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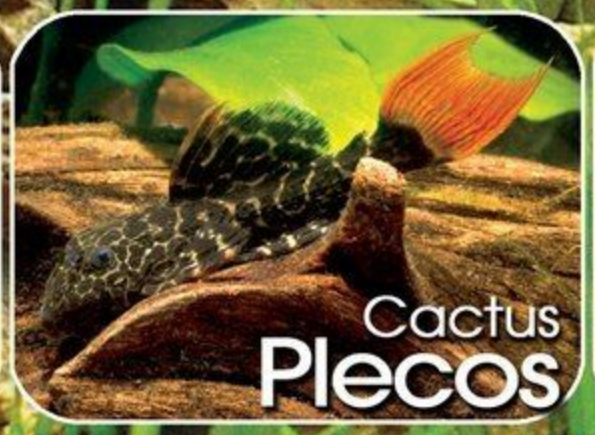
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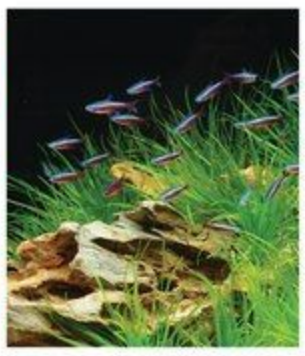

One of the most challenging things to learn in the hobby is exactly how many fish your tank can hold. There are many things to take into consideration, including aggressiveness, activity level, and body plan. While the old "inch-a-gallon" rule might work for certain small species, no one guideline is applicable to every potential stocking scheme. That's why professional aquarist Jay Hemdal provides advice on how to properly stock a tank in this month's excerpt of his upcoming TFH/Animal Planet book, *Your First Aquarium* (p. 50).
Photograph by Dobermaraner/Shutterstock

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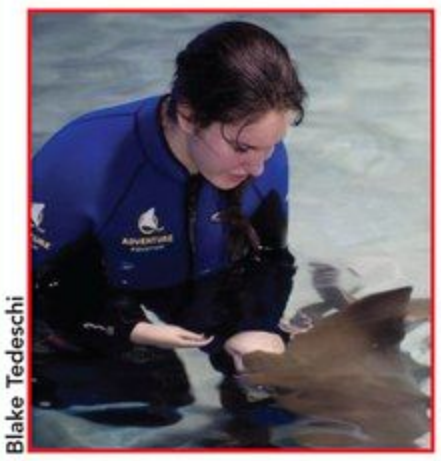
editor's note



Blake Tedeschi

It may seem at first glance like fishkeeping is a solo activity, or at least one enjoyed in the privacy of one's own home, but the aquarium hobby is remarkably social. On a local level, there are fishkeeping clubs, and on a larger level, there are national hobbyist groups and online forums (such as the *TFH* Forum) that unite aquarists from around the world. Of course, nothing can truly replace face-to-face interaction, and that is why I recently attended the sold-out 25th anniversary of the Marine Aquarium Conference of North America (MACNA).

MACNA featured a dazzling array of saltwater aquariums, the latest in new technologies, and some of the best speakers in the marine hobby. However, the best part of the show was how many of participants came to Ft. Lauderdale, and how enthusiastic everyone was to be there. If you haven't attended a fish club meeting, show, or convention for whatever part of the hobby you are involved in, I highly recommend it.

But even if you can't, *TFH* magazine provides an excellent resource for aquarists to help other aquarists. This month, our "Planted Tank" columnist, Amanda Wenger, tackles one of the most common questions she gets asked by people about planted tanks—do you have to add CO_2? The truth of the matter is that CO_2 is not a requirement and is only necessary depending on what you are trying to achieve. She offers some sage advice for setting up a planted tank that meets your (and your fishes') needs while staying within your budget (p. 22).

Another common question that is often asked is about stocking—specifically, how many fish can I fit into my tank? In our exclusive preview of the upcoming Animal Planet book *Your First Aquarium* (available this December), professional aquarist Jay Hemdal outlines various ways to determine how many fish of what type can fit into your tank (p. 50).

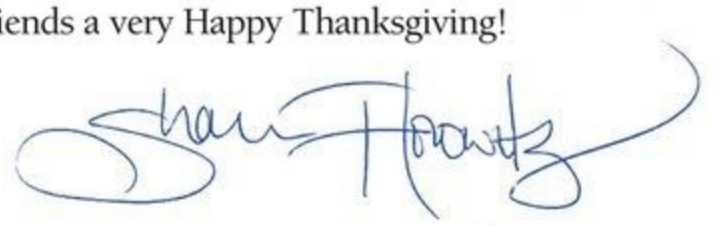
For those beginning in the saltwater hobby (and who couldn't make it to MACNA this year to get advice), expert hobbyist Phil Hunt addresses one of the most difficult topics: lighting. There is an almost unbelievable range of choices when it comes to aquarium lighting, from programmable LEDs to metal halides to fluorescents, and, as Phil explains, the decision on what you need comes down to what you are keeping and the size of your budget (p. 66).

Shari Horowitz

■ A tank at MACNA 2013 featured a rack of *Acropora* frags cultured by the Coral Restoration Foundation.

Finally, sometimes you need to reach out to people who have similar interests, even if they may not keep tanks. As both a fishkeeper and scuba diver, I know all too well the need for aquarium hobbyists and divers alike to help conserve our oceans. Fellow diver/aquarium keeper Alex Rose addresses the potential benefits to both the aquarium and dive industries if we can all work together to help save the world's reefs and oceans (p. 80).

As a final note, as our thoughts turn to family feasts this time of year, I can truly say that I am thankful for having fellow aquarium keepers like you to connect with in the pages of this magazine and face-to-face at the various events that bring us all together. We at *TFH* wish you, your family, and your fishy friends a very Happy Thanksgiving!



Shari Horowitz
Managing Editor
Tropical Fish Hobbyist

TFH Facebook Poll
What is essential to your fishkeeping hobby?

My children; their curiosity and interest keep me going even when I want to cut back.
Sean Kirk

Live plants for my fish.
Diane Hummel Myers White

My husband to do water changes for me.
Jennifer MacAulay

DIY projects.
Tim Palmer

All my fish friends (and by that I mean people)!
Mark Denaro

TFH Magazine.
Ed Hahn

Friendly bacteria aid.
Edy Lindsey

Heater, garden hose w/sink adapter, water conditioner, thermometer, food, test kit, meds, tanks, filter, air pumps and lines, fish, electric, fish nets, discus (not considered as fish—expensive beauties).
Wendy Burgenstock Bailey

Glo fish and platies.
Sarah Williamsen

A good support partner.
Fish Talk

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The Florida Gar

The Florida gar (*Lepisosteus platyrhincus*) is a primitive fish from the streams, canals, and lakes of Florida and Georgia, where it is usually found living in slow-moving, mud- or sand-bottomed water with plenty of aquatic vegetation. This long-bodied predator has an elongated snout lined with sharp teeth, which enables it to catch and devour fish, shrimp, and crayfish in its native habitat.

Even though it's only a mid-sized species as far as gars go, *L. platyrhincus* still grows to a size of about 2 to 4 feet, and its aquarium-keeping requirements include a very large tank (think several hundred gallons) with strong filtration and frequent large water changes. As ambush predators, Florida gars also appreciate some cover to hide amongst as they lie in wait for their next unsuspecting meal.

Q&A freshwater

got a question?

Send your questions about the freshwater side of the aquarium hobby to "Q&A," T.F.H. Publications, P.O. Box 427, Neptune, NJ 07754, or submit via e-mail to editor@tfh.com. For answers to more time-sensitive questions, opinions on your setup, or just to converse with like-minded members of the aquarium community, please visit the *TFH* Forum at forums.tfhmagazine.com.

Q What in the World Are Aufwuchs?

I've been doing some research on Lake Malawi cichlids, and the term "aufwuchs" keeps popping up in the list of required food items for these species. What on earth are these things?

Burt Marcus
Cleveland, Ohio

A *I'm guessing you've probably been researching the various species of mbuna cichlids, as aufwuchs are an important part of their natural diet. "Aufwuchs" is a German-derived term that essentially refers to the film of organisms that coats the surfaces of rocks and other substrates in aquatic environments and consists of algae, all the detritus that accumulates in it, and any microorganisms, tiny crustaceans, insect larvae, etc. that cling to it. Think of it as an aggregate of plant and animal life and detritus rather than as a single organism or substance. Mbuna, whose name basically means "rock fish," are well adapted to scraping this material off the rocky aquascape in their native Lake Malawi.*

Q Duckweed in a Planted Tank?

Do you think it would be okay to add some duckweed to my planted tank? I really like the natural look of it growing on the surface and would harvest it regularly to keep it from getting completely out of hand and blocking the light.

Mary Lengel
via email

A *My inclination would be to discourage the intentional introduction of duckweed to a planted aquarium. When conditions are right (and if conditions are conducive to aquatic plant growth in general, they're likely conducive to duckweed growth), this tiny floating plant can reproduce like gangbusters, completely coating the surface, outcompeting slower-growing plants for dissolved nutrients, clogging filter and pump intakes, and getting tangled in the foliage of fine-leaved plants. Even with regular harvesting, duckweed can become a real nuisance, and once established, it can be very difficult to eradicate. Also, keep in mind that those tiny plants tend to cling to fish nets, aquarium brushes, aquarists' arms, etc, making it easy to transfer them unwittingly to other tanks if tools are shared between systems.*

Q Labyrinth Organ Location?

I understand that anabantoids have a special organ that allows them to breathe air from above the surface of the water, but where exactly is this organ located and how does it work?

Jack Wagner
via email

A *The accessory breathing organ that gouramis, bettas, paradisefish, and other anabantoids (members of the suborder Anabantoidei) possess is known as the labyrinth organ and is located in a chamber in the head just above the gills.*

This organ, which functions much like a lung, is a convoluted (hence the "labyrinth" designation) bony structure covered with a very thin, highly vascularized (containing lots of blood vessels) membrane. Atmospheric air gulped at the surface is forced through the labyrinth organ, and oxygen from the air then diffuses through the thin, vascularized tissue and enters the blood stream to be circulated throughout the body. As you're probably aware, this fascinating adaptation gives anabantoids a survival edge in stagnant, oxygen-depleted waters.

Congo Tetra Tank

I'm planning to set up a freshwater aquarium for a single schooling species (possibly to include some bottom dwellers) and I'm leaning toward Congo tetras. What size tank would you recommend for this species, and what's the minimum number I should keep?

Spence Wilson
via email

Congo tetras (Phenacogrammus interruptus) *should be kept in groups no smaller than five or six specimens, but more would be better. If you can manage a 40- to 50-gallon tank, you'll get the best results from this species. This may seem like a lot of tank space for tetras, but* P. interruptus *can reach upwards of 3 inches depending on gender (females are somewhat smaller than males) and is a very active, almost constantly moving species. To accommodate this, you'll need to offer a lot of open swimming space across the front of the tank. In addition, ample sheltering structure should be provided along the back and sides to give your Congo tetras a sense of security.*

Reconstituting RO Water

Can reverse osmosis (RO) water be added directly to a freshwater aquarium without treating it in some way first? I read on a web forum that RO water needs to be "reconstituted" before it can be used, but I'm not really sure what that means. Plus, I have a friend who uses RO water exclusively for his saltwater tanks, and he doesn't do anything to reconstitute his water as far as I'm aware.

Ed Heyen
Kenosha, Wisconsin

Dobermaraner/Shutterstock

■ Mbuna cichlids from Lake Malawi are adapted to eating aufwuchs, which essentially are all the organisms in the biofilm that coats the surface of the rocks in the lake.

FormosanFish/Shutterstock

■ Labyrinthfish, such as paradisefish, use a labyrinth organ to absorb oxygen from air.

Because the reverse-osmosis process removes both desirable and undesirable elements—the good with the bad—RO water does need to be treated, or reconstituted, before it can be used in a freshwater aquarium. "Reconstituting" simply means adding back in the desirable minerals and trace elements that are necessary for the fishes' health and for maintaining buffering capacity. Synthetic sea salt mixes contain all of these necessary minerals and trace elements in the correct proportions, so whether he knows it or not, your friend does reconstitute his RO water before adding it to his saltwater system.

You can use various commercial products, available in liquid or powder form, to reconstitute RO and/or deionized water for a freshwater tank. Or, some hobbyists blend RO-purified water with dechlorinated tap water or RO waste water to produce water of the desired pH and hardness for their aquariums.

Slender Hemiodus School

I'd like to keep a school of slender hemiodus. Is it okay to keep this species in a group? Also what requirements does it have with respect to water conditions, temperature, tank setup, and feeding? Thanks!

Anne Copenhagen
Portsmouth, Virginia

A *Not only can you keep the slender hemiodus (presumably* Hemiodus gracilis*) in a group, but you really should keep this schooling characin in a group of at least six. Appropriate water parameters for this species are a pH between 5.8 and 7.2, hardness between 4 and 15 dH, and a temperature between 73° and 81°F (source: FishBase).*

As far as your tank setup is concerned, H. gracilis *reaches a maximum length of about 6 inches and is very active and fast-moving, requiring ample swimming space. I would recommend housing it in a tank no smaller than 55 gallons. It's also a somewhat nervous species, so subdued lighting, floating plants, and dense plantings and/or driftwood tangles around the back and sides of the tank will help to make it feel secure. Be sure to cover the tank well, as* H. gracilis *will jump.*

Feeding is pretty straightforward, as this species will accept most standard aquarium fare. It also relishes small live foods. Just be sure to keep its diet varied.

Q Bluegill/ Pumpkinseed Hybrid?

On a recent fishing excursion on a local inland lake with my brother, I caught a sunfish that had a dark gill spot like a bluegill along with the really pretty orange and blue color of a pumpkinseed. I also noticed that the dark ear flap seemed to extend much farther back than it usually does on either a bluegill or pumpkinseed. I'm pretty sure both species are supposed to be stocked in the lake, though, so is it safe to assume this fish was a hybrid of the two?

Martin Hildebrandt
via email

Kevin H. Knuth/Shutterstock

■ *Lepomis megalotis* has an exaggerated black opercular flap, which led to its common name of longear sunfish.

A *Well, bluegill* (Lepomis macrochirus*) and pumpkinseed* (L. gibbosus*) will readily interbreed, so it's certainly possible that you caught a hybrid specimen. However, the detail you included about the extended "ear flap" (more accurately called the opercular flap), indicates to me that it might have been a different sunfish altogether. Specifically, it sounds a lot like* L. megalotis*, the longear sunfish. This species, as its common name suggests, has a black opercular flap that is much more exaggerated than the same feature on either* L. macrochirus *or* L. gibbosus*. However, its orange and blue coloration and vermiculated patterning are very similar to that of* L. gibbosus*.*

Of course without the specimen or even a photo of it to examine, this is pure speculation on my part. You might want to consult with your local Department of Natural Resources to find out if L. megalotis *is even stocked in*

Knorre/Shutterstock

■ Rough or abrasive substrates can damage the delicate barbels of cory catfish.

the lake you were fishing. A little research on the Lepomis *genus on FishBase and in hobby literature might help you pinpoint the specimen's identification as well.*

Q Airstones and Oxygenation

I have a question about using an airstone to oxygenate aquarium water. Since all the bubbles rise to the surface and break there, doesn't it stand to reason that any oxygen they contain would be released into the atmosphere rather than get dissolved in the water? How, then, does placing a bubbling airstone in the tank help increase the level of dissolved oxygen in the aquarium?

Chuck Patton
via email

A *It's not the air contained within the bubbles produced by an airstone that oxygenates the water. Rather, it's the turbulence that the bubbles create when they burst at the surface of the water that contributes to oxygenation. Also, as the bubbles rise from the bottom of the tank to the surface, they create a gentle circulation that continually brings water from deeper in the tank to the surface where it comes into contact with the ambient air. So bubbling airstones will, indeed, help oxygenate the water in an aquarium, just not the way we tend to visualize they do. In fact, powerheads that do not produce bubbles actually oxygenate the water better than airstones because they create more water movement.*

Q Cory Cats Missing Whiskers

I was looking closely at my peppered cories today and noticed that several of them have whiskers that are either missing or half gone. They seem fine other than that. What could be causing this? Will the whiskers grow back? Also, I notice that they swim to the surface every few minutes like they need to get air. Could these two factors be connected?

Rodney Fazzari
Warren, Michigan

A *You didn't provide any details about your system or other livestock, so I can only speculate as to the cause of your problem. However, the barbel (whisker) damage you describe often occurs when* Corydoras *catfish are kept on rough, abrasive substrates, such as gravel, so that's a strong possibility. Generally speaking, it's best to keep these cats on a soft, sandy substrate and to avoid other sharp or abrasive décor in their tanks. Another possibility is that other fish in the tank are bullying your cory cats and nipping their barbels. Given proper care and good water quality, the barbels should grow back with no problem, but you should identify and correct the source of the problem so it doesn't keep recurring, potentially leaving your cory cats open to infection.*

Frequently swimming to the surface to gulp atmospheric air is perfectly normal behavior for Corydoras *species. They're actually able to swallow air and absorb oxygen from it through their intestines, which is an interesting adaptation to low-oxygen environments. So, there's probably no link between this behavior and the barbel damage you're observing.*

Q&A saltwater

got a question?

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Q A Squirrel in the Reef?

Can I keep a longspine squirrelfish in a 200-gallon reef tank, or will this species pick at corals? Also, I know this squirrelfish eats crustaceans, but can it be trusted not to eat small fish?

Eugene Agee
Chicago, Illinois

A The size of your tank will be just fine for a longspine squirrelfish (presumably Holocentrus rufus*), and this species is technically reef safe in the sense that it won't eat or pick at corals or other sessile invertebrates. However, you may not see much of this nocturnal species in a reef system, as it will tend to remain hidden from the intense lighting. Be sure to provide ample ledges, overhangs, and caves for the squirrelfish to take refuge in. Positioning these shelter sites so they're visible from the front of the tank will increase your viewing opportunities. Also, the use of moonlights will give you a chance to observe this species out in the open at night when it emerges to forage.*

With respect to fish tankmates being eaten, you should assume this is the potential fate of any fish small enough to be swallowed.

Q White Scrape on Purple Tang

My purple tang started to have a white scrape around one side of her eye. What would this be, and how do I cure her? Please advise. Thank you.

Terry Kim
Houston, Texas

A There's a possibility that your purple tang's (Zebrasoma xanthurum) *scrape is just a physical injury from running into a rock or other abrasive object in the tank, in which case, it should heal in a matter of days with proper feeding and good water conditions. However, while I hope that's the case, I have a sinking feeling it's not the real problem.*

What I suspect is that your tang is developing head and lateral line erosion, or HLLE. Z. xanthurum is highly susceptible to HLLE which, as the name implies, causes light-colored lesions and pitting around the head and along the lateral line. This condition is not immediately fatal, but as it progresses, it will weaken the fish and leave it vulnerable to secondary infection. In any case, it can be permanently disfiguring. The condition very commonly manifests around the eye as you describe.

The exact cause of HLLE has not been precisely pinpointed, but several possible factors have been suggested, such as water-quality issues; dietary deficiencies; bacterial, viral, or protozoan infection; and even the use of activated carbon (I know of at least one study that confirms this to be causative). Of course, it may very well be that more than one of these factors (and others not listed here) or combinations thereof could cause the same symptoms, just as many different ailments can cause flu-like symptoms in humans.

Since the exact cause of HLLE is unknown, there's no surefire cure for it. The best advice I can give is to address any environmental or dietary factors that might be suspect. Provide pristine water conditions through frequent water changes and vigorous protein skimming, and make sure your tang's diet is varied and nutritious and includes plenty of algae-based foods. Occasionally soaking the tang's dry foods in a supplement containing essential vitamins and fatty acids is strongly recommended as well. Also, if you are running activated carbon in your system, you might want to discontinue its use just to be on the safe side.

Improving your purple tang's environment and diet may not cure the condition, and there's no guarantee the lesion that's developed will go away completely. However, these steps may stop the condition from progressing and they'll certainly do no harm.

Q Queen Angelfish Undersized?

My local fish store recently special ordered a queen angelfish for me. I said I wanted a larger one, but when it arrived, it turned out to be only around 5 inches long. The dealer said that's actually a good size to start with—not too small and not too big. I'm not sure whether to believe him or not though. What's your opinion?

Mick Cappelletti
via email

A Actually, I would agree with your dealer's assessment here. With angelfishes (and many other marine fishes, for that matter), it's best to start with a middling-sized specimen. Very small specimens are often too delicate to endure the stress of capture, shipping, and repeated acclimation, while large ones tend to have more difficulty adapting to a captive environment, accepting aquarium fare, and tolerating tankmates (think: trying to teach an old dog new tricks). Middle-of-the-road-sized specimens, on the other hand, are generally hardy enough to handle the rigors of collection and transportation yet still malleable enough in their behavior and food preferences to adjust relatively well to captivity.

John A. Anderson/Shutterstock

■ Longspine squirrelfish require plenty of hiding places to get out of the intense lighting found in reef tanks.

Clay S. Turner/Shutterstock

■ Large queen angelfish may have a difficult time adjusting to captivity.

Q Knock, Knock!

I keep hearing a knocking sound coming from my aquarium, but for the life of me, I can't figure out what's causing it. I hear a single knock maybe every 2 or 3 minutes. It's almost like clockwork. Could it be a stowaway mantis shrimp?

Jasmine Carmichael
Fontana, California

A If it were a mantis shrimp excavating in your live rock, I don't think it would produce just a single, knock at 2- to 3-minute intervals. The sound would be more erratic and most likely heard at night. While I wouldn't completely rule out an organism as the cause of the sound, I'd be more inclined to suspect a mechanical source of some sort.

I would first look at any pumps or powerheads in the system to see if anything seems amiss with them. For instance, sometimes a damaged impeller or propeller or debris trapped inside the unit can cause intermittent knocking. If you have an overflow or standpipe, give that a listen/close inspection as well. Sometimes these elements can cause rhythmic gurgling or popping sounds as they drain water to the sump. I've even had submersible heaters that made a very subtle knocking sound whenever they kicked on.

Of course, that's just a handful of possibilities. Your best bet is to stakeout your tank for a while to see if you can at least figure out which part of the tank the sound is coming from and then use the process of elimination (i.e., temporarily disconnecting powerheads, the heater, etc.) to isolate the actual cause.

Q Heavy on the Base Rock

I'm planning to set up a 90-gallon FOWLR tank, but unfortunately, I'm discovering that the price of live rock is more than I can manage at this point in my life, as I'm a full-time college student who works part-time. Are there any drawbacks to using inexpensive base rocks for most of the rock structure, and topping it off with a small quantity of high-quality live rocks? Will the organisms on the live rocks eventually spread to the base rocks, making them live?

Lucas Hutto
via email

A This is a perfectly reasonable, cost-effective alternative to using only live rock in your aquascaping. In fact, some would argue it's the most sensible approach because when you use all live rock, several of the pieces that you paid a premium for will simply end up buried at the bottom or middle of the pile anyway. And, yes, the organisms on the live rock—nitrifying bacteria, coralline algae, amphipods, copepods, snails, brittle stars, etc.—will eventually spread to the base rock and colonize it. You will just

have to be patient because this will be a process measured in months, not days or weeks.

The only drawback I've experienced with this approach is that bare base rocks are more prone to become attachment sites for undesirable algae—much the same way the open soil in a sparsely planted garden tends to invite dandelions. With quality live rocks, however, most of the tiny little niches where problem algae might find a purchase are already occupied by desirable life forms, such as the aforementioned coralline algae. But then, if you avoid overstocking and overfeeding and maintain exceptional water quality through protein skimming and routine water changes, you should be able to keep nasty algae out of the equation while the good stuff gains a foothold on the base rock.

Q Can Mantis Shrimp Really Shatter Glass?

I've heard that a mantis shrimp can shatter a glass aquarium if it strikes it with its claws. Is that really true?

Peter Scofield
via email

Dray van Beeck/Shutterstock

■ Large harlequin mantis shrimp (*Odontodactylus scyllarus*) are capable of smashing glass and should be kept only in tanks with very thick acrylic.

A *It is true that some mantis shrimp species are capable of shattering aquarium glass if they should happen to strike it with sufficient force with their hooked feeding appendages (called chelae). This is primarily a concern with larger species whose claws are more club-like in design and used to batter hard-shelled prey items versus those species with razor-sharp chelae used to slice into soft-bodied prey. The peacock or harlequin mantis shrimp* (Odontodactylus scyllarus) *usually serves as the "poster crustacean" for this phenomenon, being relatively well known in the hobby, quite large (up to about 6 inches), and sporting the necessary club-like chelae. If kept, this and other large mantis species belong only in thick acrylic tanks.*

However, most of the mantis shrimps that stowaway into aquariums aboard live rock don't get anywhere near the size of the peacock mantis—more like the 1- to 2-inch range—and present a less significant (though perhaps not non-existent) threat of breaking the glass.

Q Brittle Star's Bad Reputation Deserved?

Is the green brittle star really as big a threat to fish as it's reputed to be, or is this an exaggeration? Before I heard that this species supposedly eats fish, I added one to my 55-gallon reef tank, but it hasn't bothered any of the fish or my cleaner shrimp as far as I'm aware. How would it even capture a fish?

Joe Harms
via email

Dobermaraner/Shutterstock

■ The green brittle star can prey upon small fish and inverts and may require a tank of its own.

Assuming you're referring to Ophiarachna incrassata, *this species' piscivorous tendencies are not exaggerated. Any small fish occupying the same tank is potential prey. Your cleaner shrimp is in danger of winding up on the menu as well.* O. incrassata *is a nocturnal hunter, so it often nabs fishes while they're sleeping. It's also been observed utilizing a fascinating capture technique, in which it arches its arms, raising its central disc above the substrate, then "springs the trap" by dropping down and wrapping its arms around any fish or motile invertebrate that swims or crawls underneath.*

School's Out for Threadfin Cardinalfish

I have a group of eight threadfin cardinalfish in a 150-gallon fish-only-with-live-rock aquarium. When I first added the group, they schooled nicely and roamed around the tank together, but now they've stopped schooling and stay hidden most of the time. The only things that have changed since I added the cardinalfish are that I introduced a large Red Sea sailfin tang to the tank and I got a new LED light fixture. But the tang is a herbivore, so I don't see why they'd be afraid of it. Do you think the lights are upsetting them?

Maria Napier
Washington, DC

Really, either or both of these factors could have influenced your threadfin cardinalfish (Zoramia leptacantha) *to stop schooling and go into hiding. While it's true that the Red Sea sailfin tang* (Zebrasoma desjardinii) *is herbivorous, the presence of any large, fast-moving species swooping around the tank can be unsettling to these diminutive cardinals, which, let's face it, are basically snacks for a wide range of predators in nature. As far as the new LED fixture is concerned, if it produces significantly brighter illumination than you had previously, it could certainly be spooking your nocturnal-by-nature cardinals.*

In time, the cardinals may acclimate to the brighter light and begin to emerge more often, but the presence of the tang is more of a wild card in my opinion. They may or may not get comfortable with its presence in the tank.

ask jack

Dear Jack,

On a website recently, I saw a do-it-yourself substrate for aquatic plants. If you know this website, do you know whether the materials to be used are safe, especially for discus? I have been successful for seven years breeding livebearing tropical fish—platies and swordtails—in aquariums with many plants and a sub-sand filter in approximately 4½ cm of silica sand. Will I be able to keep discus in this type of arrangement?

The plants I have in my swordtail and platy tanks are kinds that grow in many of our slow-moving streams, and I keep the water temperature at 25°C (77°F). If I should need other aquatic plants, I am able to purchase them here in Montevideo.

Carlos Tossi
Montevideo, Uruguay

Dear Carlos,

You didn't say anything about the pH in any of your aquariums, but I have to assume that it is suitable. However, I'm certain that the plants growing successfully in your slow-moving streams and in your aquariums are doing so in water that will be a bit too low in temperature for any discus. If you do purchase some discus, an aquarium temperature of 28°C (82°F) will be excellent.

