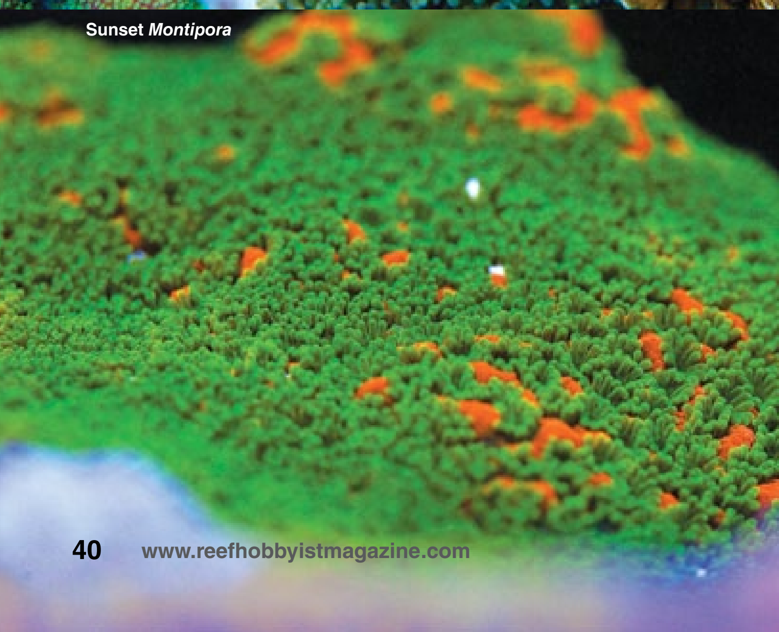

Return plumbing runs the length of the tank above the eurobrace.


Aussie gold torch


Orange and green plate coral


Acropora austera


Pink branching *Cyphastrea*


Sunset *Montipora*


Acropora plana

Poison Ivy *Acropora*

Multicolor *Stylophora*

The entire system is a peninsula that functions as a room divider between our living and dining rooms. This has always been my favorite positioning for a tank as it presents three viewable sides (two long and one short). With any tank there is the customary maintenance schedule. I have determined that the scope of the maintenance required is directly proportional to the algebraic equation where 't' is the time you put in, 'm' is the money you've spent on the tank, and 's' is the size of said tank, plus $42.42 for good measure. Yes, the journey can be a bit of a rollercoaster ride, but the rewards are wonderful.

HARDWARE

Controller: Profilux Plus III with ORP, temperature, salinity/conductivity, pH probes, and water-level sensors

Lights:
- 72-inch Sunlight Supply Maristar combo fixture
- (3) 250-watt Phoenix 14,000K DE HQI halide
- (4) 39-watt ATI SuperBlue Plus 22,000K T5
- (2) Profilux SimuSpot (controlled by the Profilux controller)

The red sunrise/sunset LEDs are on in the mornings from 9:30 a.m. to 10:30 a.m. and again in the evenings from 9:30 p.m. to 10:30 p.m. The 22,000K T5s are on from 10 a.m. to 10 p.m. and the 14,000K halides are on from 1 p.m. to 7 p.m. Every Monday, Wednesday, and Friday at midnight, there is a lightning storm (white LEDs flash randomly). Moonlights are on following the natural cycle of the moon.

Skimmer: Bubble Magus Curve 9

Return Pump: MagDrive 18 (1800 gph)

Powerheads: (2) Jebao-RW8

Reactors: Vertex Aquaristik UF 20 universal media reactor with 1 liter of NP bio-pellets powered by a generic pump

Heaters:
- (1) Stealth 250 watts
- (1) JBJ 250 watts
- (1) Jager 250 watts

Doser: Profilux 3-pump doser (controlled by Profilux controller)

Auto Top-Off: two switch (main and emergency) top-off system

Miscellaneous:
- Profilux digital power bars
- Profilux Propeller Breeze 4 fan

The Profilux controller is the brain of the system.

DIVINELIGHT

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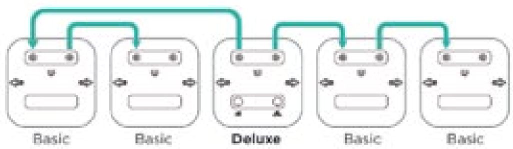

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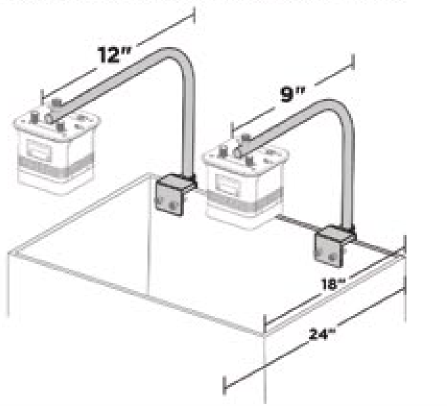

