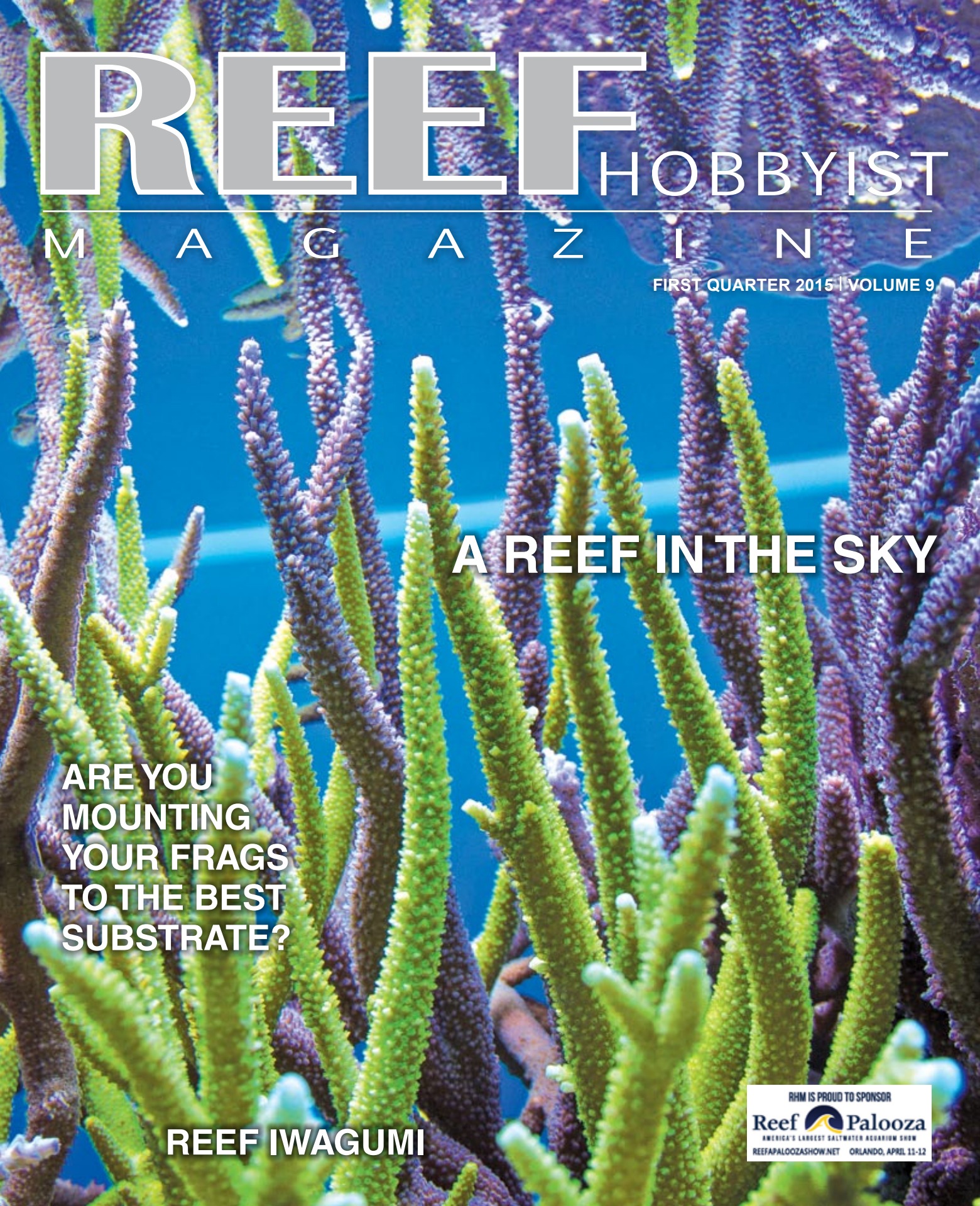
REEF HOBBYIST MAGAZINE

FIRST QUARTER 2015 | VOLUME 9



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- **Reef-A-Palooza Orlando:** April 11-12, Orlando, FL – reefapalooza show.net
- **OSRAS Reef Conference:** April 19, Warwick, RI – osrasconference2015.com
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NEW PRODUCT SPOTLIGHT

ANDREW GRAHAM

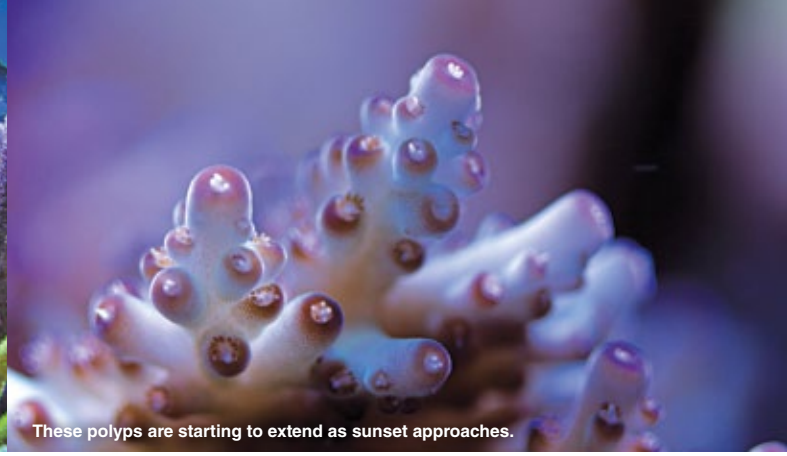
A REEF IN THE SKY

My name is Andrew Graham, and I am from Australia, but currently live in Hong Kong due to work commitments. Growing up, I had a strong interest in marine life, and I always had various goldfish and tropical fish tanks. I'd always wanted a saltwater aquarium showcasing beautiful corals and fish and decided once I moved to Hong Kong that I would finally try my hand at it.

My first saltwater aquarium was a Red Sea Max (RSM130) that I set up back in 2008. I maintained that aquarium for 17 months and gradually became accustomed to the basics of keeping fish and corals. The RSM130 is certainly a great all-in-one saltwater aquarium for beginners, and I'd highly recommend it for anyone starting out in the hobby. Roughly 9 months after setting up the RSM130, I realized that I was addicted to this hobby and wanted a larger tank that could house more corals and fish. I'd seen how wonderful SPS coral tanks looked and wanted to try to recreate what I'd seen, although I knew from my research that it would be challenging.

So I began planning for what is now known as "A Reef in the Sky." I wanted to incorporate new ideas that made my everyday chores easier and push boundaries that I hadn't tried or perhaps even seen tried before. My planning process was very detailed—some might say over the top. However, I attribute the success I have had over the past 5 years to this detailed planning.

Many of the acros have grown beyond the water level.



These polyps are starting to extend as sunset approaches.

My primary goal was simple; I wanted to successfully keep and grow SPS corals, as this was still seen as a challenge in the reefing community at that time. To achieve this, I decided to embark on the Zeovit method. Much had been written about this method over the years, and I liked the results that I saw in other aquariums. I have been using this method for almost 5 years now, and I am very happy with it. There was a lot of reading and research required before starting down this road since in our hobby, many things can go wrong quickly without proper preparation and understanding.

My secondary goal was to have an aquarium that looked like a piece of art in my living room. To achieve this, I had to design the tank and stand so that it looked stylish and modern. Plus, it had to operate very quietly (no pump or water-flow noises). I elected to design a rectangular-shaped tank, and due to space limitations in my old apartment, it had to be designed with an internal overflow, something I would not do again if space wasn't limited. To enhance the clean, modern look, I decided to make it a rimless tank. These types of tanks have become more popular and give a very clean, sharp look, which is what I was after. I also decided to steer away from the traditional rock wall of many SPS tanks and instead create an open rock structure that had islands and plenty of sand bed showing. The idea was to allow for better flow and more areas for fish to swim. To give a feeling of openness and depth, I designed a custom fading blue decal for the back of the display tank.

Choosing the right light unit was very important to me, as it would affect the overall appearance of the aquarium. I chose a fixture that had proven capable of growing SPS and also created the illusion of floating above the tank, emphasized by clean-cut lines and minimal cords and cables. The appearance was enhanced by having an electric light lifter, which also simplified tank maintenance.

This was the initial setup before the move.

THE MOVE

Not many people would want to dismantle a fully established saltwater aquarium and set it up again, but that was my task back in 2011 after my wife and I elected to move. The aquarium was running well, and the corals were growing nicely, so the move had to be planned carefully. I took the opportunity at this time to redesign and remake the stand. The previous steel stand had too much rust, and some of my initial designs weren't being utilized or were just not efficient. The redesign allowed me to create an electrical section that adds to the display's clean, modern look. Currently, the tank has been running nicely for over 3½ years.

FILTRATION

Filtration is a very important topic for anyone wanting to keep SPS corals. My sump consists of two main sections, and there is a third, smaller section that receives the water draining from the display tank and minimizes the spread of micro-bubbles. Water passes through the skimmer chamber before flowing through the bubble traps and into the return section, which houses the Zeovit reactor, chiller, return pumps, and a carbon bag. There is minimal live rock in the display tank and a shallow layer of sand. I only use filter socks fitted to the drains for 24 hours after performing a water change, and I often stir the sand bed. The Vertex 200 skimmer is the backbone of the system, and it does an extremely good job. The skimmer cup is cleaned weekly during water changes.

LIGHTING

As I mentioned earlier, I elected to go with a stylish and proven light system for keeping SPS corals. The initial unit was an ATI Powermodule (8 × 80 watts). However, as interest was growing within the reefing community around LED lighting, I decided to try two Eco-Lamp KR93SP LED units. Switching to LEDs was a big gamble, and although I had success with the Eco-Lamps, after some debate, I decided that I would return to using the ATI Powermodule. I liked the colors T5s gave and missed the clean look of a single unit floating above the display tank.

Around 15 months ago, I upgraded and combined the best of the two lighting options and now use the ATI Hybrid 8 × 80-watt T5s with 4 × 75-watt LEDs. I particularly like this unit because it still has that clean and stylish appearance and each of the four clusters of LEDs can be adjusted to represent any of the ATI bulb colors. In my opinion, the combo T5/LED light fixture is the future of reef lighting.

This is one of many colorful and dense *Acropora* in the display.

