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FOURTH QUARTER 2018 | VOLUME 12

THE WONDERFUL WORLD OF DIGIS

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BOOM!

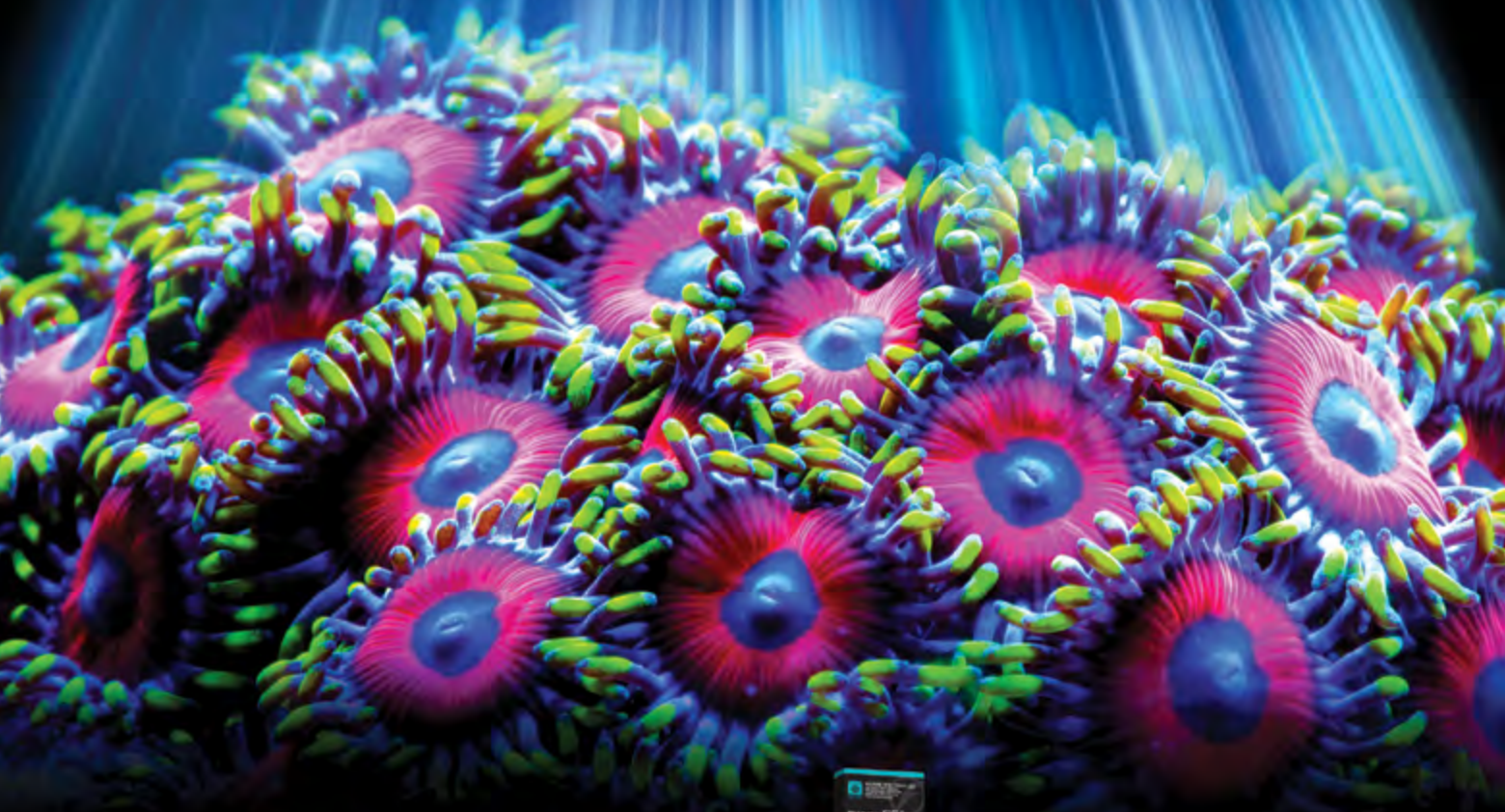
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Colby Johnson is an all-around fish nerd and the owner of Pacific Island Aquatics. Proper quarantine is absolutely required before introducing new fish to an existing community. Learn the most effective techniques from a professional in the business.

12 ON THE COVER



THE WONDERFUL WORLD OF MONTIPORA DIGITATA

Jared Burbank, owner of My Reef To Yours, has been reefing since the mid '90s. *Montipora digitata* is an old favorite in our hobby and a particular favorite of Jared's. This quick review provides valuable pointers and tips to get the best out of your Digis.

Cover image by Dillon Dugan (WWC)



18 A LUSH AQUA FOREST

Damian Pogorzelski set up his first aquarium at age 7, has been reefing for 20 years, and is the founder of Aquaforest. This tank started with a clear design priority and, over time, has become a vivid example of what dedicated husbandry and attention to detail can achieve.



24 UNCOMMON CLEANING CREWS pt 2: Sandbed Scavengers

Sabine Penisson is a French photographer and author focused on coral reef fauna. Cleanup crews are a utilitarian necessity for all reef tanks but can also be composed of interesting and exquisite animals. Sabine recommends some uncommon options.



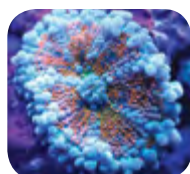
34 LIGHTING THE WAY TO BETTER CORAL COLOR

Immo Gerber has been an aquarist since childhood and writes for www.salzwasserwelten.de. LED lighting has brought a new level of control to hobbyists who pine for the perfect spectrum. Learn how to optimize your spectrum in this detailed article.



42 TESTING, TESTING: EASY AS 1, 2, 3

Keith Moyle is a 40-year veteran reefkeeper and writer on reef topics. What, when, and why do we test? All these questions and more are answered in this thoughtful piece on the fundamentals of reef tank testing.



48 SHROOM BOOM!

Darwin Ngo is a co-founder of Legendary Corals and lives in San Jose, CA. Mushrooms were some of the first corals kept in reef tanks and, despite a slump in their desirability, are back in the spotlight. See the newest morphs and learn about their resurgence in popularity here.

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- **Fargo Exotic Pet Expo:** October 6, Fargo, ND – www.redriverreefandreptileexpo.com/
- **Reef-A-Palooza (LA):** October 6–7, Anaheim, CA – www.reefapaloozashow.net
- **Aquatic Experience 2018:** October 19–21, Secaucus, NJ – www.aquaticexperience.org
- **Reef League:** October 20, Jacksonville, FL – www.reefleague.com
- **Carolina Coral & Fish Expo:** October 20, Columbia, SC – www.columbiamac.org
- **Ohio Reef Frag Swap:** October 20, Dayton, Ohio – www.ohioreef.com
- **Reef-A-Palooza (FL):** April 6–7, 2019, Orlando, FL – www.reefapaloozashow.net
- **Reef-A-Palooza (NY):** June 22–23, 2019, Secaucus, NJ – www.reefapaloozashow.net

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HOW TO QUARANTINE LIKE A PRO

Ofentimes in reefkeeping, we pursue the most technologically advanced solutions for our little boxes of ocean. And with good reason! Recent innovations in lighting, filtration, supplementation, and nutrition are transforming our hobby.

I occasionally see new medications or methodologies for quarantining fish that promise to revolutionize the process; while some of these have merit, most do not. When it comes to quarantine, I have found that categorically, the most effective

method is the old standby known as the Tank Transfer Method. Coupled with a few choice medications in the medicine chest, the Tank Transfer Method is a bulletproof way for a hobbyist to quarantine like a pro.

As an ornamental fish breeder and retailer of high-end marine fish, I consider proper quarantine to be of the utmost importance. In many instances, freshly imported fish arrive with a litany of protozoan diseases, monogeneans, ammonia burn from transit, and bacterial infections. Using conventional quarantine and medication protocols



The short list of supplies needed includes an airline tube, airstone, check valve, air pump, thermometer, and small submersible heater. | Image by Jim Adelberg

for treating any one of these diseases or disease-causing agents fails to address most of the others. This is the beauty of the Tank Transfer Method: we can more effectively (and safely) address multiple problems at once.

Let's examine exactly what the Tank Transfer Method entails and how it works. Then we can look at particular diseases and how to treat them using this method. The primary function of the Tank Transfer Method is to disrupt the life cycle of protozoan infections, thus stopping reinfection or transmission to new hosts. By moving the fish into a clean, sterile tank every 24 hours for a period of 7 to 10 days, we can effectively ensure elimination of protozoan diseases with indirect life cycles, such as *Amyloodinium* spp. and *Cryptocaryon* spp. Moreover, because we are not relying on chemotherapeutants (such as copper or chloroquine phosphate) to treat for protozoans, we are free to address other diseases with medications that may have contraindications with antiprotozoals.

EQUIPMENT REQUIRED FOR THE TANK TRANSFER METHOD

When I talk to clients, the biggest excuse I hear for not quarantining is the high cost associated with the process. This is a bit of a false economy. The list of equipment required is amazingly short. Here is a quick rundown of the basic equipment needed for this quarantine method. Much of it will likely already be in the average marine aquarist's collection.

- (2) 10-gallon glass tank or plastic tote
- Air pump, airline tube, check valve, and airstone
- Refractometer
- Thermometer
- Ammonia and pH test kit
- 70 to 100 gallons of clean salt water
- Small submersible heater

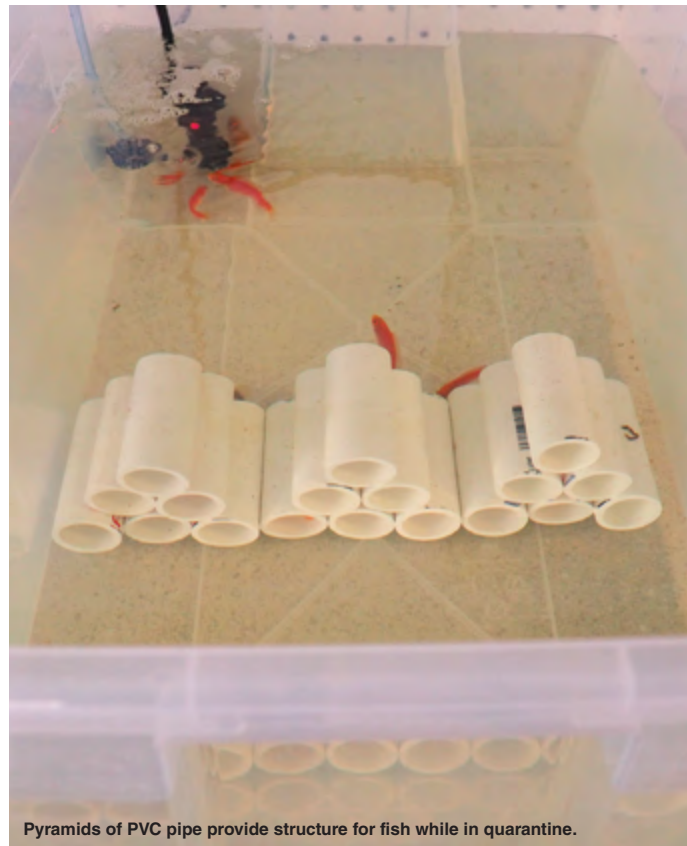
The approximate cost for a complete quarantine setup is \$50 to \$100. Keeping in mind that the majority of this cost estimate is for equipment that can be used many times, it is clear that this is one of the highest returns on investment one can find in this hobby. When even the average fish collection can cost several hundred to



You will need two 10-gallon tanks for the Tank Transfer Method. | Image by Jim Adelberg



This pair of basslets is acclimating before moving to the first day's tote.



Pyramids of PVC pipe provide structure for fish while in quarantine.

several thousands of dollars, a small investment to protect against loss just makes sense.

TANK TRANSFER METHOD PROTOCOL

Now that we have our equipment in order, let's examine the basic Tank Transfer Method protocol.

In Advance: Prepare a tank/tote of salt water with airstone, heater, and thermometer at the salinity and temperature of the display tank.

Day 1: Acclimate the fish and place it into tank #1. Sterilize tank #2 for use on day 2.

Day 2: Move the fish to tank #2 with clean salt water, airstone, heater, and thermometer. Sterilize tank #1 for use on day 3.

Day 3: Move the fish to tank #1 with clean salt water, airstone, heater, and thermometer. Sterilize tank #2 for use on day 4.

Continue the above rotation for a minimum of 7 days, though a few days longer is always a good idea. If you are quarantining a large fish, the tank size will need to be increased accordingly. However, for most small reef fish, a tank or tote of 10 to 15 gallons is plenty. I like to set a schedule, moving the fish to a new tank at the same time every day. Most often, this is in the morning, though it does not really matter. I like to feed the fish before the day's transfer, and once they're all done eating, I move them to a fresh tank. This means no uneaten food will foul the water and cause an ammonia spike in the new tank. That's it!