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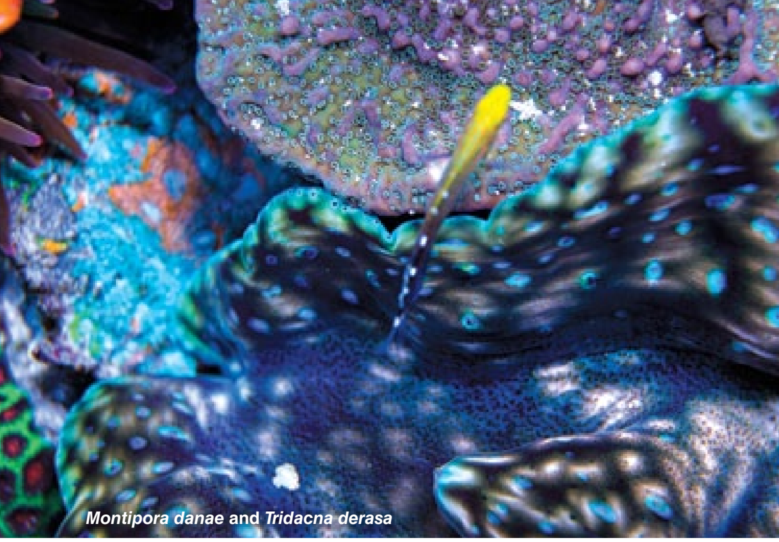
Montipora danae and Tridacna derasa


Meteor Shower Cyphastrea

- Profilux View II Display Panel (a heads-up display for the tank if you will)

MAINTENANCE

Cleaning:
- Every 3 to 4 days: clean glass with a Mag-Float
- Every 5 to 7 days: clean out the skimmer's collection cup
- Every 2 weeks: 15% water change with H2Ocean or Reef Crystals
- Every 6 months: top up the bio-pellet reactor
- Once a year: replace all bulbs

Testing: The controller gives me a constant view of the salinity, pH, temperature, and ORP, so the only weekly tests are alkalinity and calcium. I also test magnesium once a month.

Feeding: I feed a combination of Formula 1 and 2 flakes, pellets, nori sheets and homemade fish mush consisting of *Mysis*, scallops, shrimp, clams, squid, and octopus. I like to feed a large variety so that the type of food is alternating every few days. The frozen food is pre-soaked in garlic. My fish are fed three times a day. First thing in the morning, a sheet of nori is placed in the tank for the fish to nibble on. Then midway through the day, an automatic feeder kicks in and drops flakes and pellets into a feeding ring. Finally, in the evening about an hour before the lights go out, I hand feed frozen foods. Every few days, I will whip out the turkey baster and spot feed my LPS corals.

Dosing, Additives, and Supplementation: The only additives I regularly add to the tank are sodium carbonate for alkalinity and dry calcium. I mix up the two-part based on Randy's two-part formula. This has worked out quite well for me, and once the depletion rate is determined, there is very little fussing involved. The two solutions are mixed every couple of weeks and stored in 4 L jugs. The controller doses the two on an alternating 2-hour interval from 2 L soda bottles. A total of 37 ml of alkalinity and 57 ml of calcium are dosed per respective dosing event (8 times a day). I inspect the bottles every day during feeding to observe the depletion and


Red Bubble Tip Anemone and clownfish


Zoanthid garden

top up if necessary. Magnesium is dosed on an infrequent basis as required.

Parameters:
- Salinity: 1.026 (~35 ppt)
- pH: 7.9 (night)–8.4 (day)
- Temperature: 77° F (night)–80° F (day)
- Alkalinity: 8 dKH
- Calcium: 420 ppm
- Magnesium: 1300–1400 ppm

I perform roughly 10 to 15% bi-weekly water changes. For salt, I like to alternate between using H2Ocean and Reef Crystals. For nutrient export, I utilize NP or Vertex bio-pellets in a reactor. Every few days, I inspect the reactor to make sure the pellets are tumbling efficiently and monitor their depletion rate.