The ATI Powermodule appears to be floating above the rimless tank.

Electrical section

Filtration system

XStream 3500
120V - 60 Hz
925 US gph
4 w
up to
Marine Water 70 US gal
Fresh Water 105 US gal

XStream 5000
120V - 60 Hz
1320 US gph
6 w
up to
90 US gal 130 US gal

XStream 6500
120V - 60 Hz
1720 US gph
9.5 w
up to
120 US gal 200 US gal

XStream 8000
120V - 60 Hz
2120 US gph
14 w
up to
150 US gal 250 US gal

XStream-E
120V - 60 Hz
from
800 US gal
to
2250 US gal
6-16.5 w

XStream
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Enhances aeration and filtration.

XStream-E
wave pump

5 Speed Modes from 800gph to 2250gph

4 Pre-set Timing Programs:

• Short Pulse	5 sec
• Medium	20 sec
• Long	30 sec
• Random	Random

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WATER CIRCULATION

Good, strong water circulation in the display tank is an important factor in keeping corals healthy. Since my corals have grown so much over the years, the flow within the tank has been reduced. I haven't elected to purchase any more pumps for the time being, but I often move the pumps around to maximize flow.

The display tank has two Tunze 6105s (one at either end), which are controlled by a Profilux controller. An EcoTech Marine MP40W ES and MP20 are located at either end of the tank as well. There is a Tunze 6055 located on the side of the overflow to provide extra flow behind the corals. About a year after moving the tank, I elected to place a Tunze 6045 pump in each of the two main sections of the sump. Both are pointed toward the bottom to prevent detritus from settling. It has helped dramatically and reduced the time required when cleaning the sump. A Red Dragon 6500 return pump ensures a solid amount of water is circulated through the display each hour.

MAINTENANCE, FEEDING, AND ADDITIVES

The tank is monitored by a GHL Profilux II controller, which I have elected not to upgrade since 2009. The controller monitors temperature and pH and controls various equipment. Heaters are only connected for approximately 3 months of the year, and the chiller operates the remaining 9 months. I've been using ESV B-Ionic Calcium Buffer 2-part System (alkalinity and calcium) for almost 5 years and am extremely happy with this product. Both components are automatically dosed multiple times per day at 10-minute intervals directly into the sump. There is no need for me to dose magnesium as I find it is maintained nicely by my weekly water changes and dosing the 2-part B-Ionic. Dosing has become more expensive recently due to the size of the corals and

their daily intake requirements. I would most certainly consider a calcium reactor upgrade in the future.

Just over 1.5 L of zeolite media is used, and approximately 90 percent is changed every 6 to 7 weeks after letting the new media soak in RO water for 1 to 2 days. My Zeovit supplements are constantly changing as I try new dosing patterns and amounts. The current dosing schedule is as follows:

Zeostart: 0.45 ml (2 times per day)
Zeobak: 6 drops (2 times per week)
Biomate: 6 drops (2 times per week)
Food 7: 4 drops (2 times per week)
K-Balance: 3 ml (4 times per week)
Spur2: 3 ml (every 9 to 12 days)

The fish are generally fed once per day, and I feed various small Ocean Nutrition pellets and seaweed in addition to some frozen food a couple of times a week.

In my opinion, tank maintenance is very important, and I'm often asked how the tank is kept so clean. Below is a list of my chores.

Daily: replenish Zeovit supplements, clean glass, feed fish, monitor sump water level, and top off if required
Weekly: do water change (23 gal.) using Korallen-zucht Reefer's Best Salt
Monthly: change carbon, change zeolites (every 6 to 7 weeks)
Ad Hoc: clean various pumps, clean skimmer, change T5 tubes

WHAT WOULD I CHANGE?

I feel that I have achieved most of my goals with this tank, and the journey has been fantastic. Over the years, I've realized that I could tweak or change a few elements of the tank to make it run and perform even better. If I had my time over again, I would choose an external overflow. This would dramatically improve water movement within the tank and would also allow easier maintenance for cleaning plumbing parts. Secondly, the sump would have greater space between the baffles to make cleaning and general maintenance easier. Thirdly, I would have stirred the sand bed during every water change rather than once every 4 to 5 water changes like I used to do. If the sand is not stirred regularly, large pockets of organics may develop, which can be dangerous when stirred up into the tank.

Side view of the display

And finally, I would create space to run a calcium reactor to help keep up with the high calcium demand.

The best experience over the recent years has been watching the corals grow and taking photos every few months. The biggest and most important lesson I've learned is to have patience. Avoid touching and moving the corals. With time, your corals will thrive and look beautiful.

SYSTEM SUMMARY

Display Tank: ~145 gallons (66 in. × 26 in. × 22 in.)
Sump: ~40 gallons (46 in. × 22 in. × 15 in.)
Lighting: ATI Hybrid LED (8 × 80-watt T5s with 4 × 75-watt LEDs)
Display Circulation: (2) Tunze 6105, (1) Tunze 6055, (1) MP40W ES, (1) MP20
Sump Circulation: (2) Tunze 6045
Skimmer: Vertex Alpha 200
Return Pump: Red Dragon 6500
Chiller: Arctica DBA-250
Chiller Pump: Red Dragon Mini 5000
Reactor: Zeovit Reactor
Controller: Profilux II
Doser: Profilux 4-way
Heater: (3) 50 watts

WATER PARAMETERS

Specific Gravity: 1.025-1.026
pH: 7.8-8.2
Calcium: 380-400 ppm
Alkalinity: 6 dKH
Phosphate: 0.02-0.04 ppm
Temperature: 27° C-27.5° C
Potassium: 380-400 ppm
Nitrate & Magnesium: not tested

CORALS

Acropora prostrata
Acropora formosa
Acropora millepora
Acropora tenuis
Acropora tortuosa
Acanthastrea lordhowensis
Duncanopsammia axifuga
Favia sp.
Montipora capricornis
Scolymia australis

FISH & INVERTEBRATES

(1) Blue Hippo Tang (*Paracanthurus hepatus*)
(1) Yellow Tang (*Zebrasoma flavescens*)
(1) Achilles Tang (*Acanthurus achilles*)
(3) Lyretail Anthias (*Pseudanthias squamipinnis*)
(1) Bartlett's Anthias (*Pseudanthias bartlettorum*)
(2) Clownfish (*Amphiprion ocellaris*)
(1) Magnificent Foxface (*Siganus magnifica*)
(2) Black Sea Cucumber (*Holothuria atra*)
(2) *Tridacna maxima*
(1) *Tridacna derasa*

ACKNOWLEDGMENTS

"A Reef in the Sky" would not be possible without the assistance of my wonderful wife, Christine. She not only looks after the tank while I'm away on work trips but has a strong interest in the hobby herself. Thank you to *Reef Hobbyist Magazine* for letting me share my aquarium and experiences. I would also like to thank the many others who have followed "A Reef in the Sky" and its progress over the years on various forums. I enjoy sharing my experiences and ideas, so if you are ever in Hong Kong for travel or business, feel free to contact me through the forums. Happy reefing!

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Image by Tim Wong.

STU WOBBE

EXPLORING COLD-WATER REEF TANKS

For as long as I can remember, only the most advanced marine aquarium hobbyists attempted to keep species from cooler waters with required temperature ranges well below tropical. There was essentially no cold-water hobby, and that was caused by a lack of two things: available livestock and readily available information on keeping these systems. All of that has changed in the past few years, though. In this article, I will share some of the advances in the cold-water hobby and a bit of accumulated knowledge gained from my experiences and those of others.

Before I get into the nitty-gritty of it all, I'll tell you about how I came to love temperate marine life. My interest began in my early years tide pooling and fishing on the Oregon coast. I always wanted to bring home a crab or fish that I'd caught. Inevitably, my father would have me dump my small collection bucket of critters back into the ocean, and we'd head home with some Dungeness crab and salmon for dinner. In my teenage years, I finally tried keeping some of those animals long term. Using a 20-gallon glass tank and a DIY chiller from an old mini fridge, I was able to bring home my first little collection of animals. Moderate success followed. I was able to keep that tank in the low 60s and watched as colorful nudibranchs and anemones proliferated in a mostly condensation-covered home aquarium. As happy as I was that my tank was semi-functional, it left a lot to be desired as a worthy display of temperate marine

This *Urticina piscivora* is a fish-eating anemone. Image by RHM.

Corynactis californica polyps put out their tentacles to capture any zooplankton that may pass by. Image by Tim Wong.

life. Eventually, that tank came down, the animals were donated to the local community college, and I put the temperate-tank idea on the back burner to focus again on my tropical marine aquariums.

In 2009, I again had the opportunity to take a stab at my childhood desire. I was able to purchase a used Marineland lobster tank for a whopping $150, and it was game on! This time, before even getting my hands wet, I dug in and researched what advances had been made in keeping temperate marines in home aquariums. To my dismay, not much had changed and there was still a dearth of easily available hobbyist information. So I started looking online for other people who might have tried their hands at a cold-water reef. Luckily, a lot of the information I lacked at the time had been gained by an iconic local reef keeper, Steve Weast. Steve was kind enough to share the information he had gained keeping his own temperate tanks. I had only seen some of his spectacular fish and invertebrates in books before, and I dreamed of keeping some of these rarities myself.

With inspiration from Steve's beautiful aquariums and a desire to do what only a handful of people had done, I once again dove into the world of keeping cold-water tanks.

From that point on, I started setting up more and more cold-water aquariums and helping others with the same interest to do the same. I was collecting my own livestock and inviting enthusiastic people to join me. I was constantly searching for new temperate livestock from around the globe for my tanks and not finding much readily available. Looking for temperate livestock used to be quite the chore, to say the least. Most people relied solely on collecting specimens on their own and working within the local restrictions put in place for recreational sport fishing. For me, that works passably well, but for the vast majority of people who live nowhere near the ocean or in areas where personal collection is heavily restricted, livestock sourcing was a problem. These days, temperate livestock for your home aquarium is readily available from select retailers.

WHAT IS THE IDEAL TEMPERATURE?

One of the questions I get asked most often is, "What temperature should I keep my cold-water tank at?" The short and vague answer is, "At a temperature where your livestock will thrive." A temperature those animals would normally be found at in the wild

Blackeye Goby (*Rhinogobiops nicholsii*). Image by Tim Wong.