DISEASES

For the sake of this article, I have lumped diseases and disease-causing agents into similar categories based on treatment protocols.

Parasites With Indirect Life Cycles

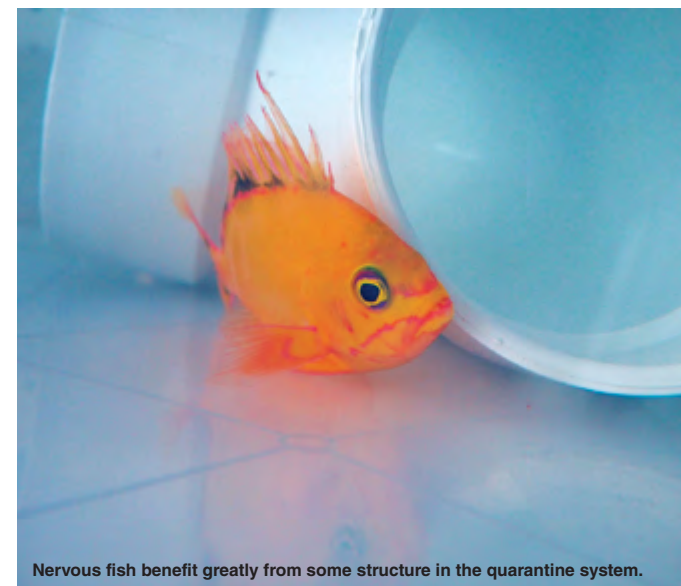
This section includes some of the most common parasites, such as Marine Velvet (*Amyloodinium ocellatum*) and Marine Ich (*Cryptocaryon irritans*). Some fluke species also fall into this category. These are my favorite parasites to deal with because they can be eliminated simply by moving the fish. All the aforementioned parasites have a feeding stage in which they are actively infesting the fish. However, to reproduce, they must exit the fish and either encyst or lay eggs. Different parasites have different lengths of time during which they are actively feeding, and incubation time of the eggs varies, so some research may be warranted. However, generally speaking, at tropical temperatures, a 7- to 10-day Tank Transfer Method quarantine will be sufficient for breaking the life cycle. If the parasites cannot incubate and reinfect the host fish, then the fish is cured!

Parasites With Direct Life Cycles

Parasites such as *Trichodina* spp., *Uronema* spp., and some fluke species fall into this category. Whether through binary fission or bearing live young, these parasites do not have to leave the host fish or incubate remotely, so the Tank Transfer Method itself is not sufficient to remove these nasties. Luckily, most of these parasites can be removed in between transfers through the use of chemical baths, such as formalin or praziquantel.

Bacterial Infections

The Tank Transfer Method is a great way to treat bacterial infections, as most antibiotics should be redosed every 24 hours. So if a



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Once they've completed quarantine, these clowns will be safe to add to established, healthy tanks.

bacterial infection is suspected, the fish can be treated in situ with fresh antibiotics dosed daily.

MEDICATIONS

While there are numerous medications available, there are four primary ones that I rely on regularly.

Chloroquine Phosphate

Chloroquine phosphate is an older medication that has recently been regaining favor in the hobbyist world. It is an antimalarial medication that seems to be very effective against early-stage *Uronema marinum* infections. One of the biggest downsides to this medication is that there is currently no way to accurately test for it. Thankfully, in a Tank Transfer Method scenario, testing is not needed, as it's redosed every 24 hours to full strength. Note that one of the leading manufacturers of this medication suggests its efficacy is significantly improved at hyposalinity (down to 11 ppt).

Kanamycin

Kanamycin has become my favorite antibiotic due to its effectiveness at the higher pH levels of salt water and the ease with which it is absorbed into the fish's tissue. Kanamycin seems to have a strongly synergistic relationship with nitrofurazone, and they can be quite powerful when used in combination.

Methylene Blue


Methylene blue is frequently used on the freshwater side of the hobby, but it is often abandoned by saltwater hobbyists, which is a real shame since it has many uses. Methylene blue is highly effective at treating ammonia and nitrite burn, has some antiparasitic properties, and can be safely used with antibiotics.

Formalin

Formalin is an extremely potent medication that has many applications. It can be used at lower concentrations in long-term baths or higher concentrations for shorter periods. I like to administer short-term formalin baths three to five times during the tank transfer process, which virtually ensures complete elimination of most parasitic infestations.

Please be aware that many medications, including the ones I have listed here, have been shown to be dangerous to human health. Consult the SDS (safety data sheet) for appropriate precautions, and always wear personal protective equipment when handling medications.

CONCLUSION

I hope this article has given you the courage to tackle a Tank Transfer Method quarantine. I rely on this method to quarantine all my fish for clients due to its extreme ease and reliability. There is really no reason at all not to quarantine every new fish. It is a solid investment in the future of your tank. With such an easy, reliable, and inexpensive method, I am optimistic more marine aquarists will soon be quarantining like pros! 

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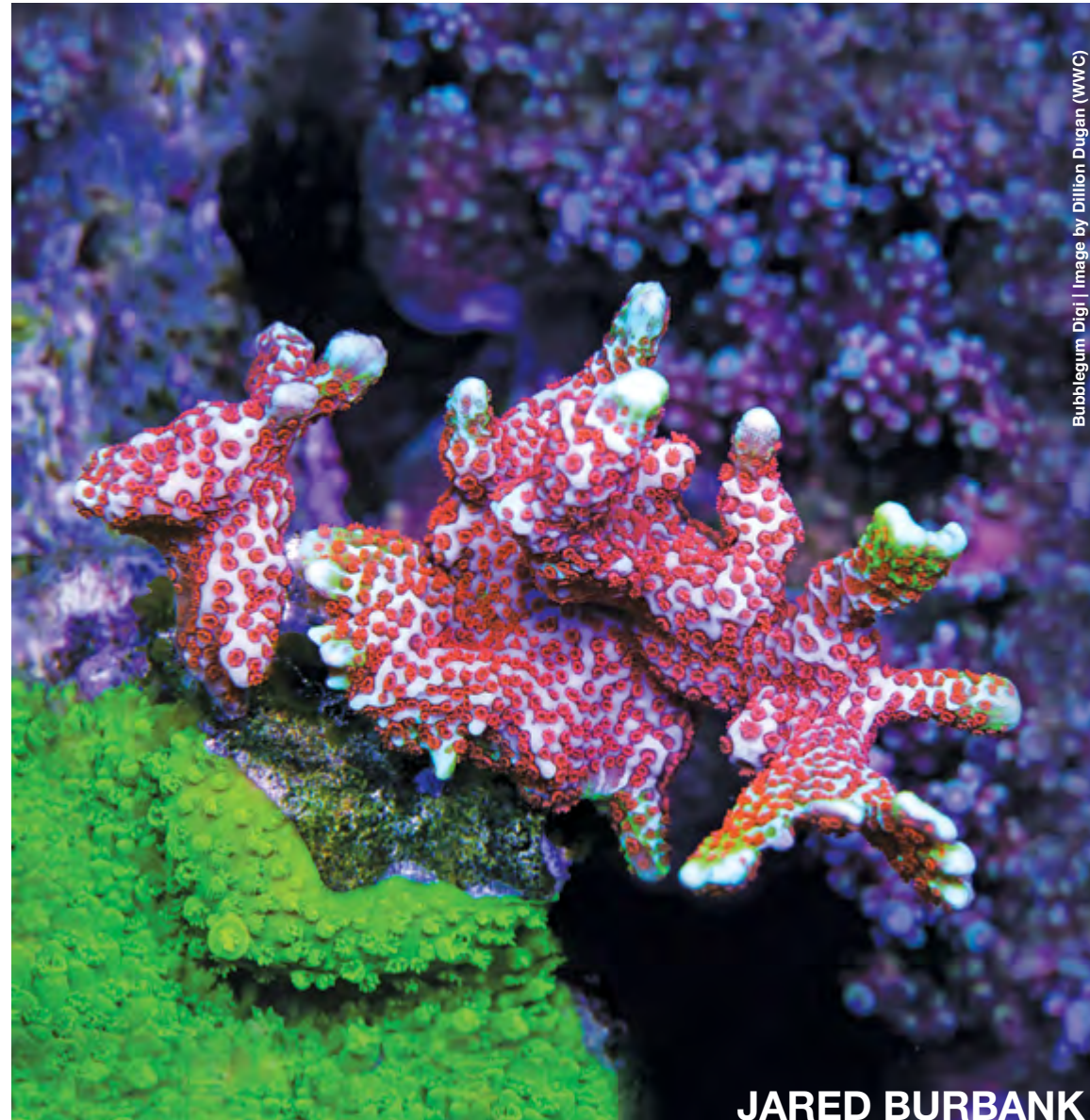
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Bubblegum Digi | Image by Dillon Dugan (WWC)

JARED BURBANK

The Wonderful World of *Montipora digitata*

When it comes to small-polyp stony (SPS) corals, *Montipora digitata* is one of my all-time favorites. This species is fast growing, comes in a variety of colors, and has a unique growth pattern. Thriving colonies can become quite large in home aquaria under proper conditions. In just a few years, I had a Digi colony grow from a 2-inch frag into a massive colony well over a foot across.

Digis are found across a wide swath of the Eastern Hemisphere, from East Africa to Asia and the exotic South Pacific. They are relatively hardy—not as prone to bleaching as other coral species—but still under potential long-term threat from rising ocean temperatures, ocean acidification, and ever-worsening storms. The *Montipora* genus to which Digis belong was first described by French zoologist Henri Marie Ducrotay de Blainville in 1830 and is a major contributing genus to reef formation. According to the University of Queensland's Great Barrier Reef Invertebrates webpage, it's thought that this genus has been around for roughly 30 million years.

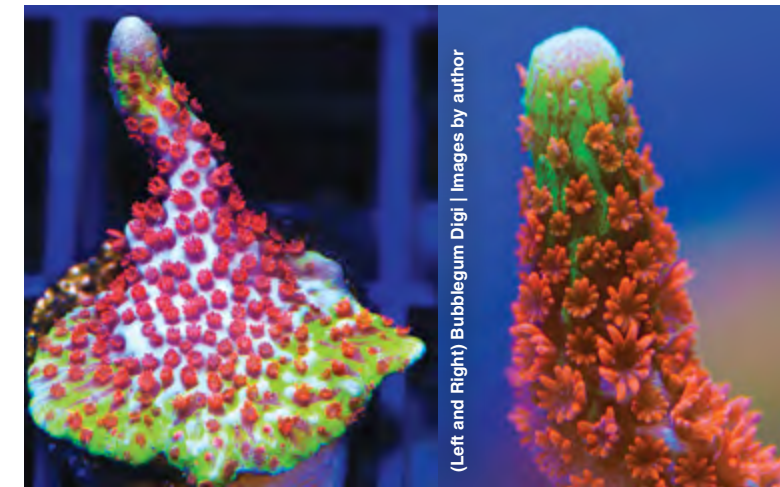
Most Digis adapt very well to home aquaria. I have personally been aquaculturing the same Digis for nearly a decade with fantastic success. They are generally considered an easier SPS for the home aquarist. Because they come from shallow waters in the wild, they do require somewhat strong lighting. Over the years, I have grown them under metal halide, T5, and LED lighting, all with great success.

I have found that Digis prefer moderate to heavy water flow. In lower flow, they grow thin, brittle branches, but in stronger flow, they grow thicker branches with irregular tips and forks and generate nice curvy growth patterns. Digi tips are usually white, which denotes new growth. But if your coral's tips are short and growing slowly, it's usually a sign of low alkalinity and calcium in the water stunting the growth. Excessive nutrients in the system can also be a problem and will cause Digis to brown out and grow at slower rates.



FC Bubblegum Digi | Image by Ian Ang

Like most other SPS corals, Digis require consistency in water parameters. Signs of problems include poor polyp extension and loss of color. For me, the most sensitive Digi is the Bubblegum Digi, which will retract its polyps if something is off or lose its vibrant green tips if the alkalinity and calcium parameters don't remain consistent. I experienced this firsthand when I was having a problem with my calcium reactor. I was losing the green



(Left and Right) Bubblegum Digi | Images by author

color from the tips of my Bubblegum colonies and found that the pH controller in my calcium reactor was reading the incorrect pH, causing low alkalinity and calcium levels in my system. The Bubblegum was the first to show signs of a problem, even before my more delicate *Acropora* showed any negative effects. Generally though, if your Digis are having a problem with poor polyp extension, you're probably up against a salinity issue or excessive nutrients in your system.