You can attempt to maintain the discus plants at that temperature, although the fact that they're coming from local streams means your temperature may not allow them to grow. How about a few of the Cryptocoryne *species? At 82° you will see them do very well.* C. griffithii, *a broad-leaved plant, will do nicely located in the back of your discus tank.* Elodea *has medium-sized leaves and is dark in color, as is* C. cordata, *with the same size leaves.*

Hola Jack,

In the fall of this year, I will have the opportunity to purchase a number of wild-caught blue discus from an importer here in Los Angeles. I must pay cash only at the time of purchase. Because of this opportunity, I want to know what action will be necessary on my part to succeed in this venture. As I understand, the discus will be semi-adult and adult sizes. If they are as nice as I hope they will be, I plan to buy 15 to 20 of them. I have plenty of tank space, with ten 55-gallon tanks, and all tanks are placed at eye level. I also have a number of large sponge filters that are presently operating in other tanks, and they will be used in the 55-gallon tanks for the discus. I've never had discus, but with your help, I believe I can succeed.

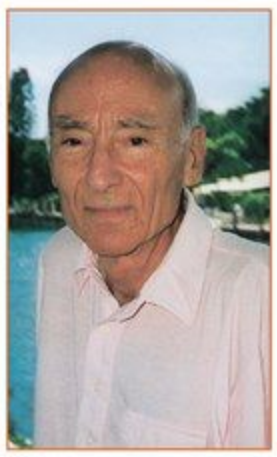
C. L. Robinson
Oxnard, California

Hola C. L.,

Like many others, you've said nothing regarding pH, water changes, water temperature, and the food you'll be using for your discus, and my concern is whether or not you have an understanding of the husbandry requirements of discus, especially a number of wild-caught discus as you plan to obtain. I am somewhat surprised, but happy, that you are interested enough to obtain a good number of the wild-caught discus at this time.

If your new discus are blue discus, they will probably be from areas near Lake Manacapuru. Any discus I collected that were colorful enough to attempt to return with were caught in small streams west of Manaus, Amazonas. I find it interesting that many discus enthusiasts have never seen any of the colorful discus that can be found in these many streams. For that reason, if I were you, I would get to your bank and obtain the cash-only payment as soon as possible.

You are fortunate to be near Los Angeles, a city where many shipments of tropical fish—both marine and freshwater—arrive directly from Brazil. In most cases, your blue discus will have gone through the fisherman's holding water cages, where they will be kept (not fed) until he has collected enough discus to sell to the broker or exporter—when these fish are finally exported to major US or European importers. There is money in all of this action, and I know you want to get these fish as soon as possible. However, by the time you finally do have them in your tanks, you can be assured your fish have not been neglected.



Jack Wattley is worldwide the most recognized name in discus breeding. Breeder, judge, collector, scholar, Jack is the foundation on which modern discus keeping has been built. He has been sharing his experience and knowledge—and the discus he breeds—with aquarists throughout the world for decades, and just one of his many awards was his recent Lifetime Achievement award from the ACA. Long past the age at which most people retire, he still serves as ambassador of discus and goodwill across the planet.

jack wattley

When you finally do have your blue discus, I assume you will have already made all the plans for their arrival. Water will have to be conditioned, with a temperature initially at 84°F. Don't have a pH set in any of the tanks until you see what the importer has in his tanks.

You have sufficient tank space to place four to five semi-adult or adult discus in each tank. All discus are jumpers, especially those that are placed into new tanks, so it's necessary to have the tanks completely covered! Regardless of the condition of the fish water at your importer's place, you must not use any of his water.

There are several theories as to how to place your new discus into their new tanks. Needless to say, this transfer of your fish from one water to your water is to be made after both temperature and pH readings are properly adjusted and your sponge filter is operating.

If your discus are from native waters with a pH in the 5.0 to 5.5 range, you may find it unnecessary to medicate the fish, at least initially. I don't remember any time, in bringing discus back to Florida, that I had to medicate the fish. Nearly all the discus I collected were from waters with low pH readings. Upon maintaining them in my 6.0 pH water, I never had any problems regarding intestinal or gill parasites in any of the fish.

However, should you find at any time that your imported discus do have parasites of any kind, you will be in a position to solve the problem without having to use any medications. This will be accomplished by feeding fresh garlic to all the blue discus. Once you have your discus successfully eating the foods offered to them, you can introduce the fresh garlic with the regular foods.

I have found a food for humans that—in the raw form—will be accepted initially by nearly all newly imported discus, that being raw tuna! I know it's even more expensive than Pacific salmon, but the raw tuna, when cut into very small pieces, will be accepted by most wild-caught discus initially. The feeding program for these discus should eventually consist of tropical flake and pellet foods, with the costly raw tuna destined for your plate.

I don't know the distance from Oxnard to your importer's place, but I hope you can be in the position to choose the fish you are obtaining. If you were purchasing small, 20-week-old fish, I would then suggest that you get the largest and best colored. But if they are truly semi-adult and adult fish—with not much disparity among the adult fish in size—then obtain the very largest as males and the smaller as females. However, if the semi-adults are being kept in the same tanks as the adult fish, this will be virtually impossible.

You are now back home with your 15 to 20 wild-caught blue discus. If they are nicely colored fish, they will no doubt show more color as they become fully adjusted to their tanks. A question I probably should have asked you before this is the following: If you are able to choose the fish you want, would you be able to choose all semi-adult or adult fish?

As I asked whether or not the semi-adult discus have been mixed in with the adults, how about taking all adult fish or all semis? In this way, if you should ask for only adult fish, you will certainly have the opportunity to pick out what you hope are the compatible sexes. This action is not a guarantee that you have chosen what you hope to be your number-one pair, with more pairs to follow, but it will give you a fairly reliable measure as to what to look for at the time of purchase.

In most cases, your male discus will be larger than the females and can show more body color than the mate. If the fish are truly adults, your male fish will generally have a larger and more pronounced dorsal fin than its mate.

Evgheni Manciu/Shutterstock

■ Plants chosen for a discus tank should be able to withstand the high temperatures discus prefer.

A Little History Lesson for New Hobbyists

Discus fish of the genus *Symphysodon* made their initial appearance in Europe in the 1960s. At that time, most of the discus being imported from Brazil were sent directly to European tropical fish importers, where the Brazilian exporters could rapidly command a better price than here in the US.

Symphysodon aequifasciatus axelrodi had already shown up here in the US at the same time, but the European importers were especially excited to see for the first time *Symphysodon haraldi*, the blue discus, and to a lesser extent *Symphysodon discus*, the Heckel discus.

In the early 1960s and into the early 1970s, the beautiful green discus (*Symphysodon aequifasciatus axelrodi*) came onto the scene in streams near Fonte Boa and Tefe, Amazonia, Brazil, and it was at this time that I made my initial discus-collecting trips. Moving east along the Amazonia's coastline, one enters into the Manacapuru lake area with many feeder streams where *Symphysodon haraldi* can be found. *Symphysodon haraldi* was correctly named after the Brazilian Harald Schultz, although many of us were using the very unscientific name Tarzoo blue, after my good friend Mike Tsalikis in Leticia, Colombia.

In 1963, I was able to collect a small number of these blue discus and ultimately crossed these fish with green *Symphysodon aequifasciatus axelrodi* from a tributary of the Rio Jurua. What color does one get when mixing green with blue? Turquoise, of course! I thus marketed the offspring of this crossing the Jack Wattley Turquoise discus. That was the first time the word "turquoise" was ever used in connection with discus.

In the 1970s, discus interest in Europe, as well as here in the US, began to wane some, picking up some in early 1980, at which time I introduced my Jack Wattley Turquoise discus to the Japanese market. And one of the major contributions concerning a new color form of discus was the development of the pigeon blood discus. This fish was developed in Bangkok, Thailand, and pigeon bloods have been sold in nearly all parts of the world since. It would certainly be difficult to find a discus enthusiast who has not had pigeon bloods in his aquariums.

cichlid world

Tilapia

The last column that I wrote for *TFH* listed my top ten most influential cichlids of all time, and I placed food tilapia on the list at number five. Apparently, I touched the nerves of several people who took issue with either having tilapia on the list at all or not having them placed high enough. I was even informed that a tilapia is not even an aquarium fish. Not an aquarium fish? *Au contraire*…

What Is a Tilapia?

The genus *Tilapia* lends its name generically to a collection of species that all share some basic characteristics, but the name tilapia is derived from the much larger *tribe* of cichlids commonly known as tilapiines. The tribe is part of the subfamily Pseudocrenilabrinae, which basically covers all the cichlids in Africa. The tilapiine tribe not only includes the large (in number and often size) species of the genera *Tilapia*, *Oreochromis*, and *Sarotherodon*, but also some of the other popular African cichlid fishes in the genera *Pelmatochromis*, *Steatocranus*, and *Stomatepia*.

Andrew Smith erected the genus *Tilapia* in 1840, and over the years, many different fish that mildly resembled the going definition of a tilapia were placed in the genus. These included fish of so many different shapes, sizes, reproductive strategies, and other differences that just about everyone agreed that changes would have to be made.

The 2013 publication by Dunz & Schliewen accomplished most of the task by taking the approximately four dozen species assigned to *Tilapia* for the past few decades and splitting them up into six different genera.

Coptodon

Most of the species were placed in the genus *Coptodon* (Gervais, 1853). The most notable aquarium species in this genus are the collection of cichlids from Lake Bermin (Cameroon), which took the hobby by storm about two decades ago. The diminutive *C. snyderae* is an excellent aquarium fish that is said to stay very small in the lake and is known to breed at less than an inch in length. They grow to be a few inches in captivity, are not horribly aggressive, and range in color from a golden yellow to bright red. Other Lake Bermin *Coptodon* species of interest to aquarists include *C. bythobates*, *C. bemini*, *C. flavus*, *C. bakossiorum*, and *C. thysi*. Lake Bermin is very inaccessible to commercial fish collection, so wild fish are very rare. Only a few of the species (*C. snyderae*, *C. bythobates*, and *C. bakossiorum*) are established in the hobby.

C. zillii, *C. guineensis*, and *C. rendalli* have been in the hobby for decades and are sporadically made available through breeders. These fish are relatively small tilapiines, and the breeding colors can be spectacular. Their only drawbacks, depending upon your point of view, are that they can be aggressive and very, very productive.

The Big Meany

The bumblebee or zebra "tilapia," now valid as *Heterotilapia buttikoferi*, is one of the most recognizable tilapiines to aquarium hobbyists. I will sometimes refer to it as the "African oscar" because unsuspecting aquarium keepers often buy one when it is 2 inches long, colorful, and cute. *H. buttikoferi* grows to be a large beast of a cichlid, however, and is often so aggressive that nothing can be kept with it.

The zebra tilapia earns its name by its stripes, but the slate gray with dark and light barred adult pattern cannot be called colorful. *H. buttikoferi* looks and acts its best when kept in groups in very large aquariums (such as a hippopotamus enclosure at a zoo).

The Clown Cichlid

Coelotilapia is one of the new genera erected this year, and it contains only the classic

Ted Judy is an aquarist with over 25 years of fishkeeping and breeding experience. He is a generalist who enjoys all types of fish, from anabantids to tetras, and always finds plenty of space in his fishroom for species from West Africa—especially the dwarf cichlids. Ted has served on the Board of Trustees of the American Cichlid Association and is an active member of the Milwaukee Aquarium Society. Ted also maintains the websites www.tedsfishroom.com and www.forum.apistogramma.com.

ted judy

aquarium "tilapia," *C. joka*. The common name of "clown cichlid" comes from the juvenile pattern of bright yellow-white narrow stripes on a dark-brown body. Adult fish lose the stripes, but they are still attractive. Thys van den Audenaerde first described the clown cichlid in 1969, and it was a very popular fish coming out of Liberia and Sierra Leone in the 1970s and early 80s, but *C. joka* has become much more rare in the hobby today.

The adult clown cichlid is peaceful and moderately sized at 7 inches. Even a spawning pair will not become overly boisterous in territorial defense. The juveniles are very social, and a group of them will school together almost all of the time as they search the aquarium for food. A group of six adults can live peacefully in a 50-gallon aquarium with other community fish with no problems. The only negative to *C. joka* is their herbivorous nature, but if the plants are tough and the fish well fed, they will not do too much damage to the foliage.

The Widespread Spotted Tilapia

Probably the most populous and widespread of all the recently former *Tilapia* spp. is the spotted or mangrove cichlid, *Pelmatolapia mariae*. This is one of the species that has been introduced nearly worldwide in areas where it has become a huge invasive problem. *P. mariae* has a wide natural range in West Africa that extends in the Atlantic coastal areas from Cote d'Ivoire in the northwest to southern Cameroon in the east. The spread of this species is facilitated by its ability to live in fresh, marine, and brackish waters, which is where one of its common names, the mangrove cichlid, comes from.

P. mariae is a very attractive cichlid that grows large and needs ample space. They are on par in aggression with *H. buttikoferi* but do not grow quite as large. *P. mariae* adults will grow to about 12 inches, but they are fully reproductive at only half that size. Pairs will defend large areas around a suitable spawning site, usually a flat rock upon which the pair will deposit well over 1,000 eggs. The eggs hatch in about three days, and the fry grow quickly. Spotted cichlids are monogamous, biparental caregivers that do an excellent job of driving any other fish out of their territory, which pretty much means that nothing is welcome in an aquarium with them when they spawn.

P. mariae is not a bad aquarium fish, as long as the need to control their aggression is understood. They are certainly pretty enough to earn a place in the hobby, and their breeding behavior is as interesting and intense as that of any of the other large, substrate-spawning species that are being kept.

The Genus *Sarotherodon*

The *Sarotherodon* spp. have been split off from *Tilapia* for quite a while, though at one time, most of the species in the genus today were considered to be *Tilapia* spp. I am including them here because there are a few species that are interesting enough to keep in an aquarium.

The type species of the genus, *S. melanotheron* or the black-chinned tilapia, is another widespread species in West Africa that has the ability to thrive in estuary habitats, and it is another species that has managed to make a nuisance of itself in other places in the world where it is not native. The body color of this species varies in shades of light blue, orange, or yellow. The common name comes from the distinctive black markings that most specimens have on the lower jaw and cheek, but the amount of black varies greatly among individuals. Black spots can also appear irregularly anywhere on the fish's body, but they are mostly confined to the head. There is little sexual dimorphism, though males will sometimes have a larger head and jaw.

The black-chinned tilapia is easy to keep in an aquarium and rarely grows larger than 8 to 9 inches. They are moderately aggressive fish that can coexist with other fish of similar size and toughness. *S. melanotheron* is a pair-bonding paternal mouth brooder (which explains the males' larger heads and mouths). When breeding, a pair will defend a large pit in the substrate, but their aggression rarely extends beyond the edge of the pit, so tankmates are not harmed if there is enough space for them to get away.

Andrzej Zabawski

■ A remarkably aggressive species, the zebra tilapia (*Heterotilapia buttikoferi*) can only be kept with other fish in huge enclosures.

Andrzej Zabawski

■ The spotted tilapia (*Pelmatolapia mariae*) is amazingly prolific, laying over 1,000 eggs in a single spawning event.

The other species in the *Sarotherodon* genus that have the most interest to aquarists are found in the Cameroon crater lakes of Barombi Mbo and Ejagham. Lake Barombi Mbo is home to three species, two of which are pretty enough to find a place in aquariums. *S. linnellii* is a coppery-orange on top with a black breast and belly. *S. caroli* is nearly jet black with a greenish shine on its face. Lake Ejagham is home to the recently described *S. knauerae*, which is a surprisingly pretty fish that looks like a piece of burnished copper.

None of the *Sarotherodon* species of interest to aquarists grow very large. All of them are phytoplankton feeders in the wild but will devour anything given to them in an aquarium. They are very efficient at cleaning out floating particles in the water, and a fun way to feed them (which they seem to enjoy) is to crush flake food into very small particles and swirl them around in the water column so the fish can hover off the bottom and strain the food out of the water.

Ted Judy

■ One of the best tilapia for aquariums, *Tilapia ruweti* remains small and is quite colorful.

The Remaining Tilapia

What is left of the genus *Tilapia* consists of four valid species and a few other species that are not considered true *Tilapia* spp. but have not yet been classified elsewhere.

One of these hangers-on that will eventually be split away is an excellent aquarium species: "*Tilapia*" *brevimanus*. This is a larger, robust species that needs some space, but it is not brutally mean and makes a nice centerpiece species in a big aquarium with African barbs, tetras, catfish, and even mormyrids. The juvenile and young adult *T. brevimanus* have dark vertical bars on a golden-brown body. The bars fade with age and dominance, and the unpaired fins can grow out to spectacular proportions. The net result is a majestic-looking fish with an intricate pattern of light and dark golden stripes.

The remaining true tilapia are *T. sparrmanii* (the type species of the genus), *T. baloni*, *T. guinasana*, and *T. ruweti*. The type species is a popular aquarium species that is, unfortunately, not easy to find. *T. sparrmanii* is a manageable size at 6 inches, very colorful, and easy to keep, but it can be a little picky on other fish. *T. sparrmanii*'s breeding colors of dark reds, greens, and blues with black highlights make it worth trying.

The best aquarium tilapia of them all has to be the diminutive *T. ruweti*. This dwarf species is found in the southern tributaries of the Congo River but is best known for its populations in the Okavango Delta. This unique habitat is the largest inland delta in the world and was created by the Okavango River spilling out onto a desert plain like a coastal river meeting an ocean. This habitat is completely surrounded by harsh desert and is truly an African oasis.

T. ruweti is small; the males may grow as large as 4 inches in length, and the females will stay a bit smaller. The color of this spectacular little fish can range from bright copper to nearly black, depending upon mood, with a lot of iridescent red, green, and blue spots and highlights. I have seen specimens as red as a jewel cichlid and others that look like little black-green-blue Jack Dempsey cichlids. They are feisty little fish, but their small size is easy to manage.

Not all tilapia are large, ugly, invasive, and nasty fish (those types are generally pretty good eating though). There are plenty of good aquarium species in the tilapiine tribe to choose from. Many of them are hard to find, and some of them are species of special concern for conservation. So it is not fair to judge all tilapia by the drawbacks of a few, and there is certainly room in our hobby for tilapia to find some homes.

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the planted tank

To CO_2 or Not to CO_2

I often get questions from fellow attendees of local clubs about my planted tanks. Most of the local aquarium clubs are full of "fish people" who think plants are nice and all, but firmly believe that aquatic fauna take center stage. As such, they've dubbed me "The Plant Lady," and, in my tireless pursuit of encouraging said fish people to come to the greener side of the hobby, I always try to answer their inquiries.

A recurring question I encounter involves the use of carbon dioxide (CO_2) supplementation. It seems to be something of an urban myth among the fauna-focused hobbyists (at least the ones around here) that we plant enthusiasts all run around using bazillion-dollar fancy equipment to regulate the input of pressurized CO_2 into funny little bubble devices that the uninitiated can never hope to understand. As a result, anyone who prefers to keep things simple in their fishroom has an excuse to never bother trying to set up a planted tank.

While some of this is true to a degree—setting up a high-tech planted tank is usually a couple-hundred-dollar investment, and certainly many serious hobbyists do choose to go that route—it doesn't *have* to be the case. Note: The very existence of the term "high-tech planted tank" implies there is an alternative, a "low-tech planted tank."

So which way is the right way to have a planted tank? Both and neither. Whatever you most want to do is the best thing for your personal venture into planted tankdom.

Personally speaking, I have nothing against CO_2. It works wonders for many aquaria. But it's not something I'm willing to do for every single tank I set up. Depending on what you count as a tank (I use the somewhat loose definition of "any watertight container housing aquatic lifeforms"—up to and including random storage bins full of plants and plastic shoeboxes used to breed or quarantine small fish), there are some 60 aquaria in my basement fishroom at the moment. As I write this, not a single one is using CO_2 supplementation (occasionally that number maxes out at one or two, depending on what I'm working on at the moment). With the exception of a few units, such as the sole African cichlid tank and the 10-gallon I breed marbled crayfish (*Procambarus* sp.) in, all of those tanks are planted to some degree. Often, those "fish people" I mentioned earlier are quite surprised to hear about this, but it's not that unusual—plenty of plant hobbyists keep just one or two high-tech tanks and a bunch of miscellaneous low-tech setups.

Reasons for Using CO_2

There are a number of reasons one might choose to utilize CO_2 injection in their planted tank(s). First and foremost among them is probably the desire for faster growth. Given sufficient lighting and enough nutrients, the plants in CO_2-injected aquaria can grow several times

Amanda Wenger is a lifelong hobbyist who inherited a love of aquaria from her father, when he gifted her with her first fish at age two. A decade and a half later, she started putting plants in the fish tanks and was hooked. Today, she lives in Connecticut, where she's the current President of the CT Aquatic Plant Enthusiasts (CAPE) and, with the assistance of her family, maintains a well-planted fishroom and a hobby-sized greenhouse filled with aquatic plants. She's also part of the moderating staff at AquaticPlantCentral.com. Aside from the aquarium hobby, Amanda is a professional illustrator and graphic designer with a soft spot for wildlife illustration.

amanda wenger

faster than those in their non-supplemented counterparts.

Competition aquascapes and many professionally installed and maintained planted tanks supplement CO_2 levels to rapidly produce lush, bushy hedges (or streets if the aquarium uses a Dutch-style layout). Since competitions have deadlines, it's beneficial to get the plants to fill in as quickly as possible rather than come up against the deadline with a tank that still could use another week or two of filling in. In the case of aquaria on display in offices, in public locations, or for decorative purposes, the sorts often maintained by professional aquarium-installation companies, one doesn't want the tank to take too long to grow out again and look pretty after a trimming, so it's worth it to add CO_2.

Even hobbyists who keep tanks in their homes for their own private entertainment may feel the added effort or cost of CO_2 supplementation is a small price to pay in order to have the excitement of a more dynamic, ever-changing, fast-growing planted tank.

Nurseries also benefit from the boosted growth rate of CO_2 injection. While nurseries typically grow as many plants as they can in emersed form (atmospheric CO_2 levels are far higher than anything you can add to water, and emersed plants grow very quickly as a result), some plants are obligate aquatics and have to be grown in vats of water. Adding CO_2 to those vats increases productivity, which means better profits for the nursery.

Reasons to Avoid CO_2

There are just as many circumstances in which adding CO_2 is not preferable. Many people prefer not to have the added chores of weekly fertilizer dosing, frequent plant trimmings, and preserving the balance between plant growth and fish safety (excessively high CO_2 levels can be harmful to fish). For people who want to keep things as low-maintenance as possible, CO_2 probably isn't worth adding.

Others prefer not to invest in more expensive, high-output lighting units and, therefore, grow only low-light plants—CO_2 is pretty much never necessary in a low-light aquarium because the lighting is the factor that limits plant growth, not the available CO_2. Some people just prefer to have their aquascape remain fairly stable from day to day and week to week—once you get a tank to look nice, there's a certain impetus to keep it looking the same for as long as possible, and that's easier to do with slower plant growth.

Some plants prefer very soft, acidic water—these will benefit from CO_2 supplementation, which lowers pH and precipitates the alkaline buffers in the water. Plenty of other plants like harder, higher-pH conditions, though—and many even prefer slightly brackish conditions. Though many brackish-friendly plants, such as Java ferns and *Vallisneria* species, do well in lower lighting, this is not always true. Some brackish plants, such as *Samolus valerandi* and a dwarf hairgrass species, *Eleocharis parvula* (note: real *E. parvula* is rare in the hobby; most of what is traded as that species is mislabeled *E. acicularis*, the common dwarf hairgrass), prefer strong lighting.

Aleksey Stemmer/Shutterstock

■ Some hardy plants can thrive in low-light conditions and do not require CO_2.

Bos11/Shutterstock

■ Heavily planted tanks can be supplemented with CO_2 to keep them looking lush.

Amanda Wenger

■ Shrimp prefer water with a high pH and may not be good candidates for tanks supplemented with CO_2.

Nano tanks are another case in which CO_2 may not be helpful. Nano tanks contain very small volumes of water by definition, which means even a slight increase in the rate of CO_2 input can drastically alter the water parameters, making it a more risky venture than supplementing a larger tank with more stable chemistry.

Secondly, most nano tanks are quite shallow and have sufficient proportional surface area that gas exchange with the air is fairly quick—thus, even though the plants may quickly use up the available CO_2, it diffuses back into the water fairly quickly as well, reaching down to the substrate easily (getting CO_2 down to the bottom of a 24-inch-deep tank is much more of a challenge). There's always more available CO_2 at the surface of the water, and when the surface and the substrate are 6 or 8 inches away, there's not a lot of variation in CO_2 levels anywhere in the tank. Add strong lighting and a nutrient-rich substrate, and plants that would require CO_2 supplementation in a larger tank may thrive just as well without it in a nano setup.

Some kinds of fauna are more sensitive to CO_2 addition than others. Shrimp, for instance, need very well-oxygenated water, and water can hold only so much diffused gas. The more CO_2 is added, the less room there is for oxygen, and the carbonic acid increase as a result of CO_2 injection can be harmful to the carapaces of invertebrates. In the case of common, fast-breeding shrimp like red cherry shrimp (*Neocaridina heteropoda* "red"), you might take a chance, but few would risk a tank full of prized Taiwan bee shrimp (*Caridina* cf. *cantonensis*).

Focus on the Goals of your Setup

The next time you think about starting a tank and wonder whether you should put a CO_2 system in the setup, give careful consideration to what you want to accomplish and act accordingly. It may seem like all the cool tanks use CO_2, but I assure you that it's just as possible to have a gorgeous, lush, well-designed planted tank without it.

On a side note, I'd like to hear from *TFH* readers what they want to know about plants and planted tanks. If a subject is of wide enough interest, I may devote a column to it in the future. Send any questions you may have to asukawashere@yahoo.com—I can't promise to answer every last question (depending on how many emails I get), but I will promise to read them all and pay attention to what subjects interest several people!

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life with livebearers

A True-Breeding Hifin Platy

The genesis of this column was an email to a customer, Steven Framke, who recently bought some of our freckled hifin variatus. In that email confirming the shipment of the fish, I made the offhand statement, "Just so you know, the freckled hifin variatus strain we have is one of three known populations of hifins that breed true. We get fewer than 1 percent non-hifins each generation."

He promptly emailed, "What are the other two populations that breed true?"

True-Breeding Hifins

I remembered that at the American Livebearer Association's 2012 convention in Fort Lauderdale, Florida, I was discussing these fish with Dr. Roy Levine and he mentioned two other strains. I emailed him, and he responded, "As far as I know, you are the only one that has true-breeding hifins. Glenn Takeshita told me about a true-breeding hifin variatus line that he developed many years ago. I have had female hifin swordtails that dropped greater than 95 percent hifins, but I didn't have the tank space needed to develop a line." Then he added some tasks for me, "Were you able to transfer the trait to another line of maculatus or variatus? More specifically, is the trait dominant; do you obtain hifins in the F_1s when you cross your hifins to an unrelated maculatus or variatus?"

While in Florida, Roy and I had discussed performing these very tasks. I had to reply I had failed to do so. This lit a fire under me to complete the tasks. Unfortunately, I won't be able to present any findings since this correspondence occurred just shortly before I wrote this column. But, I'm going to describe our freckled hifin variatus, and then I'll tell you the what, why, and how I'm going to answer Roy.

Breeding Hifins

We acquired our freckled hifin variatus from Ekkwill, a Florida fish farm, in March 2007. My records don't show the number received, but it was probably 50. I do remember that they all sported hifins. Also, they weren't very attractive. Some were flesh-colored with black freckling, others were very bluish with freckling, and some had no freckling. But, they did have nice hifins, a gene I wanted to transfer to our other color varieties.