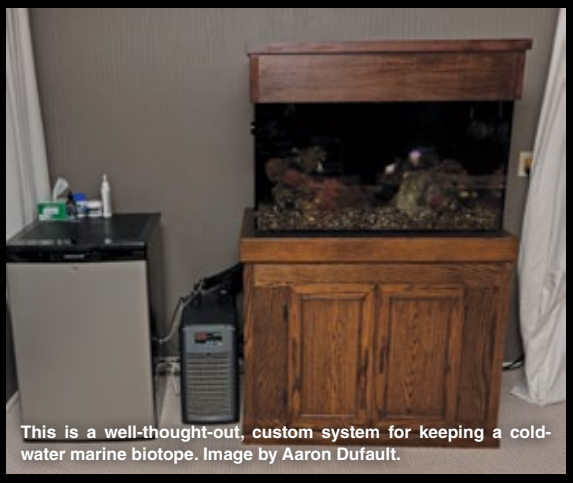
The Painted Greenling (*Oxylebius pictus*) can be highly variable in color and pattern. Image by Tim Wong.

is ideal. Many of the animals that are definitively considered cold or temperate water have a huge geographical range, as well as a huge temperature range throughout which they occur. Some of the same species occurring in the frigid waters of Alaska also occur in the beautiful swimming and surfing waters of Southern California. Researching the natural habitat of any animal you plan to keep is highly encouraged. And if you can go one step further and know the specific locales where your animals were originally collected, that is even better. Now, I imagine that if you've read this far, you might want a more definitive answer and might be thinking, "What's the number, buddy?" Well here it is. I personally run my own tanks anywhere from 55° F (12.7° C) to 60° F (15.5° C) since this allows me a good middle of the road temperature range at which I can successfully keep both inter-tidal and sub-tidal species. Now that I have my recommended temperatures out of the way, I want to say that they are just that, recommendations. I have seen many animals do extremely well in temperatures lower than that and many animals do very poorly in temperatures just slightly higher. So what does this mean to a hobbyist looking to begin keeping a cold-water aquarium? The best advice I can give to anyone in reference to temperature is to pick a temperature and stick to it. The more stable your temperature is, the more stable your system will be. The lower the temperature is, the more oxygen your water will retain. Remember that over time, your fish become acclimated to whatever temperature range they're kept at, and temperatures outside of this range can be very stressful.

WHY DO I NEED THICK ACRYLIC?

The reasoning behind using acrylic for cold-water tanks is simple; it insulates and it's readily available. Even the thickest of glass aquariums will just not insulate the water volume as well. Things like dual-paned glass panels with a sealed gas void are used, but usually only on commercial lobster systems. These tanks are not often available to the average home aquarium keeper.

In an ideal world, every cold-water tank would be made of extremely thick acrylic. Lots of public aquariums use acrylic so thick on their cold-water displays that it could stop a bullet. The problem for most people is that acrylic gets more expensive the thicker it is. Ideally, 1-inch-thick acrylic would be the most bulletproof (no pun intended) solution to insulating the water and preventing condensation on the outside panels of a cold-water system. However, 1-inch-thick acrylic is not always in everyone's budget for a tank. For that reason, I played around with a lot of acrylic thicknesses in the past to figure out what the best bang for your buck is in regard to thickness versus insulating capacity. I've found that ½-inch-thick acrylic is the thinnest you can use while still providing a modest amount of thermal barrier between the outside air temperature and the water temperature (in order to prevent condensation in most cases). With ½-inch-thick acrylic, you get roughly a 5 degree (F) thermal barrier between the inside water and the outside of your tank. That value is doubled with a 1-inch-thick acrylic tank to a 10 degree thermal barrier. This means that if your target water temperature is 57° F, the outside of a ½-inch-thick acrylic tank would be about 62° F. Once you know the temperature on the outside panels of your tank, you can figure out what environmental conditions might cause condensation on your cold-water system by using a dew point calculator like the one at www.dpcalc.org.



This is a well-thought-out, custom system for keeping a cold-water marine biotope. Image by Aaron Dufault.

Refrigerated auto dosing of foods works well with cold-water NPS systems. Image by Aaron Dufault.

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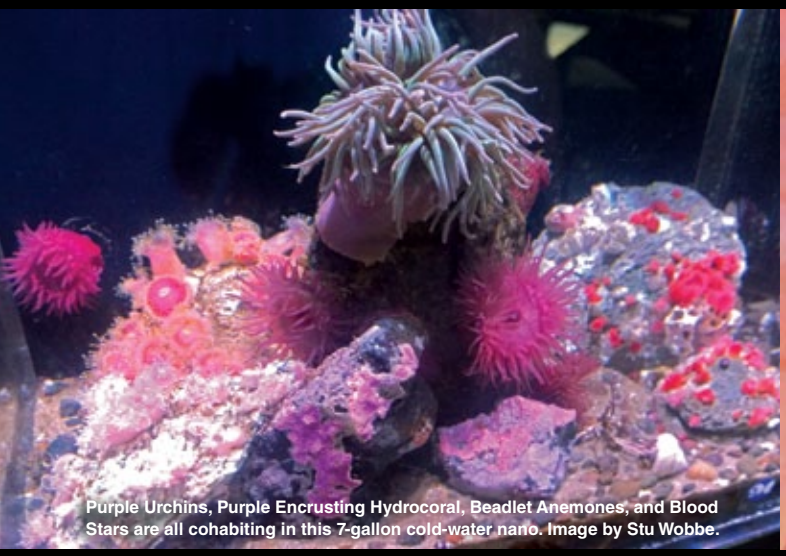

Purple Urchins, Purple Encrusting Hydrocoral, Beadlet Anemones, and Blood Stars are all cohabiting in this 7-gallon cold-water nano. Image by Stu Wobbe.

Lumpsuckers and lumpfish are adorable, unusual, entertaining fish. Atlantic Lumpfish (*Cyclopterus lumpus*) such as these have even been trained to perform tricks for food at public aquariums. Image by Stu Wobbe.

There are, however, some circumstances when condensation simply cannot be prevented, like when the humidity in the air surpasses the temperature or when both are so high it's just incredibly uncomfortable. In cases like that, you'd likely be more concerned about the high humidity in your home causing mold damage than about your aquarium sweating.

The best thing you can do is get the thickest acrylic that you can afford; you won't regret it. It will help to better insulate your tank and prolong the life of your chiller by allowing it to run less often.

TANKS FOR TEMPERATE SYSTEMS

For the tank itself, there are a great many resources. Even tanks that you might see on a regular basis could be used for a cold-water aquarium. The key is making sure the acrylic is thick. Many frag tanks currently use fairly thick acrylic to accommodate being completely rimless, and these would make amazing top-down tide-pool tanks. Local custom acrylic tank makers will usually whip something up in thicker acrylic by request. Start with your local fish stores as they may already have access to what you're looking for.

A White-spotted Rose Anemone (*Urticina lofotensis*) retracts its tentacles as it pulls food toward its mouth. Image by Tim Wong.

DO I NEED A CHILLER?

You will without a doubt need a chiller to successfully keep a cold-water system. A chiller is the life support system and heart of your tank, so make sure you choose the right one the first time. There is a bit of a balancing act involved in choosing a chiller. You'll want a large enough chiller to easily cool the volume of water you're working with, but at the same time, you don't want something loud and obnoxious sitting underneath or next to your display tank. I've never once regretted going with an oversized chiller, but many times, I've regretted purchasing an underpowered chiller. Usually, the underpowered chillers have been thermal electric chillers or TECs as they are sometimes called. I've gone through a number of thermal electric chillers hoping that they could handle the temperature load I put on them. All of them have come up short when pushed to cool any system larger than just a few gallons unless I add additional TECs to the system. Financially, this makes little sense, considering the price of a pair of small thermal electric chillers is the same as one small compressor-based chiller.

However, if you live in a house that uses air conditioning to keep the interior temperature stable year round, then that's a different story. If your house temp is stable at 70° F year round, and you want to keep a small cold-water tank in the low 60s, you should have no problem using a small thermal electric chiller.

So my advice is to take advantage of the information readily available to you. Ask others who have used a chiller of the type and brand you may be considering, and do a little Google research for reviews of chillers online.

The chiller I use on my 7.2-gallon cold-water nano tank is a $^{1}/_{13}$-horsepower Resun Mini 200 compressor chiller that uses 200 watts of power when running. It runs for about 5 minutes every 45 to 60 minutes (about 60 hours of use per month), which costs me $1.32 in electricity, or about $16 a year in chilling, on average.

Remember that the thicker the acrylic of your tank, the less you spend on chilling in the end, albeit a very little amount of savings

when running a nano. If I was to go with a 1-inch-thick tank of the same size as my existing one, it would only save me about 65 cents a month in chilling (not worth it in my opinion), but it would decrease my chances of condensation issues by 50 percent.

While not the most elegant swimmer due to its rounded body shape, the Pacific Spiny Lumpsucker (*Eumicrotremus orbis*) has a modified pelvic fin that acts like a suction cup to secure itself to rocks in areas of strong water flow. Image by Tim Wong.

This Vermillion Starfish (*Mediaster aequalis*) lives amongst *Corynactis* polyps and other corals. Image by Tim Wong.

LIVE ROCK FOR COLD-WATER TANKS

Live rock in cold-water tanks is not the same as its tropical counterpart. The rock itself is usually dense granite, unlike the porous, coral-based live rock from the tropics. This dense rock is used more for its aesthetic value than for filtration, so use rock that you know is safe in the aquarium and go with what is aesthetically pleasing to you. The majority of your biological filtration will not be happening in the rock. The best way to promote and establish needed biological filtration is through the use of ceramic bio-media, submersed bio-balls, or a good sand bed. The more surface area you can provide, the more bacteria you can establish and the higher the carrying capacity of your system.

CYCLING THE TANK

There are several ways to cycle your cold-water system. You can introduce small amounts of livestock and slowly build your bioload while monitoring your water chemistry. You can introduce live sand, algae, and rock rubble from another established system. A third option is to use some of the commercially available (bottled) fast-cycle products to jump start your cycle. I've tried all these methods and honestly have no preference since they all work. There really is no right or wrong way, just ways that take longer than others. In the end, as long as your system can remove or break down the waste being produced by the animals you are keeping, you are doing it right.