In my system, I run oversized skimmers and do regular 20 percent water changes. Most Digis do not require an ultra-low nutrient system but actually prefer some nutrients in the water for better

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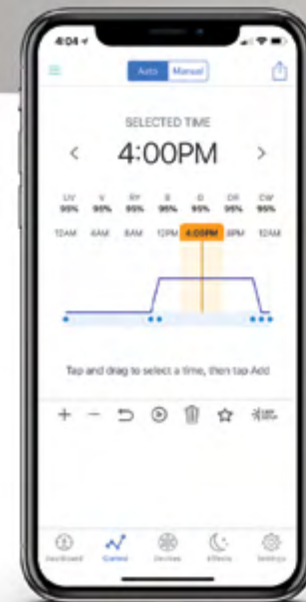
Montipora digitata | Image by Miguel Tolosa

growth. The one exception I have found is, once again, with the Bubblegum Digi, which achieves optimum colors in lower-nutrient environments.

Like plating *Montipora*, Digi's are commonly found in hues of tan to brown, green, red, orange, and purplish-blue. In recent years, new ones have appeared in the hobby, including Superman (light blue body with bright-red polyps), Forest Fire (green body with red polyps), and the exceptionally striking Bubblegum Digi (light blue body with brilliant red polyps and bright green to chartreuse tips). While the Bubblegum Digi is slightly more temperamental in

maintaining its vivid coloration, it's totally worth it as it can be the centerpiece of any reef tank.

Digi skeletons are more porous than other SPS skeletons, which can make the branches susceptible to accidental breakage during tank cleaning. On the flip side, this makes propagating very easy. Branches can be easily broken or snipped off and glued (superglue or epoxy) to a frag disc or straight onto one of the rocks in your tank. I have fraged well over a thousand Digi's through the years, and with their hardy nature, I don't think I have ever lost a single one due to fragging.



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Superman Digi | Image by Dillion Dugan (WWC)



Turquoise Fire Digi | Image by Miguel Tolosa

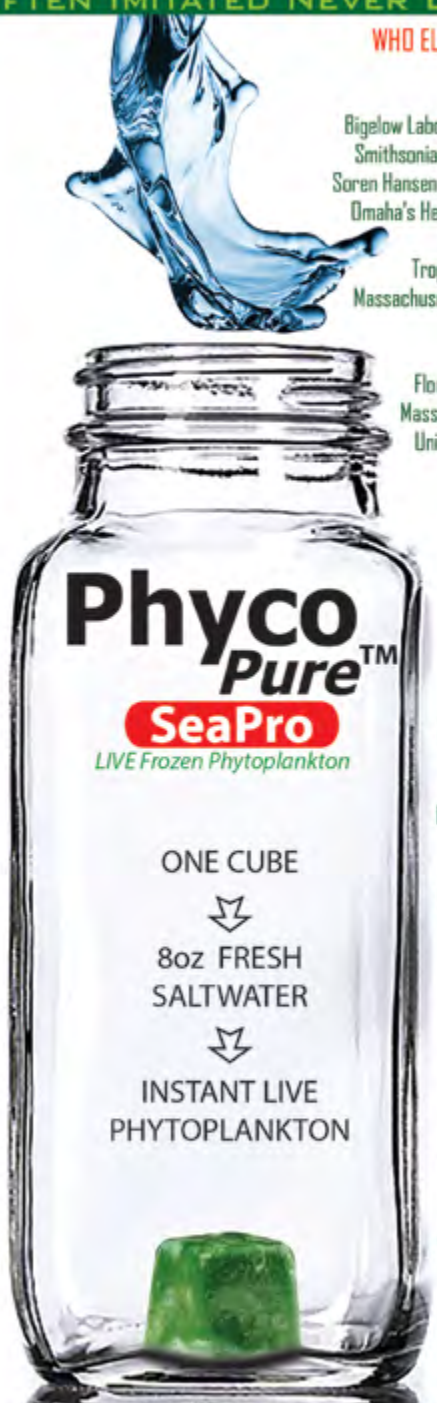
Generally, a new frag will encrust a solid base with minimal vertical growth before sending off new branches. This can take several weeks. But once it encrusts, it will often really take off, sending up multiple branches at once within the following month or two.

When placing a new Digi in your tank, be sure to give it ample space to grow, as it is a faster-growing coral. It is also a very peaceful coral that won't sting other species but is susceptible to being stung by more aggressive corals. I have grown various Digis together on the same frag plugs, and like *Montipora capricornis*, they will do just fine with different color morphs next to each other.

Digis have long been a favorite in the hobby, and with so many colors to choose from, it's easy to see why. They run the gamut from the single color Digis of green, orange, and purple to tricolored collector beauties. If you are just getting into SPS corals, *Montipora digitata* is an excellent choice. It is much hardier than most of the other small-polyp stony corals and will add a vibrant splash of color to any tank.

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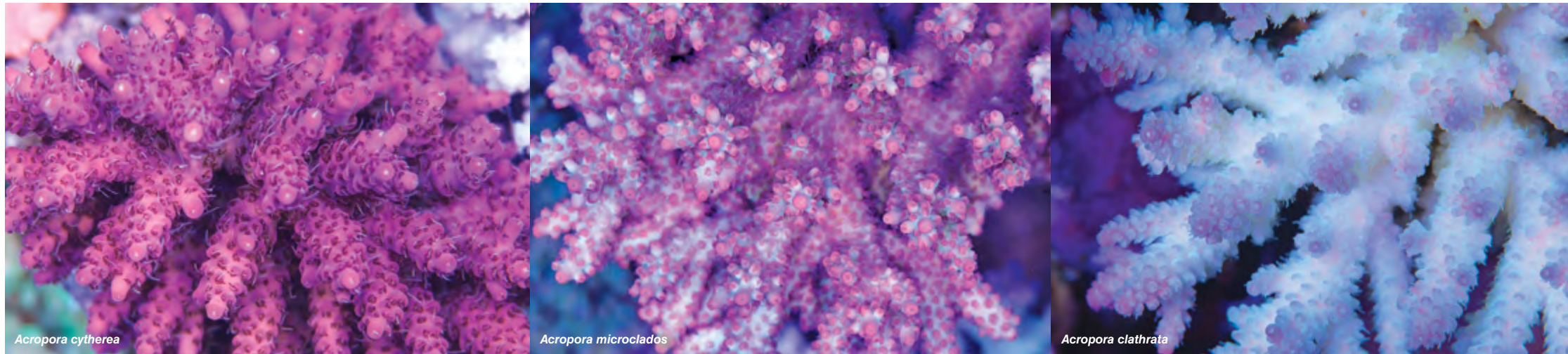
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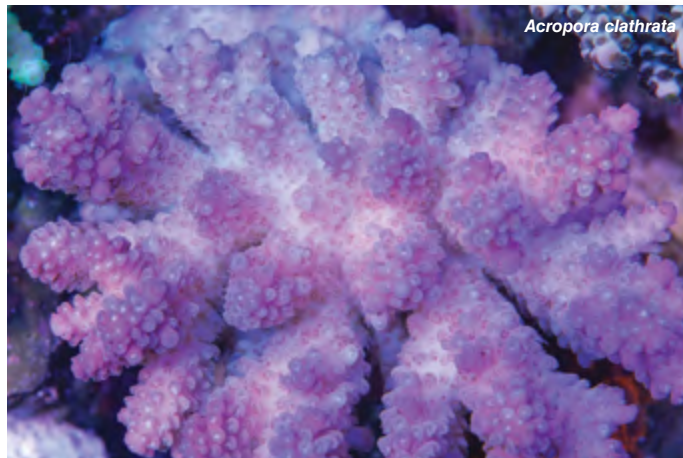
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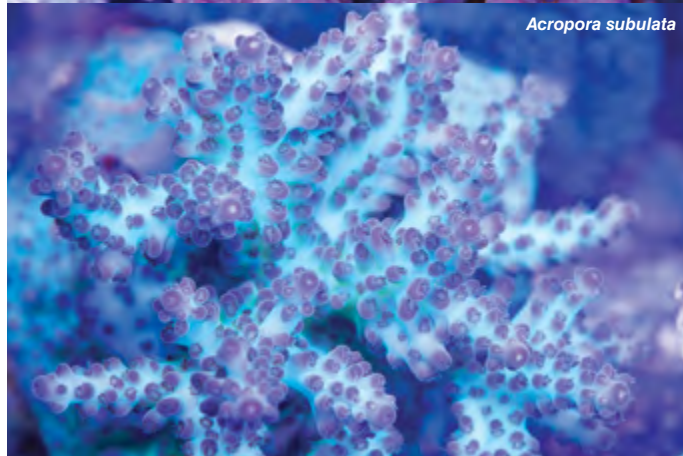
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Acropora microclados



Acropora tenuis

My SPS (small-polyp stony) aquarium was started in 2017. Most of the corals here came from my previous tank, but I also added new frags during setup. Using what I'd learned from 20 years of reefkeeping, I designed this system to keep a large number of the most demanding *Acropora* and a large population of fish, so I gave it a massive filtration system. Even so, after only 2 months, I decided the sump had to be enlarged by nearly 80 gallons so I could add more live rock. Currently, the tank has more than 150 different types of *Acropora*. Tank maintenance takes between 30 and 60 minutes per day, including a daily water change of 5 gallons.

SPECIFICATIONS

- Display:** 55" x 28" x 22" (~132 gallons)
- Sump:** ~238 gallons
- Skimmer:** AF250 with AquaBee 8000 pump
- Return Pump:** AquaBee 11000 (sump and filtration are located one floor below)
- Water Movement:** (3) EcoTech Marine VorTech MP40, (2) Tunze 6085
- Reactors:** (2) Aquaforest AF90, (2) Aquaforest AF110, Aquaforest AF150, Pacific Sun CalcFeeder Pro AC3



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PARAMETERS

Temperature: 77° F
Salinity: 36 ppt
Calcium: 430 ppm
Carbonate Hardness: 7.6°

Magnesium: 1350 ppm
pH: 8.3
Phosphate: 0.01 ppm

DOSING, FEEDING, AND MAINTENANCE

DAILY

- Pro Bio S: 2 drops
- -NP Pro: 2 drops
- AF Amino Mix: 4 drops
- AF Vitality: 4 drops
- Iodum: 5 drops
- AF Energy: 5 drops
- AF Build: 5 drops
- Component 1+: 300 ml
- Component 2+: 300 ml
- Component 3+: 300 ml
- NitraPhos Minus: 20 ml
- AF Anthias Pro Feed S
- AF Marine Mix S
- Calcium reactor: 1200 ml/h

TWICE WEEKLY

- AF Power Food: 4 measuring spoons
- AF Pure Food: 4 measuring spoons
- AF Plankton Elixir: ½ cap
- 60 L water change with AF Perfect Water

WEEKLY FEEDING

- AF Life Source: 1 spoon

TWICE MONTHLY

- Replace carbon inside sump: 0.5 liter
- Replace Phosphate Minus: 0.5 liter

MONTHLY

- Replace carbon: 2 liters
- Replace Zeo Mix: 2 liters
- Replace Life Bio Fil: 20 percent



Acropora echinata



Acropora tenuis



Acropora microclados

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Cowabunga!
Holy Smokes!
Shazam!
Zowie!
Wow!
OMG!**

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KPM Ø2.55 x 2.64 in	1150 - 2700 gph	12W-25W	0.78 in	50 - 125 gallons





Lentigo lentiginosus

SABINE PENISSON

UNCOMMON CLEANING CREWS

Part 2: Sandbed Scavengers

In the Q3 2018 issue of *RHM*, we talked about unique cleaners for the rockwork of reef tanks. Now, let's review some of my favorite sandbed scavengers. These creatures will be very effective in helping you maintain an immaculate tropical sandbed in your aquarium.

SNAILS

Whether you want a detritus feeder or an algae grazer, with a little effort, you can find some interesting species of sand-cleaning snails

for your aquarium. The popular species from the genera *Nassarius* and *Babylonia* are necrophagous and detritus eaters. They live under the sand surface, but when they smell food, you'll see their long trunks (proboscis) elevate above the surface of the sand like olfactory periscopes. They will then rise to the surface near the food item, fold their foot around it, and swallow it using their radula. These snails usually look apathetic and slow, but when a meal is presented, they move incredibly fast. Their sense of smell is very sharp, detecting food from many meters away in the wild! Other popular species are found in the genera *Strombus*, *Cerithium*, and

Nassarius coronatus emerge from the sandbed after meaty food is added to the aquarium.



Cerithium spp. breed well in aquariums.