I set them up in a breeding vat. In the meantime, in another Ekkwill order, I got a bag of mixed hifins. Some of these were nice and had color patterns matching our other maculatus and variatus strains. As a result, I used those fish and simply maintained the freckled hifin as a separate strain for no good reason.

Two or three months later, our fish database report told me it was time to process the freckled hifins. I was in for a surprise—out of several hundred juveniles, only a handful were non-hifin! Let me explain why I was surprised.

The hifin characteristic in platies, both maculatus and variatus, and swordtails, all members of the genus *Xiphophorus*, is specified by a dominant allele (a variation of a gene) causing any fish bearing it to have an elongated dorsal fin, hence the name "hifin." The characteristic apparently arose as a mutation in swordtails raised by Thelma Simpson, and for decades,

Charles Clapsaddle began keeping fish at age 7, winning some goldfish at a carnival. Successfully spawning them, he was hooked on fish. Mastering goldfish, his attention turned to livebearers, locally collected mosquito fish (Gambusia affinis)*, and sailfin mollies* (Poecilia latipinna)*. By junior high he graduated to fancy guppies. His fascination with livebearers continues. Although his commercial hatchery breeds many other fishes, the development of new livebearer strains and the improvement of existing strains occupy his best efforts. Charles speaks to aquarium clubs across the country on various hobby topics. He has a BSc in Zoology from The University of Texas at Austin.*

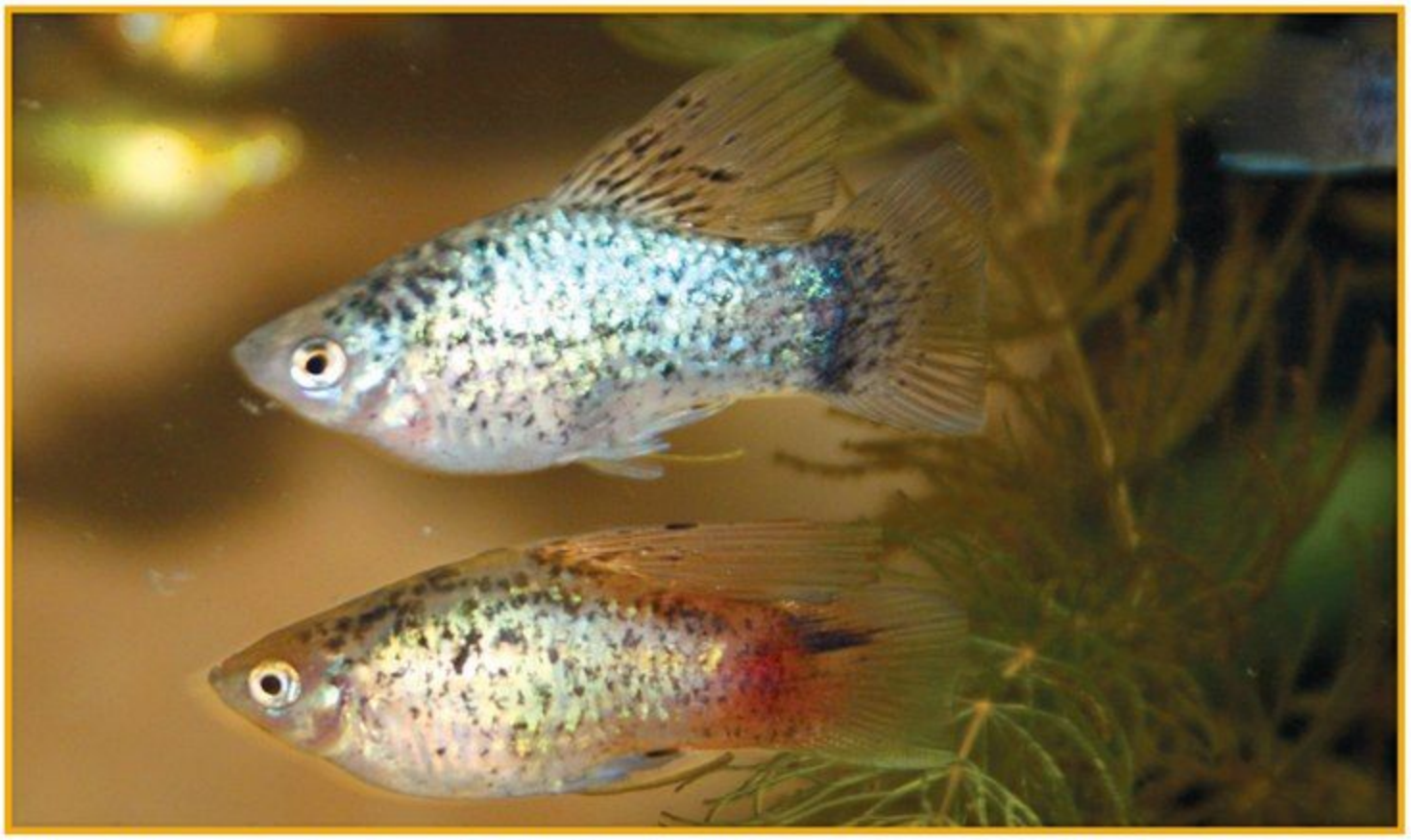
charles clapsaddle

photographs by the author

hifins were called Simpson hifins. The characteristic was transferred via hybridization to maculatus and variatus platies.

A Genetic Quandary

An unusual aspect of this mutation is that it is a homozygous lethal. Homozygous means an individual has inherited two identical copies of an allele. Any egg carrying the hifin gene fertilized by a sperm also carrying the hifin gene doesn't survive. There are practical impacts of this when breeding hifin swords and platies; most significantly, it's not possible to develop a true-breeding strain of hifins. Since the hifin homozygotes (those inheriting two copies of the allele) die, the only surviving hifins carry the recessive allele for non-hifin; they are heterozygous (carrying both alleles, one for hifin and one for non-hifin).



Blue (top) and flesh-colored (bottom) freckled hifin platies were used to attempt to breed a true-breeding strain of hifins.

Typically the gene for hifins is lethal if a fish has both copies, but the author's stock exhibited no such problem.

Normally, in cases where a homozygous dominant allele is not lethal, mating two heterozygotes produces a distinctive 3:1 ratio of fish showing the dominant characteristic to those not showing it. This is because half the eggs will have the dominant gene and no matter which type of sperm fertilizes them, the fish that develop from those embryos will have the dominant characteristic. Half of the other half of the eggs, which have the recessive allele, will by chance be fertilized by sperm carrying the dominant allele, and the fish that develop from those embryos will show that characteristic—one-half plus one-fourth yields three-fourths, or the 3:1 ratio.

In the case of a dominant homozygous lethal, one-fourth of the embryos, those carrying the dominant allele from both the egg and sperm, will never develop and will essentially be missing. The resulting ratio will be 2:1 instead.

Remember, these numbers are averages over large numbers of matings. For example, in humans, blue eyes are recessive to brown eyes. If two brown-eyed heterozygotes marry (each carrying the recessive allele for blue) and they had four children, you'd expect three brown-eyed children and one blue-eyed child on the average, but it's not unusual to have families such as this with four brown-eyed children, four-blue eyed children, or some other mixture.

Further Investigation

So I was surprised because I expected 2:1 hifins to non-hifins and I got more like 50:1. What was going on? I picked some nice breeders, probably six males and 40 to 50 females, and set them up for spawning. About three months later, I eagerly processed the offspring of these breeders. Again I got only one to two percent non-hifins. I began to get excited. These results have continued time after time. If anything, non-hifins are getting rarer. Just last week, out of 254 juveniles, there was only one non-hifin.

Last year, after talking to Roy in Florida and reviewing the results of breeding our freckled hifin variatus, I came home determined to set up the crosses to see what was going on genetically. Things happened, and I didn't do it. I'm writing this column and committing to conducting the mating tests to understand what is happening. Y'all need to keep my feet to the fire and insist I follow through. In the rest of this column I'll explain what I plan to do, why I'm doing it that way, what the results might be, and what those results might mean.

First, I'll pick out some strains of platies and swords that have genetics allowing me to easily pick out hybrids.

White Mickey Mouse maculatus are an easy pick. Why? Because I know the white body color of this fish is recessive. Using a fish of known genetics allows me to avoid raising virgin females, a time-consuming process. I simply place about 20 white Mickey Mouse females in a vat with one freckled-hifin male.

Why this instead of a male white Mickey Mouse maculatus and female freckled hifins? Because any white offspring of white females won't be hybrids and can be discarded. If I used freckled-hifin females,

It is possible that the freckled hifin results from a number of different alleles.

I wouldn't be sure if the offspring were hybrids or not. This way, any non-white fish are hybrids. Things get a bit sticky here. The following only works if the freckled hifin gene is dominant. If so, I expect all the hybrids to be hifins, although there is a chance the male could be heterozygous, in which case, about half the hybrids would be non-hifin. I plan to use a single male to do this test. If all hybrids are hifin, the male is homozygous for hifin. If half are non-hifin, then he is heterozygous. I will use a large number of females to get a large number of offspring to play the odds. Remember the blue- and brown-eyed humans? Small numbers can lead to misleading results. One other result could be none of the hybrids are hifin. This interesting result would indicate the freckled hifin is recessive, a possibility.

Regardless of the F_1 (first generation hybrid) result, I'll continue the mating program and testing.

If all the hybrids are hifin, which is the result I expect, I'll set up two crosses. I'll mate the F_1s together, and I'll mate F_1s back to the freckled hifins. If the F_2 fish (resulting from mating the F_1s together) yields 3:1 hifins to non-hifins, this confirms the freckled hifin gene is a non-lethal dominant as a homozygote. This would be further confirmed by the F_1 matings to freckled hifins yielding 100 percent hifins. Other results would be interesting but confounding.

Similarly, if all the F_1s are non-hifin, indicating it is a recessive characteristic, I'll mate the F_1s to produce F_2s and backcross the F_1s to freckled hifins. If indeed it is a recessive characteristic, the F_2 would be 3:1 non-hifin to hifin and the backcross would yield a 1:1 non-hifin to hifin.

There are other possibilities. The freckled hifin could be the result of multiple genes and alleles. I don't think this is the case, but it could happen. In this case, all the ratios discussed wouldn't happen. It's too complicated to contemplate.

Testing the Theory

I used white Mickey Mouse maculatus as an example. I also plan to use red maculatus because any hybrids wouldn't be bright red. I'll use red swords for the same reason. I'll use male redtail black variatus with freckled-hifin females since the hybrids would have a tuxedo pattern (our redtail black variatus breed true, indicating they are homozygous for tuxedo).

To test other hifins, I'll use our blue opal hifin maculatus. Any hybrids wouldn't be blue opal, which is a recessive characteristic. If the freckled hifin is recessive, this would set up an interesting interaction with the dominant hifin of the blue opal. We raise 54 varieties of commercial swordtails, maculatus, and variatus, so there's a lot of genetic material to work with.

With time and determination, I'll solve the mystery of our true-breeding hifins. At the same time, I hope to transfer the characteristic to each of our swordtails, maculatus, and variatus. A major labor cost of ours is sorting hifins from non-hifins. I hope to reduce this cost by producing true-breeding hifins of each of the xiphophorines we raise.

Well, that does it for this month. Remember, you can send any questions or comments to me at charles@goliadfarms.com. If I use your e-mail, you'll see your name in print.

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into the labyrinth

Fruit Bettas

The *albimarginata* species complex of the genus *Betta* contains only two species, but they are both among the most beautiful of bettas. They are also the two whose common names reference fruits: *B. albimarginata* is known as the strawberry betta, and *B. channoides* is known as the cherry betta. *B. channoides* is sometimes called the snakehead betta in literature (this appellation comes from the species name "channoides," which refers to the similar head shape between this species and some of the snakeheads of the genus *Channa*), but I've never heard anyone refer to them by this name in conversation.

Prior to their description by Kottelat and Ng in 1994, hobbyists presumed the two species were geographic variations of a single species.

Identifying Species

One thing that sets the fruit bettas apart from other bettas is the number of anal fin spines. With 9 to 11 spines in *B. albimarginata* and 12 spines in *B. channoides*, these two species possess by far the highest number of anal fin spines of any known betta species.

Differentiating between males of the two species can be difficult, but there are differences to the practiced eye. As you might guess from the species name *albimarginata*, males of this species tend to have wider white margins edging the dorsal, caudal, and anal fins, but the width of the white band is variable and some male *B. channoides* will have wider white bands or margins than some male *B. albimarginata*.

Another clue comes from the common names. When in good condition, male *B. albimarginata* are a rather strawberry-red color while male *B. channoides* are a darker, more cherry red. Additionally, *B. albimarginata* features an orange gill cover.

By contrast, females are much easier to identify. Female *B. albimarginata* have a pattern of horizontal striping on the body while *B. channoides* have vertical striping. Sometimes the easiest way to identify the species of a pair of these fish is to just look at the females.

However, the best way to identify the species may be to find out where they are from. While both species originate from Kalimantan Timur, or eastern Kalimantan, in the Indonesian part of Borneo, they hail from different river systems. *B. albimarginata* lives in the Sebuku River system, which runs through the northern part of Kalimantan Timur and empties into the Celebes Sea near the island of Nunukan. *B. channoides* hails from the Mahakam River system. The Mahakam is the second longest river in Indonesia, starting in the Muller Highlands near the border with Sarawak and flowing 610 miles to the coast at Samarinda, the capital city of Kalimantan Timur, where it empties into the Makassar Strait, which separates Borneo from Sulawesi.

Keeping Fruit Bettas

Both species are fairly easy to maintain in the aquarium. Aquariums to house them can be set up in several ways depending on your goals and the available space you have for these species. The aquarium décor can be very simple, consisting of a few hiding places and a small filter. The addition of some leaf litter, in the form of almond, beech, or oak leaves, is beneficial, as it replicates their natural habitat and provides some hiding places, plus the microfauna that live among the leaves can provide a natural food source for very young fry. The addition of some Java moss is also beneficial for the same reasons.

Both of these species do best in dim lighting, but that still leaves a number of plants that can be added if you choose. The various growth forms of the Java fern, any of the *Bolbitis* species that are available in

Mark Denaro has been keeping freshwater aquariums since 1970 and marine aquariums since 1976. He currently operates Anubias Design (www.anubiasdesign.com), an aquarium and terrarium design, installation, and maintenance company serving southeastern Pennsylvania, and an importer/online retailer of new, rare, and interesting freshwater fishes, invertebrates, and plants. A former president of the International Betta Congress, Mark's primary interests are anabantoids, cichlids, and planted aquariums.

mark denaro

the hobby, smaller *Nymphaea* species, and most *Anubias* and *Cryptocoryne* species work well.

If you want to keep the bottom of the aquarium bare to make cleaning and maintenance easier, attach the rhizome-growing species to small pieces of driftwood. The crypts can be grown in small containers or small flowerpots that can be moved when necessary. Small, empty flowerpots can also be used to provide hiding places for the bettas. As with all other bettas, a tight-fitting cover is essential because these species are prodigious leapers.

The water should be soft and slightly acidic, though both species will adapt to and spawn in hard and alkaline conditions. The temperature should be in the low to mid-70s.

Breeding Fruit Bettas

A single pair can be housed in a tank as small as 5 gallons, though a 10-gallon tank would be preferred. If you're planning to keep more than one pair, a 10-gallon tank should be considered the minimum size, with a 20-gallon long to a standard 30-gallon probably being a better choice.

A colony of four to five pairs, or three to five females with six to eight males, would do well in a 30-gallon aquarium. The idea of keeping more males than females in a group may seem odd at first because most hobbyists are accustomed to setting up spawning groups with more females than males. In the case of mouthbrooding anabantoids, however, it is the males that brood the eggs and fry and the females that initiate spawning, so the best situation is to maintain the fish in pairs or with more males than females.

Because the males will brood the eggs and fry for approximately 12 to 16 days depending on water temperature, it is important to ensure that the male has time to recover and rebuild his reserves between spawnings. Females will be ready to spawn again by the time the male releases the fry, and if a single pair is maintained, he may spawn again that day or within the next few days, which will result in a significant depreciation of his reserves. If this happens continually, the male will eventually burn out and die prematurely. Maintaining these species in a colony setting with more males than females increases the likelihood that each male will have a little more time to recover from the ordeal of mouthbrooding before spawning again.

A better alternative, though, is to move the male to a brooding aquarium approximately 10 days post-spawning. By this time, he is less likely to spit or swallow the brood due to the stress of capture and moving. If possible, try to keep him submerged at all times by capturing him in a plastic or glass container rather than a net. After the male releases the fry, feed him well and heavily for a few weeks before returning him to the aquarium with the females. If you are maintaining a single pair, it is better to remove the female. This eliminates the risk that the male will eat or spit the eggs or fry when he is moved. The simplest way to accomplish this is to set up a set of three to four breeding/rearing tanks so that there will always be a tank ready for the female. The male can be left with the fry to recover or moved into another of the waiting tanks. When he is ready to spawn again, put him back in the tank with the female.

Marion Zöller

■ Cherry betta (*Betta channoides*); Java moss provides useful hiding places for fruit bettas.

Marion Zöller

■ Male fruit bettas brood their eggs for approximately 12 to 16 days.

While *B. albimarginata* and *B. channoides* have much in common, there are some significant differences as well. *B. channoides* is more readily available through the aquarium trade and more commonly kept by hobbyists. *B. channoides* seems to be rather more adaptable and easier to keep than *B. albimarginata*. It is also far easier to spawn than its counterpart and has larger broods.

Both species spawn in the typical mouthbrooding-betta manner, including the male wrapping the female and the female picking up the eggs and passing them to the male. An average spawn of *B. channoides* consists of about 20 fry, with exceptionally large spawns numbering in the 30s. *B. albimarginata*, on the other hand, spawns far less frequently and generally has 10 or fewer fry each time.

Marion Zöller

■ The strawberry betta (*Betta albimarginata*) gets its common name from the male's strawberry red coloration.

If you don't have a lot of experience with mouthbrooding bettas, *B. channoides* is probably the better choice. Once you've mastered *B. channoides*, it will be time to move on to the challenge of *B. albimarginata*.

As always, try to find out as much information as you can about the original collection location of your fish and keep fish from different collection points separate. There are several geographic variations within these species, and it is entirely possible that one or more of these will eventually be raised to species status. Keeping fish from different locations separate helps to prevent unintentional hybrids.

Raising the Fry

The fry of both species are easily reared. They are large enough to accept newly hatched baby brine shrimp upon release. Vinegar eels are another useful food, and microworms can be fed sparingly. If you are maintaining a daphnia or cyclops culture, these can be sorted through sieves and the smallest are an excellent addition to the diet as the fry grow a bit. The feeding of cyclops and baby brine shrimp will help to enhance the red color of these species. The fry will generally accept powdered dry foods fairly quickly, too, and this can make it easier to feed them multiple times a day if you don't have time to work with the live foods at every feeding.

While I wouldn't recommend either of these species as your first mouthbrooding betta, experienced hobbyists should be successful with them, and anyone who has spawned *B. edithae* or any member of the *picta* or *pugnax* species complexes should do very well with *B. channoides*. If you're up for a bit of a challenge and like pretty fish, give them a try. And remember, fruit is good for you!

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adventures in aquascaping

Adventures with Inverts: The Pico Riparium Project Part 3, the Tale of Small Aquascapes and Big Chemistry Woes

Lea Maddocks is a long-time fish enthusiast and has been a scuba diver since age 15. A biologist, Lea is fascinated with aquarium science, including fish and invert husbandry, planted aquariums, reefs, and the art of aquascaping. Lea was the former owner of Acumen Aquatics providing aquarium installs, assistance, and maintenance. She supplies her own FinSafe betta ornaments, is an active member of the Canberra District Aquarium Society, contributes to several fish and aquatic plant forums, and has written for the Australian RSPCA on the nitrogen cycle, goldfish, and betta care. Lea owns three planted tanks, and routinely maintains many freshwater tanks, a turtle tank, a marine reef, and was a volunteer worker at the National Zoo & Aquarium in Canberra—in the aquarium section of course!

lea maddocks

photographs by the author

In my last article, I noted that the riparium started with three canes of lucky bamboo (actually not bamboo, but young canes of *Dracaena braunii*) for instant emergent growth. The *D. braunii* was married to a twiggy construction over the sump, accented with rootless *Tillandsia* air plants and a mini bromeliad. The twigs covered my rear sump, gave the top a nice river-bank feel, and provided a trellis for emergent aquatic plants to grow on.

With this all in place, it was time to consider things below the water line. For my riparium planter, a small mesh bag full of *Bacopa* was suction-cupped below the water surface and hidden behind some floating *Riccia* and bladderwort. The *Bacopa* stems were left emergent and tangled among the trellis where they were sprouting well.

The first challenge for the remaining submerged pico garden was the rear wall. It is bright red. This was a bit overwhelming compared to the black or neutrals I'd used before. I considered sliding some black or cream aquarium backing over it, but looking at the bamboo, I recalled a nugget of information I'd learned about the ancient Chinese practice of Feng Shui.

Feng Shui is a complex topic (of which I know only a small amount) but is generally regarded as the practice of bringing positive natural energy (qi) to yourself and your home by orienting, designing, or decorating your environment in an auspicious manner—often by combining elements of nature (wood, water, metal, fire, and earth) and compass direction following certain rules. Basic Feng Shui decorating in the West has popularized the sale of pots of lucky bamboo, red-threaded lucky coins, small water features, Buddha and animal statuettes, and, for aquarists, aquariums or ponds containing koi, goldfish, or, the best of all, arowana, which are considered the luckiest of fish (particularly gold- or red-colored varieties).

The colors of gold and red on fish are particularly auspicious as they represent the fire element, though white or silver can also be used, as they reflect the metal element. Combine these element representatives with water in the tank, earth in the substrate, and wood in the live plants, and a healthy aquarium or pond can be one of the luckiest Feng Shui items to have (the aquarium structure can also be counted as a metal element and the lighting as fire, so most aquariums can potentially bring a lot of luck!).

Plants are also lucky items, as they combine most elements (wood, earth, and water), and decorative lucky bamboo pots are also often seen with metal coins or glass pots (glass counts for metal) as well as a red or yellow ribbon tied about its stems to symbolize fire. On observing my fire-red tank wall next to my lucky bamboo, accompanied by water and the wooden top section, all seemed to instantly fall into place as a novel Feng Shui tank.

While I may lose points in traditional aquascaping, the red did complement the bamboo and was a cheery change to any other aquascape I'd previously done. Interestingly, a little more digging on this topic revealed that incorporating three canes of lucky bamboo was certainly a lucky choice, as it is said that this number brings happiness (certain other numbers are said to also bring good fortune of varying kinds). To fully round out the theme and elements, I also found a trio of red-threaded Chinese lucky coins to place next to the tank to fill the need for metal and enhance the theme.

Time to Plant

I had collected a nice bunch of small plants from a generous friend, and the aquascape

seemed to fall into place easily with them. All except the *Blyxa* were also chiefly rootless and so could be trimmed or pulled out with ease as they overtook the tank, a vital and regular chore to keep a small tank looking sharp. The Christmas tree moss was used to cover the base of the lucky bamboo like a shrub.

Influenced by the golden ratio and rule of thirds, three tufts of *Blyxa* were positioned across the tank, two on the left side in front of the bamboo, one on the right for balance. Also on the left, there is another feature plant, some tiny *Anubias*. Its deep-green and round leaves contrasted well against the paler and spiky *Blyxa*. A few tufts of slow-growing Java fern "windelov" were also added for variety. I also had some thin, globular subwassertang that was perfect for tucking amongst the lot, tying the aquascape together and providing the look of some dense understory growth. Again, being rootless, I could move it around and remove what was needed at will.

A small cleared space was left at the front, with a path running around the corner to the distance to give some negative space and illusion of depth as well as showcase the fine black gravel, which added a little drama to the tank and matched the greenery and hot-red wall perfectly. A few gray, marbled stones were used to complete the hardscape. The stones had to have fine details to seem miniature enough to match. Some smaller branches arching upwards were toyed with, as well as a basic *iwagumi* arrangement in the center, but these hardscape items seemed just too overpowering on this scale. Indeed, the plants were the only feature that felt necessary in this tiny space.

To break up the glaring red and add interest to the middle to upper sections, needle-leaf Java fern was employed and tucked at the back behind the plants, its thin leaves arching to the front. This covered the red enough to tone it down to a peaceful level. Once again, any leaves that got too large could be easily removed from the back without disturbing the remaining aquascape, given the rootless nature of Java fern. With all of this happening beneath the mass of *Riccia* and bladderwort, it was looking promising.

Finally, a little floating *Hydrocotyle* was inserted here and there for another touch of leaf variety and a little lily-pad charm. Much to my surprise, this plant readily scrambled up the sides and into the floating plants where it matched well—and then emerged! Using the floating mass of *Riccia* and bladderwort as a base, it put up shoots everywhere. These were subsequently trained onto the twiggy aerial section. It attached to the riparium planter as well and overran the *Bacopa*.

■ *Blyxa* and tiny *Anubias* were used to create a focal point on the left side of the tank.

This was a great solution to some problems that emerged with the *Bacopa*. It started to die off just as it was looking good. I am still uncertain whether this was due to allelochemical warfare between the several plant types colonizing the tank or whether my cat (who has a taste for some of my houseplants) was chewing on the leaves. More was ordered, and the cat was banished from my tank room. Hopefully round two of *Bacopa* would fare better. If not, it would be confirmation of allelochemicals at work. These chemicals are released by plants into the water to help compete for resources, and any nano keeper should be warned of this, as such interactions are magnified in a small space. Similar silent warfare occurs among corals too, one of the reasons good nano marine keepers have large sumps and/or perform regular water changes to help keep this diluted.

Round two with the *Bacopa* failed also, and while I have no definitive proof, I suspect it just wasn't a good match for the chemistry of my garden. Still I found that I needn't persist with that species. My other plants were coexisting happily, and the *Hydrocotyle* continued taking over the twigs and the planter, eventually anchoring into it. Along with the *Riccia* and bladderwort, it had a renewed purpose.

Pico Chemistry Woes

It was then time to address the more serious problem of creating a stable tank environment. Preventing parameter fluctuations in small volumes of water is a royal pain for any aquarist attempting it, and a reason so many beginner tanks just outright fail. I was also not immune from these issues, and it was not luck but some compromises and prior knowledge that finally saved the day.

When something goes wrong in a planted tank, one (or two) of three central driving factors is generally out of balance. These are CO_2/O_2, nutrients/hardness, and lighting. When one is limiting or in excess, algae, plant illness, and death can occur. I was faced with two issues, a small amount of irritating hair algae in the floating *Riccia* and bladderwort and, most importantly, wild pH swings.

Swings in pH in a heavily planted tank come as a surprise to some who believe plants can do nothing but good. Indeed, I believe plants are essential to every tank for their properties as natural filters, the habitats they provide, and their good looks, but a heavily planted tank can sometimes hide an invisible daily menace. I am referring to their normal respiration and photosynthesis cycles.

When O_2 is supplied and CO_2 is used up by photosynthesis in tanks that have little dissolved CO_2, the pH can rise sharply. When CO_2 is dissolved in water, it forms carbonic acid, which naturally lowers the pH. When it is removed entirely by heartily photosynthesizing plants, the lack of acid results in a higher pH. At night when the lights are off, photosynthesis stops and plants along with the other livestock and bacterial/microbial life are all respiring together. When CO_2 builds up again in the water, carbonic acid will form and the pH will again fall. These daily swings can be severe enough to kill livestock or stress them to the point of illness, so they should be accounted for.

The best way to beat this issue is to buffer the water with carbonates and test your carbonate hardness (KH). Carbonates resist changes in acids and bases to prevent such swings and even provide a source of carbon to some plants, but if the KH drops low enough, swings will return and potentially harm your tank life. My local water has a KH of 1 to 2 degrees (17.9 to 35.8 ppm); a bare minimum for good buffering is 3 to 4 degrees (53.7 to

71.6 ppm). Indeed, I was seeing pH swings from 8.0 to 7.2 over the course of a day (my normal pH is 7.4).

