The Jaubert System Revisited

by Mike Paletta

It has now been four years since what has come to be known as the Jaubert system of reefkeeping was introduced. I have used modified versions of this system in two of my own tanks as well as in six other tanks, all of which have been set up for at least one year. Two others have been set up for almost three years. After working with this system in several different forms, I recognize both its strengths and inadequacies.

When this concept was first explained it seemed simple enough: use a plate to produce a space for water (a plenum) under a bed of live sand to allow for anoxic conditions to develop. When the oxygen levels in the plenum fall low enough, processes will occur that convert nitrate into nitrogen gas. In addition to lowering nitrate levels, there is also a gradual dissolution of the carbonate live sand bed, which produces a constant introduction of calcium, strontium, and trace elements into the tank.

I set up tanks according to this simple system, but it seems I did not read all the fine print. The patent by Dr. Jaubert as well as videotapes and lectures by him and his staff

Continued on page 4

Notes on the Adult Coloration in the Annularis Angelfish (Pomacanthus annularis)

by Adam Betsky, Aquarium Systems France

In the last few years I have observed an unusual change in the line pattern on my adult Pomacanthus annularis angelfish.

I obtained this fish in 1981. It had a total length of 10 centimeters (4 inches) and exhibited juvenile coloration. Over the next few years it grew slowly and developed the typical adult pattern of a small circle behind each eye and six to seven lines on each side. During this time it was kept in a 900 liter (237 gallon) community fish aquarium. In 1987 it was moved to a new 2000 liter (526 gallon) aquarium equipped with a wet/dry filter. Both aquariums were filled with saltwater made from Instant Ocean® sea salt. The fish was fed a mixed natural diet of frozen mussels, shrimp, squid, and spinach. Since the move to the new tank it has experienced a period of renewed growth, and the body lines have continued to evolve.

Continued on page 4
The Cell Structure and Aquarium Success of the Bryopsidales

by Robert Day, Department of Zoology, The Ohio State University.

The Bryopsidales, also known as the Caulerpaceae or Siphonales, are a fascinating group of green macroalgae found in oceans across the globe. They are well known to aquarists because the group includes several genera that thrive in the aquarium environment. Some of the most commonly grown ornamentals such as Caulerpa, Derbesia, Cacileps, Fuscocystis, and Halimeda belong to this taxon. Considering how difficult many species of macroalgae are to culture, why is this group apparently so obliging?

Presumably, members of the Bryopsidales possess adaptations that promote survival in captivity. In nature, many occur in shallow, coastal waters where they have developed tolerance to elevated nutrient levels and fluctuations in temperature, salinity, and pH. These conditions are common in the aquarium environment. The rapid growth of the Bryopsidales and their ability to propagate vegetatively from small fragments probably also contribute to their aquarium success. At the Ohio State University, we are investigating the unusual cell structure of the group, which we believe is at least partially responsible for these useful characteristics.

Experiments with different Bryopsidacean species have shown many that can be easily cultured with minimal equipment. Currently, we maintain permanent cultures of Caulerpa taxiflora, C. filiformis, C. verticillata, C. microphylla, C. mexicana, and Halimeda pleroma. Other Bryopsidacean species can be grown, but we have found it impractical to maintain them permanently because they seem to require more diligent and expensive attention to water chemistry and light quality.

We maintain several species in 50 gallon to 100 gallon community tanks. In smaller volume tanks different species tend to compete with each other and often cannot co-exist, hence we culture individual species separately in tanks as small as 5 gallons. We use Reef Crystals® sea salt mixed with distilled water to a specific gravity of 1.023. Cultures are kept at 22-25°C (70-76°F) on a 12 hour light/12 hour dark cycle. We have found that the species listed above can grow with as little as 15 watts per gallon actinic and cool-white fluorescent light per gallon. Cultures are filtered using Maxi-Jet® driven undergravel filters with a coarse, crushed coral substrate. In our larger culture tanks we employ a protein skimmer with ozone to reduce the accumulation of organic impurities. We have found that regular addition of nutrients and trace elements is essential to maintain continuous growth. We add commercial macroalgal growth supplements from Florida Aquaria, Inc. according to the manufacturer’s instructions, and small pieces of ocean perch as a nitrogen source. For newly established tanks or whenever algal growth seems slow, we add up to 0.1 grams per gallon of ammonium nitrate and potassium phosphate. Uptake of these nutrients by the macroalgae is so rapid that levels usually remain undetectable in our tanks, even after several additions.

Typically, the Bryopsidales consist of branching green filaments containing a mass of continuous cytoplasm held inside a hollow, cylindrical cell wall. There are usually no cross walls in the filaments and therefore no physical separation between nuclei or other internal structures. In some genera, such as Halimeda, the filaments are highly branched and packed into a dense mass called a thallus.

In Caulerpa the filaments are massively enlarged, strengthened with internal support struts, and shaped into organs resembling the stems, leaves, and roots of land plants. Unlike land plants, these organs are not made up of thousands of separate cells packed together. Instead they are filled with a single uninterrupted mass of living cytoplasm.

In essence, Bryopsidacean algae could be considered a single, multinucleate cell. Such a cell is said to be coenocytic (pronounced see-no-sit). This condition appears elsewhere among living things, but never so strikingly. Caulerpa taxiflora, for example, can form a network of rhizomes filled with a mass of cytoplasm 0.25 mm in diameter and several meters long. In some species of Halimeda there is evidence that whole meadows of natural growth consist of a single individual connected by fine filaments running through the substrate. This suggests that some of the largest and most morphologically complex cells of the living world may belong to this algal order.