Lentigo lentiginosus mating ritual



Mitra mitra (Indian Ocean)



Rhinoclavis. These snails seek microalgae and bacterial films on grains of sand and the lower parts of live rock. They more often stay above the sand surface than under it and are mostly nocturnal. *Strombus*, however, are less nocturnal than the others and may be seen seeking out a meal even during daylight hours.

Less famous, but no less beautiful, *Mitra papalis*, with its large bright-orange-spotted shell, is a great and original addition, but it is very secretive and lives only under the surface of the sand, so you won't see it too often.

All these snails are very beneficial to aquariums with sandbeds and are good alternatives to hermit crabs. If you're wondering how many snails to put in your aquarium, below are my recommendations:

For every 5 gallons: (1) *Nassarius* and (1) *Cerithium* or *Rhinoclavis*

For every 10 gallons: (1) *Babylonia*

For every 30 gallons: (1) *Conomurex luhuanus* (formerly *Strombus luhuanus*)

For every 60 gallons: (1) *Euprotomus bulla* (formerly *Strombus bulla*), *Lentigo lentiginosus* (formerly *Strombus lentiginosus*), or *Mitra papalis*

URCHINS

Some urchins from the Irregularia infraclass are famous for helping aquarists maintain a beautiful and clean sandbed. They are sold under the common names of sand dollars or sea biscuits (mainly *Clypeaster* and *Laganum* genera in the trade) and heart urchins

(mainly from genera *Maretia*, *Metalia*, *Brissus*, and *Lovenia*). The sand dollar's common name comes from the confusion of treasure seekers fooled by these round, flat pieces at the bottom of the ocean, similar in size to the old American or Spanish coins. The heart urchin takes its name from its slightly irregular shape, with a broad, rounded anterior surface and a more pointed posterior.

The sand dollar is covered with very thin and short velvet-like spines, from cream to tan colored (gray to purplish for *Laganum laganum*), and is decorated with a darker, petaloid-like flower pattern. Each of these "petals" is a double row of pores that permits gas exchange within the urchin's endoskeleton. There are also special podia located here, which are used to cover the urchin with sand. Unlike the sand dollar, the heart urchin bears disparate-sized spines, some of which are distributed throughout the aboral (dorsal) face and are surprisingly long and flexible; this urchin looks like a fluffy and bushy lump of fur. It bears a contrasting pattern with a light base, almost white on *Maretia planulata* but more beige in *Metalia sternalis*, adorned with an ash-gray, taupe, or brown pattern. Long brown patches are found on the sides of the aboral face on *Metalia* spp., but these patches are flower-shaped for *Maretia* spp.

In the aquarium trade, the sand dollar is the most popular of these animals. Maybe a bit more uncommon and more difficult to find in stores, *Maretia planulata* and *Metalia sternalis* are often more active than *Clypeaster* spp. and are longer-lived in the aquarium too. This is probably due to their significantly smaller size and smaller appetites. Even more unusual to find is the very pretty *Laganum laganum*. Its aboral face is covered with small, dark dots surrounding a large flower pattern, but it is more delicate than *Metalia* spp.

All these animals live below the surface of the sand, sometimes barely buried and showing among the grains, sometimes staying much deeper. The classic literature commonly mentions the need

Maretia planulata



Clypeaster humilis



Metalia sternalis nocturnal reproduction parade



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Archaster typicus

for a 3-inch layer of sand and 1 square meter of area for the care of a single *Clypeaster* sp. in captivity. But such sandbeds are not very common nowadays. In my experience, a standard 1-inch sandbed in a 50-gallon tank can keep one of these urchins healthy for years if you feed your tank generously, creating a good amount of waste. The smaller the sandbed is, the more careful you'll need to be to avoid competition with other species (sand stars and snails) that compete for the same microalgae and bacterial films for food.

STARFISH

Some sand starfish are very common in the trade: *Archaster typicus*, *A. angulatus*, and, a little less common, *Astropecten polycanthus* (which, as a predator of other sand animals like echinoderms, snails, and worms, must be kept in a well-planned community). *Archaster* spp. are reef safe and necrophagous/organic



Archaster sp. emerging from the sandbed

scavengers. Although both genera display a cloudy beige, brownish, or gray color pattern, there's a noticeable morphological difference between *Archaster* and *Astropecten*: the latter sports a row of long spines along each side of the arms like a comb, while *Archaster* has much shorter spines on its arms.

As they crawl through the sandbed looking for food, these starfish stir the grains and help rid the sand of waste. They are very efficient and much less fragile than other species of starfish, but they do require a thick layer of sand. Like all echinoderms, they are sensitive to rapid water quality and parameter changes. Aquarists should be careful not to house them with aggressive crabs and big hermit crabs that could tear an arm off the star to feed on.

SEA CUCUMBERS

Most sea cucumbers have a long, cylindrical, and thick body. You may think they're all soft, as they have no bony skeleton, but they have hard parts, such as tiny calcareous wheels and anchor-shaped ossicles of nanometric size. Many sea cucumbers live on the sand where they find their main food source. The oral and aboral faces are not based on "up/down" symmetry as in most echinoderms but on a bilateral basis. A tentacled crown surrounds the mouth at the front, bringing grains of sand and organic matter to the mouth. At the opposite end is the anus. Their "ventral" face (called trivium) shows three lines of small tube feet. On their back sides (called bivium), two lines of papillae complete the usual pentaradial structure of echinoderms. They are mobile and often nocturnal. Some species, like the serpent sea cucumbers, are very long and thin (up to 3 meters long for some *Synapta* spp.).



The feeding tentacles of *Holothuria hilla*



Holothuria edulis in the wild (Maldives strain)

Sea cucumbers are fabulous cleaning agents for the aquarium, feeding on the organic matter trapped within the sandbed. As the grains of sand pass through their digestive system, they come out perfectly clean.

The sea cucumber's main flaw is the potent toxin called holothurin present in many species. This toxin is found in various organs and tissues, especially in the cuvierian tubules, and is a defensive weapon in the form of white and extremely viscous filaments. The presence of cuvierian tubules is therefore an indicator of greater toxic potential. This violent poison can be expelled during any major stress event, such as getting sucked in by a powerhead, becoming trapped in an overflow, or starvation. This release of poison can

happen whether the animal is dead or alive and even as the tissue decomposes. Fish will generally instinctively stay away from sea cucumbers. Depending on the species and the aquarium's volume, a release of holothurin in the water can lead to the death of an entire tank's population, even in a large-volume tank. A small Sea Apple (*Pseudocolochirus* sp.) can eradicate all life in a 265-gallon aquarium! But don't panic. Not all sea cucumbers are so toxic.

Among these kinds of sand cleaners, the most commonly found in the trade are the black *Holothuria atra*, the black and pink *Holothuria edulis*, and the tan and spiky *Holothuria hilla*. The first one contains many cuvierian tubules, and its concentration of holothurin is very strong, so that species should be avoided. The other two don't



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Holothuria hilla

possess cuvierian tubules, and their holothurin concentration is generally low. If you want to add a sea cucumber into your system, I recommend *H. edulis* or *H. hilla*, but be aware of the possible risks.

H. hilla is thinner and smaller than *H. edulis*, so I recommend *H. hilla* for aquariums of at least 50 gallons (then one specimen per additional 100 gallons), and I recommend *H. edulis* for aquariums of at least 100 gallons (then one specimen for each additional 150 gallons). Be sure to provide a spacious and mature sandbed.

Sea cucumbers, like many echinoderms, are continuous feeders; they need an abundant and continually renewed food source. Sea cucumbers feed on bacterial, sedimentary, and algal films, diatoms, and cyanophyceae contained in the sandbed. These are not food items you can buy and put in the aquarium; the system itself must generate and renew them naturally. It can be tempting to add a large cleanup crew when starting the tank or when a problem appears, but




Babylonia spirata, a close cousin to *B. zeylanica*

I recommend thinking about the long-term balance between the quantity of food your aquarium can provide and the number of mouths that need to be fed. You wouldn't want animals like sea cucumbers to be starved.

Aside from the risks of accidents mentioned above, sea cucumbers are robust and not very delicate. Echinoderms are usually very sensitive to poor acclimation (be careful with quick parameter changes), but once settled in the aquarium, sea cucumbers are less fragile than other echinoderms to slow drifts in water parameters. Like all echinoderms, they are very sensitive to copper. In a thriving environment, *Holothuria hilla* is also able to reproduce on its own through binary fission. If the aquarium provides a

healthy environment for the animal, you can easily end up with four or five specimens after a few years. But don't worry, asexual reproduction is regulated by food intake, so there is no chance of a sea cucumber invasion.

In the previous issue (Part 1), I suggested some unique rock scavengers to consider for your cleanup crew. With Part 2, you can now choose from a wide range of interesting cleaners for your sandbed as well. If you choose your cleanup crew wisely, an important part of the tank's husbandry will be done every day without you having to lift a finger. I hope I've offered some interesting options to help you build your perfect cleanup crew. 

TOP 3 CHALLENGES OF ECHINODERMS IN AQUARIUMS

The biggest long-term problem people have when keeping echinoderms in captivity is the lack of appropriate food. It is therefore necessary to accurately assess food requirements for these animals relative to what your system can provide.

A second problem often encountered is water quality deviation, especially for salinity, temperature, dissolved oxygen level, and, to a lesser extent, carbonate hardness, nitrates, and phosphates. A sudden deviation or slow drift far from the standard parameters of natural seawater can lead to echinoderm deaths.

A third issue to be aware of is the need for careful acclimation. Given a bad start, echinoderms can die in just a few hours. Let's repeat acclimation basics 1.0. First, float the closed bag for at least 15 minutes in the tank or sump to equalize temperatures. Then, open the bag and remove most of the water, leaving only what is necessary so that the animal stays submerged. Transfer the submerged animal and the water into a bucket. Through a semi-tied-off airline hose set up as a siphon from the tank to the bucket, slowly drip water into the bucket. When the volume of water has doubled in the bucket, discard the excess water from the bucket and repeat the drip sequence until the water volume doubles again. This process can take up to 30 minutes. Once completed, the animal is ready for the tank.

Animals should be transferred to the tank in a container with the minimum water required to keep them completely submerged. Do not expose them to air for any step of the acclimation, as an air bubble could end up in the mouth, an ambulacral canal, or a respiratory pore, remain there, and cause consequential necrosis. If ever the animal is exposed to air, immerse it in tank water mouth up and shake it slightly to dislodge any bubbles. Then, lay it right side up on the substrate, shaking slightly to remove any remaining air bubbles.

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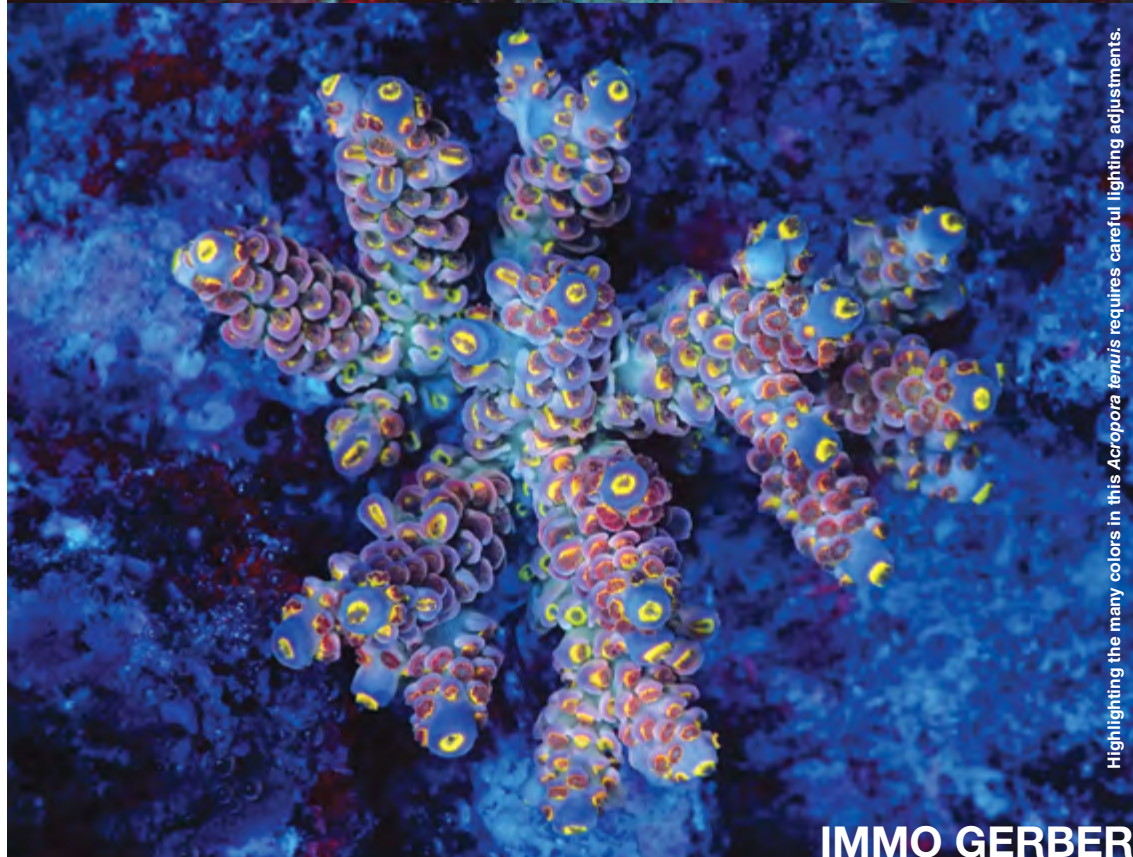
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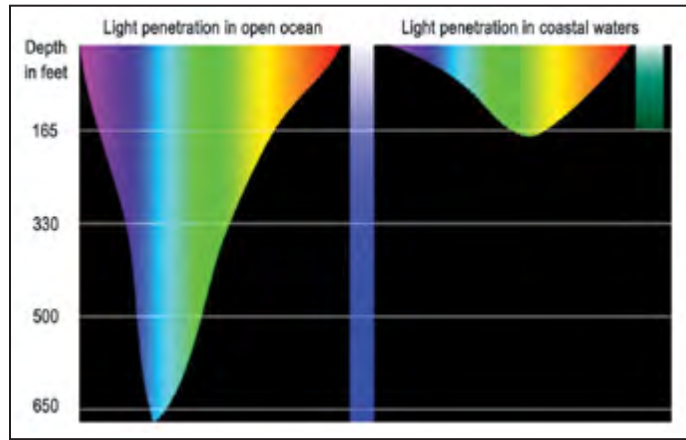
This is the same *Acropora tenuis* under a more red-biased spectrum.