My first response was to increase the KH. I used potassium carbonate rather than sodium bicarbonate to add a bit more potassium nutrition to the plants. I raised the KH to 3 degrees, which brought the pH up—I had to use an acid buffer (not a pH down, these do not work as well and can contain troublesome phosphates) to lower it to 7.4. This is my local pH, the one I currently keep shrimp in, and I was hoping for a shrimp tank. I have done this with all my larger nanos with great success.

However, the buffering was not enough for this space. Though the pH was indeed tested and stable for the first few days, I lost a colony of newly introduced yellow *Neocaridina* shrimp to pH swings that occurred a week after I boosted the KH to 3. Obviously, the carbonates were being consumed too quickly by the rapidly photosynthesizing plants. I had to add lots of bicarb and acid buffer to and fro in a bucket to get the KH higher and the pH right, and too much tinkering with pH chemicals can easily lead to error and disaster. As I had to increase the KH, I decided to just live with a higher pH for simplicity and to stock with something else. I settled on KH 6 and a pH of 7.8 and found some improvement.

■ Bladderwort was used to hide the riparium planter.

Swings, though smaller ones (7.4 to 8.0), were still occurring. Having fiddled with carbonate, CO_2 supply, and KH, I looked to another variable to try and fix the problem—lighting. The plants were photosynthesizing hard for much of the day (8-hour photoperiod with one 4-hour siesta), evidenced by constant pearling once the lights had been on a short while. If this driving factor could be slowed, the strain on other parameters might be improved.

I first replaced the lamp with a more efficient 2-watt, 24-LED, flat-black, bendable, clip-on light. Far less light intensity should slow photosynthesis down, reducing hunger for CO_2 and slowing growth, a beneficial thing in a pico tank. I also changed the photoperiod. In a low-tech system, a few hours of lights out will reduce or stop most photosynthesis and allow CO_2 to build back up before the lights come on again for another round of lighting. These siesta breaks in photoperiods are good for your plants in a low-tech system, as they can replenish the CO_2 and acid levels to keep the pH steady (they can also reduce algae caused by over lighting). By setting the timer for 2 hours on, 2 hours off (starting at 8am, finishing at 10pm, four light cycles), not much available CO_2 would be consumed, and if it was, it could be rebuilt somewhat in the time off. This strategy of fewer light cycles and less light intensity worked perfectly; the pH stayed 7.8, though a small change to 7.5 overnight was sometimes noted. Removing some of the *Riccia* that was growing very rapidly also helped. Furthermore, the change in lighting eradicated the hair-algae problem—some wonderful luck at last!

In the end, it was coming out well with patience and learning to take it slow. I am reminded of this peaceful lesson with the addition of the tank's final successful inhabitants, whom I'll discuss in the closing chapter next month along with fertilizer regimes and general maintenance of a pico planted tank.

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Corals of the Genus *Porites*

James Fatherree, MSc, is a physical and environmental sciences professor in Tampa, Florida. He has been an aquarium hobbyist since childhood, a reef aquarium hobbyist for over 20 years, and has spent many days diving in Florida, Hawaii, the Bahamas, Japan, and Indonesia. In the past he has managed a large retail aquarium store, owned and operated an aquarium design, installation, and maintenance business, and spent a summer working for an aquarium livestock collector/wholesaler in Florida. James has also published numerous articles in the U.S. and Europe, and has written and illustrated several books on the topics of reef organisms and marine aquariums, the latest of which is Giant Clams in the Sea and the Aquarium.

james fatherree

photographs by the author

Going by the names jewel coral, boulder coral, finger coral, mustard hill coral, and even worm rock, there are quite a few corals in the genus *Porites*. Many of these are quite nice looking, or at least very interesting for reasons that I'll get to below.

Basic Information

To start, the genus *Porites* sits within the family Poritidae, which also includes numerous species of the popular genera *Goniopora* and *Alveopora*. These are easy to differentiate, as gonioporids and alveoporids have relatively huge polyps, while the polyps of poritids are especially tiny. Superficially, poritids also look a lot like many corals from the popular genus *Montipora*, but there are significant enough differences in their fine skeletal structures to keep them in separate families.

Regardless, poritids' overall appearances can vary greatly, as some species can grow over surfaces in an encrusting fashion; some form large plating colonies; some form massive, boulder-like colonies; and some form branching, finger-like colonies. Some species may take on any or all of these growths forms depending on the environmental conditions they are subjected to.

Many colonies can start out as encrustations growing over the substrate, or as plating forms that produce large sheets of coral, but numerous branches may eventually emerge from these bases, growing upward and outward and completely obscuring them at times. A single colony of a single species may take on more than one form as it grows. This isn't a unique characteristic of poritids, though, as many corals will change form depending on current strength, depth, illumination, the nature of the substrate, etc.

Most of the specimens that I see for sale are branching and look about the same as many other stony corals, with branches growing to the diameter of a finger. Under optimal conditions, some of these may grow relatively quickly. However, some of those that form massive, boulder-like colonies can reach stupendous sizes by forming large mounds that grow out in all directions. In the wild, many of these can grow to the size of a big room, being well over 20 feet tall and/or wide! These huge colonies, and massive/plating aquarium specimens, may grow only ½ inch per year, though, meaning that some of the largest colonies in the wild are over 1,000 years old. That makes them some of the oldest living things on Earth.

Anyway, whatever form they take or whatever size and age they may be, poritids can also come in a wide range of colors. While many are rather plain, being cream to brown, many others are green, blue, purple, or pink, and some are even bright yellow. Some have polyps that are one color while the basal tissue covering the skeleton between the polyps may be another, and the tips of the tiny tentacles that emerge from each polyp are oftentimes a lighter color than the rest of the polyps, too, making them look even better.

Identification

According to the Integrated Taxonomic Information System (2013), there are 48 poritid species in all, but most of them can be terribly hard to tell apart. In fact, world-renowned coral expert J.E.N. Veron wrote in *Corals of the World* that "*Porites* species are the most difficult of all the major genera to identify..."

This is due to the fact that their growth forms can be so variable and change within single colonies, their colors can vary greatly within a single species and colony, and their polyps and the openings in their skeletons that they emerge from are so small. Fine details in corals' skeletons are a commonly used means of species-level identification, but you'd need a big magnifying glass and some

serious expertise to figure out who's who when it comes to these species. I usually stay away from trying to name many specimens at the species level.

Still, there are a few common poritids that are easy enough to ID, as they come from certain areas and/or have some distinction that sets them apart from their close cousins. For example, the mustard hill coral (*P. astreoides*) is not found in the Pacific but hails from the Gulf of Mexico, Caribbean, and Atlantic, and it's also yellow as can be, making it quite easy to spot. You can see plenty of them at many dive sites on this side of the world, but unfortunately, we can't get them in the hobby.

Speaking of coming from certain areas, I didn't mention it above, but poritids are also some of the most geographically widespread of all the corals. In fact, the genus is one of the few truly circumtropical ones, as one species or another can be found in the Red Sea, in the Indian Ocean from eastern Africa to Indonesia, in the Pacific from as far north as Japan down to the Great Barrier Reef in Australia and all the way across to Hawaii and western Mexico, in the Gulf of Mexico, in the Caribbean, and in the Atlantic from eastern North and South America across to western Africa. They're literally found around the world.

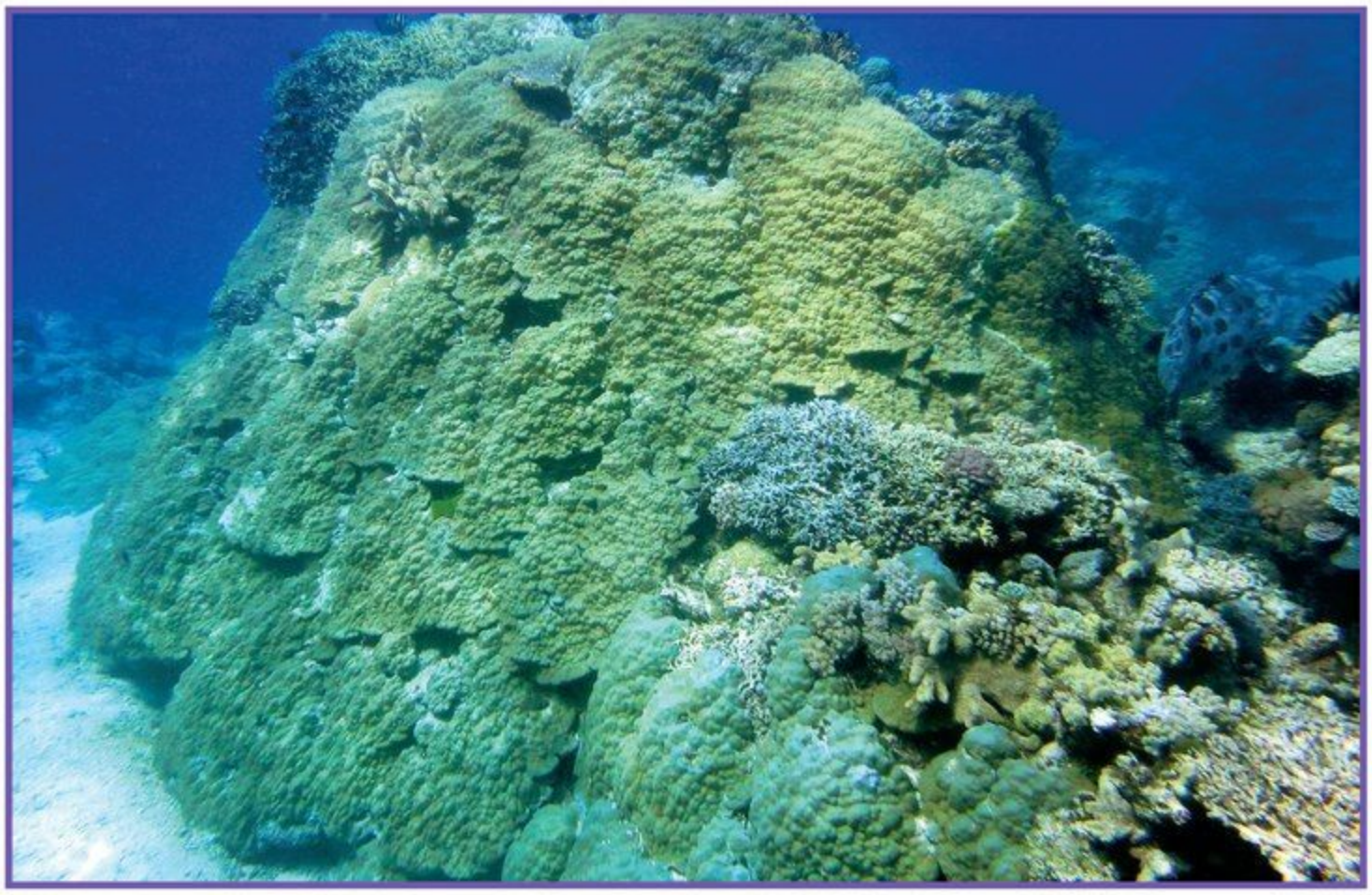
Worm Rocks?

While they aren't as commonly seen as they used to be, you may also find a *Porites* specimen that's labeled as a "worm rock." These most certainly aren't rocks, but are massive or plating poritid specimens that are housing some number of colorful fan worms. Most commonly, these are a boulder coral (*P. lobata*), which has become a home for numerous Christmas tree worms (*Spirobranchus giganteus*). While the corals themselves aren't particularly fancy looking, the little worms can certainly make up for it. These offerings are quite interesting to see, for sure.

Way, way back, when the reef hobby was still in its infancy, I think these were actually sold more for the worms than the coral, with people oftentimes buying the coral despite the lack of adequate lighting and water quality to keep it alive long-term. Unfortunately, when the corals died, the worms were usually smothered by filamentous algae that would grow on the barren skeletal areas, or they just starved to death, as they're filter-feeders that need plenty of plankton to stay alive for the long haul.

While some fan worms may get by just fine for years in aquariums, many others

This mustard hill coral (*Porites astreoides*) is from the Bahamas, but it isn't imported for the hobby.



Some colonies of *Porites* get absolutely huge and can be centuries old.

■ A branching finger coral on the Great Barrier Reef, probably the common *Porites cylindrica*.

■ This is most likely the boulder coral (*Porites lobata*) with a good complement of Christmas tree worms living in/on it.

do not, and the Christmas tree worms tend to be among those that do not. If you think you might want to buy one of these anyway, be aware that you'll very likely need to add lots of phytoplankton to your aquarium in order to keep the worms alive.

Aquarium Care

When it comes to keeping various species of *Porites* alive and well in an aquarium, they're found on reefs alongside all the other corals we keep in our tanks, so there's nothing special to note about water quality. Of course, it should always be within the limits of what is considered appropriate for any reef aquarium. Being stony corals, you will need to make sure that alkalinity is maintained between 7 and 12 dKH, while calcium should optimally be kept at 380 to 450 ppm, but that's about it.

When it comes to lighting, brighter is better. While many species are tolerant of moderate light, as best as I can tell, they all do best under relatively intense lighting. This is especially so for more brightly colored specimens, which are prone to grow duller in color under lower illumination and sometimes turn rather brown and blah. Keep in mind that many of these live in crystal-clear waters right at the surface, so they can handle anything you want to give them. Do be sure to give any specimen some time to adapt to high-intensity lighting if it has been living under lower lighting. In such a case, you should initially place a specimen in an area where the lighting is dimmer, then slowly move it into brighter areas over a period of several days, or even a couple of weeks. Otherwise, they can suffer from light shock.

It's also best to place a poritid specimen in an area where water motion is moderate to strong, with strong and turbulent being most desirable. Again, many of these corals live in

shallow waters and are constantly subjected to strong currents and wave activity. They can handle it and seem to thrive when currents are high and lighting is bright.

While a specimen is unlikely to outright die from a lack of strong water motion, they can run into trouble if flow is so low that detritus is able to settle on their surfaces between branches and especially within the sheets of plating species. At the least, be sure to provide enough flow to keep them cleaned off as well as possible, as the accumulation of detritus in any area can lead to tissue loss and further health troubles.

Also, with respect to placement, note that poritids tend to lose any fight that they may have with other types of corals. In fact, they may well be the least aggressive corals around. Don't worry about a poritid bothering other corals, but do worry about anything else that's too close giving them a fight they might not be able to survive.

There are various reports of poritids reproducing in aquariums (for example Sprung & Delbeek 1994), with new colonies showing up seemingly from nowhere. However, I can't find any evidence of them actually spawning in a tank. To the contrary, it seems that they may be able to asexually produce larvae at times, which are then released into the aquarium.

Regardless, all of these corals are easy to propagate via fragmentation. Pieces and parts of any size can be broken away from an existing colony and used to start new ones, although the massive and plating species do

■ Many specimens lack fancy colors, but many others are very attractive. This unidentified aquarium specimen has light-colored tentacle tips, too, making it look even better.

tend to be relatively slow growers compared to many other stony corals. The branching species tend to be much faster growers, though. That's something to consider if you're thinking about cutting one up. Also, if for some reason you want to cut up a worm rock, be very careful that you don't cut up a worm or its tube. They can be longer than you might think, and they can meander under the coral's surface rather than going straight down into the skeleton.

Lastly, there's one more thing to point out about these corals, and it's a weird one. From time to time, they'll produce a clear, waxy coating on themselves much like many leather corals do, but it's probably nothing to worry about, as it'll be sloughed away, usually after a couple of days. It's thought that this helps them to clean themselves off, though, so if a specimen is coating itself frequently, it may be due to a lack of current. That can be taken care of, of course.

Work Cited

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A Planted Layout with an Enhanced Sense of Depth

Takashi Amano

translated by Tomoko Schum

■ A layout with a strong sense of perspective that suggests an expansive open space; such an aquascape can be produced through creative layout techniques.

In the Nature Aquarium, which recreates natural scenery in an aquarium, ingenuity in the composition of a layout and planting helps to add perspective and a sense of depth, and this can express a wide expanse of space. A fish tank is generally not as deep from front to back as it is wide. A layout can appear cramped unless it is intentionally designed to look spacious.

Dividing an Aquarium

The basic layout method is to divide an aquarium into three zones, the foreground, the midground, and the background, and vary the height of aquatic plants from zone to zone to add a sense of depth to the layout. Creating a well-defined open space against a densely planted area also adds a sense of depth and emphasizes the spaciousness.

While the basic method applies to all aquariums in different sizes, a larger aquarium provides extra room to try various creative ideas. In a 180-cm (70-inch) aquarium in particular, various layout materials and aquatic plants can be used because of the depth and volume of the aquarium, thus making it possible to create a layout with an enhanced perspective and sense of depth.

Takashi Amano

■ The view of the framework of the layout, in which stones are stacked and buried with soil, rendering an impression of a gentle hill.

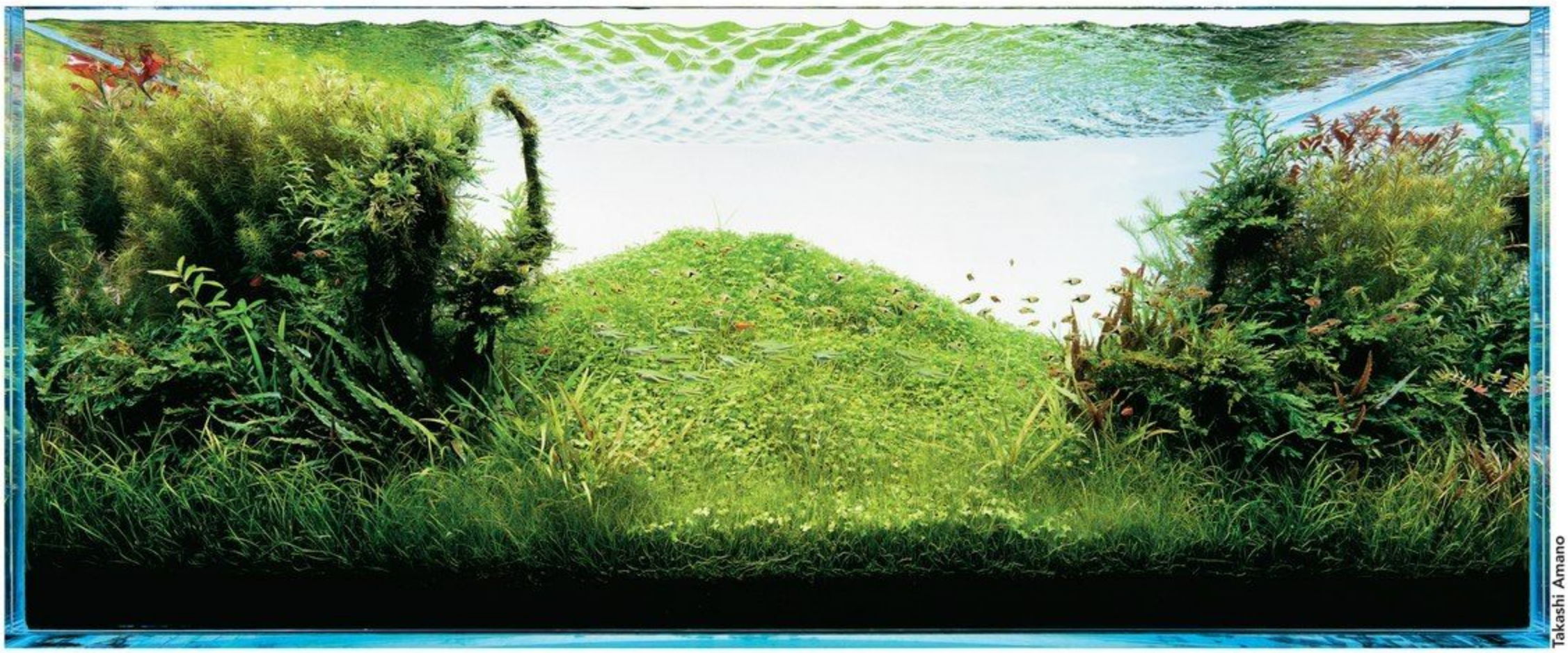
Takashi Amano

■ The appearance of the layout right after planting; driftwood was placed in the forest section, and stem plants and *Cryptocoryne* were planted around it. *Glossostigma* and *Riccia* were arranged in the hill section.

Creating Slopes

In the layout in this article, stones and driftwood are used as layout materials to enhance the sense of depth. Angular mountain stones called *Yamaya* stones were stacked high toward the rear of the aquarium around the center section. A nutrient-rich substrate was then scattered over the stones to bury them. The soil was directed into spaces between the stones using a narrow stick to avoid the formation of voids, and water was sprayed over the substrate to firm up the substrate to keep the rockwork from collapsing.

Doing so enabled the creation of a natural-looking, undulating hill in the layout. However, some areas of the substrate were



Takashi Amano

■ Looking at the layout from the front, a hill, which was created with stones and a nutritive soil substrate, extends toward the back of the aquarium between the forests, which are composed of bushes of aquatic plants, located toward the front in the left and right sides of the aquarium.

Takashi Amano

■ A view of the aquarium at an angle shows that an open space extends behind the forests, lending a sense of depth to the layout.

sloped, which could shift over time. Some slopes were steep enough that planting aquatic plants using tweezers could cause the slope to slide. Therefore, the sloped areas were planted primarily with *Glossostigma*, and *Riccia*-wrapped stones were placed on steeply sloped areas. Placing stones on a steep slope helps to prevent the substrate from shifting. *Glossostigma* grows over the substrate by spreading runners, and this helps prevent the substrate from shifting as well.

Adding Driftwood

Once the foundation of a layout is built, driftwood is placed on it. In a normal layout, driftwood is placed in the midground. In this layout, two groups of driftwood pieces were placed toward the foreground and they were positioned far apart from each other on the left and the right sides of the layout. Only a large aquarium with the right width and a good depth enables such an arrangement of driftwood.

Bolbitis and willow moss were attached to the driftwood, and *Cryptocoryne* was planted around the driftwood. This method of constructing the midground is the same one used in a normal layout. Additionally, stem plants were planted behind the pieces of driftwood and *Echinodorus tenellus* was planted in front of them. This looks like a forest of densely grown aquatic plants.

Looking at the aquarium from the side at an angle, it becomes evident that the planted sections that usually constitute the foreground, midground, and background in a standard 60-cm (25-inch) aquarium are placed toward the front in the left and right sides of the 180-cm (70-inch) aquarium, and a large open space extends from the front of the aquarium toward the areas behind them.

Additionally, cobra grass and Australian dwarf hydrocotyle are planted toward the front in the center section to keep the plants short in the area between the left and right forests. The layout method described above resulted in a panoramic view with a strong sense of perspective that looks like an expansive hillside.

The 180-cm (70-inch) aquarium appears even deeper than its actual depth of 60 cm (25 inches) due to an optical illusion resulting from the arrangement of various layout elements, which created an impression of large forests in the front with a gentle hill behind and a large open space stretching further back. Although this method is difficult to apply to a small, short aquarium, it is a good one to try in a large aquarium that has some extra room. I hope you will give this method a try!

DATA

Aquarium: Cube Garden W180 x D60 x H60 cm
Lighting: Grand Solar (NAG-150W-Green x 1, NA PC lamp 36W x 2) x 3 units, turned on for 10 hours per day
Filter: Super Jet Filter ES-2400 (Bio Rio L, NA Carbon)
Substrate: Aqua Soil Amazonia, Power Sand Special L, Bacter 100, Clear Super, Penac W/for Aquarium, Penac P, Tourmaline BC
Additives: Brighty K, Green Brighty STEP2, ECA
CO_2: Pollen Glass Beetle 50, 6 bubbles per second via CO_2 Beetle Counter (using Tower)
Aeration: For 14 hours after the light is turned off using Lily Pipe P-4
Water Change: ⅓ once a week
Water Quality: Temperature 25°C (77°F), pH 6.8, TH 20 mg/l
Aquatic Plants: *Rotala nanjenshan, R.* sp. "Ceylon," *Hygrophila polysperma, Ludwigia repens, Cryptocoryne petchii, C. albida, Bolbitus heudelotii, Hydrocotyle* sp., *Echinodorus tenellus, Fontinalis antipyretica, Glossostigma elatinoides, Eleocharis acicularis*
Fish/Invertebrates: *Trigonostigma heteromorpha, T. espei, T. hengeli, Rasbora trilineata, Puntius titteya, Otocinclus* sp., *Caridina japonica*

[Note: The hardware itemized above represents the author's specific choices; equivalent results may be obtained with other equipment and accessories—Eds.]

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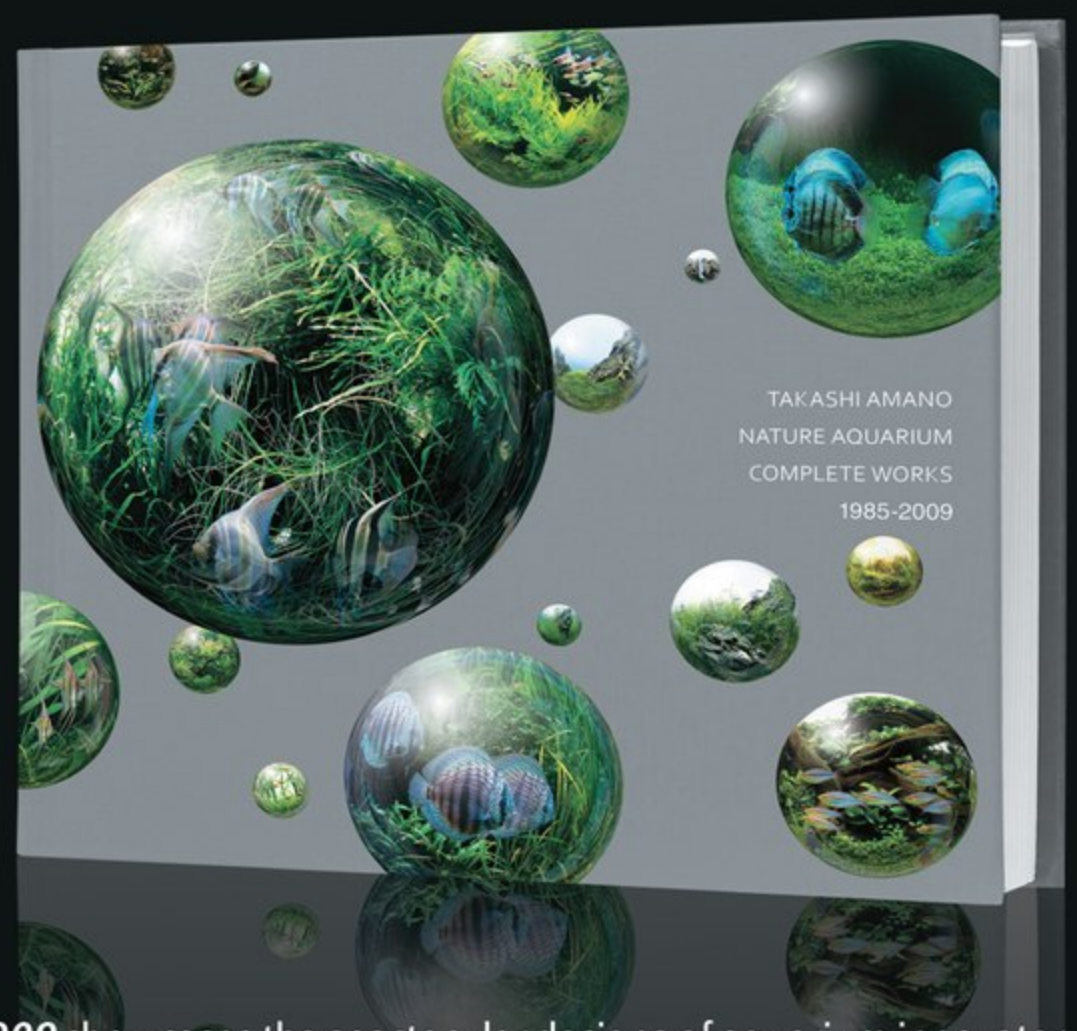

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Takashi Amano
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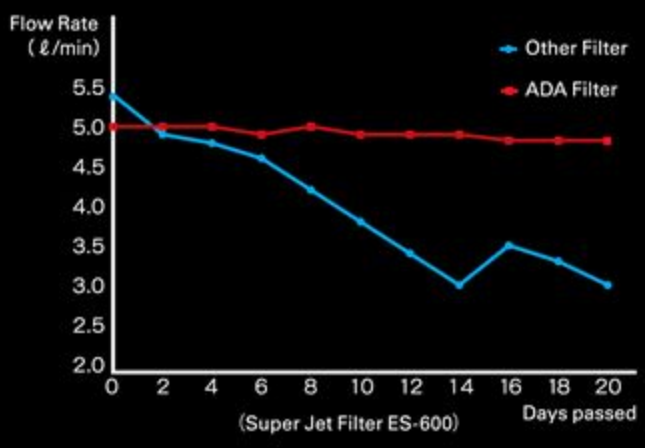

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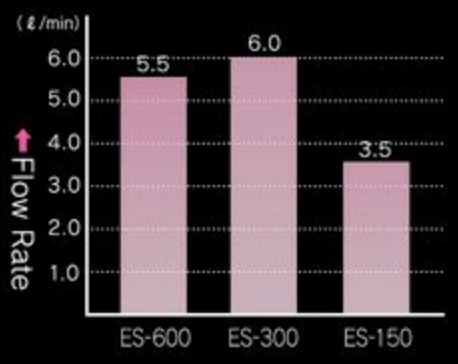
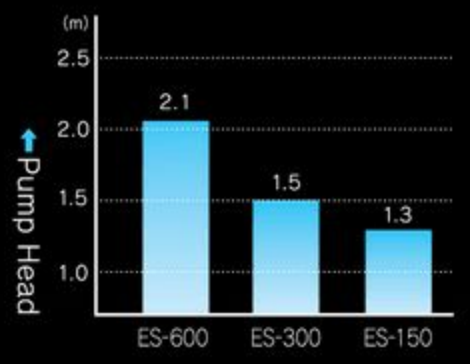
Comparison of flow rate and pump head

ES-150 has made the half of the flow rate without dropping the pump head in comparison with ES-300.