The cytoplasm of these giant cells is highly mobile. Nuclei, chloroplasts, and other cell organelles are free to move throughout the organism. This phenomenon is well known in Caulerpa, where streams of chloroplasts are visible to the naked eye as fine green lines just under the cell wall. This internal transportation of materials is facilitated by a network of fibrous proteins called the cytoskeleton which acts like a highway system. Organelles and packages of raw materials actively move along these highways from wherever they are abundant to wherever they are needed most.

It is our contention that the coenocytic structure and mobility of the cytoplasm promote survival in captivity by allowing a rapid, flexible response to the unpredictable conditions of an aquarium. For example, phototactic movement of organelles can be deployed wherever light falls on the organism most optimally. If an alga is tipped over or inverted, materials can be re-routed to allow new growth with the correct orientation relative to gravity. If a growing tip is damaged, unused raw materials can be diverted elsewhere. Even a small fragment can quickly reorganize its internal structure so that damage is controlled and photosynthesis can resume with the minimum of delay. The large mass of continuous cytoplasm and single, thick cell wall may be adaptive in that it protects the alga from the effects of sudden changes in salinity.

The coenocytic cell structure could also be the basis of some species' ability to modify their growth under certain conditions. For example, when a stock of Caulerpa is separated and cultured in tanks with dissimilar lighting, circulation, or nutrient regimes, the cultures may develop different growth patterns, varying in overall size, proportions, and color. Presumably, these different "varieties" or "morphs" optimize their growth in response to local conditions and coordinate this growth using substances that can quickly move through the continuous cytoplasm. Aquarists may even observe several distinct varieties of a single Caulerpa species growing in different parts of the same tank, all vegetative descendants of a single piece of alga.

The coenocytic structure, streaming of cellular material, and morphological plasticity of the Bryopsidales not only contribute to the group's success in marine aquaria, but also present a unique challenge to biologists. By studying an organism that seems to defy established cell theory, it may be possible to gain entirely new insights into the mechanics of all living cells, including our own.

References

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Cross-section of Caulerpa prolifera rhizome: The cell wall forms a hollow tube strengthened by finger-like internal struts. The dark dots are cross sections through huge streams of chloroplasts moving along the rhizome. (40x)

Filamentous form of Codium fragile. Special microscopy allows us to view the nuclei as light blue and the chloroplasts as red. Note that the nuclei are evenly distributed, not packaged into separate cells. (250x)
Notes on the Use of Kalkwasser - Part 2
by Tom Frakes and Bob Stott

In the last issue we reported on effects of kalkwasser, or calcium hydroxide, additions to 10 gallon saltwater aquariums that did not contain animals. As a continuation to this project we set up four 10 gallon micro-reefs to compare the effects of kalkwasser supplementation in new reef aquariums.

Method
Each tank contained one inch of live sand, five coral fragments, a piece of live rock with purple coraline algae, a Duetto® DJ-30 filter for circulation, and a Vist-Jet® VJ-100 protein skimmer. Lighting was provided by a shop light across the four tanks with one 40 watt Blue Moon bulb and one 40 watt Triton bulb. Two tanks received approximately 2 liters of kalkwasser (Reef Evolution™ calcium hydroxide) per week to replace evaporated water. The water level for the other two was maintained with distilled water.

Calcium, pH, alkalinity, and phosphate levels were routinely monitored using SeaTest® or Faàstro® test kits. The calcium level was kept above 350 milligrams per liter (mg/l) using Reef Evolution™ calcium chloride. Reef Evolution™ strontium supplement was added three times to all four tanks during the first three months. Samples were tested by an independent laboratory for levels of strontium and all major ions just after set-up, after 3 months, and after 8 months.

Results
As reported in Part 1 of this series, we found that the use of kalkwasser in newly-set-up aquariums resulted in a decline in alkalinity but elevated pH values. Also, the calcium levels in these kalkwasser tanks dropped and we had to resort to calcium chloride additions to maintain our minimum level. Buffering with SeaBuffer® was also required to keep the alkalinity at or above 2.5 milliequivalents per liter (meq/l). The calcium chloride tanks required only a limited amount of supplementation to maintain proper calcium and alkalinity levels. Graph I shows average calcium level for the two kalkwasser tanks and two calcium chloride tanks. Graph II compares the average strontium level for the two sets of tanks. As you can see, use of the kalkwasser caused a steady decline in strontium concentration even during the period when strontium was supplemented. The low calcium level that results in spite of regular kalkwasser additions indicates that the extra calcium precipitates on the aragonite substrate, taking strontium with it. Aside from a slight but equal drop in all four tanks, magnesium levels remained stable at about 1400 mg/l.

In this particular experiment we did not see significant differences in the morganic phosphate levels between both tanks. Phosphate started at 0.2 parts per million (ppm) for all four tanks, dropped to zero within three months, and remained at zero. However, green hair algae did develop after about four months. Various snails and hermit crabs failed to fully control this nuisance algae.

Discussion
It has been suggested by Richard Greenfield of CaribSea that the calcium carbonate precipitated from a supersaturated calcium solution would be in the form of aragonite. This aragonite would have a low magnesium content but should contain significant amounts of strontium. He also pointed out that coraline algae deposits calcium carbonate and magnesium carbonate, with a significant percentage of magnesium, and we did experience a heavy growth of coraline algae on the walls and pumps of each tank. This could explain our slight magnesium loss, but probably does not completely explain the very low magnesium levels experienced in the past by reef hobbyists. It is unlikely that coraline algae alone would account for the reduction in magnesium levels from 1300 mg/l to the 800 mg/l that has been reported. This would require the addition of 1960 mg/l calcium to the aquarium, five times the natural sea water level, assuming all the added calcium is deposited as coraline skeleton. Because of this, we stand by our conclusion that the very low magnesium levels that have been reported are due to sea salts deficient in magnesium.