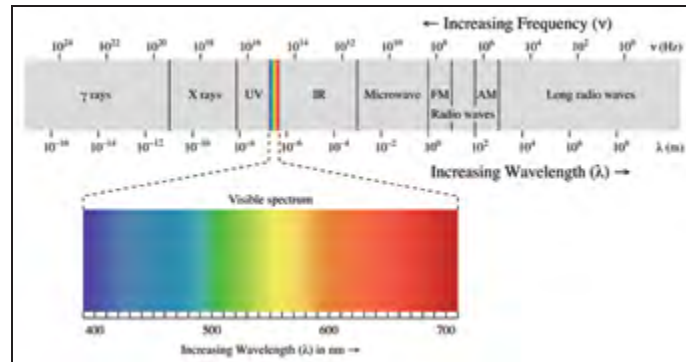
Highlighting the many colors in this *Acropora tenuis* requires careful lighting adjustments.

IMMO GERBER

Lighting the Way to Better Coral Color



This illustration shows the spectral drop-off at various depths in the open ocean and coastal waters. | Image by NOAA



Visible light is only a tiny part of the electromagnetic spectrum. | Image courtesy of Philip Ronan, Wikimedia Commons

I started in the salty hobby in 1989 and was extremely lucky to live more or less in the same neighborhood as Mr. Peter Wilkens, one of the founders of the Berlin System. I had the chance to learn a lot from this outstanding and legendary pioneer of reefkeeping. I also became obsessed with understanding reef tank lighting. Most reefkeepers have two goals: get the best possible coloration and the best possible growth out of their corals. A lot of scientific research has been done on these topics. We've always known that our choice of lighting directly impacts the colors of our corals. But since LED lighting entered the market, we have new opportunities to study the effects of various spectral choices on our corals. In this article, I will show you some of my current choices and the rationale behind them.

LIGHT

Technically, light is defined as those wavelengths of energy that are visible to the human eye, roughly between 380 nm and 780 nm. This is only a small range compared to the whole spectrum of electromagnetic radiation. Only half of the energy produced by the sun falls within this visible range. What we can learn here is that you can't evaluate the suitability of a given light for corals based solely on how corals look under that light. A far better approach is to understand the light and environmental conditions under which our corals grew in the wild.

LIGHT, CORALS, AND MORE

Let's review some of the basics of sunlight transmission in seawater. Out of all the sunlight hitting the surface of the ocean, some is reflected immediately. The wavier the ocean is, the more light is reflected and refracted. The spectrum of light that is not reflected is then altered by depth, turbulence, and particles in the water. Water itself scatters and absorbs different wavelengths of light differently, so the deeper we go, the more this effect impacts what light spectrum reaches corals. We know that red, yellow, and orange spectrums are reduced first in seawater (almost no red light reaches 50 feet and almost no yellow light reaches 100 feet) and that what dominates the spectrum more and more are the shorter wavelengths of blue, violet, and green. This means that in shallow water, more of the full solar spectrum reaches the coral, whereas in deeper water, more of that spectrum is scattered or filtered out.

If we get corals from the shallows and areas with very clear water, we know the corals are used to relatively high PAR (photosynthetically active radiation) and nearly the full spectrum of sunlight. Most *Acropora humilis*, *A. gemmifera*, *A. millepora*, and *A. prostrata* come from these locations. If a tank's nutrient levels and parameters are at reasonable levels, we can expect corals from these waters to display good growth and coloration with low to medium Kelvin (7,000 to 14,000 K), high-PAR lighting.

If we get corals from deeper areas, we should ensure that the corals receive the appropriate PAR and spectrum to simulate their native environment. By doing so, the corals have a greater




Take a look at the nice green glow on the base of this coral. You can see the green protective pigmentation, but there isn't a lot of it.



The red light makes the corallite margins pop on this *Acropora tenuis*.


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Some corals, like *Acropora hyacinthus*, are well suited to show you if you're on the right lighting path.

probability of maintaining their original coloration. If we give these corals too much PAR, they may produce a new layer of pigment to protect themselves. This new pigmentation may prevent corals from displaying their original colors. In many cases, you will see this as a green fluorescence. Careful attention to a new coral's color changes will provide clues about its PAR and spectral requirements.

CLOUDS

Some hobbyists say clouds are just a bauble and that nobody needs this kind of gimmick in their lighting scheme. In the natural environment, we not only have real clouds, but we also have particles in the water, such as algae and plankton. So what does this mean for light intensity? It means that light intensity continually changes throughout the day. If we introduce some clouds into our schedule, we can simulate the constantly changing intensity of light in nature. As we tweak the intensity and spectrum of our lights, we are directly tweaking the coloration of our corals.

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Ga	0.01ppm	I	0.02ppm	K	340.69p...	La	0.01ppm	Li	0.46ppm
Mg	1217.7p...	Mn	0ppm	Mo	0.01ppm	Ni	1325.71...	Ni	0ppm
P	0.09ppm	Pb	0ppm	Rb	0.01ppm	S	249.89p...	Sb	0.01ppm
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The ability of precise lighting control to enhance base colors or highlights is clearly seen in these three corals (*Acropora tenuis*).



Acropora tenuis



Acropora tenuis

HIGH PAR WITH LOW NUTRIENTS

Why is high PAR with low nutrients a challenging environment for corals? With higher PAR, corals have higher metabolic activity. With low nutrients, the coral's flesh grows very thin. When combined, corals may experience metabolic stress, making it difficult for them to thrive. You absolutely can get nicely colored corals with this combination, but it's a delicate balance. Hobbyists who use the ZEOvit system are familiar with this strategy. The corals are pastel colored with a ceramic look. I don't recommend illuminating these corals predominantly with blue spectrums. You will have more success if you use a wider spectrum.

COLORS AND NUTRIENT LEVELS

Not long ago, most people thought that with higher nutrient (nitrate) levels, corals would turn brown. These arguments were made before ICP-OES (Inductively Coupled Plasma-Optical Emission Spectrometry) testing was introduced to our hobby. We now know that this isn't strictly true. At the time, we had no ability to measure many of the important trace elements, but now, hobbyists are using ICP to precisely monitor their tanks and know exactly what is in their water. As hundreds of examples have shown, you can have great-

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This *Acropora tenuis* has multi-colored polyps, a detail revealed by carefully adjusted lighting.



Finding the right spectrum and water parameters to coax out multiple subtle colors from corals is part of the fun of the hobby.

colored and healthy corals with higher nitrates. The ratio of phosphate to nitrate is far more important (aim for 1:100) than phosphate or nitrate levels individually. And with that understanding, we have seen more and more great tanks with various nutrient levels. The key is that we can now control our water chemistry precisely and, for the first time, accurately monitor and control the trace elements. We now have nearly full control of our lighting and water parameters, and this opens up a whole new world of understanding the relationship between these two factors, allowing us to manipulate that relationship to the corals' advantage.

MORE GROWTH

If your goal is to have faster coral growth, I recommend a metal halide-style spectrum (broader spectral output), keeping enough nutrients in your tank, and keeping your water parameters stable by careful adjustments and monitoring with ICP analysis. Good coral growth also means the coral must maintain a robust metabolism. Take a look at your nutrient levels (NO_3 and PO_4), especially if you have a ZEOvit or ultra-low nutrient system (ULNS). Consider whether a lack of available nutrients is inhibiting coral growth.

If your goal is to enhance fluorescent coral colors, I recommend a T5-style spectrum (more narrow and targeted spectral output) and tweaking your spectrum with cloud options until you reach your preferred color rendition. Don't keep your nutrient levels too low, and feed your corals with high-quality coral food, like Fauna Marin Coral Sprint.

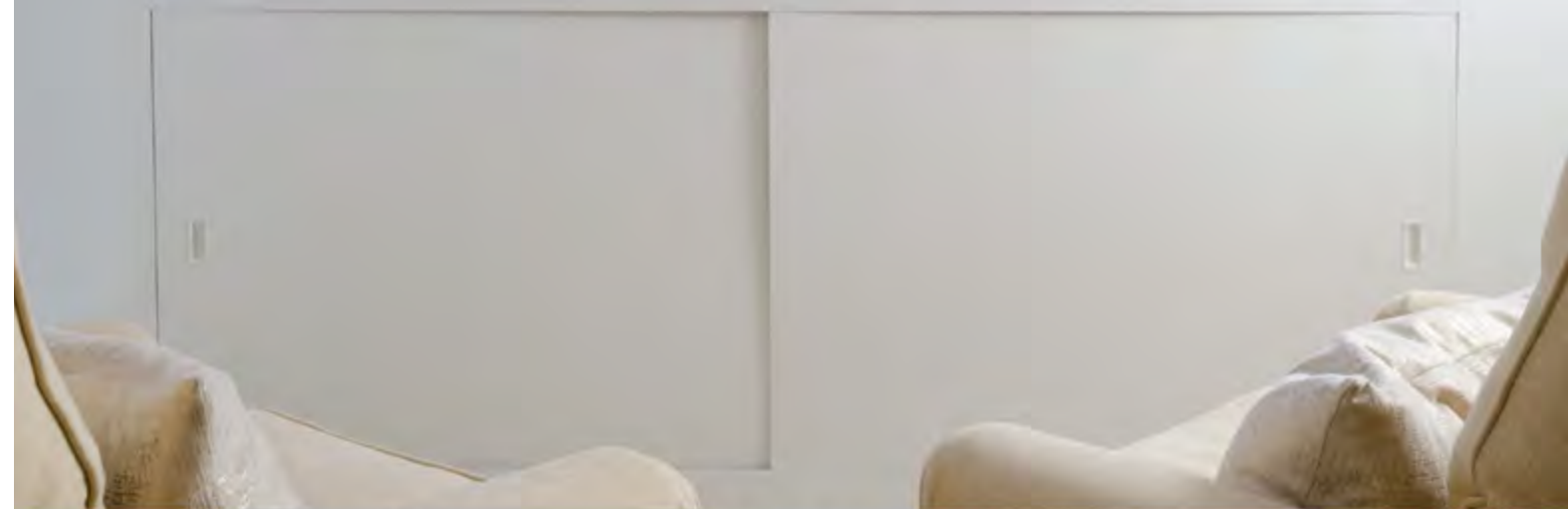
CONCLUSION

With LED lighting, the power is at our fingertips to give our corals exactly what they need. Metal halides and T5 bulbs offer simple solutions, in that we do not have to worry about adjusting the spectrum of light. They can provide very good lighting for most of our corals. But with this simplicity comes limitations. And as you have seen in this article, you have a big advantage with a proper LED fixture. You can create the best spectrum for any type of coral, and you are better able to simulate natural environments because you can change specific parts of the spectrum. Hopefully, this article has helped you to better understand the relationship between corals, their natural habitats, and how we can best provide for their lighting needs.