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ES-300 Spin type

Super Jet Filter ES-600

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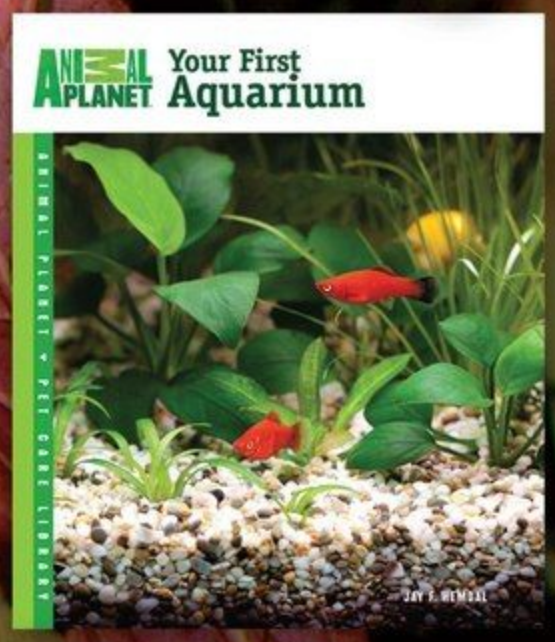

ISBN: 978-079383799-1

Your First Aquarium

Jay Hemdal

Chapter 4

Getting Your First Fish

Nikita Tiunov (Shutterstock)

Planning Your Collection

The very first fish you buy for your aquarium sets the overall tone for your tank and determines what other types of fish you will be able to add later on. Some fish are peaceful and many other species will get along with them, while a few fish are so aggressive that they can't be kept with any other fish. Some fish have specific water quality requirements that other fish do not share—you would have difficulty keeping brackish water mollies with soft water tetras, for example. Do you want to see shoals of small fish drifting peacefully through aquatic plants? If so, you need to remember that big fish often eat little fish, so you won't be able to keep an African cichlid in that same tank.

It will help to go through chapter three to get some basic ideas of what fish interest you. You should also visit your local pet store to see what type of fishes they have in stock (although this will change from week to week). Make a list of the species you are interested in and select one or two types to start with.

How Many Fish of What Size?

A very common question asked by beginning home aquarists is how many fish a tank can hold. This is called the stocking rate. This rate takes into account the type of fish being considered, the swimming needs of the fish, as well as the number of fish and their potential adult size. Aquariums can be overcrowded in three ways. There is a biological limit where there simply are not enough beneficial bacteria present to detoxify the amount of fish waste being produced. If the biological limit is exceeded, the ammonia and nitrite levels will rise, poisoning the fish. Aquariums also have a territorial limit where the addition of certain other fish will cause serious fighting among the inhabitants. Finally, there is a swimming room limit. An aquarium must have enough room for the fish to swim around and exhibit normal behaviors.

Biological Limit

There have been many attempts to answer the basic question of how many fish a tank can hold, but most of them are flawed. You see, they usually give this stocking rate as "so many inches of fish per gallon of water." This actually compares two unrelated units of measure, length and volume, so it can't work. It would be like saying that a car gets 100 pounds to the mile. As a fish's length increases linearly (from 1 to 2 inches, for example) the volume goes up by the cube, changing the ratio. The example that makes this clearer is that while you might be able to keep twenty 1-inch tetras in a 24-inch-long, 15-gallon aquarium, just try putting one 20-inch pacu in the same tank—all of the water would splash out! Even though the "inches of fish" were the same at 20 inches total, the single 20-inch fish weighs about 70 times more than the 20 smaller fish combined!

Another factor that needs to be considered is the effectiveness of the filtration system used. An aquarium with an efficient filter will have a higher biological limit than a tank with a small economy filter. Finally, the water exchange rate affects the aquarium's ability to properly house fish. A tank that gets a 25 percent water change each and every week is going to be able to house more fish than an aquarium that only gets a water change once every month or two.

So what method can you use to determine the number of fish that an

Dobermaraner (Shutterstock)

■ If you choose to keep a school of small, peaceful fish, you cannot add a large, aggressive one to the tank later on.

aquarium can house? Fisheries biologists often use the weight of the fish per gallon of water (since fish weigh as much as the water they displace, it is the same as comparing volume to volume). For a normal home aquarium, a normal value for this is around 1 gram of fish weight per gallon of water (0.27 grams per liter). Crowded conditions would be seen at a rate of 1.5 to 2 grams per gallon (up to 0.54 grams per liter). Obviously, you cannot easily weigh your home aquarium fish. The best that can be done is to see examples in the sidebar that have been shown to work, and then try to duplicate them. Remember that unless you buy them as adults, your fish will grow and require more room as they get older.

Body Style 1 Minimum ratio 1:4	Body Style 2 Minimum ratio 1:7	Body Style 3 Minimum ratio 1:9
Bettas	Barbs	Danios
Corydoras catfish	Cichlids (most)	Kuhli loach (divide length by 2)
Eels (divide length by 3)	Cyprinids – minnows	Monos
Gobies	Goldfish	Pangasiid shark-catfish
Killifish	Gouramis	Pictus catfish
Plecostomus	Poeciliids – livebearers	Rainbowfish
Puffer fish	Rasboras	Sailfin mollies
Suckermouth catfish	Tetras	Silversides (Atherinids)

Swimming Room for Fish

Swimming room is also an important factor for most fish—they need to have room to swim, turn, and interact with each other. Many of the calculations that have been used have the same flaw as mentioned before: stating that a 4-inch fish requires 30 gallons of swimming space, for example. Again, this is comparing a fish's length to water volume, and it cannot work. What works better is to measure the open water length and width of your aquarium and add them together. This gives a linear measure. The height of an aquarium is usually proportional to its length, so you don't need to be concerned with that measurement. Next, determine the adult captive size that the fish is expected to grow to.

You can either get this data from aquarium books or estimate it by looking up the fish on www.fishbase.org. The final step is to make a ratio of the fish's length to open water swimming room. If the fish has a maximum adult size of 4 inches and your tank measures 30 inches long and 12 inches wide, the ratio would be 4:42. You need to reduce this so the first number is a one. To do this, divide the second number by the first number (42 divided by 4 = 10.5). Your working ratio is then 1:10.5. These ratios work the same whether you are using English measurements, as in this example, or metric units. Just be consistent with which you use.

Armed with that information, you then determine which of the three categories your fish belongs to in the chart above. If you are in doubt, select category two as a compromise. The final step is to compare the ratio you calculated to the minimum ratios given. Make sure that none of the fish you want to buy will fall below the minimum ratio. You do not need to calculate this ratio for every single fish in your aquarium, just the one that has the potential to grow the longest.

Compatibility

Determining which fish will coexist peacefully in an aquarium is more of an art than a science. The basic compatibility chart (see p. 54) is a useful starting point in selecting compatible fish. Understand though, that in the end, fish are individuals and not always going to follow any set of rules. Even fish that have lived together peacefully for years can suddenly begin fighting. It is always best to have a backup plan for what you can do should

Tony Terceira

■ Kuhli loaches have elongated body shapes and would seem to need more horizontal swimming space than many other fish. They are bottom dwellers, however, so they only need as much room as a normal fish half their length.

your fish stop getting along. If you have multiple aquariums, you may have enough options to move your fish around as needed. If you have just one tank, you may want to invest in a tank divider. These plastic perforated plates are used to keep incompatible fish separated in an aquarium while still allowing water to flow from one end of the tank to the other.

Selecting Individual Fish

Now comes the time for you to visit your local pet store and buy your first fish. You may want to confirm your fish stocking plan with store employees and gain their approval. While this book gives you good general information, the pet store employees can offer you specifics about the fish they have in stock.

In choosing an individual fish, you should look at all of the fish in the tank to ensure they are healthy. One sick fish can very easily infect all of the others because fish diseases transmit so easily through the water. Look especially closely for signs that the fish might have ich. The fish should be actively swimming, without ripped fins or other wounds, and their eyes should be clear. The tank should be clean, and the water should be clear, not cloudy.

When it comes to selecting what individual fish you want to buy, remember that the pet store employee may have difficulty in capturing a specific fish from a tank full of identical species. The general rule is that if there are big differences in the fish (differently colored fancy guppies, for example), or if there are less than six fish in the tank, you should feel comfortable pointing out exactly which fish you want. For tanks filled with similar fish, it is usually best to first observe them to make sure there are no damaged fish in the tank, and then let the employee

Different Stocking Amounts for a 20-gallon (76-liter) Tank

Thirty	1-inch (2.5-cm)	tetras
Fifteen	1.5-inch (3.8-cm)	rasboras
Eight	2-inch (5-cm)	livebearer fish or barbs
Four	3-inch (7.6-cm)	angelfish
One	6-inch (12.7-cm)	cichlid

Chawalit S. (Shutterstock)

■ Healthy fish have clear eyes and no visible wounds or ripped fins.

To Catch a Fish!

Catching a fish in an aquarium can be difficult. It takes lots of practice to become good at it. Some fish are more difficult to capture than others. Never chase a fish with the net—they can always swim faster than you can push the net through the water! Try using two nets and herd the fish into one net with the other. Never pin the net against the side of the tank—the fish could get pinched. Fish get wise very quickly; if you don't manage to capture the fish in the first minute or so, stop and try again later. One trick that may work is to sprinkle a little fish food on the surface while holding the net above the tank. As the fish rise to feed, you may be able to scoop down with the net and capture them.

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- **Super Brine Shrimp**
- **Super Carnivore**
- **Clams (Half Shell)**
- **Oyster Eggs**
- **Silversides**
- **Cyclops**

Omega Sea www.omegasea.net

Basic Aquarium Fish Compatibility Chart

	Angelfish	Barb	Betta	Cory	Danio	Goldfish	Gourami	Livebearer	Loach	Rainbowfish	Rasbora	Shark	Tetra
Angelfish	Yes	May	May	Yes	Yes	May	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Barbs	May	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	May	Yes	Yes
Bettas	May	No	No	Yes	No	No	No	May	Yes	No	May	No	May
Cory cat	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Danio	Yes	Yes	No	Yes	Yes	Yes	Yes	May	Yes	Yes	May	Yes	May
Goldfish	May	Yes	No	Yes	Yes	Yes	Yes	May	Yes	Yes	No	May	No
Gourami	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	May	Yes	May
Livebearer	Yes	Yes	May	Yes	May	May	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loach	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rainbowfish	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	May	Yes	May
Rasbora	Yes	May	May	Yes	May	No	May	Yes	Yes	May	Yes	May	Yes
Shark	Yes	Yes	No	Yes	Yes	May	Yes	Yes	Yes	Yes	May	No	May
Tetra	Yes	Yes	May	Yes	May	No	May	Yes	Yes	May	Yes	May	Yes

pick the fish out. Remember, though, that the fish most easily caught may also have some problem that made it slower than its tankmates! Watch how the employee catches the fish—did they have to chase the fish all around the tank? Did it take them a long time to make the capture? Did the net come up with lots of gravel in it as well as the fish? Did the fish flop out of the net and onto the floor? All of these things show that the capture did not go well, and the fish may have been severely stressed. In such cases, you may want to ask for a different specimen.

Acclimation

Whenever a fish is moved from one aquarium to another, it undergoes some degree of stress. If the difference in temperature or pH between the water in the two tanks is great enough, the fish could die from shock. Acclimation is the process of allowing a fish to gradually adjust from one water type to another.

Jay Hemdal

When acclimating fish, first float the bag in the aquarium to equalize the water temperature in the bag and the water temperature in the tank.

Your new fish will typically be placed in small plastic bags at the pet store. Usually, a third of the bag is filled with water and the rest with either air or oxygen. Then the top is tied in a knot or sealed with a rubber band. If the store uses air to fill the bag, you should plan on getting your fish home within 30 minutes or so. If the store uses pure oxygen, the fish can remain in their bags much longer, even over 24 hours. During transport to your home, the fish need to be kept in the dark and at the proper temperature. Once you arrive home, the physical acclimation process can begin. If your pet store supplies you with instructions on how they want you to acclimate their fish, you may want to follow them. Otherwise, proceed as follows:

1. Turn off the aquarium lights and float the bag at the surface of the tank. After about 15 minutes, the water temperature in the bag will be the same as the water in the tank.

2. Open the bag and carefully pour about half of the water into a container. Take care that the fish doesn't slide out during this process!

Beware of Anything That Doesn't Look Right!

If you see something about your aquarium or fish that seems unusual, it is vital that you stop and take a moment to investigate why. Too many times, people ignore a minor first symptom and are then faced with a larger problem later on. There is always an underlying reason for a change in a fish's behavior. One example is a group of Oscar cichlids I noticed one morning, lined up next to one another facing the front of the aquarium, but resting on the bottom. That definitely didn't look right, but because the fish looked so comical doing that, it wasn't thought to be serious. A day later, white spots appeared on the fish. They had contracted ich and had to be treated. While they all survived, it was a close call, and any further delay would have resulted in some of the fish dying.

TFH Archives

What to Do with an Unwanted Fish?

Despite your best intentions, there may come a time when you need to close down your aquarium and find a new home for your fish. Your first choice should be to see if friends or family can take the fish. If that doesn't work, you can try contacting the pet store where you purchased them. If the fish are healthy, your local pet store may be able take them back and find new homes for them.

Under no circumstances should you ever release a pet fish into the wild! This apparent kindness can have only two outcomes; the fish dies or is eaten by another animal, or it thrives and potentially becomes an invasive species. It is actually against the law to release an aquarium fish into any natural waters in the United States.

3. Next, turn the top of the plastic bag down and in on itself a few times to form a floatation collar. You may find that the bag is less likely to tip over if you use a clip like a clothespin to attach it to the side of the tank.

4. Add some water from the tank to the bag. This amount should be approximately 25 percent of the volume of water that was in the bag at step 3. Wait five minutes.

5. Remove some water from the bag by pouring it into a container (not back into the tank). Add water from the tank to the bag again, but this time, add double the amount of water you added in step 4. Wait another five minutes.

6. Repeat step 5. This gives a total acclimation time of 30 minutes, which is appropriate for all basic freshwater fish purchased at a local pet store. Fish that have been shipped to you by overnight express will require a different acclimation procedure. Check with your dealer for instructions.

7. Gently release the fish into the aquarium.

Watch all the fish in the aquarium closely for the first day. Try feeding them to see if the new fish are feeding properly. Watch for fighting between the old and new fish. Some chasing almost always occurs, but if any of the fish develop ripped and torn fins, they may need to be isolated.

Quarantine

There is always a danger that a new fish will bring some disease into your tank and infect all of your fish. You can minimize this problem by choosing your fish carefully, but the risk never entirely goes away. Public aquariums and people who have very expensive fish collections (like some marine aquarists have) will quarantine all new fish to reduce this risk even further. This process isolates any new fish for a time so any diseases they may be carrying can be identified and treated. To do this, you'll need a dedicated quarantine tank, and this is sometimes too costly for beginning home aquarists to manage. Still, having a quarantine tank can be helpful, not only when buying new fish, but for isolating any of your existing fish for one reason or another.

Observing Your Fish

Watching your fish is really why you have an aquarium in the first place—you cannot enjoy your tank if you don't look at it! Proper observation can also show you impending disease problems, or if some fish are not getting along together. Fish are quite able to see outside their aquarium—they soon learn to beg at the water's surface for food when they see you enter the room. Because fish will interact with movement outside their tank (and this changes their behavior), it is best to make your observations from a darkened room and with the aquarium light on. Fish cannot see you under these conditions, so their behavior will not include reacting to your presence. It is important to observe your fish every day, not just at feeding time.

Excerpted from the book Your First Aquarium. *ISBN 978-0-7938-3799-1*

Big Little Fish: The Convicts

Mike Hellweg

■ *Amatitlania siquia*; all species of convict cichlids are fairly undemanding in their water-chemistry needs.

We hobbyists are always looking for something new and different. Sometimes we find that by hunting out new imports, but other times we can find it by looking back into the hobby's past. Many cichlid hobbyists are now moving back to the cichlids of Central America—fish that have often been dismissed as "beginner's cichlids," but which are now finding a new generation of advanced hobbyist followers.

Since the Great Depression, the fish we currently call the convict cichlid has been vexing aquarium hobbyists. They are excellent parents and are often the very first species of cichlid that spawns for many budding breeders. They are attractive, fairly small, undemanding in their food preferences, easy to care for, incredibly adaptable to varying water conditions, easy to breed, and almost legendarily fecund. As parents, they are fierce defenders of their young, almost to the point of driving much larger fish from their tank. In fact, given the choice, I'd bet the larger fish would leave the tank if they could!

The Name Game

The convict has gone through the familiar wringer of the name game, both in the vernacular and in science. For some reason, though, they've seen change a bit more than most other species. Looking back in the literature, someone doing research may find them listed in any one of five different genera or under at least three different common names.

First described in 1867 as *Heros nigrofasciatus* by the German-born British ichthyologist Albert Gunther, in the scientific literature it was moved to the catch-all genus *Cichlasoma* in 1980. It was then split out into *Archocentrus* in 1997 and renamed into *Cryptoheros* in 2001. In 2007, it finally became the type species for the new genus *Amatitlania*, where it resides today with three other convict species, all of which were created at that same time in 2007.

Not to be outdone, the common name has also changed a few times over the past 80 years. At first, in the 1930s, they were known by the bizarre misnomer of "Kongo" cichlid. When I first encountered them in the early 1970s, they were known as zebra cichlids, but even then many folks were referring to them as convicts, a name that has now pretty much taken over. It is apropos, too: The banded pattern reminds one of the stereotypical black-and-white-striped prison uniform, and their behavior when spawning is reminiscent of the stereotypical convict–somewhat less than amiable.

In the Wild

Convicts are found in Central America from Guatemala in the north to Panama in the south, with the heaviest concentration in Guatemala, El Salvador, and Honduras. There is quite a bit

of variability in the geographic populations, enough that some are now regarded as full species and more may follow. They seem to prefer shallow streams and lakes. In fact, their current genus name, *Amatitlania*, is given for Lake Amatitlan in Guatemala where the type species, *A. nigrofasciata*, was first found.

They seem to prefer habitats with rocky bottoms, where they can dig their spawning caves under larger rocks. Their diet is quite extensive, with everything from aufwuchs (biofilm) to algae to insects and crustaceans on the menu. This rocky habitat also provides plenty of shelter, even though the parent fish will challenge any comers, including humans, who approach their nest or the foraging fry.

They are most often found in the lowlands where water temperatures are generally in the 70s, though they are sometimes found much higher up. Lake Amatitlan, a volcanic lake, is at nearly 4,000 feet above sea level and can be somewhat cooler. Water over most of their range is somewhat basic and moderately hard, with moderate carbonate content. In other words, tap water in most of the US is perfect for them, another factor in their favor.

A Home for Convicts

The Latin phrase *multum in parvo* ("much in little") certainly applies to the convicts. They are a lot of fish packed into a small package. Keep that in mind when picking out a home for them. You can successfully (temporarily!) keep and even have them breed in a container as small as a 5-gallon bucket with a sponge filter in it, but that is not in any way appropriate for these wee beasties.

I would recommend nothing smaller than a 20-gallon long, with a 30- or 40-gallon breeder tank even more appropriate for a pair. A nicely aquascaped 75 is perfect for a pair and their family, and you can watch many of the fascinating behaviors that make cichlids so popular in the hobby.

The tank should be decorated with hardscape—piles of rocks and well soaked driftwood that is no longer leaching tannins into the water. Most plants are not appropriate. Convicts are diggers and will move the substrate and smaller rocks around as they see fit. Unless you glue things together, be prepared for the fish to move just about anything they can. They will usually ignore Java moss, Java fern, *Anubias*, and other plants that are attached to larger, immobile rocks and driftwood. Usually. But even these plants will be rearranged (or torn apart) if the parents perceive a threat to their young.

Their digging before spawning and their aforementioned method of feeding their fry also stirs up a lot of material, so a fairly powerful filter is in order. A hang-on-tank waterfall type filter or a canister filter is the choice most hobbyists make.


Aquariumphoto.dk

■ Convict cichlids have a widely varied diet that includes everything from algae to crustaceans.


Aquariumphoto.dk

■ Be sure to include plenty of hardscape items to make caves and break up lines of sight in a convict cichlid tank.

Whatever you choose, make sure it is something you can service easily, as you will have to clean it frequently. Since they are a widely distributed species or group of species, convicts aren't too picky regarding water parameters. Adding a bit of crushed coral or aragonite sand to the substrate will help buffer the water and keep it slightly basic and alkaline.

Large, regular water changes help keep the water in pristine condition. I change at least 50 percent every week. The gravel cleaners that attach to a faucet and allow you to do a water change and clean the gravel at the same time really come in handy. Just make sure you don't suck up any fry!

Feeding

Feeding convicts is easy. Even wild-caught fish will consume just about anything edible. They love worms and will eat any kind of cultured food as well as any kind of commercial diet. They should receive a mix of foods just to make sure they get all the nutrients they need. I feed a commercial spirulina flake and a commercial plankton flake, along with live blackworms, whiteworms, and daphnia and frozen bloodworms. They eat all with gusto.

Breeding

The joke is that all you need for convicts to spawn is to have some water and a pair. That's not too far from the truth. They are precocious and can start spawning when they are only an inch or so in length. Males are generally larger, sometimes up to twice the size of their consort. The male's fins are larger and more pointed too. Females are generally heavier bodied and often develop a red- or orange-colored belly as their eggs ripen.

Convicts are cave spawners. They like to lay their eggs away from prying eyes. They will utilize coconut shells, upended

flower pots, ceramic caves, little castles, slate pieces stacked up, or even an out-of-the-way corner of the tank if nothing else is available. One time in a wholesaler's fishroom, I watched a small female, barely 1¼ inch long, spawn with a nearly 4-inch male on the glass in the back corner of the holding tank. In the wild, they excavate under a rock, and in our aquaria they often dig under an ornament or rock to make a cozy little spawning niche.

The mother guards the eggs and newly hatched fry. Both parents will take turns excavating pits in the gravel, to which they move their fry as soon as they hatch. They will often move the fry a couple times a day until they are free-swimming. In our aquaria, it's not unusual for convicts to use the same cave to spawn every time they do so. I have a pair of Honduran red points that are the third generation using the same cave and the same set of pits around the tank that their parents and grandparents used.

The males generally guard the perimeter, and the females stay right with the fry. They will lead them around to feeding grounds all over the tank, where the fry will be seen picking at microscopic life and likely algae as well.

They will attack anything that threatens their fry, including the hobbyist's hands while doing maintenance. I recommend

Aquariumphoto.dk

■ Male and female convicts will lead free-swimming fry around the tank.

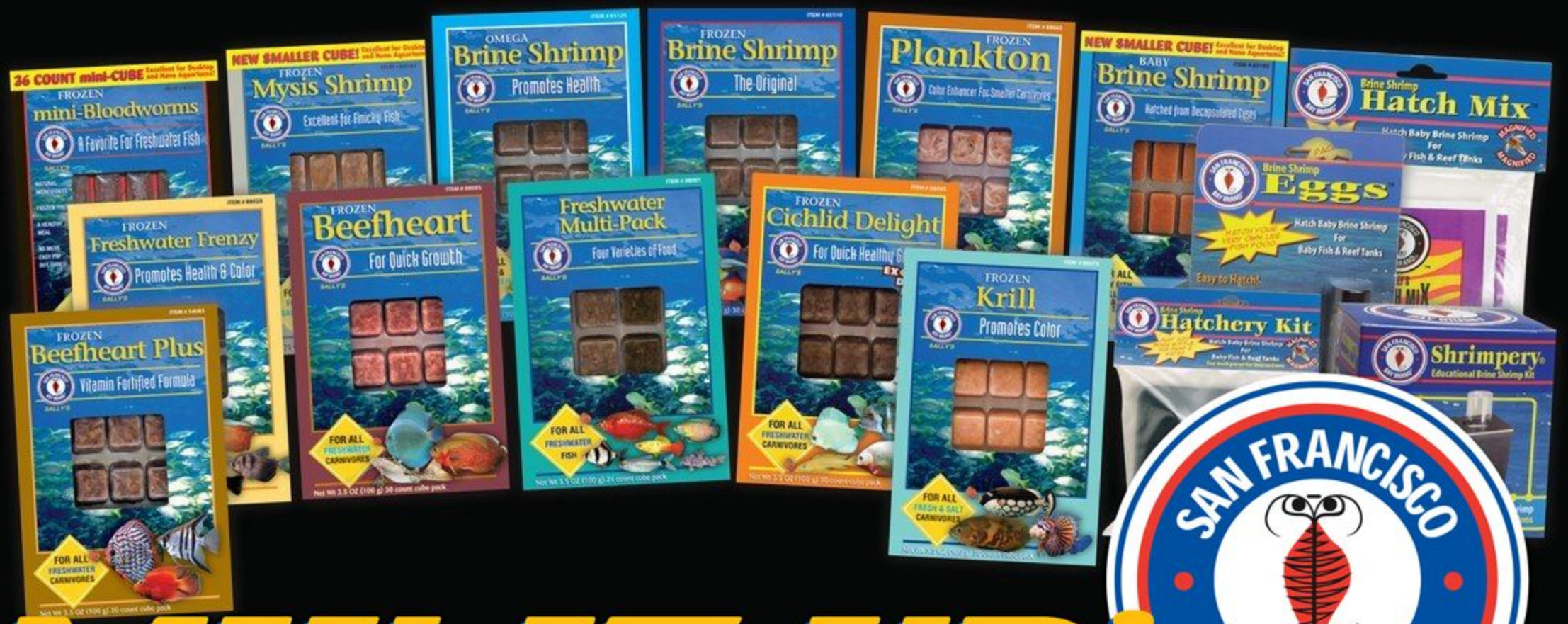
forgoing all but water changes while a pair is tending their fry just to cut down on stress.