The loss of strontium was very significant in the kalkwasser tanks, confirming the need for supplementation. The tanks receiving Reef Evolution™ calcium chloride supplements tested high in strontium after the first half of the experiment. For this reason the strontium supplements were suspended during the second half for all four tanks, resulting in a significant drop in the strontium level. An 80% drop in strontium was observed in the kalkwasser tanks.

Conclusion
It appears to us that, at least for new aquariums with carbonate gravel, the addition of kalkwasser (calcium hydroxide) can cause the precipitation of calcium carbonate due to a temporarily elevated calcium level and higher pH. The result is a decline in calcium, strontium, and alkalinity. It is likely that the precipitation is somewhat dependent on crystals forming on exposed gravel surfaces. Older tanks with biofilms and calcareous algae on gravel surfaces may not experience these drops and may exist in an apparent state of supersaturation.

In mature heavily stocked reef tanks, rapid growth of hard corals and coraline algae may remove excess calcium before it precipitates as aragonite. Therefore, use of kalkwasser may be more useful in established aquariums than in newly-set-up reefs. It should also be noted that the method of dosing is extremely important. Rapid addition of freshly mixed, unsettled calcium hydroxide tends to magnify some of the detrimental side effects previously noted. The best method would be a slow drip administered after the aquarium lights are off to help offset the pH drops that are associated with nighttime algae respiration.

Calcium and alkalinity levels should be monitored closely in new aquariums with carbonate gravel. It is common for new gravel surfaces to initiate calcium carbonate crystal precipitation. Finally, regardless of the method of calcium supplementation, strontium must be added to any aquarium experiencing calcium precipitation, whether it is due to biological uptake or inorganic precipitation.

Acknowledgments
We wish to thank LeRoy Headee of Geothermal Aquaculture Research Foundation for supplying live sand and matched sets of coral cuttings. Aquacultured live rock was provided by Anclote Aquaculture.
reveal that this system is not quite as simple as it appears to be. As a result it has been my experience that success using this system depends on a number of variables. Some of these variables and the effects of small design alterations follow.

As would be expected, the quality of the live sand bed is critical to the success of this system. The type of sand chosen is of course important. Its inhabitants have a major effect on the processes that occur in and under the bed. I refer now to the amphipods, copepods, burrowing molluscs, and particularly the worms. Jaubert describes a mini-ecosystem within the live sand bed that is critical for the success of this system. Unfortunately it has been my experience that very few of us are able to obtain live sand with the quality of inhabitants that Jaubert describes. In particular, worms and burrowing molluscs are almost always missing from the live sand that is available. This seems to be a distinct disadvantage, because these animals act in a manner similar to their terrestrial counterparts; they aerate the sand and remove any small bits of organic matter that lodge there. The lack of worms and molluscs is probably a result of live sand collection from areas devoid of these creatures, or from crushing during shipping. In either case, lack of these critical components of the live sand bed starts us off at a disadvantage. Without them the sand is not adequately aerated, resulting in dead spots. Organic matter accumulates in the substrate and results in an increased likelihood of algal blooms.

Another crucial component of the system is sand-sifting organisms. Jaubert uses brittlestars, sea cucumbers, hermit crabs, and sand-stirring fish to further aerate the sand. In many instances the quality and quantity of these animals in our tanks is also low. Many of us also start off with only a small amount of actual live sand, with the rest of the substrate being dead aragonite sand or crushed coral sand. We hope that we can inoculate this dead sand with animals from the live sand. This may occur over time, but most of us are not patient enough. As a result we stock the tank and feed the inhabitants long before this sand is fully mature. Once again this results in the accumulation of waste and decaying material that acts as a nutrient sink.

One other aspect of Professor Jaubert’s system that has gone almost completely unnoticed is that, for the most part, the substrate does not have much live rock or corals resting on it. Jaubert attaches most of his corals and live rock to the side walls of the tank. Thus the substrate is not compacted and does not have rock-algae interfaces that act as detritus traps. In most of Jaubert’s systems less than 30% of the substrate has anything resting on it. This helps to limit the amount of waste and detritus that accumulates. Unfortunately, this large amount of open space is the exception rather than the rule in many of our tanks.

There has been debate about whether these tanks are actually closed systems. They are all at least partly open and many get as much as a 10% water change with ocean water each week. This further reduces any buildup of nutrients.

Based on the design details already mentioned, I no longer recommend this system for the typical hobbyist. My own two tanks experienced algal blooms within two years, forcing me to remove the Jaubert plates and most of the substrate. I did not make this decision lightly, because they were a 90 gallon tank and a 400 gallon tank. The 400 gallon tank contained 24 square feet of substrate three inches deep. Once I removed the plates and the substrate it took three months for the algae to die.

In the remaining six tanks that I helped set up using this system only two are free of algae and none have nitrate levels lower than 5 parts per million (ppm). The two successful tanks both contain high-quality live sand and have less than 40% of the substrate covered by live rock.

I believe that several other factors influence how successful an aquarium set up on Professor Jaubert’s system will be. Use of a protein skimmer may affect the dynamics of this system by removing organic material that might otherwise act as a nutrient source for the anaerobic bacteria. Ozone and carbon levels may also have some impact. My tanks are smaller and contain a much higher ratio of animals to water than Jaubert’s tanks. This probably has a negative impact on the system. I also make water changes less frequently.