If you want learn more about light, spectrum, and that kind of fun stuff, feel free to visit our weblog at www.salzwasserwelten.de.



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KEITH MOYLE

Testing, Testing: Easy as 1, 2, 3

While all hobbyists acknowledge the importance of water quality in maintaining a successful reef aquarium, it's quite surprising to read that many aquarists don't have a regular water-testing regimen, relying solely on tank observations. It's only when something goes wrong that they resume testing. Had this instead been a regular task, it could have given advance warning that something was amiss.

Testing isn't as daunting as it may seem, and many of the kits on the market make it a straightforward and quick process. In my opinion, the time taken to perform tests is a good investment, and tests should be carried out regularly. In this article, I want to consider what we test and why, discuss the types of kits available, and offer advice on how to obtain accurate and consistent results.

WHAT TO TEST AND WHY

Testing provides invaluable information about your water chemistry. There are a multitude of test kits available, ranging from the commonly used ammonia (NH₃), nitrite (NO₂), nitrate (NO₃), pH, alkalinity (Alk), phosphate (PO₄), calcium (Ca), and magnesium (Mg), to the more specialized iodine (I), potassium (K), strontium

(Sr), and iron (Fe) often used to enhance SPS (small-polyp stony) coral coloration.

Ammonia and nitrite levels are indicators of the effectiveness of your filtration system, while high nutrients can be identified by nitrate and phosphate measurements. The ionic balance of aquarium water can be determined by taking calcium, magnesium, and alkalinity tests, allowing you to calculate the dosing requirements for your system to maintain equilibrium. If you only keep fish, soft corals, or LPS (large-polyp stony) corals, then you're unlikely to need iron, strontium, or potassium kits. Recording test results provides important insight into the changes in water chemistry over time and helps identify trends, providing an early indication of deterioration in water quality.

TEST OPTIONS

By far the most common tests used are based on titrimetry and volumetric analysis to measure the concentration of a chemical in water samples. A measured volume of aquarium water is used (normally a few milliliters), which is usually mixed with a chemical reagent to which a liquid chemical solution (titrant) is added and mixed, producing a color change. The actual test result is provided



Red Sea Pro color wheels help obtain precise readings.

by either measuring the titrant used or by comparing the final color of the test sample to a chart. Although prone to user error, either through incorrect measurement of water samples or reagents, or inaccurate color recognition, these kits are capable of providing an effective means of water testing and remain a popular choice.

An alternative that alleviates the potential for error in color comparisons is Hanna's range of digital checkers. These are still colorimetric tests, though the color comparison is performed electronically, producing a digital readout.

Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) is the most accurate testing available to the hobbyist, and several laboratories now offer this service by mail. ICP testing also offers an unrivaled range of elemental analysis, although you should expect to pay a premium for this service.

ACCURACY OF TESTS

Some context is essential here, as hobbyist test kits represent an inevitable compromise between cost and accuracy. For the vast majority of hobbyists, this compromise is acceptable, and providing we maintain stable conditions, it doesn't really matter if the calcium reads 5 ppm higher or lower than our target value. What is important is that the kit produces consistent results. It's worth noting that all manufacturers' stated testing accuracies are based on strict adherence to their instructions. However, variables such as accurate measurement of water samples and reagents, water clarity, lighting conditions, eyesight, and color recognition can all impact accuracy.

Test kits should have an expiration date on the box or bottles, as the chemicals will deteriorate over time, and the kit's accuracy is compromised if these dates have passed. Deterioration will also occur more quickly when chemicals are exposed to air.

A QUESTION OF MEASUREMENT

Most test results are measured in parts per million (ppm), but there are exceptions such as the Hanna Checker for ultra-low-range phosphorus, which measures in parts per billion (ppb). Alkalinity is generally measured as dKH (from the German term degrees of carbonate hardness), though meq/L (milliequivalents/Liter) is also commonly used. Another less frequently used measurement for



Hanna Checkers provide an accurate digital readout.

alkalinity is calcium carbonate equivalents (in ppm). Conversion factors for the different units of measurement are as follows:

1 dKH = 0.36 meq/L = 17.8 ppm. A typical alkalinity of 7.5 dKH is the equivalent of 2.7 meq/L or 133.5 ppm.

TEST KIT SELECTION

Research is important when choosing your test kits, and there are many good ones available from brands such as Salifert, Red Sea, Elos, and Nyos. It's worth noting that the manufacturer of what's deemed to be the best nitrate kit may not produce the best calcium kit. Basic kits provide a test vial and color chart for interpreting readings, while other more sophisticated designs provide devices

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Avoid mixing syringes and vials since they may be different for each kit.



that hold the test vial and syringe to make it easier to be accurate when adding titrants to the sample.

Some manufacturers produce low- and high-range kits, so be sure that you purchase the kit with a suitable range for your needs. Also, check the increments of the color chart provided to make sure they provide the accuracy required, rather than having to decide if the reading lies somewhere between two similar colors on the chart. Some kits have fewer steps than others, have shorter waiting times, and are easier to use, meaning you can complete the test more quickly.

Purchasing a bundled set of tests in one package or buying bulk refills of individual test reagents are good ways of saving money.

FREQUENCY OF TESTING

How often to test is a difficult question to answer definitively, as many people (myself included) have their own regimens based on intimate knowledge of their own system's tested trends. Tests such as ammonia and nitrite are performed as frequently as every couple of days when cycling. These are then rarely tested once the system has matured, other than when the

Follow instructions carefully for each test kit to obtain the most accurate results.



aquarium bioload is increased. For other parameters, the following schedule (based on my own regimen for my predominantly SPS, low-nutrient system) is provided as a guide only.

- Weekly: alkalinity, phosphate, iodine
- Twice monthly: calcium, nitrate, pH (mine isn't tested as it's monitored constantly)
- Monthly: magnesium, strontium, potassium, iron

OBTAINING ACCURATE TEST RESULTS

The following guidelines are based on my experience performing water tests, and while some of the advice is nothing more than common sense, these principles have served me well over the years.

Above all else, be sure to read, understand, and follow the instructions, even if you've previously owned the same kit, as the instructions may have changed.

"By failing to prepare, you are preparing to fail" may be an old adage but is very apt when it comes to testing. Always have everything needed to complete the task at hand, and set out reagents in the required order to make for a smooth process. Ensure that test vials are clean, and always rinse them out a couple of times with the water being tested to prevent any potential contamination.

It's of vital importance to measure reagents and water samples accurately, using only the scoops and syringes that are supplied with the kit. Ensure that scoops are level and that drops of reagents are fully formed by holding the bottle vertically.

Familiarize yourself with the syringes being used, and ensure you know which end of the plunger is used as the reference point for measurement. This is usually the bottom at the end toward the syringe tip. Fill test vials using the correct point of the meniscus as the reference; the meniscus can be either concave or convex depending on the liquid in question. Salt water and fresh water both have a concave meniscus, so you generally take the measurement at the bottom of the waterline in the center of the vial, not from the edges, which will be higher.

For accurate results, mixing and waiting times are critical for the chemical reactions that take place in the test. Failure to follow the timing instructions can also lead to inaccurate results, so use a watch or the timer on your cell phone for best results.

When mixing reagents by shaking the test vial, ensure the chemicals are dissolved and there is no sediment left at the bottom of the vial.

Avoid cross contamination by always using a dedicated syringe for each reagent.

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Use it to accurately calibrate seawater refractometers and to check the accuracy of swing-arm hydrometers. You may also want to use it as a reference for test kits used to measure the concentrations of various seawater components, since it is natural seawater with the correct and well-known concentrations of all dissolved salts.

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Look for air bubbles in syringes, as this will mean the measured volume is less than indicated.

When interpreting results, be sure to know if you are supposed to measure the titrant remaining in the syringe or the amount used after completing the test, as this can vary on different kits.

Whenever feasible, use natural sunlight—or a lighting source as close to it as possible—when making color comparisons. Ensure you are observing the color through the sample in the correct manner, either from the top down or from the side, as indicated in the instructions. Ideally, use a white card under or behind the sample when making comparisons, and avoid any reflections which may alter the sample's appearance.

Water discoloration can affect the color of the sample, leading to an incorrect reading, though some kits utilize two vials to compensate for this when interpreting results. The use of carbon or ozone in your tank will help remove yellow tinges, keep your water crystal clear, and ensure the colors of test results are accurate.

If using an electronic checker, ensure no air bubbles are present that can affect the reading and that the outside of the vial is wiped clean before testing.

Keep all test equipment clean to avoid contamination that could lead to testing errors. Thoroughly clean all vials, spoons, and other tools with reverse-osmosis (RO) water, and dry everything after each test. Don't leave used samples in test vials, as this can cause discoloration of the glass. In some cases, it may be necessary to

soak the vials in a white vinegar solution for cleaning. Afterwards, rinse the vials in RO water to remove any residual traces of vinegar. It's good practice to clean all vials this way periodically to ensure that residues don't build up.

FINAL THOUGHTS

I always encourage hobbyists to undertake their own testing as opposed to relying on their local fish store to do this. Testing isn't as daunting as it sounds and plays an important role in tank maintenance, allowing you to monitor parameters and maintain stable conditions. Performing regular testing gives you a better understanding of your water chemistry and allows you to make informed decisions when adjusting parameters. I'd also advise logging the results so that you can monitor trends. A notebook will suffice, but some controllers have this functionality built in. Don't chase ideal numbers (in particular pH), even if a specific parameter is slightly out of balance. Doing this may throw other parameters out of whack, leaving an even bigger issue to resolve. Provided your parameters are stable within an acceptable range and your reef is thriving, accept that all tanks are different, and be happy that you've found equilibrium.

Testing doesn't need to be expensive, and the majority of brands are more than capable of providing acceptable results. Follow the instructions and apply strict attention to details when testing. Once you get the hang of it, you will gain confidence from knowing that all is well in your aquarium. As reefers, we keep water, and if maintained correctly, the corals and fish will practically look after themselves. *R*

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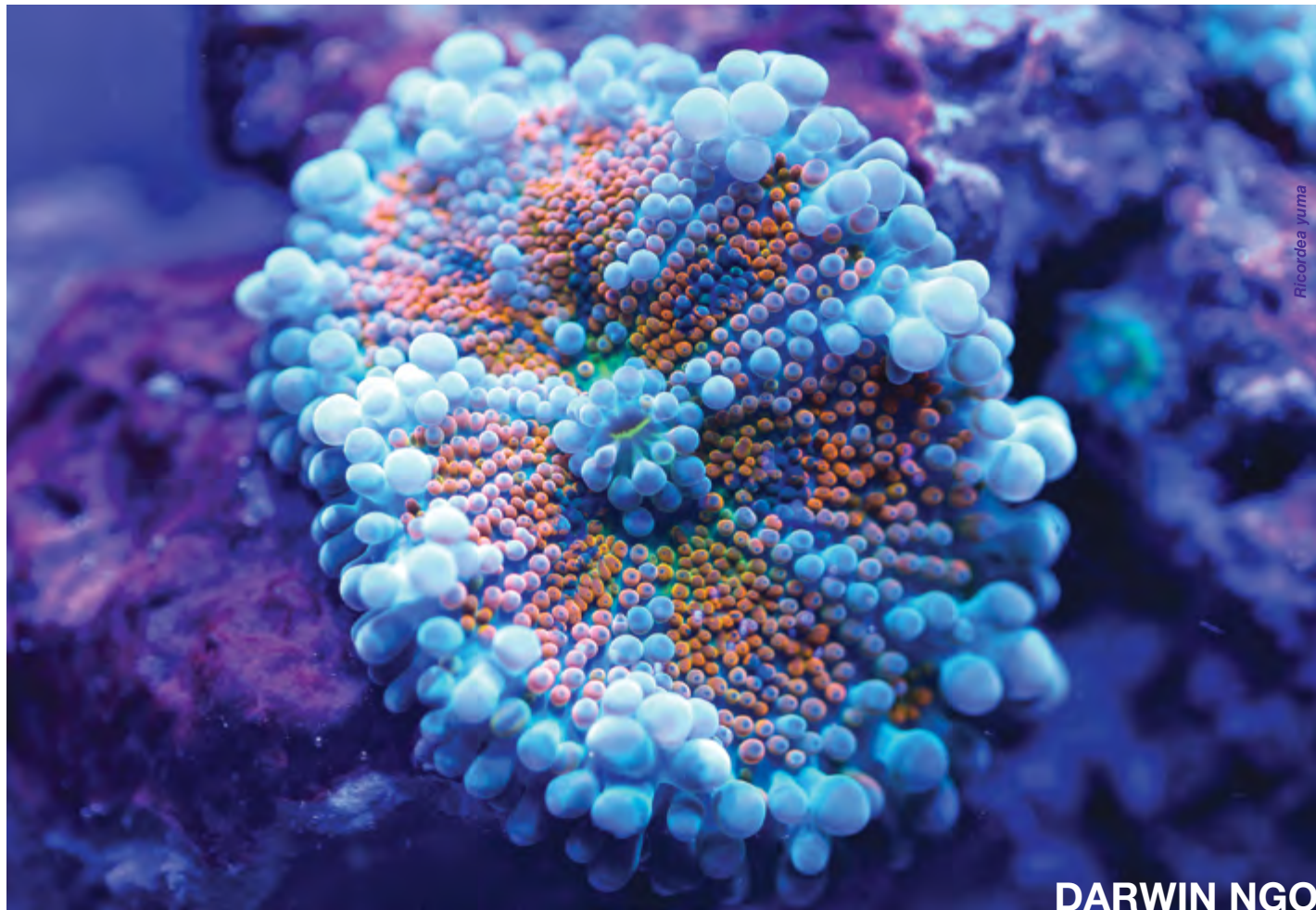
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Ricordea yuma

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SHROOM BOOM!