FILTERING THE TANK

Bacterial processes take a bit longer in cooler temperatures, so focusing on mechanical and chemical filtration to do the bulk of the waste-handling has proven effective. In my own small cold-water system, I use filter floss, bagged carbon, GFO, Chemi-pure, and an occasional water change, should things get out of whack. On my larger system, which has a fluctuating amount of livestock coming and going, I utilize an array of filtration options. Heavy skimming and filter pads do most of the physical waste removal, but additions such as algae turf scrubbers, refugia, and remote deep sand bed filters have all proven to be useful; I'm toying around with all of them currently.

The front insulation on this sump has been removed to show the filtration, which is very similar to that of a fish-only or NPS tank. Image by Aaron Dufault.

The end goal of filtering a cold-water tank is to allow you to feed all your animals well and then remove excess food and process waste as efficiently and quickly as possible. Many cold-water aquarium keepers compare their tank's upkeep to that of a fish only with live rock (FOWLR) tank or a non-photosynthetic tank, only with much cooler temperatures.

HOW MUCH LIGHT DO I NEED?

Optimal lighting for a cold-water tank depends quite a bit on what you plan to keep. LEDs put out the least amount of heat with the most light output for your dollar, so they are ideal for those cold-water systems where every degree of heat makes a difference. An LED fixture with a medium PAR output would be ideal if you plan on keeping any photosynthetic anemones like the Green Surf Anemones or Aggregating Anemones. Basically, the same amount of light you would put over a low-light reef tank, perhaps for soft corals or the like, will suffice. If you plan to keep deeper-water non-photosynthetic corals and anemones, then the lighting really comes down to personal viewing preference. Many cold-water aquarium keepers only turn their lights on to view their tanks. I like the look of RGB LED fixtures personally, since red is a fairly prevalent color in many of the cold-water anemones and this light makes the red stand out. Overall, there is really no need to heavily light a cold-water aquarium unless you intend to grow a lot of macro algae. Otherwise, you'll just end up wiping nuisance algae off the sides of the tank more often. Did I mention that I only have to wipe the algae off my cold-water nano once every couple of months?

FOR MORE ON TEMPERATE/COLD-WATER TANKS

If you have further questions about anything in this article, I've set up a dedicated Facebook group for us at www.facebook.com/groups/coldwaterowners. Those of you in local reef clubs or involved in online forums are welcome to post a thread and join the discussion. More than once, I've been surprised at how many people have thought about setting up a cold-water tank. As we share our experiences, our triumphs, and our failures in keeping these unique aquariums, we provide the stepping stones for the next person diving into the brisk and fascinating waters of temperate marine aquariums.

CHOOSE WISELY FOR ALL CONCERNED: FISH PURCHASING GUIDELINES

Image by author.

RICHARD ASPINALL

Your retail purchase is the most important one in the entire chain of custody from reef to tank, and your choices impact the whole hobby. As the person that drives the industry, you, the hobbyist, have the greatest responsibility to ensure you do business with the best stores and make the wisest purchasing decisions. In the end, buying the healthiest fish from the most responsible stores is in your best interest in every sense.

DO YOUR RESEARCH

Nearly every writer in the hobby will at some time have urged hobbyists to do some basic research. Yet I still hear of people who buy a tank full of fish online and then contact fish stores to ask how to care for their new charges. I still overhear shoppers in stores saying something along the lines of "That's a nice one. What's it called? Let's get it," with absolutely no awareness of that fish's diet, behavior, eventual size, temperament, etc. This is simply inexcusable when there are so many printed and online resources out there to help hobbyists plan their purchases to better achieve a harmonious aquarium and save lives (and money) in the long term. Put simply, don't buy a fish on a whim, read up on the species, consider your options, and only then look to buy.

In the olden days (if you're of a certain age, you'll remember the dark days before the interwebby), a good book or two was crucial. I still have and refer to a small library of tomes on a regular basis

for advice, ID, and the wealth of information imparted by the experts who wrote them.

We are now blessed with web-based media, which is often excellent, but can be driven by personal opinions or marketing concerns as much as a desire to inform. As ever, don't rely on one source only; seek out multiple voices and opinions and read around the subject. For example, a direct search may tell you what a fish eats but may not tell you its preferred habitat. If you are new to the hobby, the best advice I can give is to take your time and do your research. The chances are that you might not be aware of just how many things you are unaware of. In a sense, Rumsfeld was right with his "known unknown and unknown unknowns" speech.

This Naso Tang is a good example of a skinny, malnourished specimen. Image by Sabine Penisson.

This Yellow Tang is a good example of a well-nourished, healthy specimen. Image by author.

FISH HEALTH

Some fish are described as shipping badly, i.e., they suffer physiologically from the rigors and stresses of being caught, warehoused, shipped, held, and transported again between the wild and your aquarium. To me this suggests we need better methods of shipping some species, and we should carefully consider the purchase of species known to be problematic in this regard.

As an example of the above, I will mention the Copperband Butterfly. These are well known as fish that do not survive the entire capture and shipping process with ease and all too often succumb to disease or never start feeding once in the home aquarium. A good fish store will, in my opinion, carefully consider whether they stock these fish and will question potential keepers as to their knowledge of fish care before letting them take a Copperband home. If a fish store recommends that you not buy a particular fish, don't take this personally. It's a good sign, a sign that they are interested in keeping you as a customer over the long term by helping you choose fish that you can keep successfully.

HOW DO YOU DETERMINE IF A FISH IS HEALTHY?

I would refer you to my first piece of advice: Do your research! Find out what a healthy specimen of that species looks like. Take tangs, for example. The good old and oft-abused Yellow Tang is a constant grazer and needs large amounts of vegetable food to build up its body mass. Underfed tangs will clearly be skinny and show a shrunken appearance, with their skin almost looking as if it's stretched over their bones. Sunken areas behind the skull and the belly are indicative of ill health and may be related to internal parasites, organ damage, or more likely, a lack of specialized feeding.

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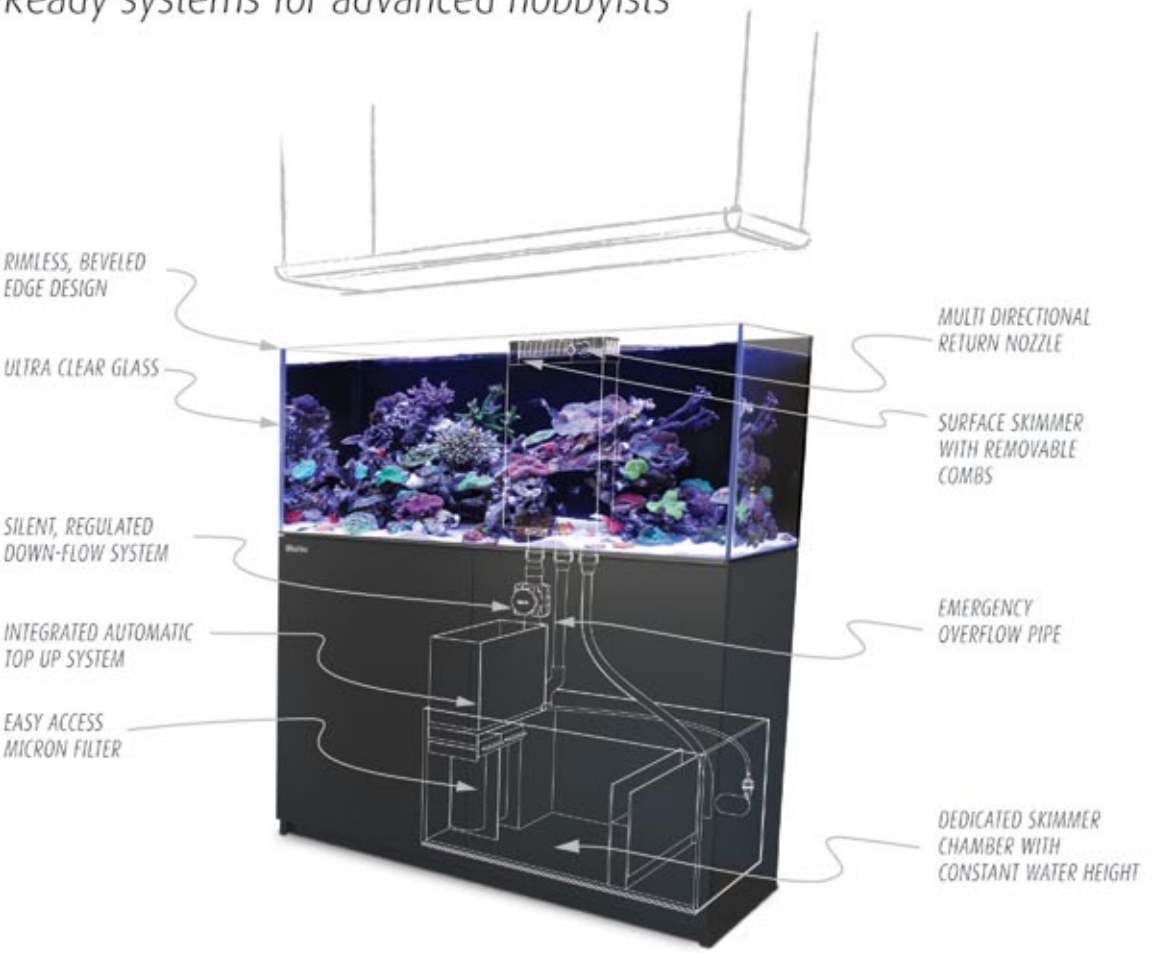

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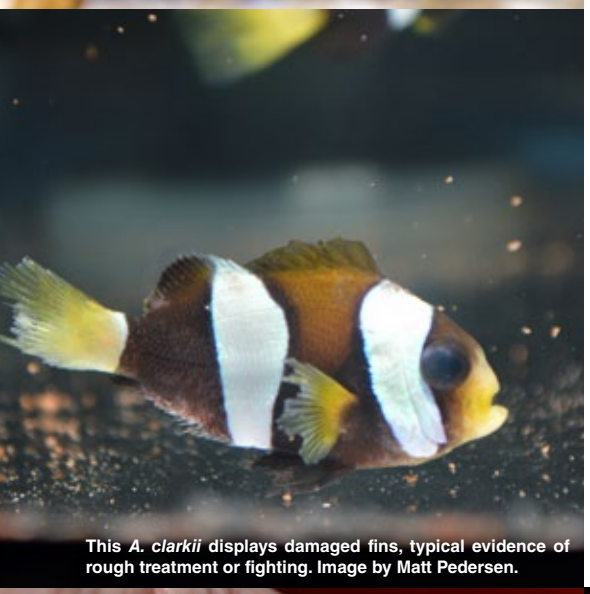
Red Sea

This butterfly clearly has lymphocystis and should not be taken home from the fish store. Image by Sabine Penisson.