Despite all of this I will probably continue to experiment with the Jaubert system, but I will make one major change. The Jaubert plate and substrate will be in an external chamber separate from my tank. If problems do arise the system can be simply taken off line without the effort now required to remove the plate and substrate.
The HANDY Reef is simple to set up and maintain, and costs much less than high-tech reef aquariums. The simple system was inspired by an article in the Fall 1993 SeaScope about Dr. Jean Jaubert's coral reef mesocosms at the Musée Océanographique in Monaco. Many people were skeptical that Dr. Jaubert's simple system would function as described, because other reef systems employ expensive and complicated high-tech equipment. Using no plumbing or protein skimmer was blasphemy.

It took me a year to get up the courage to try this system. My original system was discussed in my articles in Marine Fish Monthly and Freshwater and Marine Aquarium magazines. With the improved method described below a 55 gallon reef system can be set up that is cheaper than most others, but works just as well.

**Construction**

My system will work with any size aquarium, but 55 and 75 gallon sizes are very popular. I have both, as well as a 20 gallon. The following example is for a 55 gallon aquarium. Begin by cutting 3/4 inch PVC pipe into 36 pieces, each 1 inch long. Scatter these on their sides on the bottom of the aquarium. Do not smooth the cut edges and they will not move. Cut a piece of eggcrate lighting diffuser to be 1 inch away from each wall - front, back, and ends. Place this on top of the PVC pieces. Cover this with screening, stretching the screening out to the edges of the tank bottom. This creates a hidden plenum.

I cover the plenum with 4 inches of CaribSea® Aragonite Reef Sand, which buffers the water and adds calcium, strontium, and some trace elements to the water as it dissolves. In consequence I do not need to add kalkwasser supplements. Push the sand off the edges of the plenum and cover it completely. No airlift tubes are used. Water will circulate slowly through the sand, the sand will develop anaerobic conditions, and harbor anaerobic bacteria that will break down nitrates. I use a total of 80 pounds of sand for a 55 gallon tank. After adding 2/3 of this amount I place a double layer of window screen, and then add the remainder of the sand.

Now I fill the aquarium with saltwater made from a reliable sea salt, either Instant is well-represented in the saltwater hobby. Some of the six genera and seventy-two described species are very common. There are three species of blue tangs, the bristletooth *Chromis* tangs, the pelagic *Pomacentrus* tangs, the ever-present yellow and *Zebrasoma* tangs, as well as many *Acantthuras* tangs: powder brown and blue, *Achilles*; gold rim, orange-shoulder, sohal, mimic, and clown. These fish are essential to the marine aquarium hobby.

The sub-family Nasinae is comprised of one genus, *Nas*., and seventeen species. These are the unicorn fish. They may be distinguished from all other surgeonfish by two anal spines instead of three, and three soft pelvic rays instead of five. As do all surgeonfish, they have one or two sharp spiny processes on each side of the tail that are formidable weapons. Unicorn fish can be either of a slender, tubular shape or the more typical flattened shape, and may or may not possess a horn. Although the best-known example is *N. lituratus* because of the distinctive color and markings, there are other members that are

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**Unicorn Tangs, Genus Naso, Family Acanthuridae**

By Robert Fenner

Just how many unicorn or *Naso* tangs are there? Almost every aquarist is familiar with the *Naso*, or lipstick, surgeonfish, *Naso lituratus*, but there are at least sixteen other species. All of these tangs are active swimmers, possess prominent surgeonfish spines, and grow to be BIG.

Unicorn fish are unlike other *Acanthuridae* genera in their space and food requirements and their temperament. Following are my ideas of what makes a good specimen, how to go about selecting it, and some notes on successful maintenance in captivity.

**Classification**

*Acanthuridae*, the family of surgeon tangs,
The Conscientious Marine Aquarist

Continued from page 1

worthwhile keeping.

Most members of the genus Naso are unknown to hobbyists. *N. luteres*, the most well-known species, is also known as the tricolor or lipstick tang. Some individuals are blonde in color, or possess streaming fins. They are all members of the same species. This species grows to 18 inches (0.45 meters) in the wild.

*N. unicornis* is commonly known as the large or big nose unicorn fish. It is a deep-bodied fish that develops a prominent rostral horn when it reaches 5 inches (12.7 centimeters) in length. The body is light olive to gray, with yellowish highlights on the abdomen. The species can reach a length of more than 2 feet (0.6 meters).

The shortnose tang, *N. brevirostris*, is misnamed both scientifically and commonly. It has a long nose as an adult. There are other species with much shorter horns or none at all. This grayish-green fish is occasionally imported from Hawaii and the Indo-Pacific.

*N. uncommonis* has only a convex nose bump for a horn. Adult males are especially beautiful with bright blue and white highlights over a dark blue body.

*N. hexaenius* is sometimes called the black tongue unicorn fish. It has a slender green body with a bright navy blue tail. Neither sex develops a horn, but both sexes do have black tongues.

Range

Most unicorn fish are found in the Indo-Pacific from Hawaii to the Indian Ocean and the Red Sea. Their habitat is usually around steep coral or rocky reefs, but some can be found in deep open water.

Size

The smaller Nasso species grow to about

*Photo by John Ponn*

18 inches (46 centimeters). The largest can reach 3 feet (0.9 meters). None of them could be called small aquarium fish.

Full-size healthy tangs appear to be chubby. The stomach area of a healthy tang may be pinched in, but a hobbyist should not purchase any specimen that does not appear to be well-fed in other areas. Abnormally thin specimens may not have eaten for as much as two weeks, from the time they were collected and have gone to a wholesaler and a retail store. This malnutrition could cause seemingly mysterious death after purchase.