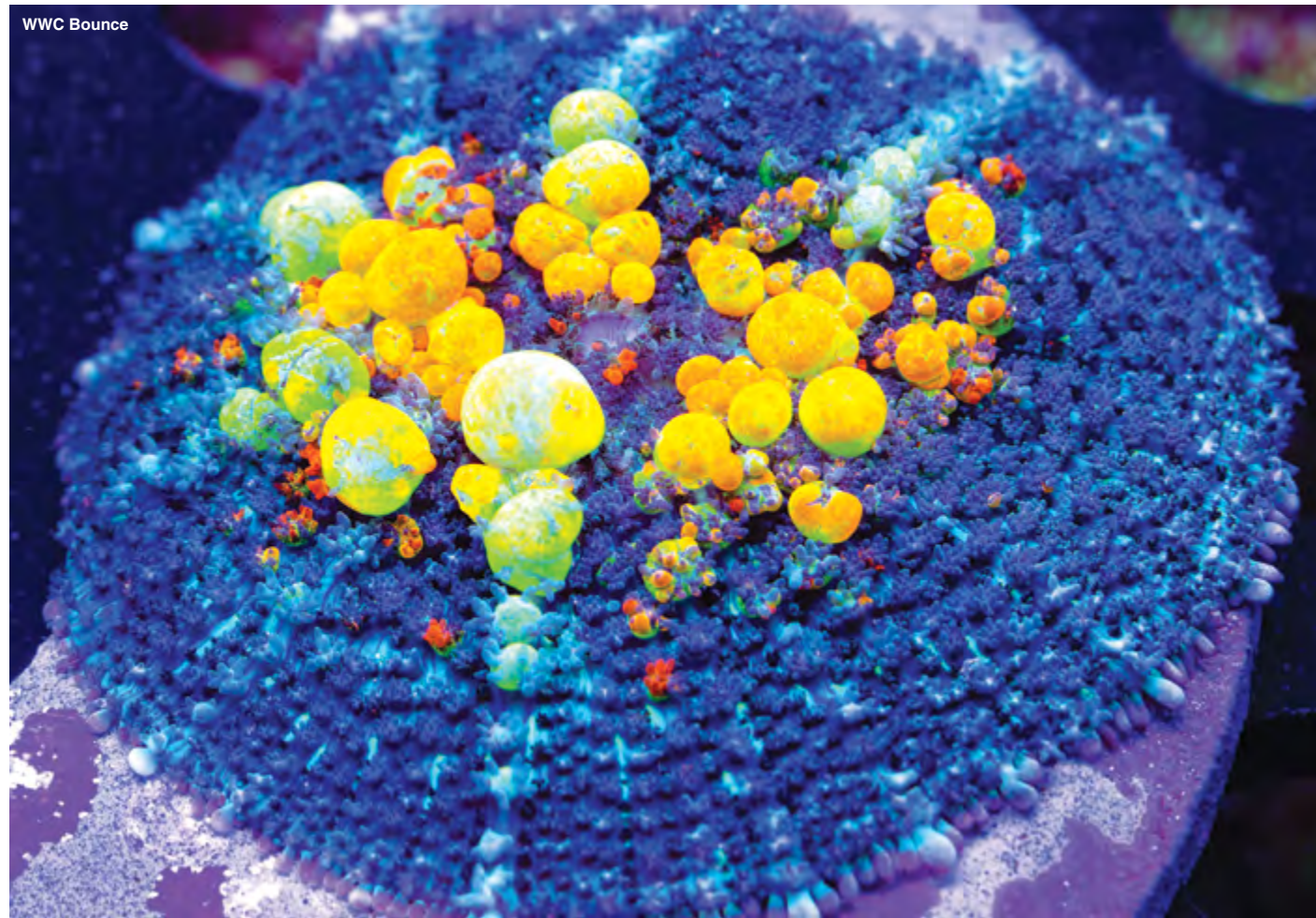
Many years ago, mushroom corals were considered to be mainly for beginners. Solid red-, blue-, or green-colored mushrooms were staples of every bargain section in local fish stores. But these cool-looking corals could quickly become an invasive nuisance, taking over all available real estate in a reef over the span of just a few months. And so, they were branded as a type of pest coral, something you shouldn't purchase if you planned on keeping other types of corals.

But now, the opposite has occurred. Mushroom corals have emerged as one of the hottest types of corals to collect. Mushrooms of all shapes and colors are becoming highly sought after. Their demand caught the attention of many wholesalers and divers, resulting in more variety and types than we have seen in the hobby before. Unique colors and body forms demand top dollar, some even reaching thousands of dollars per polyp. Hobbyists

are starting to create specific tanks just for these mushrooms or purchasing dedicated acrylic containers called "shroom boxes" for the sole purpose of keeping their mushrooms in low flow.

Social media groups such as the "Shroom Room" on Facebook have created dedicated pages to appreciate and share photos of just mushroom corals. There are a few of these groups, with each group having at least a few thousand members.

But how did this resurgence in popularity begin? The new craze for these corals can arguably be traced back to the introduction of the WWC Bounce mushroom. Before this, there weren't many high-end mushrooms except for the Jawbreaker (*Discosoma* sp.) and a few others. The unique bubbles on the WWC Bounce mushroom encouraged hobbyists to search for other mushroom species with similar traits. Soon, other "bounce" mushrooms began emerging, such as the Sunkist, Jersey, and Biohazard, to name a



WWC Bounce

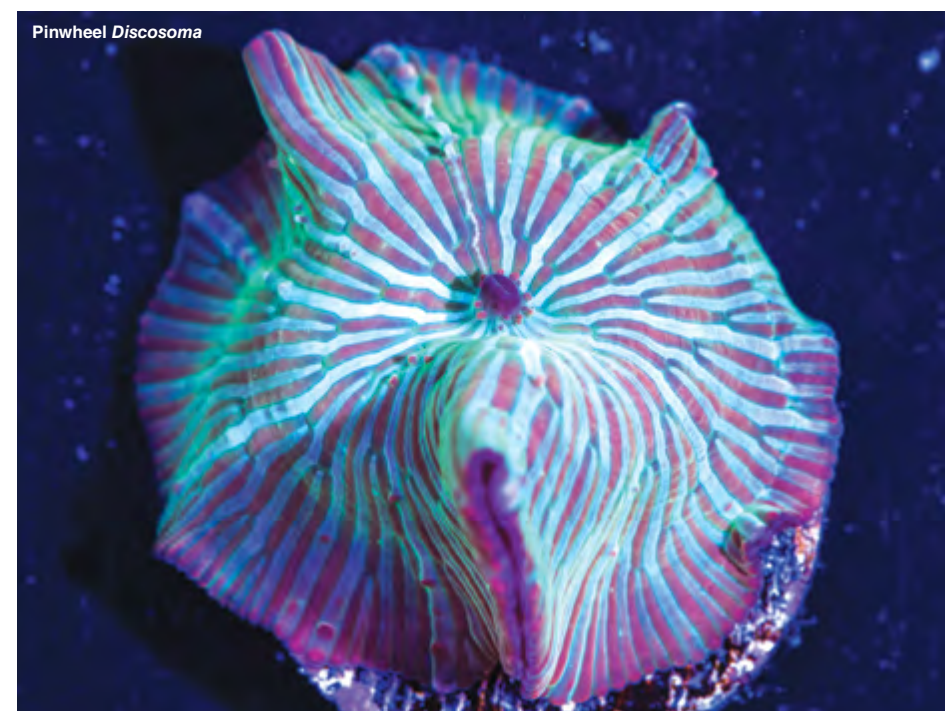
few. Any mushroom with a "bounce" trait began to demand a few hundred dollars, regardless of whether the bubbles were as large as the WWC Bounce.

Hobbyists began to appreciate mushrooms once again, realizing that mushroom corals offered bright colors and unique textures with very undemanding care requirements. Those who had simple setups and limited experience could keep collector mushrooms just as well as those who had full-blown mixed reefs.

Let's look at a few different popular mushrooms, categorized by genus.

Discosoma spp.

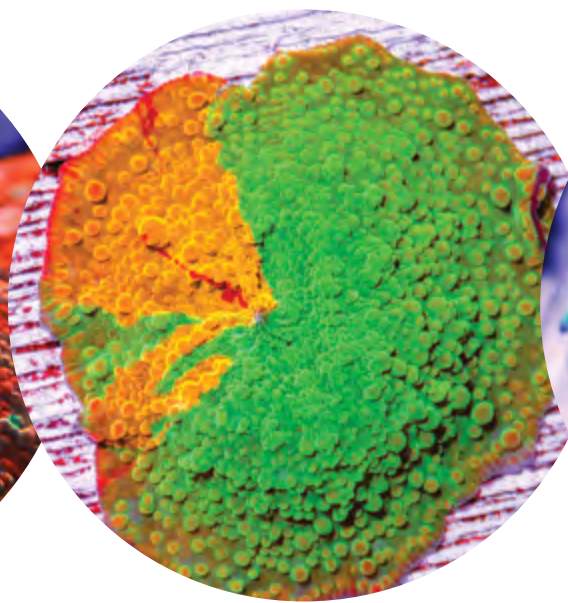
The *Discosoma* genus is characterized by the individual's smooth oral disk. These mushrooms tend to multiply by moving and leaving a part of their foot behind,



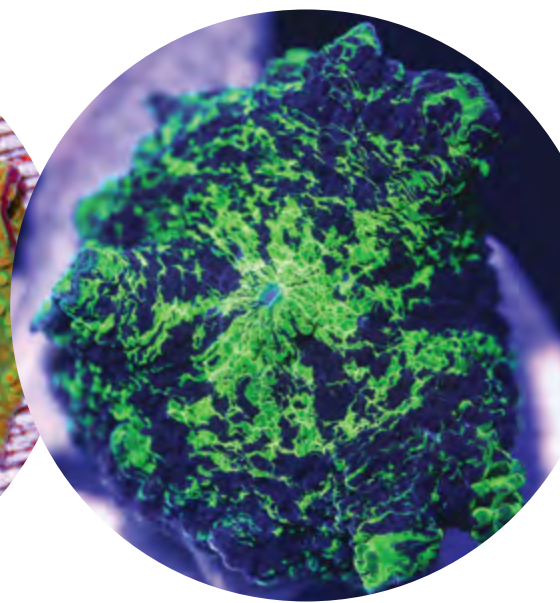
Pinwheel *Discosoma*



Original Tie Dye *Discosoma*



Andre's Ultimate Jawbreaker



Kryptonite *Discosoma*

which in turn will develop into a baby mushroom. The most famous *Discosoma* is the Jawbreaker, first identified at Aquatic Gallery in Milpitas, CA. The Jawbreaker is known for starting off completely orange colored and gaining three additional colors over time: red, green, and purple. There are two strains floating around, one that has been branded as the Tie Dye by The Digital Fish Room and the Poletti strain. The Tie Dye strain is known for gaining new colors rapidly. Unfortunately, not many Tie Dyes remain in the hobby. The Poletti strain tends to propagate more quickly and is the more common variety that we know as Jawbreakers today. Not much information is available about where the Poletti lineage originated, but it's believed to have come from a local fish store.