This *A. clarkii* displays damaged fins, typical evidence of rough treatment or fighting. Image by Matt Pedersen.

This *Amphiprion pacificus* exhibits a red spot on its body, a possible early indication of a bacterial infection. Image by Matt Pedersen.

Other signs to look out for are indicators of infection, such as the dreaded marine white spot, whitish lumps on the fins and body indicating lymphocystis, or indeed any skin problems at all. Damaged fins and open skin lesions may indicate rough treatment or fighting. As a result, overall ill health may be just around the corner. Look out also for fish that are breathing abnormally and rapidly; this could indicate parasitic infections on the gills and once again, overall ill health.

HAVE THEY GOT THE EQUIPMENT?

Disease should not be visible in any fish store's display tanks. Diseased fish should be immediately removed from display and treated in quarantine (QT) where they cannot act as a source of infection. Some stores don't have this facility and may simply allow you to take the fish home, which could infect and destroy your own fish collection unless you quarantine it yourself.

Good stores will have QT holding areas and will have invested in suitable filtration systems that may employ large, commercial-grade UV systems or carefully dosed ozone to reduce pathogen density. Fish stores that have hobbyist-grade gear that is clearly not sufficient for the system's bioload should be avoided at all costs. Fish stores with efficient filtration systems are better able to offer their fish and inverts all the food that they need to recover from shipping and remain healthy, as the filtration systems will not be overwhelmed by large nutrient inputs.

At this point, I should add that all of this equipment, time, and care costs money, and rightly so. If a fish store is charging a few dollars more for a fish, ask yourself if the price is justified. Don't select a store based mainly on price; consider quality of animal care instead.

You can, of course, take extra care to ensure that any fish you buy are monitored for disease in your home with the use of a simple QT system. A small tank with a heater, simple canister filter, and basic lighting rig can be very useful for monitoring and even treating a fish with medication, if needed. Trust me; anything is better than watching a disease like marine white spot devastate your fish when your collection of copper-sensitive invertebrates stops you from dosing effective medications.

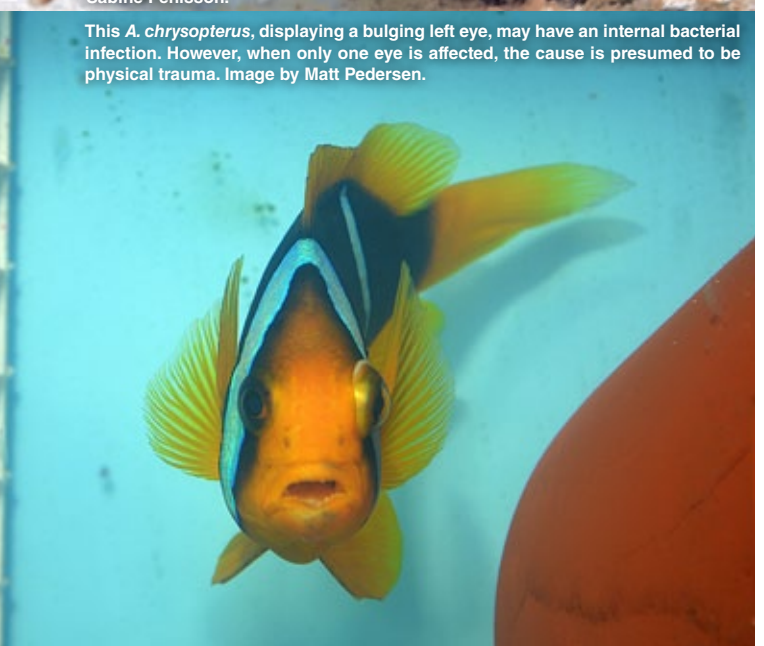
Another option would be to add an ultraviolet sterilizer to your system. Some hobbyists have these handy pieces of equipment running permanently. I have chosen not to, but I have one plumbed in that I can activate when I add a new fish to my system. This serves the purpose of destroying the free-swimming stages of pathogens and parasites in the water. It isn't foolproof, and nothing beats a QT tank, but it is a handy addition.

This fish store has invested in a filtration system that can handle a large bioload. Image by author.

Adding this Imperator Angel infected with white spot disease to your tank could wipe out your fish population. Image by Sabine Penisson.

Avoid fish that exhibit white spot disease, also known as ich. Image by Sabine Penisson.

This *A. chrysopterus*, displaying a bulging left eye, may have an internal bacterial infection. However, when only one eye is affected, the cause is presumed to be physical trauma. Image by Matt Pedersen.



FISH THAT SHOULD JUST BE LEFT IN THE OCEAN

One of the simplest ways you can send a strong message to importers to source responsibly, and also to avoid wasting cash, is to buy species that are known to do well in captivity. Some fish are more challenging due to their highly specialized diets, which cannot easily be provided by average hobbyists. Orange-spotted Filefish, Mandarins, and cleaner wrasses all have specialized diets, and many will die unnecessarily due to starvation. Some fish simply grow too big; batfish, groupers, and many wrasses become tank busters and should not be imported for sale to home aquarists.

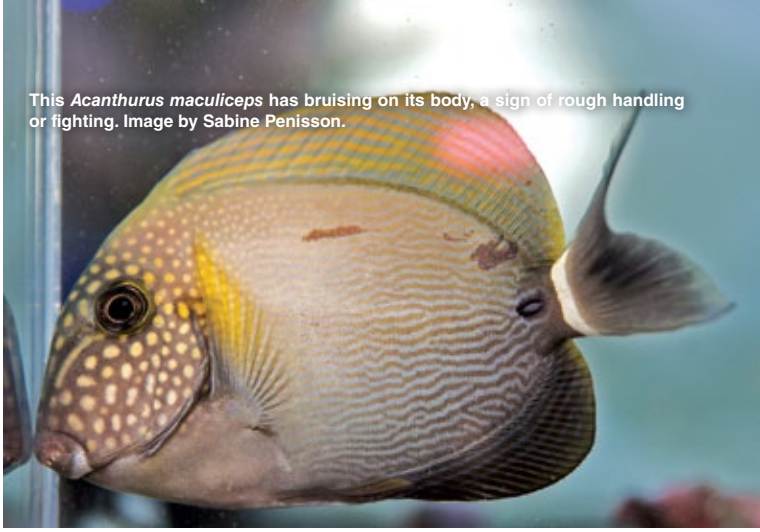
How many novices have bought pretty and cheap damsels, sold as ideal beginner's fish, that have then gone on to terrorize and bully to death every other fish added afterward?

Good fish stores will sell you fish that will give you years of pleasure. They will take time to offer advice about the fish they are selling, and they will politely ask you about your current stock and future plans for your aquarium. This is to be encouraged and is good business sense. If they sell you fish that you can be successful with, you will return for years to come and will have more money to spend on equipment. Most importantly, you won't become disheartened and leave the hobby entirely.

A GOOD DISPLAY TANK SPEAKS VOLUMES

It's often been said that a good fish store will have a good display tank. This isn't always possible as stores sometimes don't have a lot of room, and every square foot of retail space matters in these economically challenging times. However, even a small display tank is, in my opinion, indicative of a store's commitment to the care of their livestock. It's a window into their ethos, ability, and level of expertise.

If a display tank's corals are healthy with good color and growth and the fish are well fed and happy, the staff clearly has experience and skills. If the corals regularly appear to have been stuffed in



This *Acanthurus maculiceps* has bruising on its body, a sign of rough handling or fighting. Image by Sabine Penisson.

the tank on a rotating basis and the fish are never the same from one visit to the next, then perhaps this isn't the best advert for that store.

Exceptional displays also provide an opportunity for stores to demonstrate equipment and methodologies, as well as inspire hobbyists.

GOOD PEOPLE MAKE GOOD STORES

Further down my arbitrary list, but no less important than any of the other criteria listed above, is the personality, commitment, and philosophy of the owner or manager and staff in the store. Good staff will take the time to get to know you, will prefer to keep you as a long-term customer, and above all, will be very knowledgeable about their stock and the wider hobby.

Good fish store staff will take pride in their store and their role in the industry and hobby and will also take pride in their level of knowledge. They will recognize that having good quality equipment and healthy fish and inverts for sale are good business practices for the long term.

This store's displays are well kept, and the livestock is healthy. Image by author.

In summary then, do your research, take your time, be patient, and get to know your local fish stores. Your relationship with the store and its staff is paramount and is possibly the most important relationship you will forge in your time as a marine hobbyist.

Fish stores are increasingly under threat from Internet-only retailers. I'm not criticizing this sector of the market, but good fish stores provide a resource that, in my opinion, is second to none. We must learn to recognize the good ones and reward them with our hard-earned cash. We, as consumers, have an enormous amount of power to drive the hobby and industry towards a more sustainable future where the welfare of our livestock is the most important consideration.

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JOSEPH RAMIREZ

HOW DIFFERENT SUBSTRATES AFFECT GROWTH RATES IN BIRDSNEST, XENIA, AND RED MUSHROOM CORALS

Coral are sessile animals that create and inhabit complex structures known as coral reefs. Countries all over the globe harvest coral for many purposes and in various ways—some of which are highly destructive and contribute to reef depletion worldwide. In addition to the harvest of reef materials for local construction and other markets, a significant harvest exists to supply the reef aquarium hobby.

This Birdsnest colony was fragmented for my experiment.

These are the stationary baskets in which the Birdsnest frags were placed. There were 9 frags per substrate totaling 36 frags per species.