Tangs smaller than 4 inches (10 centimeters) rarely adapt to living in captivity unless they are well fed and have unlimited access to food. It is wise to buy only tangs that are larger than this size. It is important to avoid buying a tang that is too big for the aquarium where it is to live. I have seen a 12 inch (30 centimeter) *N. luteres* placed very successfully in a very large aquarium. This same fish would not have survived if it were put in an 6 foot long (1.8 meter) aquarium, and the death would probably have been attributed to vague behavioral problems.

Behavior

Healthy unicorn fish are visible during the day, briskly swimming horizontally along the length of the aquarium. Any specimen that hides or does not swim should be refused. Such behavior may be caused by confinement in an aquarium that is too small, but it is best to purchase a fish that acts naturally. Specimens should also be eating before they are purchased. The best unicorn fish come from the Red Sea, the second choice being Hawaii. The relative merits of cost versus likelihood of success of adapting to the aquarium environment can be discussed with the supplier. Color patterns and hues can change very quickly depending on the environment and the mood of the fish. Observe a fish for some time before purchasing it.

Remember that most of these fish are large and powerful and have both thick skin and sharp projections that are aptly named scalps. The fish often launch themselves like missiles when they are cornered or netted. Be careful. It is best to herd them underwater into double plastic bags whenever they must be moved.

Habitat

As has been mentioned before, these fish require large amounts of tank space. The minimum length of a system for a small specimen is 4 feet (1.2 meters); 6 feet (1.8 meters) or larger would be better. In the wild these fish range over large areas on steep reefs, picking attached algae. At night they forage cryptic coloration and settle into the reef. Replicating this kind of environment should add to success in keeping them.

Unicorn fish are tolerant of a wide range of water conditions, and standard fish aquarium conditions are acceptable. Adding a tang to an aquarium after all the other fish are in should allow enough time for algal growth and detritus accumulation that can serve as food, and reduce the likelihood of interspecific aggression. Any filtration method chosen should provide brisk water circulation. Unicorn fish are big, fast-moving fish that require high oxygen concentrations. The water cannot be moving too vigorously for them.

These tangs are generally not very aggressive, provided they have adequate swimming room. They may be troubled by larger triggers and angelfish, however. Take care to consider relative size of all prospective inhabitants of a new system, and make sure that the system has more than enough room. It is best to house just one Nasso per tank, unless the system holds hundreds of gallons of water. Nasso tangs are not suitable for a reef tank. They are too big and rambunctious, and are very likely to chew on prized invertebrates and algae.

Nutrition

Once they accept standard aquarium food, unicorn fish will eat greedily, but it may be difficult to gain this acceptance. Live adult brine shrimp may work for small tangs. The best greens are live marine algae, either attached or free-floating. Dried algae, flakes, or other greens are a second choice. Cruciferous vegetables such as broccoli, Brussels sprouts, or boiled cabbage are more nutritious than most types of lettuce. Nasso tangs are herbivorous in the wild, but will eat zooplankton as they get older. They can become acclimated to accepting many types of food in an aquarium. Shrimp and various types of worms can be offered along with the daily ration of greens.

Disease

Infectious disease can be avoided in these fish through use of quarantine procedures and freshwater dips. Copper treatments will cure

Continued on page 4
HANDY Reef Update

Continued from page 1

Ocean® or Reef Crystals®. Then I can add 3 to 4 pounds of live sand on top of the CaribSea® sand and mix it in. The bacteria and other life forms in this live sand will spread and multiply into the Aragonite sand. An abundance of nitrifying bacteria and other microfauna in the sand and live rock helps purify the water.

Next I push several small rocks down into the sand to rest on the divider screen. These provide a foundation for the reef structure. I try to construct a loose vertical rock reef that is irregular and interesting in shape, while still leaving 60% to 70% of the sand surface exposed and available for live sand filtration. Dry Aragonite rocks can be used to construct most of the reef. They will grow coralline and other life forms over the following months. Of course, several pieces of coralline-encrusted live rock should be placed on top of the reef structure to seed the Aragonite rocks. Epoxy putty such as HoldFast™ will help stabilize the structure. I try to create many caves and hiding places for the fish when I build a reef.

Equipment

For a 55 gallon aquarium I use one 150 watt or 200 watt Visi-Therm® heater, a Visi-Jet® PS-100 protein skimmer, and two Maxi-Jet® 750 power heads placed in the back corners and aimed toward the center front. I have a Millennium® power filter on the back of the tank, without the filter cartridge or BioGrid®. This provides extra circulation and a place for a bag of phosphate remover granules, a bag of activated carbon, or a bag of Mega Media® Aquarium Purifier.

Start-Up

I run the aquarium pumps and filters for 3 to 6 weeks with the aquarium lights off. This is to get rid of nitrates and discourage hair algae. I add food as if there were fish in the aquarium. The cycling process is accelerated because I do not run the protein skimmer, the phosphate remover, or activated carbon until 2 days before turning on the lights.

Lighting

I have found that the most cost-effective lighting is four 40 watt Triton or Blue Moon Reef fluorescent bulbs. Two of each in a mirrored reflector produces light with good color and intensity. Corals develop colors as good or better than those exposed to more expensive lighting such as VHO, Power Compacts, or metal halides. Even Acropora corals grow and develop good colors under this lighting. A 55 gallon HANDY Reef with plenum and sand is not very deep, so very bright intense light is not necessary. Electronic ballasts would provide brighter output with cooler, longer burning bulbs.