LIVESTOCK

Fish:
- Blue/Hippo Tang (*Paracanthurus hepatus*)
- Powder Blue Tang (*Acanthurus leucosternon*)
- Purple Tang (*Zebrasoma xanthurus*)
- Yellow Tang (*Zebrasoma flavescens*)
- Regal Angelfish (*Pygoplites diacanthus)*
- Lyretail Anthias (*Pseudanthias squamipinnis*)
- Melanurus Wrasse (*Halichoeres melanurus*)
- Candy Hogfish (*Bodianus bimaculatus*)
- Leopard Wrasse (*Macropharyngodon meleagris*)
- Four-Stripe Damsel (*Dascyllus melanurus*)
- Diamond Goby (*Valenciennea puellaris*)
- Yellow Watchman Goby (*Cryptocentrus cinctus*)
- Orchid Dottyback (*Pseudochromis fridmani*)
- Ocellaris Clownfish (mated pair) (*Amphiprion ocellaris*)

Non-Coral Invertebrates:
- (4) Skunk Cleaner Shrimp (*Lysmata amboinensis*)
- (2) Fire/Blood Shrimp (*Lysmata debelius*)
- (4) Sexy Shrimp (*Thor amboinensis*)
- (2) Glass Anemone Shrimp (*Periclimenes brevicarpalis*)
- (4) Pom Pom Crab (*Lybia tessellata*)
- Porcelain Crab (*Neopetrolisthes maculosus*)
- Orange-spined Sea Urchin
- Blue Linckia Starfish (*Linckia laevigata*)
- Orange Linckia Starfish
- Purple Linckia Starfish
- Red Reef Starfish
- Marbled Starfish
- Sand Sifting Starfish
- Red Bubble Tip Anemone
- Red Coco Worm
- lots of snails and hermit crabs

Corals: various SPS, LPS, zoanthids, mushrooms, and a few softies (*Xenia* sp., leathers, etc.)

ECOTECH MARINE
VorTech MP40w QuietDrive

JIM ADELBERG

Here at RHM, we think it's important to keep our readers well informed on the latest quality equipment available to our hobby. And so we are grateful that Ecotech has sent us their new MP40wQD for review. In case you're new to reefkeeping, we're now almost at the decade mark since the release of the original MP40 (December of 2005). Ten years ago, there were very few options for diffuse, powerful, programmable water movement, and what systems were available required that large pumps be mounted inside the aquarium and were relatively expensive. The introduction of the MP40 (followed-up with other MP sizes, features, and upgrades) fundamentally changed the water flow options for our tanks. And in the 10 years since, Ecotech has consistently offered excellent customer service and has developed a reputation for standing behind their products 100%.

Before beginning the installation of any new product on your aquarium, it's important to read through the manual fully. And here you will find some obvious clues that you are dealing with a quality company. After alerting the new owner to read the whole manual first and listing the manual's table of contents, customer support information immediately follows. As well as being clearly written with good pictures, the manual also contains links to a number of videos that will clarify certain procedures, like wet-side disassembly. After following the installation instructions, I observed the green driver light turn to a steady green (indicating constant-speed mode), but I literally heard nothing and had to observe the water movement to see that it was actually putting out a good amount of flow. Ecotech notes that the new QD (QuietDrive) pumps produce 90% less motor noise. I can certainly confirm that the new MP40wQD is considerably quieter than the MP10w it replaced on my tank. Next, I brought the pump up to around 75% full power in constant mode and listened again. Now I could hear the tiniest bit of motor noise, but the flow was so strong I had to reduce the power right away. Ecotech notes a 40% increase in power over the MP40wES, and that seems accurate to me. Next was a quick tour through the different modes offered on the driver. These will be familiar to many of us.

Constant Mode: self-explanatory

Tidal Swell Mode: chaotic flow, followed by calmer flow, then a detritus clearing surge with subsequent reversal of the cycle; just what you think would happen in the wild

Nutrient Transport Mode: first stirs up and then moves detritus along to the overflows where it can be removed from the system

Short Pulse Mode: a series of short pulses, just like you thought

Gyre Mode: allows you to set longer pulses to create gyre effects

Reef Crest Random Mode: high energy reef crest simulation

Lagoonal Random Mode: low energy lagoonal simulation

Please be aware that with the additional flow that this pump puts out, it would be very easy to create a large reinforcing wave that can't be contained within the tank. I think that's known as the do as I say, not as I do effect.

The MP40wQD carries an MSRP of $349.00, and while that's certainly more expensive than some other options, there are a few reasons why I think this pump is a good buy. First of all, there are many control options. Ecosmart Live is Ecotech's web-based control center where you can customize and integrate all your Ecotech pump and lighting functions. It also allows very precise customer support and is accessible through browser, Android, or iPhone. Of course, you can also control all the pump modes and settings with the included driver, which is very intuitive. The second reason is that Ecotech has always been very good at offering aftermarket upgrades that bring the newest features to previously purchased units of the same model at a price considerably less than buying a new unit. This tradition continues with a line of QD upgrades to retrofit your older MP pumps. The last reason is that this pump is very close to silent. We all enjoy the calming effects of our tanks and may not even be aware of the background noises that are impacting our experience, but once that noise is gone, you'll thank yourself many times over for choosing this pump.