Coral farms can be a more sustainable way to grow and supply coral for these aquarium needs. However, many corals are very sensitive and may not grow well if not placed on a preferred substrate. In the wild, the substrate that forms the base on which a coral grows is generally complex in shape and vertical in structure. In September of 2013, I conducted a study to test different substrate types and analyze the reactions of coral grown on them. Some of these substrates are found in a natural marine environment and some are not, yet all are made of materials that can be found naturally one way or another. This study measured the growth rate of three coral species on four different substrates to determine preferred man-made substrates that coral farms can use in the absence of natural substrates.

METHODS

The corals selected for the study were *Seriatopora hystrix* (Red Birdsnest), *Heteroxenia* sp. (Pom Pom Xenia), and *Actinodiscus cardinalis* (Red Mushroom). These three coral species were selected based on their fast growth rates, temperament, and relative hardiness. *Seriatopora hystrix* is the only one of the three that is considered a small-polyped stony coral. *Heteroxenia* sp. and *Actinodiscus cardinalis* are both soft corals, meaning they are ahermatypic (not reef building). Since clay mounts are used quite often as a coral base in farming, these were used as the control substrate for this experiment. The other three substrates tested were tile, glass, and sand. The corals were fragmented and attached to each substrate. Glue was used to attach the small-polyped stony coral, and rubber bands were used to attach the two soft corals.

Each frag was removed for observation and measurement on a weekly basis.

The different coral species were each grouped in their own stationary baskets within a large coral tank, so all corals were subjected to the same water parameters and equal flow. Each basket housed only coral of the same species, and each species had 9 mounts per substrate totaling 36 mounts. Their growth was monitored for 10 weeks (11 weeks for Xenia and Birdsnest) through the use of a compound microscope equipped with a metric ruler on the lens. For *Actinodiscus cardinalis*, the measurement was taken of the width of the top of the coral. For *Seriatopora hystrix* and *Heteroxenia* sp., the measurement was based on additional encrustation on the test substrates. Data was recorded on a weekly basis. The total additional growth was recorded for each coral. For instance, if coral "A" grew .05 mm in the first week and then grew .05 mm in the second week, there was a total growth for coral "A" of .1 mm by the end of week two.

DATA ANALYSIS

A one-way analysis of variance (ANOVA) test was completed for each of the three coral species to determine significance between the four substrates. The ANOVA test let us compare the means across several sample sets. *Seriatopora hystrix* had a calculated F value of 4.865, exceeding the F critical value of 2.923, and a p value of 0.0067. These results indicate a significant difference between substrates. *Actinodiscus cardinalis* had a calculated F value of 7.385, exceeding the F critical value of 2.901, and a p value of .0006. These results also supported a significant difference between substrates. *Heteroxenia* sp. had a calculated F value of 1.219, not exceeding the F critical value of 2.901, and a p value of .3184, signifying that there was no significant difference between substrates.

RESULTS

The ANOVA analysis resulted in statistically significant differences between substrates in *Seriatopora hystrix* and *Actinodiscus cardinalis* and no significant difference between substrates in *Heteroxenia* sp. Figure 1 shows increased growth rate on clay mounts for *Seriatopora hystrix*, Figure 2 shows no significant growth difference between substrates for *Heteroxenia* sp., and Figure 3 shows an increased growth rate in sand for *Actinodiscus cardinalis*. All three figures are supported by their F values.

DISCUSSION

Through this experiment, it was determined that some coral species have substrate preferences. *Heteroxenia* sp. showed no significant growth

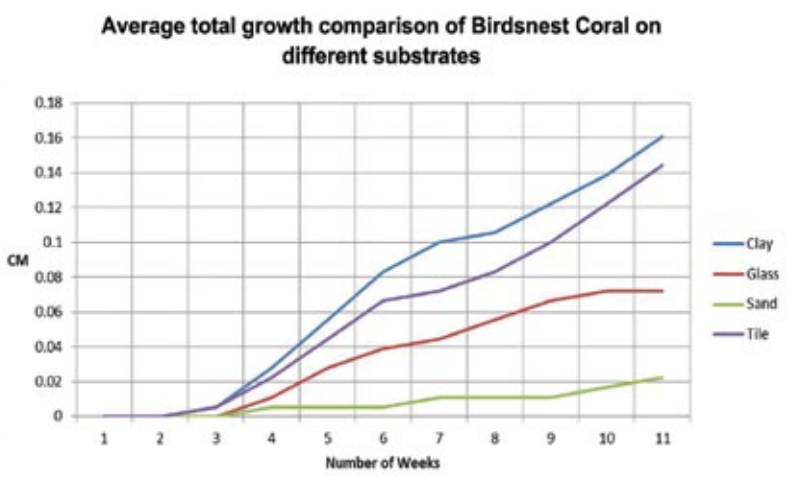


Figure 1. Average Birdsnest growth rate over 11 weeks on four substrates.

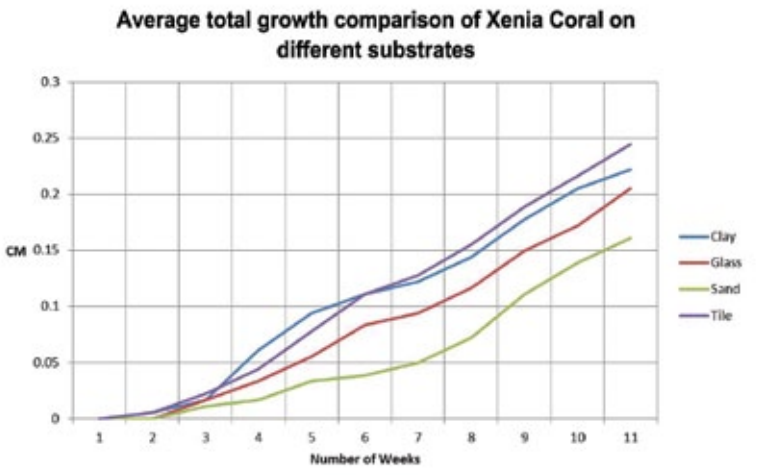


Figure 2. Average Xenia growth rate over 11 weeks on four substrates.

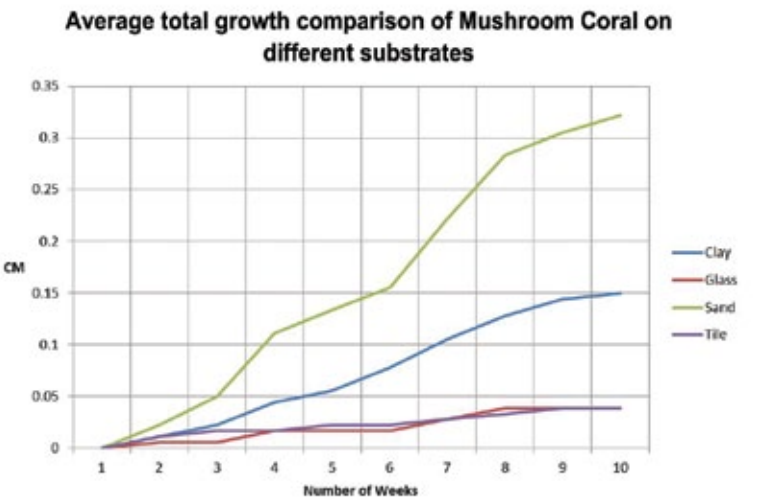
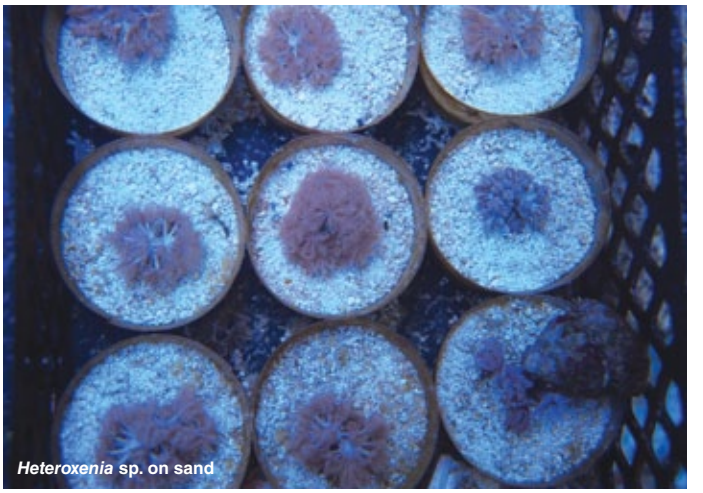


Figure 3. Average mushroom growth rate over 10 weeks on four substrates.

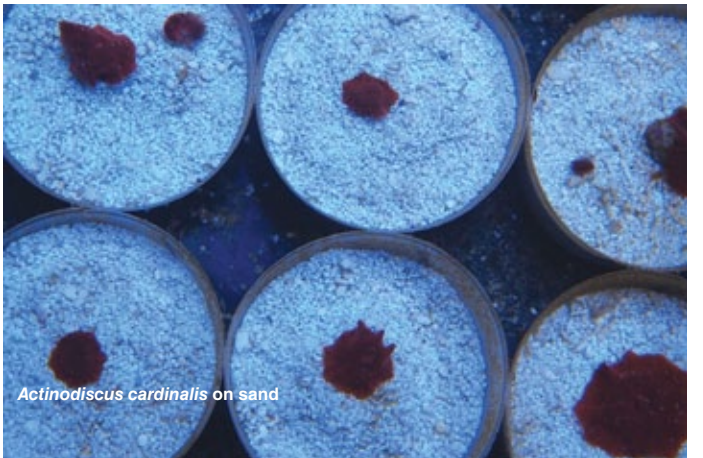
This is an image of one of the Birdsnest frags under the microscope.

Heteroxenia sp. on glass



Heteroxenia sp. on sand

This is a mushroom on clay at the end of the 10-week observation period.



Actinodiscus cardinalis on sand

difference between substrates, likely due to the way it attaches to substrates. *Heteroxenia* sp. attaches to substrates through a mucus-like substance (Benayahu 1984). This allows it to adhere to smooth surfaces and supports the common discussion among reef hobbyists that *Heteroxenia* sp. is a fairly easy coral to grow and spreads rapidly on all sorts of substrates in a short amount of time.