Maintenance

I use 4 ounces of activated carbon and 4 ounces of phosphate remover in separate bags for each 50 gallons of water. I rinse them very well before putting them in the Millennium® filter, and then leave the phosphate remover in the aquarium for 1 to 2 days. Too much phosphate remover for too long will slow the growth of more than hair algae, and could even kill Sarcophyton corals. Phosphate remover can be rinsed and reused if it is not exhausted. It should be used only when there is a problem with hair algae. Carbon can be used constantly, but must be changed every two weeks.

If the water is clear, turn off the protein skimmer and let the sand and live rock do the filtering. Many people have observed positive effects with less than maximum protein skimming. Filter feeders, including sponges, grow much better. Running the skimmer one day every week or two should be enough. I don’t add kalkwasser supplements, because this clogs the protein skimmer and also bonds to the Aragonite sand. I do add a half dose of a good broad spectrum trace element supplement such as Reef Evolution® Trace Elements every week, as well as a dose of Reef Evolution® Potassium Iodide.

I like to feed daily, even though some of the fish can scavenge a great deal of natural food for themselves. Anemones and copepods that live in the rocks and sand are not only a good source of food for fish, they also eat a fantastic amount of algae. I add only 1 or 2 Astarte snails per 10 gallons of water for algae control. I feel that the benefits of sand-stirring fish are overrated, and I do not stir the sand myself. I clean only the surface of the sand once or twice a year. I don’t want to remove too much of the microfauna or disturb the denitrification process.

Lots of people have tried this system and are very pleased with the results that are possible with such an inexpensive set-up. The HANDY Reef is not a new idea, only a variation of the Jaulters mesocosm, which in turn is only a variation of the Lee Chinn natural reef.

For more information on the HANDY Reef and other simple systems, tips, and techniques, read Tom Miller’s monthly column “Simply Speaking” in Marine Fish Monthly, or visit his new web site at http://www.handycoralreef.com.

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**OVERVIEW**

- The SeaClone™ protein skimmer’s versatile dual design functions as either a hang-on or sump model.
- The SeaClone™ protein skimmer utilizes a tornado-like motion to effectively draw wastes out of your aquarium.
- The SeaClone™ has been developed and tested in different aquarium environments. As a result, its design is simple and user-friendly.
- No airstones are necessary. SeaClone™ is more efficient than air-driven protein skimmers.

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**SeaClone**

The SeaClone™ has a Turbo-Venturi® Injector System that mixes water and air in the pump impeller chamber, creating a froth of micro-bubbles for maximum skimming efficiency. These micro-bubbles also improve gas exchange. In the Concentration Tube at the top of the "tornado" tube, the spiraling air/water mixture propels protein laden bubbles into the collection tube above. These bubbles burst, forming a frothy solution which gathers in the collection chamber. Dissolved organic compounds stay in the Large Capacity Collection Chamber, keeping waste separate from clean water until it can be removed for cleaning. This large capacity cup holds more and requires less frequent emptying.

**Aquarium Systems**

Manufacturer of Instant Ocean®

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The Conscientious Marine Aquarist

Continued from page 2

Infestations of common protozoan ectoparasites. Much work has shown that deficiencies of vitamin C and other nutrients may result in loss of color and lateral line erosion. It is easier to prevent these conditions than to cure them. This can be done by feeding nutritious food, with supplements, if necessary. Hiding behind tank decor or covering in a corner is not a disease, but such behavior should not be ignored. It may be caused by aggression from another fish, a change in arrangement inside the tank, or a tank that is not large enough. The situation should be remedied as soon as possible.

Conclusion

There is more than species of Naso tang, and all of them require very large aquariums. Choosing a healthy specimen and getting it to eat healthy food should result in a flashy and impressive display fish.

References


Protein Skimmer in a Jar

In recent years protein skimmers have become a popular means of purifying water in marine aquariums. They are considered a necessity by many aquarists, and are certainly one more weapon in the fight for better water quality. However, protein skimmers are still somewhat expensive, take up space, and can require attention, so many marine aquarists have not taken advantage of this technology.

Additionally, protein skimmers generally do not function in freshwater. For many freshwater aquarists this was not important because they made water exchanges regularly. The availability of more exotic freshwater species has recently resulted in special water conditions to accommodate the special needs of these fish. Exchanging this water is no longer a simple procedure, but reducing organic wastes in the water is even more important than before. Also, untreated tap water is often not suitable for use in either freshwater or saltwater aquariums.

The use of selective adsorbent materials can help both the freshwater and saltwater aquarist. Although activated carbon and organic scavenger resins are widely used in the aquarium hobby, they cannot remove all wastes. ProteinZorb® is a patented adsorption material that has been developed to selectively bond to protein molecules, effectively removing them from the water. Removing protein material before it is broken down into organic waste results in less frequent water exchanges and lowers the stress on fish that is caused by poor water quality. ProteinZorb® is a practical alternative to protein skimmers in marine aquariums. It is also just as effective in freshwater aquariums, even those containing delicate and exotic fish.

ProteinZorb® technology is available as Mega Media® Protein Remover. It is also available combined with activated carbon and organic scavenger resins as Super Aquarium Purifier. Both are granular media designed to be used in mesh bags that are placed in canister filters, box filter chambers, or the sumps of wet/dry filters. They are easily adapted to simple box filters commonly used in freshwater aquariums.

Hobbyists who would like to improve water quality and reduce maintenance time should try Mega Media® Protein Remover and Super Aquarium Purifier.
The Ecosystem Filtration System
by Michael Palutta and Rob Hildreth D.V.M.