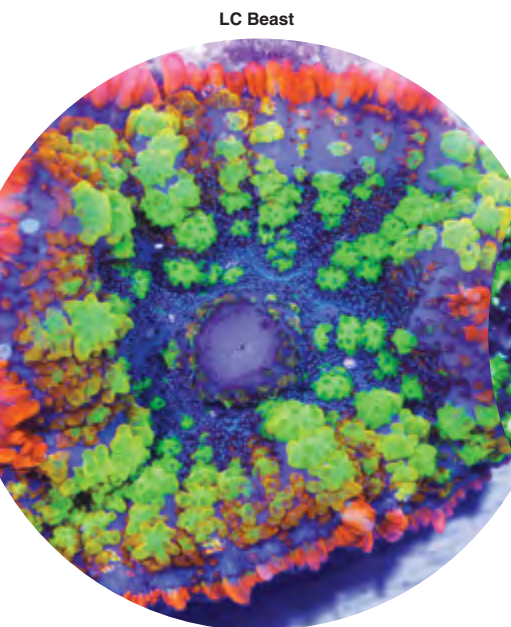
Today, there are many wild Jawbreaker varieties being imported from Vietnam, some of which are listed as Eclectus, Candy Crush, and Deadpool, based on their colors. The most expensive imported Jawbreaker to enter the hobby is the Purple Monster from BSA Corals, which sold for a retail price of \$10,000. A new type of Jawbreaker called the Andre's Ultimate Jawbreaker is another up-

and-coming morph. This mushroom becomes green instead of red first as it colors up, making for some unique markings.

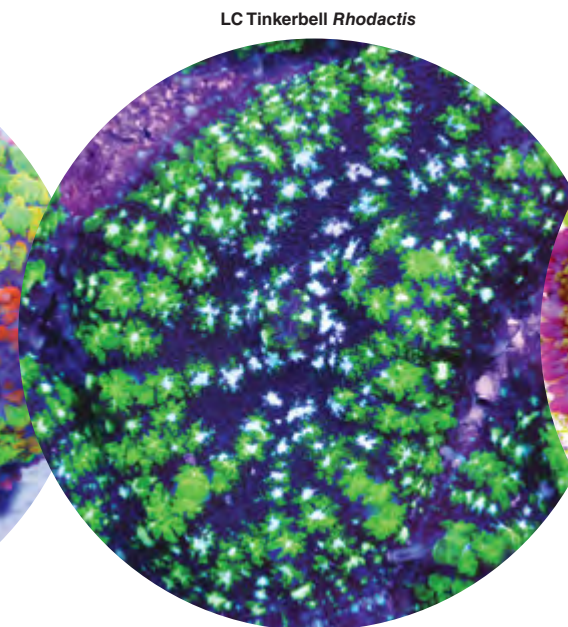
Rhodactis spp.

The majority of *Rhodactis* can be distinguished by their fuzzy-looking bodies. Unlike *Discosoma*, which have smooth bodies, *Rhodactis* have obvious texture. These textures make the shrooms look fuzzy or bumpy. They also come in a variety of sizes; some stay as small as 1 inch and some grow up to 12 inches across. *Rhodactis* mainly multiply by dividing their bodies but can also travel and leave babies behind the same way *Discosoma* do. Some of the most popular mushrooms, like the WWC Bounce and other "bounce" variants, belong in this genus.

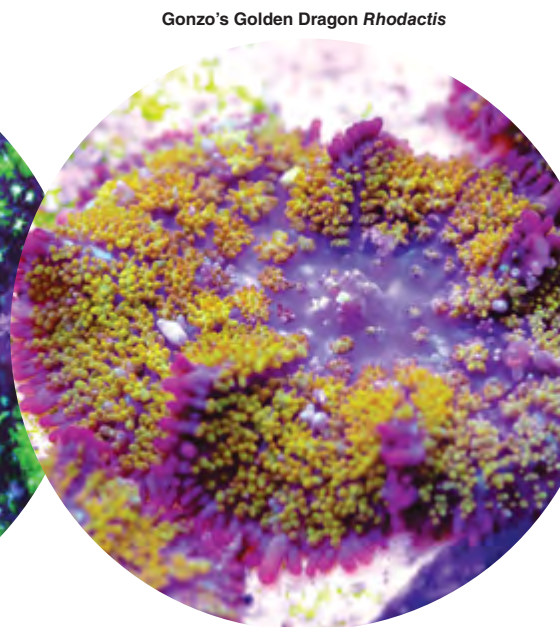
The first type of *Rhodactis* variant is the smooth-skin type. These have small bumpy nodules on their bodies and generally don't grow much larger than 2 inches across. Out of all the *Rhodactis*, these tend to be the most finicky, thriving only in very low light and flow.



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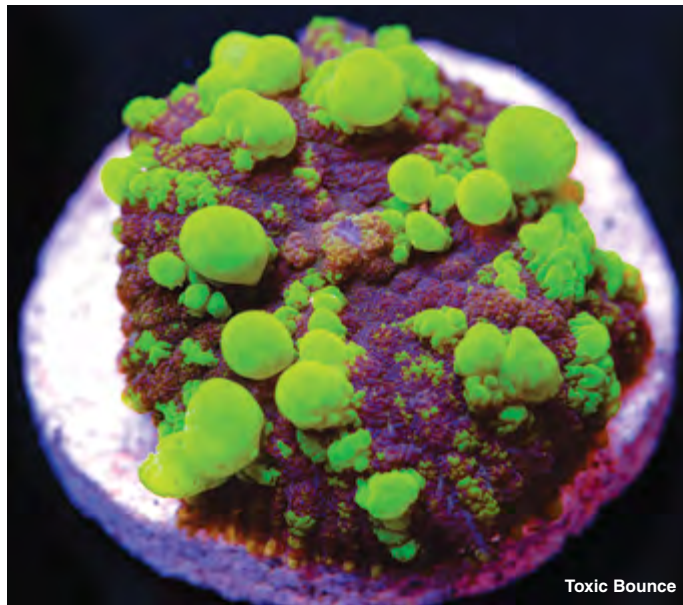
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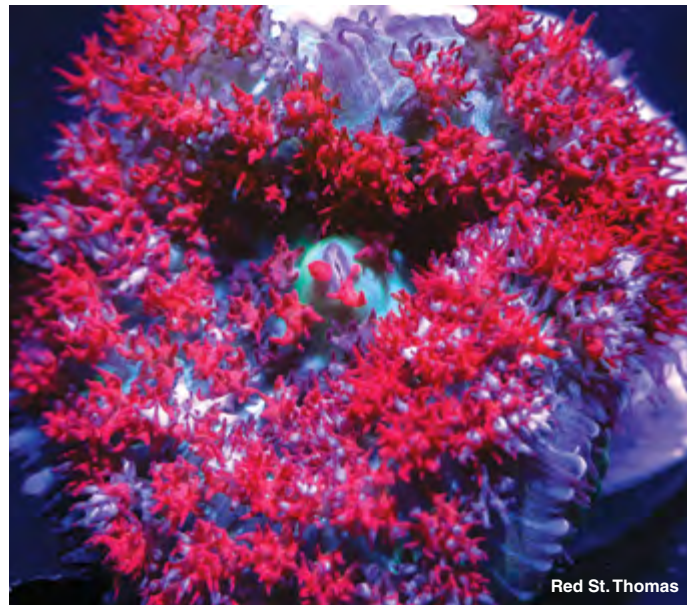
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Toxic Bounce

The second type of *Rhodactis* is the hairy variant, where larger nodules cover the entirety of the mushroom. This variant of *Rhodactis* can get very large, easily over 6 inches in captivity. The hairy variant tends not to reproduce as often and focuses mostly on growing large.

The third type is the fuzzy carpet *Rhodactis*. This type of mushroom is, as the name implies, covered with small nodules, giving it a fuzzy



Red St. Thomas

appearance all over the body. This variety generally stays very small, usually about 1 inch across, with polyps occasionally reaching a maximum size of 3 to 4 inches.

The fourth type of *Rhodactis* is the St. Thomas shroom. These mushrooms get either large warts or bubbles, depending on the type. They come mostly in shades of green and blue, but rare colors such as red and pastel rainbows come in occasionally.



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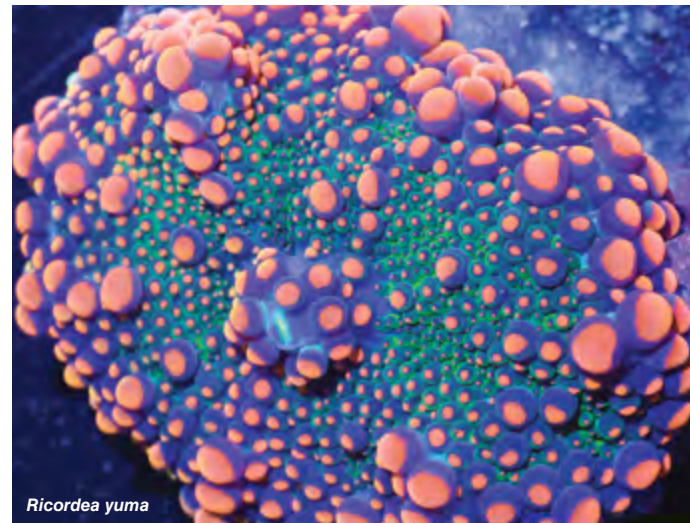
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Haitian *Ricordea florida* variant



Ricordea yuma

Lastly, the "bounce" variant is the most popular and sought-after mushroom type. These shrooms aren't limited to a particular species or strain of *Rhodactis* but are a variant of the types previously listed. The Beast shroom is part of the smooth-skinned variety of *Rhodactis*, the WWC Bounce is a part of the hairy variety, and the SR Berserker is a fuzzy variant.

Ricordea spp.

The last group of mushrooms we'll discuss are the original bubbly mushrooms: *Ricordea florida* and *Ricordea yuma*. The majority of *Ricordea florida* are collected off the Florida coast, but new collection sites have opened in Puerto Rico, Haiti, and Belize. These new collection sites are providing unique colors and variations never seen before, such as blue with red mouths and new pastel peach-colored morphs. These mushrooms are mostly collected with very little rubble attached to them, chiseled off the live rock that they are found on in the wild. *Ricordea florida* is somewhat of an odd mushroom, with some reefers having an easy time keeping them and others having no success. Lower light with high quality water seems to be the best bet for success. These shrooms are covered uniformly with bubbles.

Ricordea yuma, on the other hand, looks completely different, with bubbles around its mouth and skirt and smaller nodules on the oral disc. This species can get very large, with some reaching

almost 6 inches across. These mushrooms are infamous for being difficult to keep, melting on most reefers. But the dream to keep a beautiful all-pink Yuma is still a goal for many reefers.

CONCLUSION

Mushrooms are some of the most colorful yet undemanding corals to own. With so much variety in color, size, and texture, it's easy to find a mushroom that will suit your reef. The demand for mushrooms hasn't declined over the past few years, and it certainly isn't going to anytime soon, so you can look forward to seeing even more crazy pieces to come in the future!



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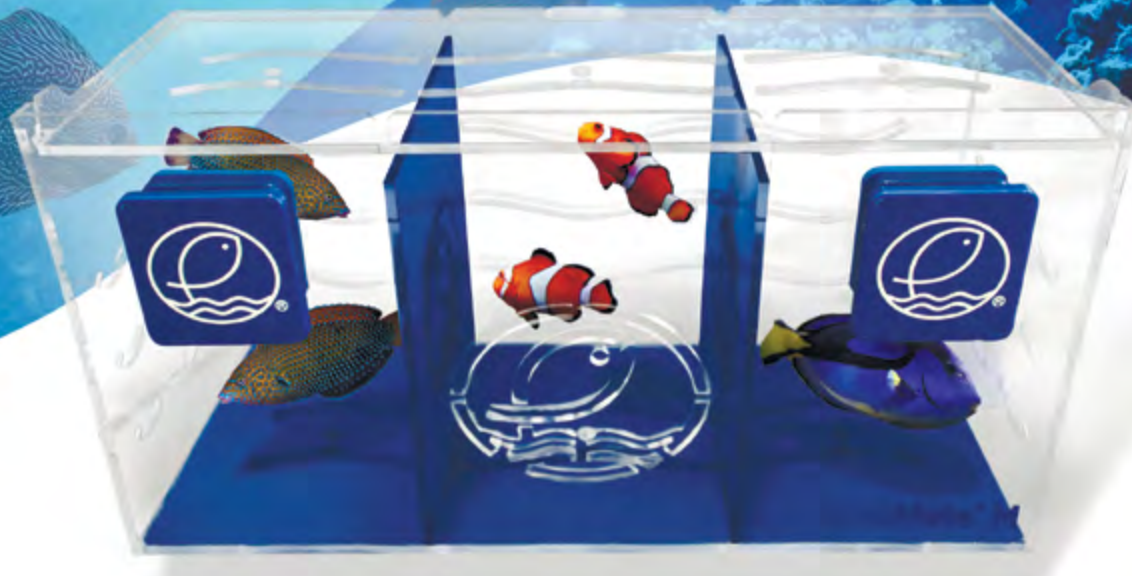
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