Seriatopora hystrix showed an increased growth rate on clay mounts. The clay mounts are given a rough texture when they're made. This rough texture allows *Seriatopora hystrix* to attach itself easily and get a better head start on growing than if it were attached to a smooth surface (Spieler 2001).

Actinodiscus cardinalis displayed increased growth rates in sand. This may be due to the fact that *Actinodiscus cardinalis* possesses a bulb-like base and can easily bury itself in the sand as compared to teetering on its bulb-like pivot on a flat surface such as the glass and tile substrates (Garf 2012). What is also interesting is that this situation is not typically found in nature. In a natural marine environment, the sandy seafloor is a place of high disturbance. Sand sifters such as sea stars and crabs dig up the sandy substrate, and water currents constantly shift the sandy landscape. Even if there are a few days of low disturbance, that is not enough time for *A. cardinalis* to colonize a sandy area. This coral needs a substrate that will not be greatly altered throughout its lifetime. In a controlled environment that is not repeatedly exposed to sand disturbances, *Actinodiscus cardinalis* proves to favor sand and grows more rapidly there.

Using these alternative substrates, coral farmers should be able to propagate certain corals more quickly. Other substrates can be tested to further support alternative growing media. My hope is that more efficient captive-farming techniques (like an understanding of preferred substrates) will allow us to grow more corals more easily and reduce the need to remove corals from the wild.

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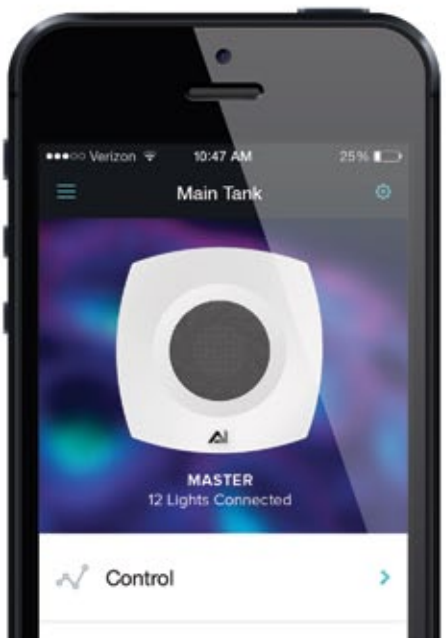

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JOSE A. GARCIA

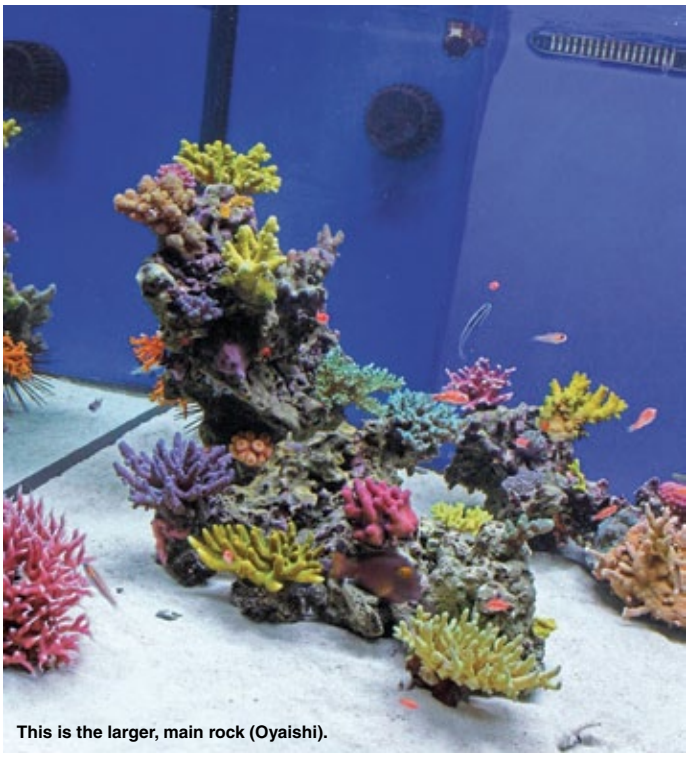
REEF IWAGUMI

My name is Jose A. Garcia, but in the world of aquatics, I am known as “yano.” I’m 40 years old and live in Spain. I’ve been hooked on this wonderful hobby for 16 years, ever since I bought my first aquarium. In the beginning, I had all kinds of freshwater fish and biotopes, but they all gave way to marine aquariums 11 years ago. My current display, Reef Iwagumi, is my second marine aquarium, and in it, I wanted to combine what have gradually become my two hallmarks within the marine aquarium hobby: a taste for small fish and minimalist landscapes.

PHILOSOPHY AND PURPOSE OF THE AQUARIUM

My idea when setting up this aquarium during the Christmas of 2009 was to recreate a coral lagoon in a miniaturized and minimalist style. This concept was fundamental in the selection and maintenance of corals and of course, the selection of fish. To accomplish this, I first took the example of some aquascaping techniques used in freshwater aquariums. Here, one frequently sees amazing recreations of miniature landscapes, such as forests, mountains, or rivers. Within these aquascaping disciplines, I found that the technique called Iwagumi could be used to achieve my goal in a marine aquarium.

The translation of the term Iwagumi is “rock formation,” and this style uses the composition of rocks as the key element in the decoration of the aquarium. There are several styles of Iwagumi,



This is the larger, main rock (Oyaishi).

but all are based on simplicity and harmony. The most classic and frequently used is the so-called "three rocks," consisting of a larger, main rock (Oyaishi) and two smaller rocks of different sizes to each other (Fukuishi and Soeishi). Of course, all the rocks must be of the same type to add continuity and harmony to the aquascape created.

In my case, I opted for a variant with five formations. All secondary rock formations have been changed and remodeled over the 5-year life of the tank. These changes were made to preserve ample open areas of sand (to provide a natural feel) and to maintain the minimalist look that I like, but the main formation, Oyaishi, has had barely more changes than those produced by the growth of the corals.

CORALS

Corals have been selected according to their shape and growth rate. For this tank, I have given priority to species with very compact

This is a top-down view of one of the smaller rocks.

Paragobiodon xanthosomus

Elacatinus multifasciatus

forms and slow growth. The most abundant corals in Reef Iwagumi are *Acropora humilis*, *A. gemmifera*, *A. samoensis*, Pocilloporids, *Stylophora*, and *Porites*. The dominance of these types of compact coral also helps to create the impression of being in a shallow water coral lagoon.

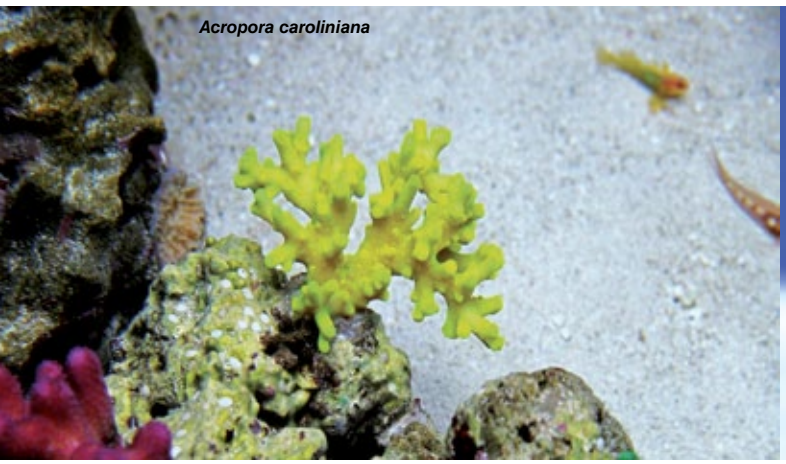
In addition to these species, I also left room, to a much smaller extent, for some other *Acropora* from deeper waters, such as *A. carduus*, *A. caroliniana*, and *A. echinata*. I have two or three kinds of staghorn *Acropora* and some other species of stony corals that grow fast, but these are located deep in the tank where I don't have to worry about their fast growth blocking light to the corals below them.

I have had to be careful, not only in my selection of coral species, but also in the tank's maintenance. I prune small pieces of coral quite often to control colony size. This way, no coral becomes large enough to dominate the aquascape and ruin the miniaturized concept. For this reason, I have a small frag tank of about 22 gallons, which is very useful since I remove frags often.

FISH

Fish have also been selected based on the idea of a miniaturized landscape, and although I have always had four or five fish of a medium size (surgeons and dwarf angels), only one of them, a *Paracanthurus* acquired at a tiny size 11 years ago (my first marine fish), has a size that exceeds 5 inches. These small surgeons, dwarf angels, and other tiny fish represent the large surgeons and angels to be found in nature. The rest of my aquarium fish are all very small and mostly belong to the family of gobies. Over 60 fish from this family, mostly from the *Trimma* and *Eviota* species (called microgobies), make up the bulk of my fish population, and they are one of the main hallmarks of my aquarium. They are a small-scale representation of the banks of anthias, damsels, and other small fish that fill the rock formations in nature. When choosing my fish, I also planned to have small species occupy all levels of the aquarium.

Trimma benjamini



Acropora caroliniana

Acropora samoensis

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Crystal Shrimp (*Urocaridella antonbruunii*)

Sexy Shrimp (*Thor amboinensis*)

Substrate: species that typically occupy the substrate and lower parts of the aquarium include *Elacatinus macrodon*, *E. multifasciatus*, *Eviota prasites*, *Stonogobiops yasha*, etc.

Rock: species remaining in the rock include *Priolepis nocturna*, *P. semidoliata*, *Trimma benjamini*, *Acanthemblemaria hancocki*, etc.

Coral Branches: species that live among coral branches include *Eviota nigriventris* and small fish of the genus *Gobiodon*.

Water Column: species that more or less routinely swim in the water column above the coral include *Trimma tevegae*, *T. rubromaculatus*, *Elacatinus oceanops*, and *Gobiosoma randalli*.

I have observed, in the case of these species, that the presence of a few individuals swimming steadily in the open (such as occurs with *T. tevegae*) encouraged other species who would not otherwise (such as *T. rubromaculatus*), to do the same. It is important for them to feel safe and not be threatened by larger fish.