Someone will ask me "What's new in reefkeeping?" at virtually every seminar where I speak. Unfortunately, the usual answer is "Not much." Several weeks ago, however, I had the opportunity to view a new method of reefkeeping. I want to try it for myself to see if it really is as revolutionary for the hobby as the trickle filter was 10 years ago. The method hybridizes techniques of other systems in a unique manner I haven't seen before. It may be that Leng Sy, the man who has developed and patented this "Ecosystem Method", has made a breakthrough in reefkeeping technology.

I know that this kind of claim has been made before. I must also admit that I was skeptical when Leng gave me a very brief description of his system over the phone. I have seen over 300 reef tanks set up by just about every method known, from undergravel filters to the Berlin system. Leng seemed to be describing a slightly modified version of the Jaubert method combined with an algae turf scrubber system. The tanks have the appearance of meticulously maintained Berlin tanks. Bright lights over absolutely crystal clear water reveal very healthy, growing corals in each tank. Closer inspection reveals phenomenal extension of the coral polyps. Leather coral polyps extend over two inches; Sinularia polyps appear so furry they look like cat paws. The same extension of the polyps is shown on virtually every colony of soft and small polyp stony coral.

Once I was convinced there was something different about this system I sat down with Leng to discuss it in detail. His system is composed of many modifications of existing techniques, resulting in a unique method. The goal is to allow corals to thrive in an uncomplicated and low maintenance system. He uses few gadgets, so there are few adjustments and few opportunities for mechanical failure.

As with most reef systems, water is drawn off the surface via an overflow and drains into a narrow chamber holding bioballs at one end of a sump. This is the heart of the system. The balls are submerged, not dry, and act primarily to break up any large pieces of detritus and

Continued on page 3

Commercial Breeding of the Dottybacks
by Todd R. Gardner, C-Quest, Inc.

This year is a landmark year in ornamental mariniculture. For the first time since the birth of this branch of aquaculture more than twenty years ago, a new family has been added to the very short list of consistently available tank-raised fish. Although many hatcheries, including C-Quest, display impressive lists of spawning and rearing successes, the only cultured marine fish regularly available to hobbyists so far have been anemonefish and a few species of gobies. Currently Jacqueline Baez, my co-worker, and I are celebrating a victory over Pseudochromis, or dottyback, larval mortality. After a two year struggle our dottyback survival rate has finally exceeded that of our anemonefish. Can you imagine a tank of 1500 newly-metamorphosed orchid or sunrise dottybacks? What a sight!

Method

Our method for raising dottybacks is fairly simple. Broodstock are housed in 120 liter (32 gallon) glass tanks, each with a small concrete block shelter. The central filtration is composed of a conventional rapid sand filter, a trickle filter filled with plastic bio-balls, a diatomaceous earth filter, a protein skimmer, and a UV sterilizer. The broodstock diet is a mixture of fresh seafood, vegetables, and vitamins, held together with gelatin.

The shelters are visually checked for spawns each morning. Dottybacks lay a gelatinous ball of eggs 2 to 4 centimeters (cm) in diameter (0.75 to 1.5 inches) containing 500 to 2000 eggs. A healthy well-matched pair will spawn about once a week. When a spawn is found, information on size, date, and species is recorded, and the spawn is assigned to a prepared larval rearing tank. After three days in the care of the parents the egg mass is moved into a hatchery made from an inverted soda bottle with the bottom removed. A steady stream of diffused air keeps the ball of eggs in

Continued on page 2

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motion. On the third or fourth evening, soon after dark, the eggs begin to hatch. If the spawn is healthy and has been kept relatively clean, all the eggs should hatch within a few hours.

Hatching

On hatching, the 3 millimeter (mm) larvae (0.1 inch) are transferred to a round 1000 liter (265 gallon) black polyethylene tank. There is no filtration or water exchange for the first week, only gentle aeration provided by a single airline. The water is kept slightly tinted with microalgae. The microalgae help to keep ammonia levels down and also sustain the rotifer Brachionus plicatilis, the readily-accepted first food of all our Pseudochromis species. We presently use the alga Nanochloris oculata. Rotifer densities are maintained between 6 and 10 per millilitre (ml) for the first 15 days. After one week the larvae tanks are connected to the larval/growout system with filtration similar to that of the broodstock system. Although at this point the larvae could easily swim through the 2 mm screen covering the overflow, they apparently are not inclined to do so. Around the tenth day Artemia enriched with Protein Selco* are introduced. Artemia will completely replace rotifers by the sixteenth day. Then a combination of commercial dry foods is administered one hour before each of the three daily Artemia feedings.

Metamorphosis

Metamorphosis begins about day 22, although in a typical 900 gallon the fish are more than 30 days old before all have passed the larval stage. The first indication of metamorphosis is a change in swimming patterns. The 1 cm (0.39 inch) larvae go from furiously swimming laps around the center standpipe to defending a small territory on the wall, floor, or even midwater if fish density demands it. Within a day of this behavioral change, the fish develop a hint of their adult coloration, and within three days are fully colored. The sight of a tank at this point, with more than a thousand tiny points of magenta, brilliant yellow, or neon blue, is spectacular, to say the least.

Price

You may be wondering if all this phenomenal success in rearing dottybacks will make them as affordable as tank-raised anemonefish. The answer is that it definitely will not. With an average larval period of three times longer than for any Amphiprion species, Pseudochromis require more time, energy, and resources just to become recognizable fish. In addition, in the interest of space for this article, description of our procedure has been somewhat simplified.