Females, and sometimes males, will dive down on the gravel and wriggle through the top ½ inch or so, stirring up detritus. The young then descend into the cloud of detritus, picking out anything edible. The young fish will eat microworms, newly hatched brine shrimp, copepods, young Grindal worms, and any sort of commercial food that is small enough to fit in their mouths. They grow quickly and should be removed when they reach about ¾ inch or when their parents stop providing care and start thinking about spawning again.

In the Hobby

Three of the four species of convicts are readily available in the hobby. Up until recently, any fish with the name "convict" usually sold for peanuts. Auctioneers would have to really talk them up just to get a buck for a bag. But recently, that has changed.

I've seen some bags of F_1 and F_2 convicts with collection locations sell for surprisingly high prices in recent auctions. And some of the rarer convict species bring even higher prices. Don't expect to get rich, but you should be able to find a home for many of your convict fry.



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There are several locality variants of *A. nigrofasciata* in the hobby.

My Experiences with Convicts

I first encountered the zebra cichlid as a young child in a Woolworth's department store. At that time, our local Woolworth's had a huge pet department. They had 32 tanks in the fish area, with everything from several varieties of goldfish to fancy swordtails and the hot new African cichlids. In one tank, they had these really cool striped fish called zebra cichlids.

I asked the lady who ran the pet department about them. She was a wealth of knowledge that never steered this budding hobbyist astray. She told me they were "nasty, mean brutes that had no business in anyone's tank." With my 10-gallon community of peaceful fish, they would be a disaster. I chose some beautiful white clouds instead.

Fast forward about 15 years, and I was now a member of my local aquarium club, the Missouri Aquarium Society, Inc., and was getting started in their Breeder's Award Program (BAP). One of the pairs going around was a medium-sized pair of convict cichlids. It was my turn to have them, so I took them home and set them up in the 55-gallon tank we had in our living room. Within a week, they had completely torn apart their tankmates and the décor in their tank and the female was guarding a plaque of eggs on the underside of a slate cave on one end of the tank.

I watched in fascination and horror as the parents herded the fry around and alternated chasing anything that came near, including me. As instructed by those who knew better, after a week, I siphoned out half the fry to another tank and left the rest with the parents. The fry were easy to raise on microworms and finely crushed flake food.

Due to my work schedule, I had to get the fish ready the day before the BAP meeting. I had moved the parents into a 5-gallon bucket with a flower pot and a sponge filter in it. When I gave the pair away, the person who got them asked me why I had given away the eggs, too. They had spawned again in the flowerpot!

There is one other funny anecdote about convicts that I'd like to share. One of our favorite restaurants had two 600-gallon tanks dividing their bar from the main restaurant. They were maintained by a local shop, and that was where the owner deposited the larger fish he took in trade. There were large catfish, pacu, oscars, red devils, jaguar cichlids, and many others.

At one point, someone added some young convicts, I'm guessing as feeders. The next time we visited, the large fish, even the catfish, were all up near the surface. On the bottom in the corners and in the rock pile in the middle were three pairs of convicts, none of which were over 2 inches in size. Any time the bigger fish made a move deeper into the tank, the convicts attacked them. It was amazing to see how tenacious those little guys were!

Meet the Species

All *Amatitlania* species are banded in a similar manner and remain small—about 4 inches or less for males and 2½ to 3 inches for females. Differences are primarily internal, and the various species can be hard to diagnose with a quick glance at a stressed fish, such as in an auction or at a shop. Care and breeding for all are similar. There are several locality variants of both *A. nigrofasciata* and *A. siquia* in the hobby. These should be kept separate in case they wind up being elevated to species status at some point.

A. coatepeque is known only from Lake Coatepeque in El Salvador. I have not seen these fish in the hobby yet and so have not had the opportunity to keep them. There are several pictures circulating showing a silvery fish with a golden-red belly. The bar pattern is slightly different, and the species is somewhat more slender than the others.

A. kanna is from the Atlantic side of Panama. They are very deep bodied compared to the other convicts, and the bars usually coalesce into a black blotch near their midsection. They are generally a bit smaller, topping out around 3 inches, and tend to do less digging according to anecdotal reports that I've heard so far. They are found more often in weedy areas and aren't as hard on plants. I have not yet had the pleasure of keeping these fish, as the few times they've been available, they have gone for prices beyond what I was willing to pay, but they are available and hopefully soon the prices will drop.

A. nigrofasciata is the most widespread species, found from Guatemala all the way to Panama, though these populations will likely be split into species as time goes by. This is the traditional convict and is well known to anyone who has been in the hobby for at least a few years. Everyone should endeavor to keep this species at least once. They are long-lived and can grow quite a bit larger in our aquaria than they do in nature. I've seen old males that were nearly 5 inches long, and others have anecdotally reported sizes of up to 6 inches, but that would be exceptional. There are at least two or three domestic morphs—one pale whitish pink, one marbled, and one golden yellow.

A. siquia is described from the Rio Siquia in Nicaragua. Several populations are scattered across Nicaragua, Costa Rica, and Honduras. Some are more yellowish in color and others more bluish. They might wind up being separated into even more species as they are studied more closely in the years to come.

The popular "Honduran red point" may or may not be a locality variant of these beautiful fish. They remain fairly small, maxing out around 3 inches, and are rather peaceful–especially in the context of being one of the convict cichlids! The Honduran red point has been bred into a platinum-colored fish that is popular in the hobby.

Whatever you may have heard about convict cichlids, if you haven't given them a try, you are missing out on a fascinating group of fish that are easy to care for, easy to breed, entertaining to watch, and full of interesting behavior and surprises for even the most jaded of hobbyists. What more could you want in a cichlid?

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Daniel Konn-Vetterlein

Breeding Cactus Plecos

The cactus plecos, species of the genus *Pseudacanthicus*, are among the most attractive and most sought-after of the big aquarium catfish. Most of them grow quite large, and their successful keeping and breeding had largely eluded hobbyists in the past. In more recent times, however, we have more knowledge about the proper care of these fishes and how to breed them.

We currently know of about 35 different cactus plecos, including real species and varieties from different localities. Among these, only five have been described: *P. serratus* (Valenciennes, 1840), *P. leopardus* (Fowler, 1914), *P. fordii* (Günther, 1868), *P. spinosus* (Castelnau, 1855), and *P. histrix* (Valenciennes, 1840). Most originate from Brazil, where they live in big rivers like Rio Xingú and Rio Tocantins. *P. fordii* and *P. serratus* are known only from Suriname and Guyana, and both species are almost unknown in the hobby. From other countries, we know of L452 so far, which is from Peru.

Taking Care of Cactus Plecos

How can you ensure your plecos will do well? First, it is important to keep in mind that some species tend to be quite aggressive towards each other and other loricariid species. The tank has to offer several hiding places to prevent the worst-case scenario: that a fish dies as a result of stress caused by others or in a direct fight with another specimen. Depending on the chosen species, the tank should measure at least 100 cm (40 inches) in length and 40 to 50 cm (15 to 20 inches) in depth. The height is not that important because plecos are mostly bottom-oriented.

The tank setup is very important too. Caves, driftwood hiding places, and stones that have large openings help make plecos feel secure. They don't need plants. In fact, almost no plecos need plants in the tank. But if there are no plants, there is also no supplemental oxygen being produced, so make sure the filter is working well. You might also want to install a second pump or air pump to increase the level of oxygen in the water.

Most *Pseudacanthicus* species inhabit warm water, so they need temperatures above 27°C (80°F) to feel comfortable and grow well. Their nutrition consists of snails, insects, dead fish, and comparable organic stuff. This is what they need in captivity; they won't get by on cucumber slices like many people still believe.

These plecos have been kept in captivity for quite a long time, but breeding successes were uncommon until a few years ago.

■ If you want to attempt to breed cactus plecos, they should be kept in a tank of their own.

Daniel Konn-Vetterlein

One main reason for this is that most people kept only one specimen. Some even collected these fishes like stamps. The interest in breeding cactus plecos was low, and they were mostly seen as status symbols for their keepers. Additionally, big plecos like *Pseudacanthicus* were rumored to be impossible to breed in captivity, so nobody really tried.

All this suddenly changed when the first serious breeding attempts succeeded. More and more keepers concentrated on the genus and tried to keep groups, hoping to find a pair that might breed. Due to this effort and some amount of luck, several species have been bred in the past few years.

The First Steps for Successful Breeding

In most species, it is possible to distinguish the genders when they reach about 15 cm (6 inches). The males will develop longer pectoral and ventral fins, and their pectoral spines will be thicker than those of the females. Furthermore, the heads of male specimens look bulky and chiseled, while females' heads are more pointed.

If the setup is adequate for these plecos, and if you are lucky enough to have a sexed pair, they might soon start breeding. You can go on to keep them in a group, or you can move the pair to a prepared tank without any other fish. A tank like this has several benefits: First, they don't have to invest their energy in territorial fights with other fish; second, they can feed in peace and will be sure to get enough to eat; third, the water parameters can be completely changed to their favor; and fourth, if they spawn and the juveniles get out of the cave, they will not be eaten by predator fish.

However, you will have to get the fish into the best possible condition. The most important factor is nutrition, because without excellent protein-rich food, the female is not able to develop eggs. Feed them mostly frozen food and meaty tablets. Don't just give them vegetables and algae wafers; they might eat these items, but it will not bring them into breeding condition.

You can tell when the female is full of eggs by comparing her belly to the male's belly. It will be much wider, and the male will look a lot more slender in comparison.

This is the right time to start with some stimulating water changes. Experience has shown that *Pseudacanthicus* react to water changes using soft and slightly acid water. If you have the ability to get clean rain

Daniel Konn-Vetterlein

■ It's important to include driftwood and stones in a cactus pleco tank so the fish can feel secure.

water, you should try to collect this and use it for the breeding tank. After adding this water to the plecos' tank, they will hopefully start getting interested in each other. The water should be warm (about 27° to 32°C [80° to 90°F]), soft, and neutral to slightly acid.

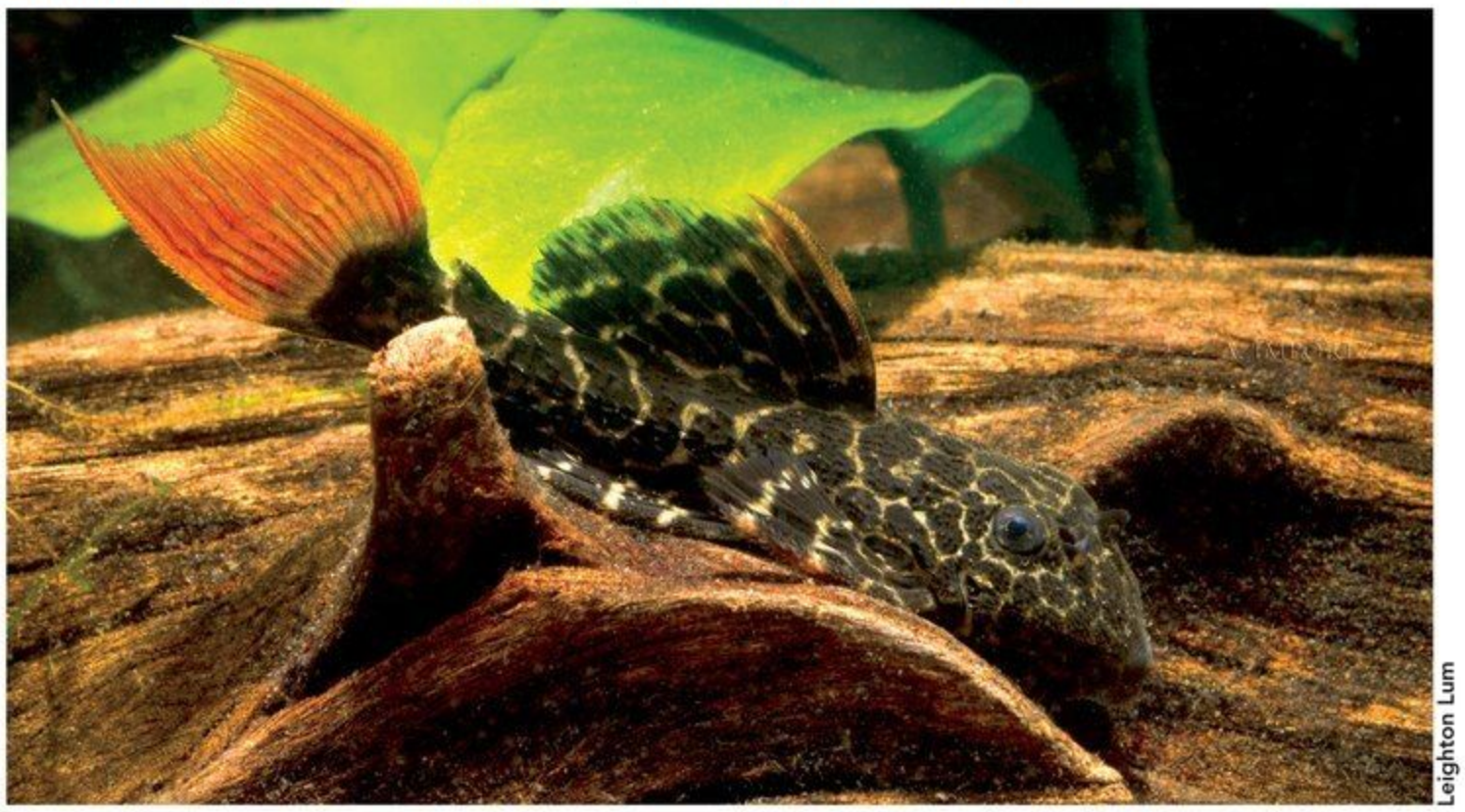
People keep asking me about the perfect cave for plecos, which color it is supposed to be, and which material the fishes prefer. I can tell you that color doesn't matter, but the surface of the cave's interior should be rough to provide a good grip for the clutch. It should be about 5 cm (2 inches) longer than the male's total length and wide enough for the male to get in with both pectoral fins half-extended.

Daniel Konn-Vetterlein

■ Coming from tropical areas, *Pseudacanthicus* spp. need water temperatures above 80°F to thrive.

Daniel Konn-Vetterlein

■ Unlike many plecos, cactus plecos require meaty foods in their diet.



Leighton Lum

■ Cactus plecos of the genus *Pseudacanthicus* are among the most colorful, and therefore most popular, of the large plecos.

While the male is staying in the cave, the female tries to get in there as well. The proceedings then depend on the character of both specimens. Usually it takes a few hours for the female to enter the cave, but sometimes she doesn't get in even after a few days. The female has to be in front of the male to lay her eggs along the top of the cave, and the male will fertilize the eggs just as they are released.

Some females stay in the cave for a few days before they lay the eggs. But not every spawning attempt is successful; from time to time, both specimens spend days in the cave and nothing happens. Often these are fish that have never bred before; they are still learning, and the second attempt normally succeeds. After the female leaves the cave, the male starts fanning with his fins. By doing this, he helps oxygenate the cave and keeps the eggs alive.

Lots of Juveniles

Adult females can produce about 500 eggs, which is a huge mass of eggs—and potential juveniles. The raising of so many young fish can cause problems considering the space that is needed.

Depending on the temperature, they hatch after six to seven days. The larvae need about five days to use up their yolk sac. During this time, the male takes care of them and does not release them from the cave. Afterwards, the juveniles spread into the tank and grow up rapidly.

Another option is to shake the cave outside of the water to get the eggs or larvae out and then move them into a separate tank. They can be fed better and a few times a day in this special tank. Young *Pseudacanthicus* grow very quickly during the first months and become more stable.

A lot of breeders have had problems at 3 cm (1 inch) in size. Juveniles often start dying at this age. The reason is that most tanks are overcrowded and the young plecos don't have enough space to hide from each other. They get stressed rapidly, and apparently they are very prone to stress at this age.

Another fact that has to be considered is the concentration of bacteria, which is very high in small tanks with so many fishes. So, make sure the aquarium is big enough for such a quantity of fish, that the water parameters are good, and they are fed several times a day. Then raising them will be easy and your cactus plecos will grow quickly, soon attaining a large size.

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Marine Aquarium Basics Part 4: Lighting

■ Lighting has a huge influence on what species can live where on a reef.

KKulikov/Shutterstock

Philip Hunt

In a previous part of this series, we talked about water movement. One of the interesting features of that topic is the way in which our knowledge and awareness of its importance increased greatly in the last few years and technology followed rapidly to deliver what our aquariums need.

The story of lighting is different. We have long known what we need from lighting, but only recently has technology really caught up—in the form of LEDs. In the last couple of years, these lamps have had a huge impact on aquarium lighting, but this is not an article about LEDs. Developments in this area are very much ongoing, so while LEDs may represent the future of aquarium lighting, they are by no means the entire present. In this article, we'll look at both the lighting needs of marine aquariums and how to meet them with currently available technology.

Let There Be Light, But What Light?

As with other aspects of aquarium husbandry, the best place to start when trying to decide what lighting to use is to look at the needs of your aquarium inhabitants, which reflect their wild habitat. Aquarium hobbyists tend to think that only invertebrates (corals and tridacnid clams) have specific lighting needs, and that fish have no special requirements. This isn't quite true.

Lighting for Fish

Most marine-aquarium fishes prefer quite bright lighting and may behave nervously or more aggressively in dimly lit tanks. There is a reason for this: In the wild, reef fishes tend to be active either during the day (when the light is usually bright) or at night. Diurnal fishes (those fishes that are active during the day) are adapted to avoid diurnal predators, but at night, they hide

themselves away and tend to sleep deeply, even having evolved defenses to prevent nocturnal predators from detecting their scent, such as sleeping in mucus cocoons in the case of many parrotfishes and wrasses. Night-shift fishes, in contrast, are adapted to life in the dark and tend to hide during the day. Twilight, the transition between day and night, which is well-represented by a dimly lit aquarium, is a nervous time for diurnal fishes, as nocturnal predators begin to emerge, hence the jittery and sometimes aggressive behavior.

The take-home message from this is that for most fishes, bright lighting is best. There are a few exceptions to this: Some nocturnal fishes are kept in the aquarium (some cardinalfishes for example), and for these species, dim lighting is in order. Some deep-water fishes also prefer subdued light, although for different reasons, namely that light levels are always lower at depth. Many such fishes will adapt to brighter conditions, but this may take time, and providing shaded areas within the aquarium can help the process.

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■ Most commonly kept aquarium fish are diurnal, meaning they are active during the day.

Orlandin/Shutterstock

■ Many cardinalfish, such as the pajama cardinal, are nocturnal and require shady areas in an aquarium.

Lighting for Inverts

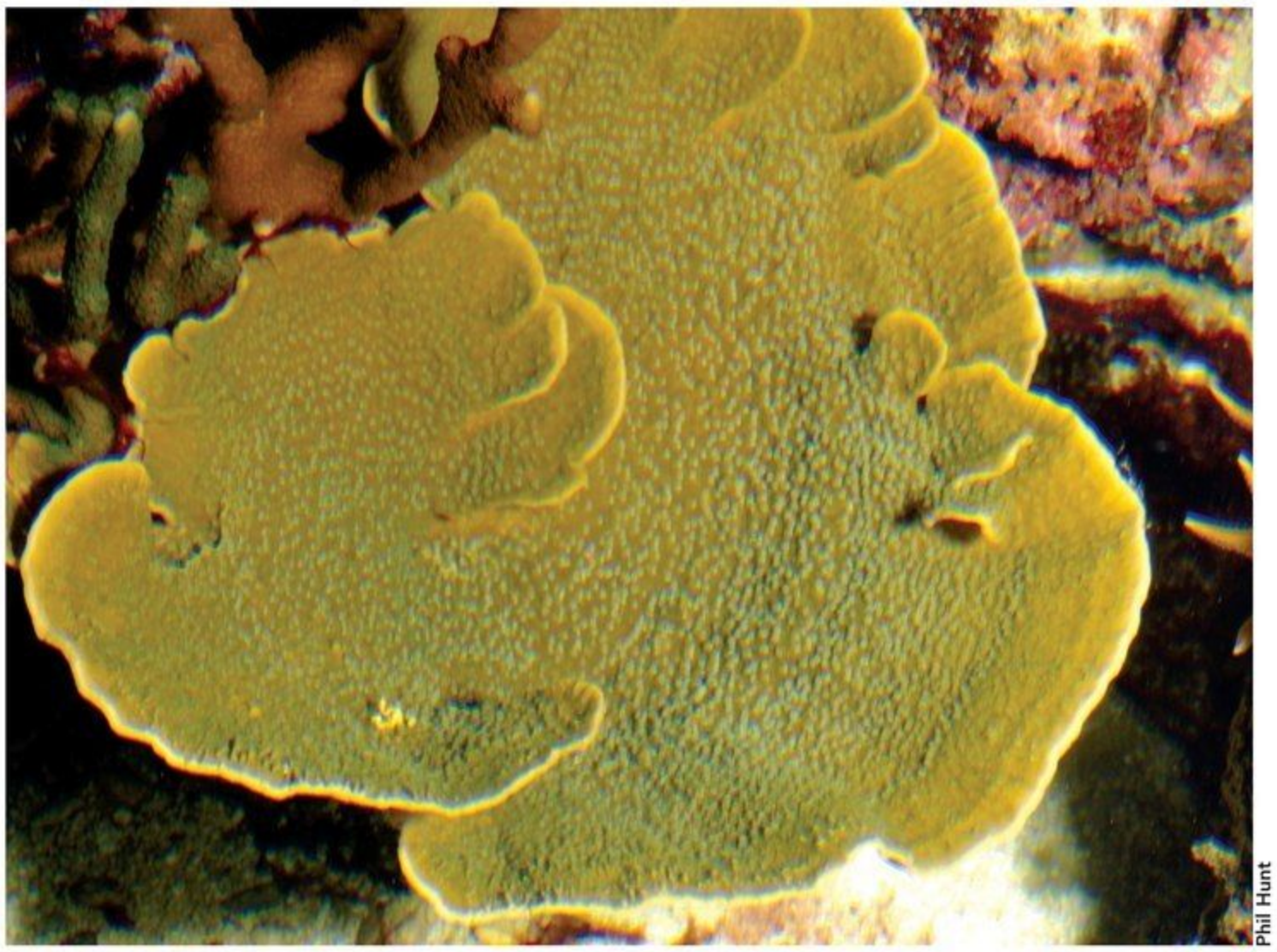
For corals (and clams), lighting is a more complex and critical topic, but the principle of looking to the wild environment still holds true. Most aquarium corals and clams are found in shallow tropical and subtropical seas, and one of the things that strike visitors from temperate countries on visiting the tropics is the brightness of the sunlight. The sheer intensity of light in the tropics gives us one clue as to what our aquarium lighting needs to be: bright. Things are a little more complex than this, however. Our visitor to the tropics is likely to be experiencing the light intensity at an airport, equivalent to that at the surface of the ocean, not beneath the sea.

Beneath the surface, the light intensity drops, even in the clearest, most pristine sea. The water absorbs light, so the brightness of the light reaching a coral depends on the depth at which it lives. Water turbidity adds an extra complication. While coral reefs grow best in clear water, without much suspended sediment, particular areas of reefs may have lower water clarity. Lagoons would be one example. Also, not all corals live on reefs. Many species can be found in murkier water, for example in seagrass beds, on muddy shores, or even in harbors. In these situations, suspended matter in the water column also reduces the intensity of light—and works in concert with the effects of depth.

Depth and turbidity also have a big impact on the color of light reaching corals. The effect of depth is simple: Different wavelengths of light (corresponding to the colors of the visible spectrum) penetrate water to different extents. Light with longer wavelengths (the red and orange end of the spectrum) is less energetic and is absorbed quickly. Short wavelengths (blue to violet in the visible spectrum) are more energetic and penetrate further. The deeper in the sea you go, the bluer things get.

The effects of turbidity are much more complex, as they depend on just what is suspended in the water. Rotting plant material (as might be encountered in lagoons, on seagrass beds, or around mangroves), phytoplankton, and mineral sediments each have their own effects, absorbing or scattering different wavelengths of light.

It is very difficult to take turbidity into account with aquarium lighting; probably the best we can currently do is to use lower light levels for corals that come from turbid water, although in the future, it might be possible to program LED units to deliver light of whatever color is needed. The effects of depth, however, are much easier to simulate, as we can control both



Phil Hunt

■ Looking at a coral's natural environment is a great way to get an idea of what light intensity it will need in the aquarium.

the intensity of lighting and the color temperature, which for our purposes is a way of measuring how blue the light is.

Measuring Color Temperature

Color temperature is measured in degrees Kelvin (K). The higher the color temperature, the bluer the light. Sunlight at noon, unfiltered by water, has a color temperature of around 5,500K. As corals are accustomed to living under water (although some species may be exposed at low tide), we tend to use lighting with a higher color temperature to reflect this.

Typically, marine aquarium lighting has color temperatures ranging from 6,000K to 14,000K. These all look white (somewhat yellowish at the lower end of the range), but the higher color temperatures look distinctly cooler, reflecting the higher blue content of the light. Also available are 20,000K lights, and these do have a distinctly bluish appearance. In practice, most corals seem to do well under any of this range of color temperatures, but if you want to create a dedicated deepwater aquarium, 20,000K lighting will give the aquarium a nice atmosphere of depth and may be beneficial to some corals from deep reef areas.

The main way of adjusting aquarium lighting to account for depth is through selection of light intensity. In the early days of keeping reef aquariums, it was a struggle to get enough light intensity using the available (mainly fluorescent) lamps. Those days are long gone, however, and today it is just as easy, and just as damaging, to provide too much light as too little.

What this all points to, just as with water movement and many other aquarium parameters, is that it is important to know as much as you can about each of your corals and use this knowledge to select lighting.

Who Needs What?

While many corals are reasonably adaptable to different light levels, some are more demanding, at both ends of the scale. Between the extremes of, say, a lot of brightly colored *Acropora* species requiring very high light intensity, and *Blastomussa* species that need quite low light to thrive, it is possible to group corals by their requirements. What follows is not an exhaustive list, but it gives some indication as to the needs of a range of species.

Corals that require or prefer very intense light include most small-polyp-stony (SPS) corals, for example *Acropora*, some *Montipora*, *Porites*, *Seriatopora*, *Stylophora*, and *Pocillopora* species among others; also, many faviid corals, including *Platygyra* and *Goniastrea* brain corals, and *Favia* and *Favites* species. Many zoanthids also prefer very bright light, and while they are very adaptable, *Sarcophyton* leather corals also thrive under such conditions, as do *Tridacna crocea* and *T. maxima* clams. The light intensity these creatures need would be found directly under metal halide or LED lamps and close to the water surface. To provide such intense light with fluorescent lamps demands multiple tubes and efficient reflectors.

The middle of the lighting range, bright but not super-intense, suits many popular aquarium corals, including many branching and encrusting soft corals such as *Sinularia*,

Phil Hunt

■ Small-polyp-stony (SPS) corals, such as *Acropora* spp., require some of the most intense light seen on the reef and should be placed relatively close to the surface in an aquarium.