INVERTEBRATES

In addition to the fish and corals, a population of small invertebrate fauna live in my tank. Tiny hermit crabs of the genus *Clibanarius*, symbiotic crabs of *Acropora*, porcelain crabs, small shrimp of the genus *Urocaridella*, and *Thor amboinensis* contribute to

Yasha Goby and Randall's Shrimp (*Stonogobiops yasha* and *Alpheus randalli*)

This image was taken in December 2011.

the biodiversity of my aquarium while still keeping to my idea of miniaturized landscape species being very small. In short, I like to describe my 100-gallon tank as a big nano.

SYSTEM SPECIFICATIONS

To implement my concept, I have chosen a cubic tank to create a large surface area and provide a comprehensive and natural landscape.

Tank: 36 in. × 36 in. × 20 in. optical glass
Skimmer: Vertex Alpha 170
Lighting: Sfiligoi 12 × 39-watt T5s

I chose a combination with plenty of white tubes to highlight the shallow feeling and naturalness of the aquascape.
- (2) KZ Superblue
- (2) KZ Fiji Purple
- (4) KZ New Generation
- (4) KZ Coral Light

Circulation: (2) Vortech MP40w
Return: Tunze Silence 2400 L/h
Activated carbon

Acropora tenuis

Water changes: 5-10% every 7 to14 days with Reef Crystals

PARAMETERS

Alkalinity: 8 dKH
Calcium: 390-410 ppm
Magnesium: 1280-1320 ppm
Potassium: 390-400 ppm
Nitrate: <1 ppm
Phosphate: 0.02 ppm

Salinity: 1.024
Temp: 25° C (~27° C during summer)

I do not use a calcium reactor or peristaltic dosing pump. I have maintained my habit (somewhat archaic today) of adding everything manually. I use Reef Builder and Reef Advantage Calcium from Seachem to maintain alkalinity and calcium, and I use Bio-Magnesium from Tropic Marin for magnesium. I also add Seachem Reef strontium and iodine, iron, and potassium additives from Brightwell Aquatics.

METHODOLOGY

During the first 3 years, I used the Zeovit method to reduce nutrients and compensated with zeolite for the lack of live rock (the aquarium was home to only 2.3 lbs. of live rock and 3.2 lbs. of dead rock). A wide range of Zeovit products were used to enhance color and feed the corals. The results were great in regard to cleaning the aquarium and color of the coral, but over time, and given my low biological load (hardly any big fish), extremely low nutrient levels made the zeolite more of a problem than a solution. With a low biological load and undetectable nutrient levels, zeolite can cause imbalances in the biological cycle of the aquarium with the consequent appearance of cyanobacteria or dinoflagellates. So I decided to eliminate the Zeovit method and add more live rock to the sump (about 3 lbs.), basing my filtration thereafter on a far simpler approach that is more specific to the needs of my aquarium. I now employ only a skimmer and some live rock to keep nutrients under control. I must say that the colors and cleanliness of the aquarium have remained very satisfactory since the change. Although the color of some of the most demanding pieces of coral and the frequency of glass cleaning can still be improved upon with

This side-view shot was taken in October 2014.

respect to the results that I managed with Zeovit, this way of aquarium keeping is certainly simpler and more stable. Hopefully, with a little more time, further improvement will be seen.

During these 5 years, I have had several species breed, including spawnings of cerith snails, trochus snails, and gobies (*Trimma rubromaculatus*). At one point, I had 75 young snails that had to be removed because they often obstructed my Vortech once they reached approximately 1/3 inch in size. I also had the pleasant surprise of seeing how large quantities of *Gobiosoma randalli* fry turned the water into soup every few months (they were naturally devoured quickly by the other fish). I even experienced the spawning of two species of giant clam (two *Tridacna maxima* and one *T. crocea*) simultaneously. Overall, I have been very satisfied with this aquarium.

ACKNOWLEDGMENTS

Finally, I want to thank the team at *Reef Hobbyist Magazine* for the opportunity it has given me to share my tank and ideas with all your readers.

Watch a video of yano's sump and filtration system.

Watch a video of yano's microgobies.

Watch yano's clams spawn simultaneously.

Image by Nick Hobgood

JIM ADELBERG

STARS OF THE REEF

There are many starfish available to us in the hobby and many specific reasons to include them in our tanks. Let's meet a few and see why you might want to find them a home in your system.

While there are some stunningly ornamental starfish (as we'll see later), most of the species added to reef tanks are brought in to do a job. Luckily for us, starfish are efficient scavengers, and many hobbyists consider them a critical part of a robust cleanup crew (CUC). A lot of the starfish we keep are omnivores and very versatile in terms of what they're willing to eat. It's very handy to have an algae grazer that will also clean up extra flake food or brine shrimp.

The first starfish on my list of favorites is definitely the humble micro brittle star. Brittle stars and serpent stars are able to thrive in many of our captive reef environments and can do equally well in tanks with or without sand. Even in systems where the fish in the display tank would eat these starfish, they can often be kept safely in a sump or refugium. Micro brittle star populations have a few very desirable attributes that put them at the top of my list. First, they seem happy to eat any leftover aquarium food they might come across, and the larger individuals are capable of ingesting a whole frozen brine shrimp. While they don't do much algae grazing, they are well known to clean the top layer of sandbeds in displays that feature sand. Secondly, the overall population seems to grow or shrink very quickly in response to available food sources.

This brings us to the third point in their favor: their ability to maintain viable populations in home aquariums seemingly forever. And while they may not do anything for that algae patch on your glass, they're practically guaranteed never to be bad actors in your reef. Unfortunately, the same can't be said of my second favorite starfish.

Brittle stars are great scavengers for reef tanks. Image by Haplochromis.

You'd do well to avoid the red- or blue-spotted *Asterina* species. Image by Sabine Penisson.

Asterina starfish have long been a subject of heated debate in our hobby. This is one of those animals that most people either love or hate with few undecided. And this makes sense if you consider a few facts. The first is that there are over 30 described species in the genus *Asterina* and likely many still unknown. People talking about *Asterina* stars may well be talking about species from opposite ends of the globe with wildly different feeding habits. Certain species are predatory on zoas and others eat SPS corals. It seems that the *Asterina* species with brightly colored spots are less likely to be reef safe. But even if we're only talking about *Asterina anomala*, the plain old brown type, they can consume ornamental coralline algae, so why add it to a list of favorite starfish? The answer is simple. They are one of the most adaptable CUC creatures available. They will eat most kinds of algae if they're hungry enough, including some of the most annoying turf algae, rasping it from the glass, rocks, and sand. They will scrape down the surface of rock, exposing and removing pockets of organics that might otherwise build up. They are small enough to get anyywhere, and they eat everything. For example, they like to climb into the clear return hose of my reef and clean out the algae that builds up in there. They also reproduce quickly and easily in tanks and similar to the micro brittle stars, quickly adjust their population based on available food. In my

Sand-sifting Starfish keep sandbeds clean and well aerated. Image by Sabine Penisson.


The royal blue of *Linckia laevigata* is hard to beat. Image by Dr. Scott Mills.


Chocolate Chip Starfish. Image by Sabine Penisson.


Red Tile starfish. Image by Sabine Penisson.

experience, they haven't bothered mushrooms, anemones, LPS, or soft coral. If you can get a batch of these starfish from a population known to be relatively reef safe, I'd recommend you give them a try.

The next starfish I consider important to include as a cleaner is the Sand-sifting Starfish (*Astropecten polycanthus*). These starfish live in the top few inches of sand and keep the sandbed from impacting with their active foraging. With a good population of these sea stars, your sandbed will stay cleaner with less likelihood of a buildup of nasty pockets of organics. These animals rarely breed in captivity but are quite hardy and can live for years in our tanks.

Let's move on to the ornamental starfish you might see offered for sale. First are the group of stars of the genus *Fromia*. These are the Red, Indian, and Tile Starfish commonly available in local fish stores. These starfish are very pretty with bold colors and interesting geometric markings. They tend to be quite hardy as long as you start with a healthy individual and have enough organics and algae to support their food requiremets. Their diet can also be supplemented with meaty and vegetable-based pellet, frozen, and fresh aquarium foods. Stars from this genus are generally considered to be reef safe.

The Chocolate Chip Starfish (*Protoreaster nodosus*) is an attractive animal that unfortunately is not particularly reef safe. While they are a great addition to large fish-only tanks, their indiscriminate grazing and bulldozing makes them unsuitable for most reef tanks. They are often sold as juveniles at 3 or 4 inches in width, but keep in mind that they can get to a foot across!

And finally, we get to my favorite ornamental starfish—the Blue Linckia (*Linckia laevigata*). The color of these stars just can't be beat, and as an added bonus, they stay out in the open a lot of the time. They're omnivores, and while I'm not aware of any reports of them bothering coral, like most starfish, they may go after clams and other sessile mollusks. They are easy to feed (plop them on a piece of food and they'll eat it if they can), and they can live for many years in captivity. My experience with this species is that it prefers very well-oxygenated water that is carefully controlled to keep dissolved organics fairly low. This is in contrast to other starfish like the brittle stars. The only other real challenge with these animals is making sure you're starting with a healthy specimen. This is a particular challenge with this species, but the guidelines are the same for choosing any ornamental starfish.

Whenever you choose starfish, there are a couple of danger signs to watch for. The first and worst of these is a bacterial infection of any kind. Only a very few starfish that contract bacterial infections in the chain of custody recover. Even a small infection (like on the tip of an arm) should rule that animal out. In fact, any open wound should rule the animal out of consideration because of the likelihood of subsequent infection. However, the starfish may have arms that have regrown from old injuries and that's fine. This is probably a good time to mention that starfish are not pets that should be petted. Leave them in the tank and enjoy them there. Despite their sluggish reputation, starfish are actually very busy creatures when in peak health, so look for starfish that are moving around or at least have very active tube-feet movement. Know the healthy shape of the animal you're purchasing. Bloated or emaciated stars are easy to pick out once you know what you're looking for. And remember that copper-based medicines (even lingering traces like in reused sand) will keep your starfish from thriving and may even do it in.

There are many more starfish available in our hobby, and I've only picked out a few of my favorites to profile here. I encourage you to look around, do your research, and consider adding some starfish to your tank. They may never be the centerpiece, but nonetheless, they're worthy additions to most systems.

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