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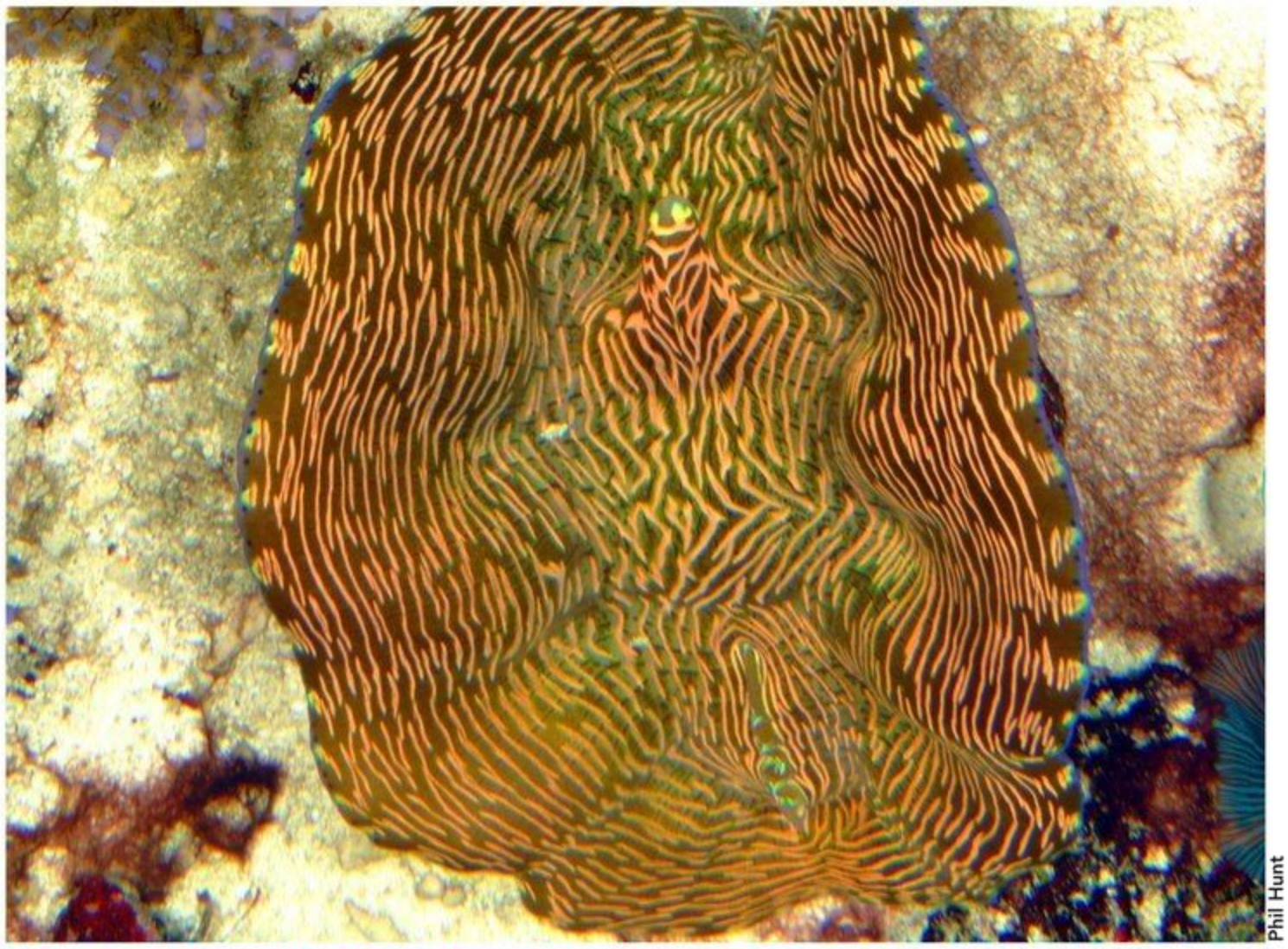

Phil Hunt

■ *Tridacna derasa* prefers light of middle to high intensity.

Cladiella, and *Lobophytum* species; *Xenia*, *Clavularia*, *Pachyclavularia*, and *Anthelia* species; and photosynthetic gorgonians such as *Pseudoplexaura* species. Many large-polyp-stony (LPS) corals, such as *Euphyllia* species, *Lobophyllia*, *Cynarina*, *Scolymia*, *Symphyllia*, *Caulastrea*, *Trachyphyllia*, *Catalaphyllia*, and *Acanthastrea,* also prefer these conditions. Many mushroom anemones also do well under these conditions, although some prefer less bright lighting. Among clams, *Tridacna derasa* and *T. squamosa* do well under these light levels. Fluorescent lamps can easily achieve this type of lighting, and in tanks with powerful LED or halide fittings, much of the tank area (except directly under the lamps) should be suitable.

At the lower end of the lighting range, bubble corals (*Plerogyra* and *Physogyra* species) do well, as do *Blastomussa*, *Duncanopsammia*, and many mushroom anemones. For these corals, shady areas in otherwise brightly lit tanks are ideal, or aquariums can be designed around these species, with less powerful lamps used.

Getting the Blues

Blue LEDs and actinic fluorescent tubes, which have a very narrow output spectrum, are frequently used in reef aquariums. The blue light from these lamps causes a variety of coral pigments to fluoresce, which has an obvious impact on the appearance of the aquarium. It is also believed that blue light may affect the production of pigments, at least in some species, although it is also clear that boosting the blue content of aquarium lighting by adding these essentially monochromatic lamps is not essential for good growth or coloration of corals.

The use of actinic fluorescent tubes began many years ago in an attempt to boost the blue content of the lighting available from the various mixtures of metal halide and fluorescent lamps used at the time.

More recently, the same approach was used in early LED aquarium lights, for similar reasons. The habit has largely persisted for aesthetic reasons, but as this approach seems to be, at worst, harmless and can look very interesting, particularly when blue lighting is used for dawn and dusk transitions, before and after the main lamps come on, it's not surprising that it remains popular.

Night and Daylight

Along with the intensity and color of lighting, the length of the photoperiod—the time that the lights are actually on—needs to be considered carefully. As our aquarium inhabitants come from the tropics, they are adapted to the day length in their home regions, which doesn't vary much over the course of the year, ranging from roughly 11 to 13 hours of daylight. For most of us living at higher latitudes, this is shorter than our summer days and longer than our winter ones. Does this matter? It is clear that corals need some time in darkness—

Phil Hunt

■ Needing less intense lighting than their SPS cousins, bubble corals can be placed in shady areas of brightly lit reef tanks.

illuminate them continuously (easily done by malfunctioning timers or forgetful keepers) and they soon look sick. This may be due to damage caused by excessive oxygen production by zooxanthellae.

A general recommendation is to aim for something close to a tropical day length of around 12 hours. This, however, doesn't always work well in terms of having the aquarium fully lit when you're at home to see it. Shifting the photoperiod to suit your

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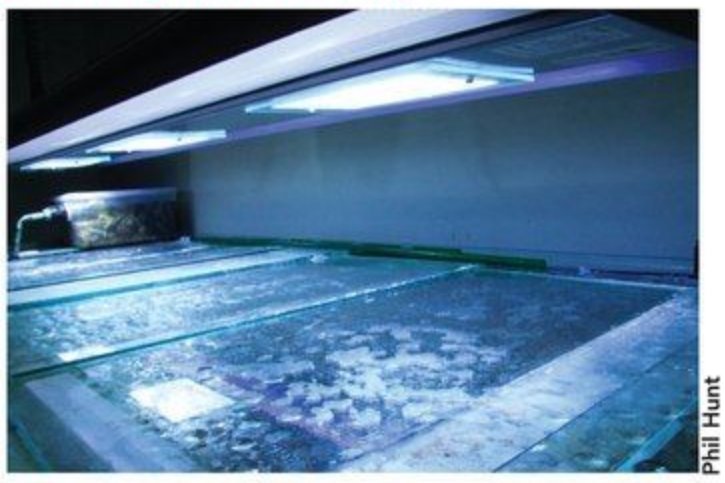
Phil Hunt

■ Actinic, or blue, lighting is used to great effect by making corals fluoresce.

schedule is entirely possible (the ambient light in most rooms is not enough for significant coral photosynthesis), but it can cause problems with fishes. This approach will leave the aquarium in what amounts to twilight for a significant part of the day, and, as noted, fish may behave erratically or aggressively as a result. Having a longer photoperiod, coinciding more with our 16-hour idea of a day, can be associated with nuisance algae problems, especially if full lighting is on for the whole period. One solution is to step the light intensity up and down during the course of the day, which is most easily achieved with programmable lamps. This should prevent over-illumination of corals, keep your fishes from spending too much time in the twilight zone, and keep your aquarium looking its best when you are there to enjoy it.

Up and Down

It's useful to be able to vary the intensity of lighting when introducing new corals to the aquarium or replacing lamps. In both cases, the intention is to avoid exposing corals to sudden increases in light intensity, which can be damaging. Where it isn't possible to decrease light intensity under these circumstances, pendant lamps should be raised further from the water surface, then gradually lowered over a few days. Alternatively, you can put a layer of eggcrate light diffuser between the lamps and the water, at first leaving it there all day, then gradually reducing the time it is present. Also, you can reduce the photoperiod, or at least the period of maximum light intensity, and then gradually return it to normal. Finally, when adding new corals, always place them first at



Phil Hunt

■ Metal halide fixtures provide very bright lighting but may overheat an aquarium.

the bottom of the tank or in a shaded spot and gradually move them to their final positions.

Getting What You Need: Types of Lamps and How to Use Them

Having established what we're trying to achieve with our aquarium lighting, let's take a look at the available choices of lamps. Before we start to look at different lamp types, however, it is worth asking a simple question: What are the characteristics of an ideal aquarium lamp?

First, it must deliver the light that we require in terms of intensity and color temperature. Next, it would be good to be able to control the light intensity in some way. Efficiency is also important; we want the most light for the least power consumption. As another aspect of efficiency, lamps should run cool to avoid the problem of heat transfer to the aquarium water. Finally, we want our lighting to make the aquarium look good—different lamps give different visual effects. With all this in mind, let's look at the three most common types of lighting used for marine aquariums.

Metal Halide Lighting

Five years ago, metal halide lamps represented the state of the art in reef aquarium lighting. Available in a wide range of color temperatures (from 6,500K right up to 20,000K) and wattages (typically 75, 150, 250, 400, and, for really big tanks, 1,000 watts), with fixtures available to suit a wide range of aquarium sizes, from single units for small tanks to triple units that can cover 200-gallon systems, these lamps can certainly deliver the lighting that corals and clams need.

The drawbacks of metal halide lighting are that most units aren't controllable beyond on-off switching, so for dusk-dawn transitions and periods of less than full lighting, they are usually combined (often in a single fixture) with fluorescent tubes; their power consumption is very high; and above all, their heat output can create a lot of problems. The light output from halide bulbs decreases and changes in spectrum over time, so the bulbs must be changed regularly (about once a year), which adds to the high running costs.

Despite these drawbacks, metal halides remain a valuable option, particularly where very bright lighting is needed in large, deep tanks. The visual effect of halides (as point-source lamps) is also very good, creating an effect like natural sunlight, with deep shadows and glitter lines.

Fluorescent Lamps

Fluorescent tubes, like metal halides, have been around for a long time. In recent years, a wide range of fluorescent tubes designed for marine aquarium use have come on the market. This is probably due to fluorescent lighting being increasingly adopted as a more economical and energy-efficient alternative to metal halides. For example, over here in the UK (where energy prices have increased greatly in the last few years), T5 fluorescent lamps are now much more commonly used than halides to light reef tanks.

For most reef aquariums, multiple tubes are required to provide sufficient light intensity, but this is easy to achieve by using a commercial multi-tube fixture or by fitting several tubes into a tank hood—a downside to the latter approach being the spaghetti-like wiring that can result. Using multiple tubes can provide adequate illumination for most aquariums, the exceptions being deep tanks, where the rather diffuse light from fluorescent lamps doesn't penetrate as well as the point-source lighting from metal halides.

While fluorescent lighting is cheaper to both buy and to run than metal halides, this is not its

Phil Hunt

■ LED lights cause little heat transfer and are very efficient to operate.

only virtue. It's possible to really fine-tune the lighting by varying the mix of tubes, and being able to switch individual tubes on and off also means that light intensity is easy to vary through the course of the day. Fluorescent lighting also runs cooler than metal halides, although if multiple tubes are used in an enclosed canopy, significant heat buildup can still occur. Fixtures suspended above the aquarium are better in this respect. Fluorescent tubes need regular replacement, as like metal halide bulbs, they gradually lose output, although the process is slower than for halides and changing tubes at 18-month intervals is usually enough.

Fluorescent lighting has a very different visual effect than metal halides, providing very even, maybe rather flat lighting, which looks much less dramatic. This even spread of light means that light intensity is pretty much the same across the whole tank area; whether this is a good thing or not very much depends on the tank design.

LEDs

The attractions of LED lighting for marine and reef aquarium use are high efficiency, low power consumption, minimal heat transfer to the water, very long life (around 10 years is claimed for most units) with no need for replacement of bulbs, and the potential for sophisticated electronic control of intensity and color.

The market in aquarium LED units is developing fast, reflecting improvements in LEDs themselves and in control circuitry. While early units tended to be suitable only for nano aquariums, with relatively poor light output (compared to metal halides, at least), much more powerful units have since become available, and it's probably fair to say that these units are genuinely equivalent to high-powered metal halides.

So are there downsides to LED units? There is one big one: the purchase price. While lifetime costs are probably lower than for other types of lighting (due to the low power consumption, long life, and lack of need for bulb replacements), the initial investment required is very high, although prices are gradually falling. Units vary a lot in their configuration of individual LEDs, each of which acts as a point-source of light. Some units use lenses to focus the light into a tight beam; others spread the light over a wide area. Which to choose depends very much on the design of the aquarium. The visual effect of LED lighting, while always tending towards the dramatic, also varies greatly among units.

It is possible to use general-purpose units to light aquariums. There is a wide range of LED spotlights, floodlights, and other bulbs with adequate intensity and suitable color temperatures (over 6,000K), and these can be used for aquarium lighting. These units do not have the sophisticated controls of some aquarium lighting systems but are typically much less expensive and are just as energy-efficient and long-lasting.

Pick What Works for You

The choice of lighting is driven by the needs of the inhabitants. That said, there has probably never been a better time to be making that choice, with many options available to meet the needs of a wide range of corals and the ability to do so while keeping running costs down and without heating the aquarium.

Francesco Ricciardi

The Struggle for Survival in Juvenile Marine Fish

■ Juvenile golden damsels (*Amblyglyphidodon aureus*) live in small groups close to soft corals or gorgonians, deep along walls.

Francesco Ricciardi

Francesco Ricciardi

A newly settled larva of an undetermined species of sweetlips with a yolk sac that is still visible.

The juvenile stage is, for many marine organisms, a real challenge. Since they are so small, the quantity of predators threatening them is almost unlimited. For this reason, many juveniles try to use different systems to survive until they become adults.

When you are a few millimeters long, life is incredibly hard. Big, scary mouths, tentacles, and siphons are all around, and to survive is more a matter of luck than of being strong or smart.

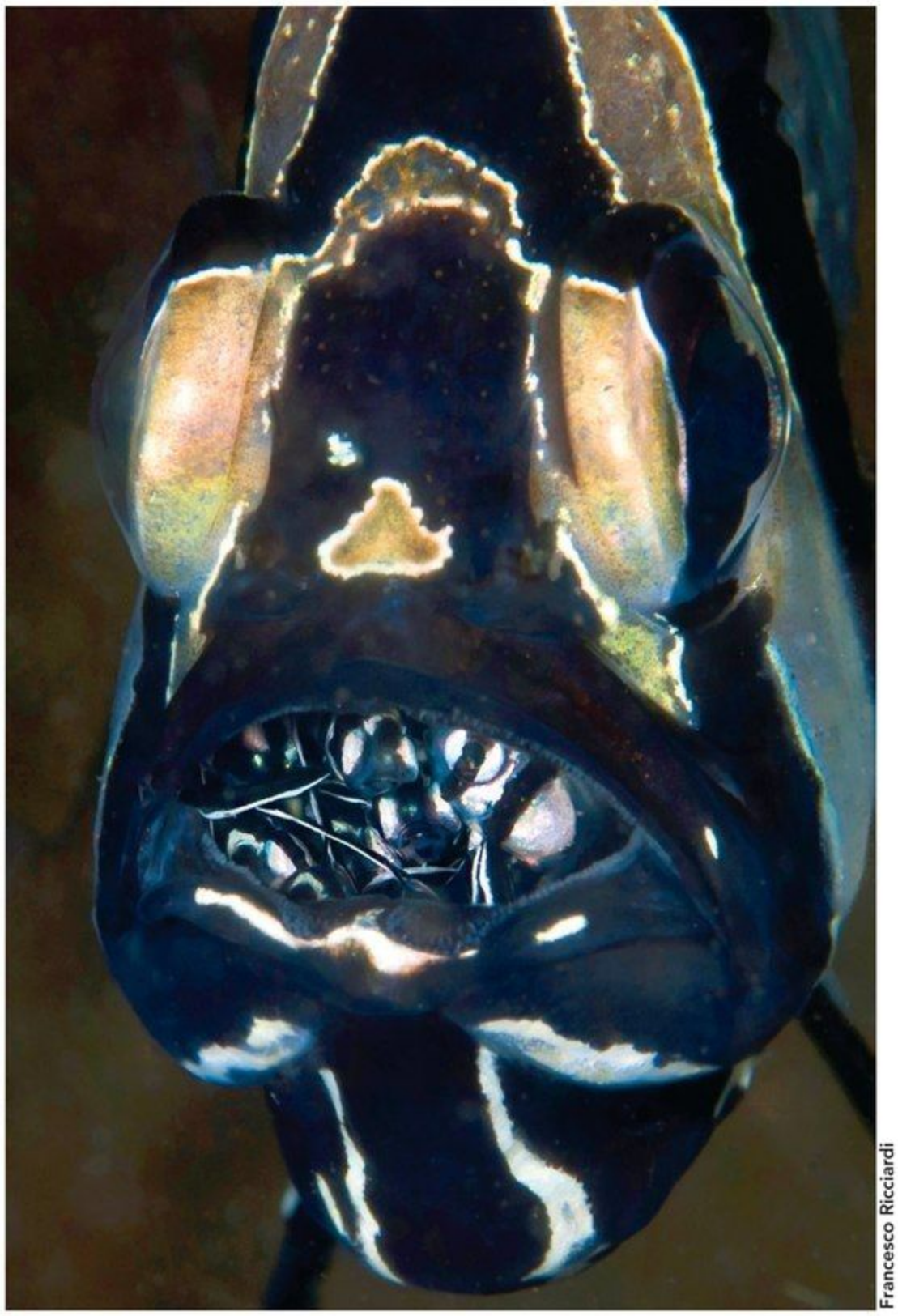
Almost every fish starts life as a tiny larva after the egg hatches. If the little fish is lucky, its parents take care of their eggs; if not, it's on its own even in the larval stage and can rely only on a little yolk sac full of nutrients that it carries along, hoping to be part of the small percentage of survivors.

The life and transformations of the fish larval stage are a complicated and very interesting story, and for some species, they are not completely clear even to aquatic biologists. That topic deserves a dedicated article; here we will talk about the juvenile phase.

Juveniles start their lives facing many of the same problems and challenges that confront adults—mainly to eat and to avoid being eaten—with the big disadvantage of their smaller size. But for this period, they don't have to worry about another important task: reproduction. When a juvenile reaches sexual maturity, it's ready to start the real adult phase.

Mama's (or Daddy's) Boys: Examples of Parental Care

The investment that parents allocate to their offspring can be quite high in some species, both in terms of energy and time. For this reason, these species have the maximum interest to guarantee to their offspring the highest possible chance of surviving until the adult phase. It's what biologists call "maximizing fitness" (simply put, the probability that offspring



Francesco Ricciardi

A Banggai cardinalfish (*Pterapogon kauderni*) carrying little juveniles in his mouth after the eggs have hatched.

Francesco Ricciardi

A juvenile yellow boxfish tries to eat some nudibranch eggs, which exhibit aposematic coloration, but it will soon spit them out due to their bad taste.

Francesco Ricciardi

The bluestreak cleaner wrasse (*Labroides dimidiatus*) has very different coloration during the juvenile stage, even if its cleaning activities are pretty similar.

Francesco Ricciardi

The change in shape and color pattern of the yellow boxfish (*Ostracion cubicus*) is quite intense.

will reach the adult stage and reproduce), and it's the concept at the base of the evolution of species. The greater your fitness, the greater the possibility that your species will survive and evolve into something more suited to the environment.

Some species of fish are able to guarantee to their offspring a very high level of parental care. Most of these fish, like the clownfishes for example, protect their eggs until hatching. Some other damselfishes, such as the golden damsel (*Amblyglyphidodon aureus*), demonstrate very aggressive behavior against potential predators, even those a lot bigger than themselves.

An interesting example, especially for aquarists, is the Banggai cardinalfish (*Pterapogon kauderni*), which is a paternal mouthbrooder. After the courtship and spawning, the father keeps the eggs in his mouth until hatching, usually for about two weeks. After that period, the young will remain in their father's mouth for an additional 10 days until they are ready to swim into the external world.

There is a common feature among these species—they are almost a miniature copy of their parents in terms of color pattern and body shape. Since their parents are in charge of protecting them from predators, they don't need to develop any kind of special feature, warning color, or special strategy to enhance their chances of survival.

There are some exceptions to this rule: In the butterflyfish family, for example, juveniles are almost identical to their parents when their larvae settle, but they don't give any kind of paternal care to the eggs, which are released directly into the environment.

Toxic Youth: Aposematic Coloration

If you are a marine predator, you learn quite early in life that if a prey item is very colorful, there is a high probability it's very toxic as well, or at least disgusting to eat. For example, colorful nudibranchs or sea slugs, potentially very easy prey, are able to accumulate toxins in their tissues and eggs, making them undesirable for a potential predator. Some fish (and even invertebrates) have learned to use bright color patterns to try to mislead big predators, making them believe that they are toxic too.

Changing Patterns

In the case of many wrasses, like the gaimard wrasse (*Coris gaimard*) and the reindeer or rockmover wrasse (*Novaculichthys taeniourus*), and many other labrids, juveniles have a wonderful color pattern that they lose upon reaching the adult phase. Even the bluestreak cleaner wrasse (*Labroides dimidiatus*) has completely different coloration in the juvenile and adult stages.

Juvenile boxfish and pufferfish have a body shape that is similar to that of the adults but often present a very different coloration. The yellow boxfish (*Ostracion cubicus*), for example, is actually yellow only during the juvenile stage, changing into light brown in the adult stage.

The change of color pattern is often very evident, especially in fish belonging to the Pomacanthidae family (the surgeonfishes). Juveniles are completely different from adults, with a pattern of lines often forming the shape of a circle near the tail. The pattern gradually changes as the fish grows, and it's possible to observe semi-adults with a mix of the two typical color patterns.

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Francesco Ricciardi

A juvenile circular spadefish (*Platax orbicularis*) has an impressive similarity to a leaf.

The presence of one or more false eyespots is quite common among juveniles of many species, including surgeonfishes and even wrasses. This strategy is very useful to distract both big and very small predators, like blennies that just take a bite of the fins of their prey.

Mimic Abilities

Another interesting tactic young fish use to avoid predation is to look like something else. This strategy is called mimicry. Some of the most amazing examples of juvenile fish mimicry are found in the batfishes. Their similarity to a leaf, moving slowly in the surge, is almost perfect. Some labrids, like the razor wrasse (*Iniistius pentadactylus*), also try to simulate the shape and movements of a submerged leaf to mislead their predators.

Fishes belonging to the Haemulidae family (sweetlips) are a very special case: Their juveniles try to simulate the movements of free-swimming flatworms, toxic invertebrates like the nudibranchs. They mimic the repetitive, undulated movements of these worms to make themselves undesirable to predators.

In some cases, once these juvenile mimics become adults, they will look completely different. In other cases, such as the waspfishes, they will use their camouflage to hunt rather than to avoid being hunted.

Francesco Ricciardi

A juvenile emperor angelfish (*Pomacanthus imperator*) undergoes several transformations before reaching the adult phase.

Francesco Ricciardi

The blue ribbon eel (*Rhinomuraena quaesita*) is black during the juvenile phase, blue when an adult male, or yellow when an adult female.

No Competition for Adults

Unfortunately for juveniles, adult fishes are not good-hearted. In the competition for food and space, age doesn't make any difference. A competitor is a competitor and must be fought to maximize the availability of resources.

Trying to avoid competition with adults, juveniles adopt various strategies. One of the most common is called spatial segregation: Juveniles simply live in a different part of the reef. For example, juvenile butterflyfish live in shallower areas compared to adults and limit their home range to the immediate proximity of a shelter, normally a branched coral like *Acropora*. When they reach adulthood, they will find a mate and extend their range to the deeper part of the reef, competing with the other adults, but it will be a fair competition.

Another strategy used by juvenile fish to avoid competition is called diet shift. Juveniles almost always have different food preferences that change during growth. These changes are typically drastic, usually taking species from plankton-feeders when they are larvae and newly metamorphosed through a series of distinct stages in which one or another prey type dominates the diet.

The purpose of these changes is two-fold: to guarantee appropriate foods will be available to the juvenile and to avoid conflict with adults of the same species.

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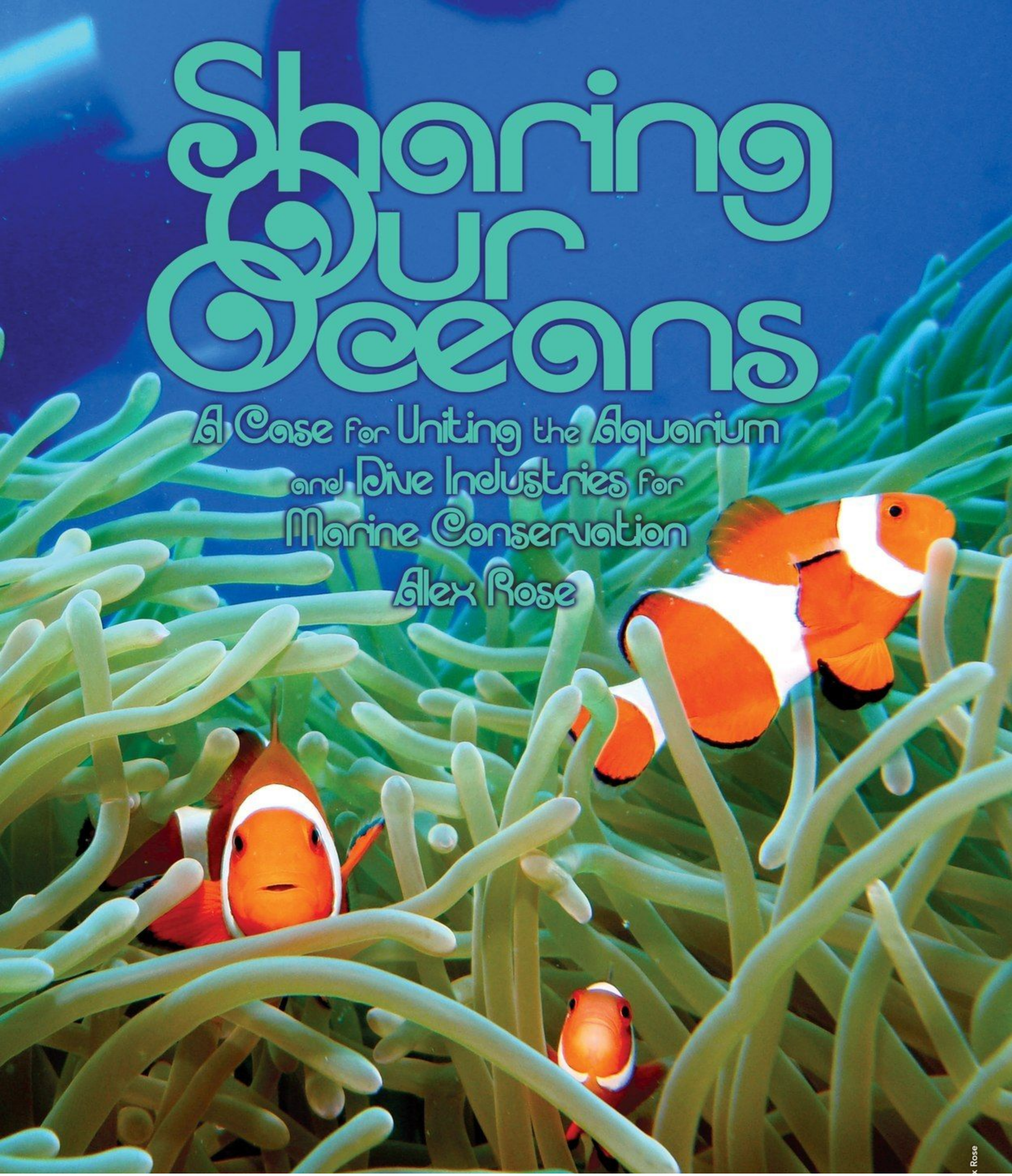
Sharing Our Oceans

A Case for Uniting the Aquarium and Dive Industries for Marine Conservation

Alex Rose



It seems that we often find the marine aquarium trade and the dive industry at odds with one another because neither one feels like the other is making positive contributions to marine conservation efforts. Each group accuses the other of taking actions that have a deleterious effect on the overall health of coral reef ecosystems, and while there are instances in which this is true, it is certainly not the norm.

Both industries have a vested interest in the protection of our underwater world and have taken steps to ensure that our priceless marine resources are preserved and restored for future generations.

The marine aquarium trade and the dive industry hold the potential to be powerful vehicles for coral-reef conservation through the implementation of various programs geared toward the establishment of Marine Protected Areas, reef survey work, pollution-reduction methods, governmental-regulation reform, and reef-health education on both a local and global scale. Their ultimate goals are congruous because neither trade could function and thrive without healthy coral-reef ecosystems. Hopefully, the marine-aquarium trade and dive industry will be able to set aside their differences and pool their efforts and resources to unite in the pursuit of a healthy future for coral reefs and the myriad of creatures that call them home.

Maintaining Sustainability

Both the marine-aquarium trade and the dive industry have a long history, but both of them really began to emerge as promising and successful hobbies around the same time. This parallel development is interesting and serves to segue our discussion into another parallel: their mutual distrust of one another. The dive industry is frequently of the opinion that our hobby decimates coral reefs through improper and unsustainable collection techniques and that the aquarium trade and its dedicated hobbyists generally have little regard for the lives of the aquarium inhabitants. The marine-aquarium industry seems to feel that divers threaten coral reef ecosystems through irresponsible diving practices and pollution from dive boats.

To a certain degree, these accusations are not invalid, as both industries can pose threats to ecosystem health, but both of them do far more good than bad for marine conservation efforts. As both a scuba diver and reefkeeper, I feel it is important to discuss the environmental impacts of both groups and the steps they are taking to ensure healthy coral reefs for future generations.

The main issues associated with sustainability of the aquarium trade stem from collection methods. These methods in question are blast fishing with dynamite, a technique primarily used to collect fish for food as well as coral rubble to be sold either as live rock or used as limestone in construction projects, and cyanide fishing, a method utilizing sodium cyanide to stun ornamentals. Cyanide fishing was banned in the 1980s but is still rampant in many parts of the Indo-Pacific.

Overfishing of certain species of marine ornamentals is another problem, one that has garnered a good deal of publicity as of late through its association with potential collection bans in Hawaiian waters. The damaging and grossly exaggerated partial-truths circulated by some concerned organizations have cast a fog of misinformation over the ethics

Alex Rose

■ Most marine fish in the aquarium trade used to come only from the wild, but now many species, including the mandarinfish, are bred in captivity.

Alex Rose

Breeder's Award Programs can help encourage hobbyists to attempt to breed a variety of species.

Alex Rose

Diver education on the importance of the impacts of their actions underwater is a critical factor in marine conservation.

and sustainability of our trade, but on a slightly more positive note, they've also focused a substantial amount of attention on improper collection methods and overfishing of marine ornamentals. These are ugly topics to discuss, as they are obviously fueled by a demand for exotic marine-aquarium livestock, and there is no ignoring the massive destruction they leave in their wake; collection and importation bans would severely change the face of our hobby. But as is often the case, recognizing the problem is the first step in finding a viable solution.

These destructive collection procedures have been recognized for decades, but the last 10 years have seen the advent of two promising solutions spearheaded from within the marine-aquarium trade: successful, reproducible, and large-scale captive breeding of desirable marine ornamentals, and sustainable wild-collection programs partnered with ecolabeling.

Captive Breeding

When Martin Moe first described captive breeding of clownfish in the 70s, he may not have realized the full extent to which his observations, and most importantly his willingness to share this valuable information, would shape the future of the marine aquarium industry. Information dissemination is one of the most fundamental tenets of successful science; replicability and scalability are essential as well. Captive breeding is an effective way to reduce collection pressure on reef environments by eliminating the need for all ornamentals to be wild caught.

Some lifelong hobbyists, such as Matthew Pedersen and Rod Buehler, have made names for themselves by breeding specific color morphs of desirable aquarium species, in this case clownfish. Matt has successfully bred the rare "lightning maroon" clownfish collected in PNG, and Rod is famous for his "Rod's Onyx" percula clowns. A few companies supply our trade with 100-percent captive-bred fish and aquacultured corals.

One of the most progressive groups promoting captive breeding is MBI, the Marine Breeding Initiative, spearheaded by Tal Sweet and Chad Penny through MASM (Marinelife Aquarium Society of Michigan). MBI is a global Breeder's Award Program (BAP) that functions as a massive bank of information for hobbyists of all knowledge and experience levels with the primary goal of encouraging "marine aquarium hobbyists to get involved in the captive breeding of marine organisms." This rapidly growing 501(c)3 boasts an impressive list of over 220 verified captive-bred marine species and shows what a dedicated group of hobbyists can do to help protect our coral reefs.

Diving to Restore Reefs

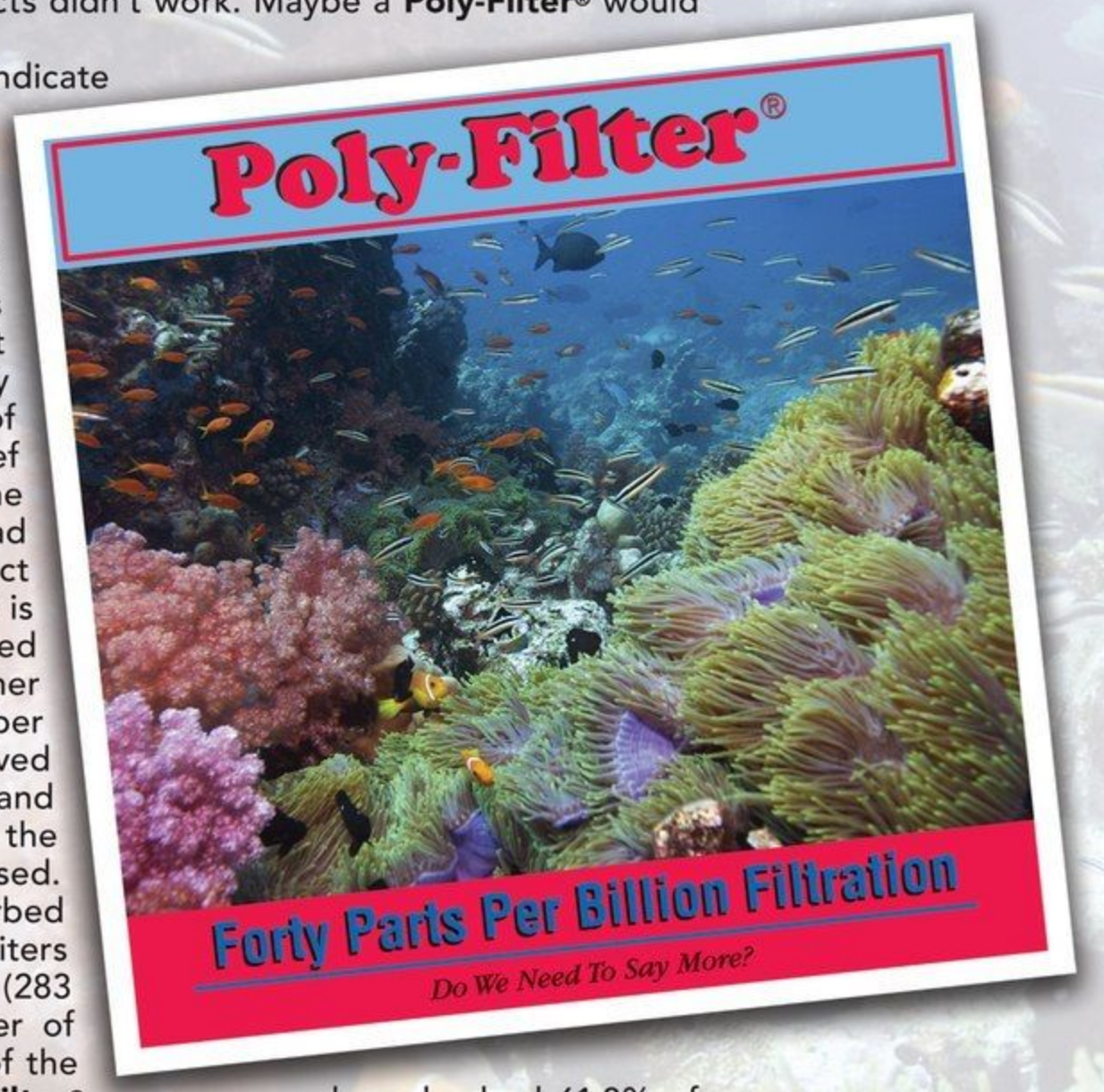
The dive industry is often accused of reef destruction through unsafe diving practices. There are five main ways that diving can negatively affect reefs:

1. Inexperienced divers can unknowingly damage corals with their fins and other gear.
2. Divers with poor buoyancy often grab or rest on corals for control and can destroy corals.
3. People may collect marine life illegally.
4. Boat anchors can severely damage corals.
5. Dive boats in developing countries are known for littering and other forms of pollution, such as oil and gas leakage and runoff.

Dive boats that guide large numbers of divers at once also have a much higher

Rescued Reef Aquaria

Poly-Filter® has rescued tens of thousands of freshwater, brackish, saltwater and reef aquaria during the past Thirty-Five years. During December 2011 alone we received ten emails, from experienced reef aquarists, all asking about the blue coloration adsorbed into **Poly-Filter®**. These long term, reef aquarists had not been previously using **Poly-Filter®**. Instead they had chosen: activated carbon, activated carbon and ion exchange resins, macro reticulated styrene adsorbents and other sorbent media. However, when problems with the corals developed each had decided these other filtration products didn't work. Maybe a **Poly-Filter®** would solve the problem?



The unique, Patented color change in **Poly-Filter®** appeared to indicate copper being adsorbed. How could this happen? Each of these aquarists had been treating tap water using low pressure reverse osmosis and mix bed deionization. We explained that if the mixed bed D. I. resins failed copper would certainly enter the aquaria. Could ten very experienced reef aquarists, all having mix bed resins fail? It is certainly possible, low pressure reverse osmosis will bypass sufficient copper that it would negatively impact corals. However, we suspected additional copper and other heavy metals, so inquiry was made about amount, frequency and types of water treatments and/or coral "additives" being used. Every reef aquarist had been dosing: calcium, magnesium, strontium, iodine /iodide, carbonates and trace elements. Would copper, iron, lead be trace contaminates found in these additives? It is a scientific fact that lead is the major contaminate in all calcium compounds! Iron is another almost a universal contaminate. Copper may have entered aquaria as a trace contaminate found in the trace elements or other coral additives? However when **Poly-Filter®** adsorbed the copper it would also adsorbed: iron, lead, excess heavy metals, dissolved organics, phosphates, volatile organic chemicals, pesticides and any biotoxins. Water quality was corrected, aquarists reduced the amount of additives and the clarity of their aquaria greatly increased. Coral health and growth problems solved! **Poly-Filter®** adsorbed 31.97% of 718.95 micrograms per liter ionic copper @ 14.307 liters per minute within seventeen seconds. Activated carbon/resins (283 grams) adsorbed only 20% of the 718.95 micrograms per liter of copper but needed 30 seconds. Zeolite resin adsorbed 14.5% of the 718.95 micrograms per liter of copper within 17 seconds. **Poly-Filter®** also adsorbed 61.8% of 211 micrograms per liter within 60 seconds at 14.307 liters per minute out of saltwater. **Poly-Filter®** adsorbed 46.4 % of 1570.2 micrograms per liter of chelated copper @ 14.307 liters per minute within 14 minutes. A strong chelating resin (1000 ml.) could only adsorb 13.03 % of 1570 micrograms per liter @ 14.307 liters per minute within 14 minutes.

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■ Hope Spots are dedicated marine conservation areas that are currently being studied.

Alex Rose

■ Education of the public is vital to reef conservation, and both the aquarium and dive industries can work together to do just that.

incidence rate due to the fact that there is little individual supervision by divemasters or instructors, so more careless diving practices occur. All of these irresponsible behaviors can lead to damaged reefs, especially when considering the already increased sensitivity of reef ecosystems due to environmental factors. Of course, the majority of divers are more conscientious and educated than this, and these are the kinds of individuals who strive to use diving as a vehicle to fuel marine conservation efforts.

Diving as a recreational activity is in a unique position to protect and restore coral reefs. The education that goes along with dive training is, of course, a necessary step in remedying the hazardous behaviors of inexperienced divers. One such organization at the forefront of marine conservation education is the Reef Check Foundation, an international non-profit founded by Dr. Gregor Hodgson in 1996. Reef Check's goals are: "to educate the public about the value of reef ecosystems and the current crisis affecting marine life; to create a global network of volunteer teams trained in Reef Check's scientific methods who regularly monitor and report on reef health; to facilitate collaboration that produces ecologically sound and economically sustainable solutions; and to stimulate local community action to protect remaining pristine reefs and rehabilitate damaged reefs worldwide."

As can be expected, The Professional Association of Diving Instructors (PADI) is another organization with a strong focus on dive education, and they have particularly inspirational programs for young people. Their Kids Sea Camps are hosted throughout the world in locations including, but not limited to, Bonaire, Palau, Galapagos, and Grand Cayman, and include a full week of diving, educational programs, and activities for kids ages 4 to 18.

Mission Blue: the Sylvia Earle Alliance, is yet another organization dedicated to raising public awareness about critical ocean issues while "inspiring support for organizations, projects, and scientific expeditions that make a positive difference for the ocean." Much of Mission Blue's focus is directed toward the extensive exploration and subsequent protection of what they call "Hope Spots, special places that are critical to the health of the ocean." PADI, Reef Check, and Mission Blue, along with many other organizations dedicated to marine-conservation education through diving, are capable of changing the future for our world's coral reefs by creating a community of informed divers/conservationists that understands the extreme importance of protecting and understanding the places they dive and the diverse variety of marine creatures that depend on these ecosystems for their continued existence.

Working Together

The dive industry and marine aquarium trade would make much better use of their varied resources if they could combine their efforts to work together toward a future with healthier, better-protected coral-reef ecosystems. Through marine-conservation education, sustainable coastal development projects, establishment of Marine Protected Areas (MPAs) or Hope Spots, captive-breeding efforts, and an overall increase in public and hobbyist awareness of the problems that need to be solved, these two industries could start a long-overdue "sea change" that could give these vulnerable and priceless habitats and all the unique species that call them home a chance at recovery and global protection.

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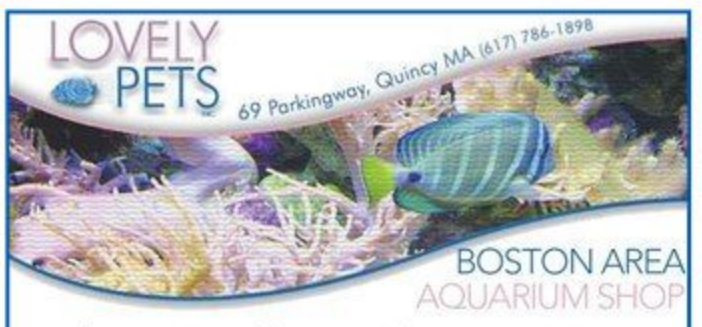

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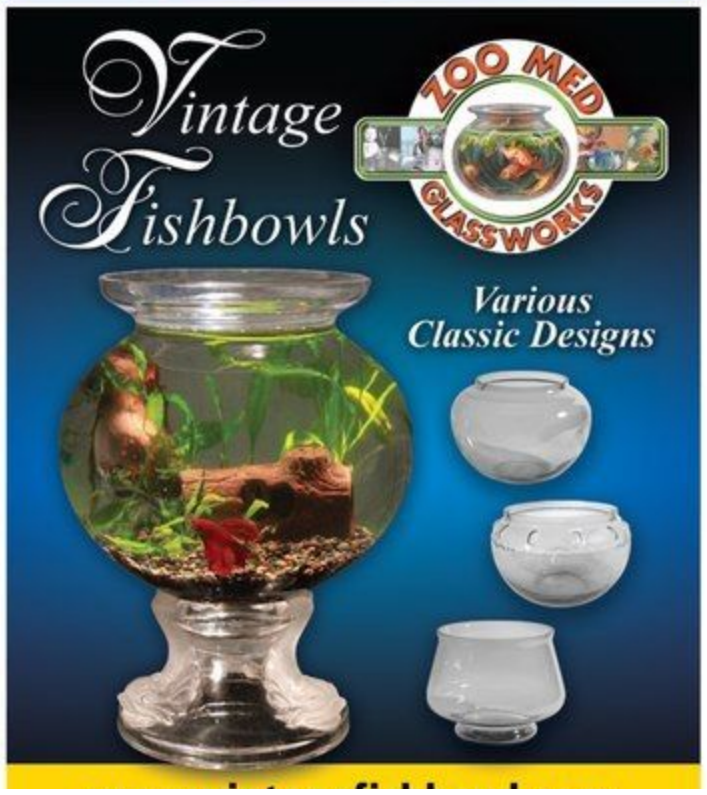

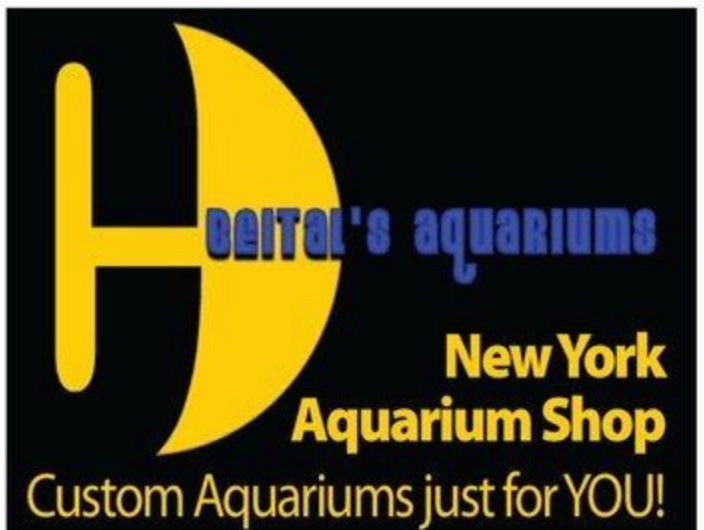

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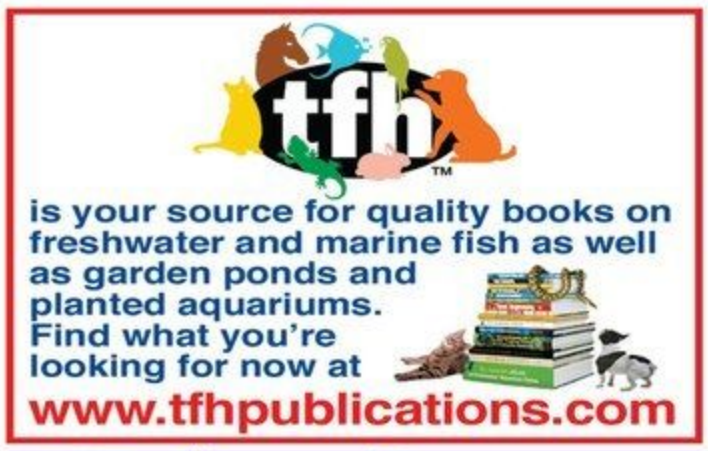


ONLINE RETAIL

advertiser index

Aquatic Experience—Chicago An Industry First

It's time for fishkeeping to resurface as one of the top hobbies in the country, and the World Pet Association (WPA) knows just how to jump-start this trajectory: Aquatic Experience—Chicago, the first show in industry history to combine everything aquatic under one roof, including saltwater fish, freshwater fish, and pond products. As the oldest industry organization promoting growth and development of the companion pet industry and related services, the WPA hopes to reel in consumers, retailers, and families for this spectacular inaugural event, set for November 15 to 17 at the Renaissance Schaumburg Convention Center. Attendees can take part in educational seminars, hear from high-powered speakers, enter a Kid's Aquarium Contest, see the only traveling shark show in the country, and enjoy a show floor filled with vibrant displays of exotic fish, product raffles and equipment experts alongside the industry's best and trend-setting manufacturers.

Courtesy of Zeb Hogan

■ The keynote speaker at *Aquatic Experience—Chicago* will be Zeb Hogan, host of National Geographic's hit TV show *Monster Fish*.

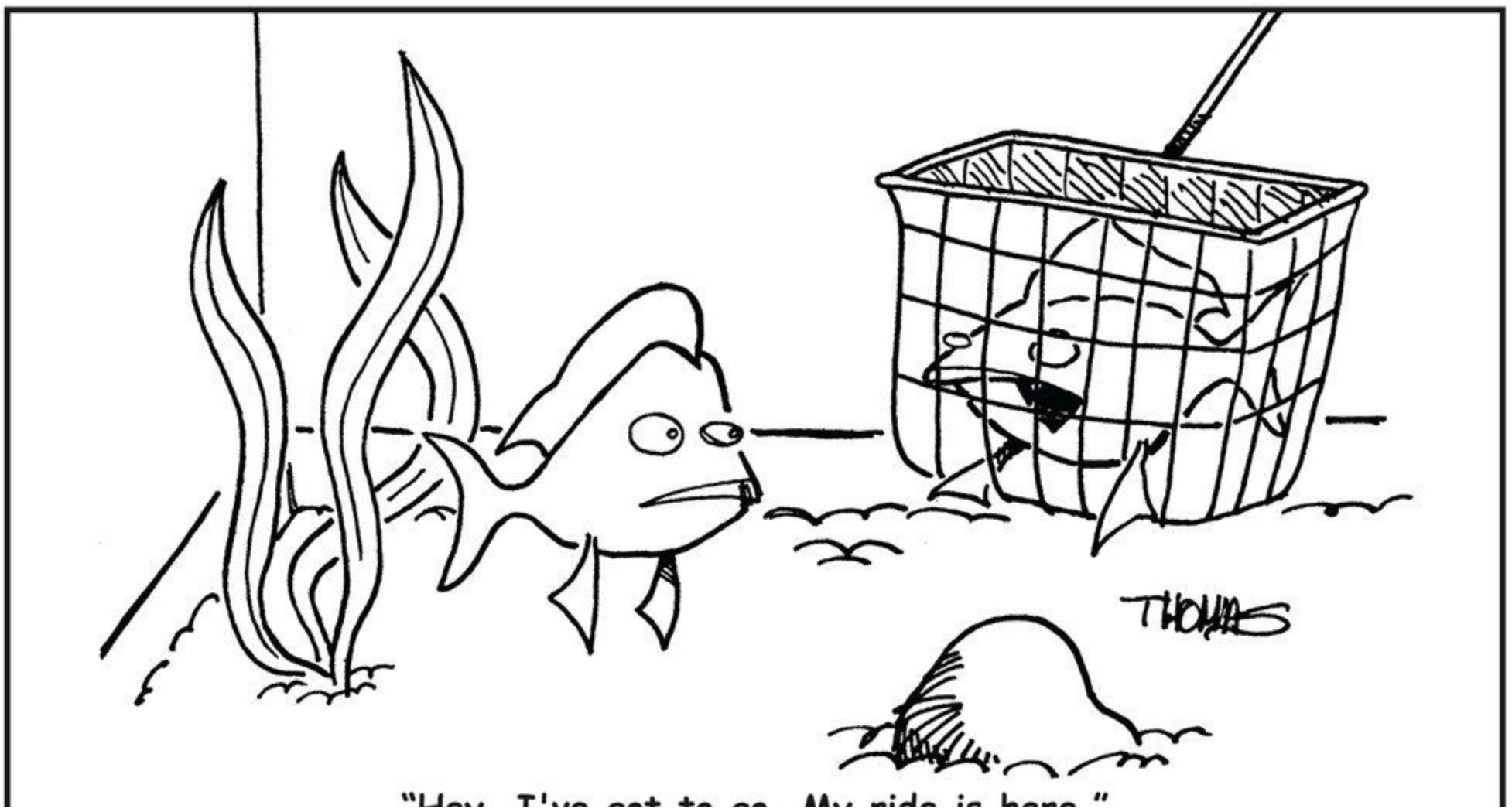
Naturally, the keynote speaker for the pet industry's first-ever aquatic super show should be the biggest fish out there. Enter aquatic ecologist Zeb Hogan, host of National Geographic's hit show *Monster Fish*, who will share his experiences tracking down some of the biggest fish in the world during Aquatic Experience—Chicago. Hogan is more than a TV personality; the aquatic conservation biologist has dedicated his life to uncovering and understanding potential threats to endangered freshwater fish and their habitats. In addition to his keynote presentation, Hogan will present two additional talks for those attendees with a fascination for fish. It will be a rare opportunity to hear first-hand about Hogan's research, discoveries and what the future holds for some of the world's most incredible aquatic creatures.

Courtesy of the World Pet Association

■ *Aquatic Experience—Chicago* combines all aspects of the hobby, freshwater, saltwater, and ponds.

Alongside Hogan, many additional experts in the field will be available on-site at Aquatic Experience—Chicago to meet in person and share their enthusiasm for the underwater world. Featured speakers include: Eric Bodrock, owner of All Oddball Aquatics, a tropical fish hatchery and independent online retailer of aquarium hobby equipment; Patrick Donston, owner and operator of Absolutely Fish, a MAC certified facility and wholesale retail store; Heiko Bleher, a conservationist, lecturer and scholar of aquatic habitats, fish and biotope correct aquaria; Oliver Knott, a German aquarium designer, professional live aquascaper and InVitro plant specialist; Bob Fenner, an avid ornamental aquatic enthusiast and author of several books; Oliver Lucanus, a German-born writer, photographer and explorer of South American fish habitats; and René Krüter, a notable pioneer in the fish keeping and breeding field, specifically Tanganyika cichlids. Topics range from aquarium hobby basics to establishing a productive husbandry practice, maintaining healthy fish and more.

Tickets are on sale now for Aquatic Experience—Chicago at the Renaissance Schaumburg Convention Center (1551 N. Thoreau Drive, Schaumburg, IL) with daily individual tickets starting at just $10 and daily family passes for $25. Tickets to the Saturday dinner with keynote speaker Zeb Hogan are $60. For more information and to purchase tickets, please visit www.aquaticexperience.org.



"Hey, I've got to go. My ride is here."

PARTING SHOT

Photo: Terence/Shutterstock

giant clam

Beautiful additions to the reef aquarium, giant clams can be hardy and incredibly long-lived charges when kept in the right conditions. They are similar to corals in that their tissues contain symbiotic zooxanthellae that use photosynthesis to provide them with food. Unlike corals, giant clams have organs such as a heart and kidneys, which means they require more food than corals. In the aquarium, they demand both bright lighting and supplementary feeding with planktonic foods.

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