What exactly does all this mean for our hobby? Most importantly right now it means a steady supply of at least seven species of tank-raised dottybacks, priced competitively with their more aggressive and highly-stressed wild-caught counterparts. Why do we raise only seven species of a family comprised of well over a hundred? Simply because many of the species we would like to raise, such as Pseudochromis splendidus and P. aurifrons, are virtually unavailable to us. I am certain these and many other species are available in the aquarium trade, but unfortunately most suppliers don't give us requests very far priority. As a result, broodstock acquisition has become a major limiting factor in our mission: reducing or eliminating the detrimental effects wild fish collecting has on the world's coral reefs. We hope to do this by offering as many tank raised alternatives as we can. If you can help us obtain broodstock contact me at C-Quest, P. O. Box 1163, Salinas, PR 00751, phone 809-845-2160, fax 809-845-3929.

Editor's Note: C-Quest, under the direction of its owner Bill Addison, has made a major contribution to the marine aquarium hobby by commercializing the breeding of dottybacks. Currently the C-Quest Pseudochromis broodstock is tank raised and reportedly less aggressive than the initial wild broodstock. Some species are already in the third captive generation. Anyone who wants to breed these fish should begin with captive-bred fish to avoid the high courtship losses experienced with wild stock.

The list of breeding successes is amazing, both for those bred for sale and those not yet available in commercial amounts. C-Quest deserves our support.

Correction

An error appeared in the article “The Cell Structure and Aquarium Success of the Broyosadidae” by Robert Day, printed in the Winter 1997 SeaScope. The article describes the use of 15 watts per gallon actinic and coolwhite fluorescent light. This should read 1.5 watts per gallon. We regret the error, and apologize for any inconvenience.

Species Reared for Sale

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<thead>
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<tr>
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<td>False clown</td>
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<td>Barrier reef clown</td>
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<td>Orange clown</td>
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<td>Australian dotback</td>
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Other Species Reared

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ATTENTION

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dissipate large air bubbles formed when the water splashes down. It then flows through two outlets near the bottom of the divider into the main filtration chamber. Virtually all filtration occurs in this chamber. In the bottom of the chamber are two one inch partitions. Between these partitions is a special “mud”, the crucial component of the system. It is a non-calcareous medium that looks like thick brown sludge. It feels like extremely fine silt and seems to be slightly buoyant; it does not pack down. It seems that the slight buoyancy acts to keep it anaerobic. When a system is new the mud contains no digging organisms. After several years in use the mud is full of worms, copepods, nematodes, and other life forms brought in with live rock. Over the years Leng tried many forms of mud, but the one he uses now seems to work best.

Also in this chamber, above the mud layer, is a large bed of Caulerpa serotinoides which is maintained in a manner unlike any I have ever seen. It is illuminated 24 hours a day by four fluorescent tubes. Because of this continuous lighting there are no wild pH fluctuations as in other systems. The lowest pH of 8.4 occurs once an hour before the lights are turned on in the main tank. The highest pH of 8.8 occurs once an hour before the main tank lights go off at night. Also, the bed of Caulerpa, even after several years, has never gone into a sexual reproduction phase. As a result none of the Caulerpa has found its way into the main tank, a problem occurring in some other algae filtration systems. Caulerpa serotinoides is a sturdy species, however, and this may explain the lack of sexual reproduction.

It is interesting that the water is crystal clear and does not become yellow over time as in other reef systems containing even a small amount of algae. This may be a result of the 24 hour light. Lack of darkness may prevent the production of a yellowing compound called gelvin, thought to be a product of the nighttime breakdown of algae chloroplasts that are released into the water. In addition, for reasons still unclear, the algae has never outgrown the filter and has never had to be removed or harvested. This of course reduces maintenance time.

After passing through the Caulerpa section the water flows over a partition and through slots near the bottom of a second partition into a chamber containing bioflee. These bioflee prevent any Caulerpa from entering the main tank through the pump. Flow per hour through the filter is approximately three times tank volume.

This system presents advantages in addition to the obvious health of its inhabitants. It requires less maintenance than just about any other system. Tank bottoms are bare for easy removal of settled detritus. Strong water current also prevents detritus from accumulating. Pumps in the 400 gallon tank collectively pump 4,000 gallons an hour to keep detritus in suspension long enough to reach the filter. The strong water movement probably also explains the exuberant growth of the corals and invertebrates. In the 120 gallon tank containing soft corals the circulation is approximately 1,500 gallons per hour.

Other than a weekly siphoning to remove collected detritus, the only regular maintenance is the addition of calcium in the form of calcium hydroxide and buffer. This is done to maintain the calcium level above 400 parts per million and alkalinity above 2.5 milliequivalents. No other additives are used. Many aquarists have tried the Jaubert system, with mixed results, and algae turf scrubber systems with less than optimal results. The ecosystem described above appears to work better on a closed system than the others. The mud which Leng has developed seems to have unique properties. It may aid in maintaining the Caulerpa, or in removing organic compounds released by the Caulerpa before they reach the main tank. In any case, the ecosystem would not work without the presence of the mud.

The ecosystem has also been shown to play a part in reversal of head and lateral line erosion (HLE) that occurs in several families of fish. More research in this area is currently underway.

Many questions remain to be answered about this ecosystem. I have set up two tanks using this method and hope to have some answers after a year. I will have a more detailed description of the ecosystem in the November issue of Aquarium Fish Magazine, and also will present some of my observations at the Marine Aquarium Conference of North America (MACNA) in September. I hope that all of this will spur renewed interest in reefkeeping.
Aquarists are eternally seeking the best filter system. It might appear that this would be easy to find, but the fact is that no one biological filter is the best. The diversity of types of displays and organisms maintained makes it impossible for one system to be optimal for all aquaria. The hobbyist must first decide what style of aquarium is desired and then select the best filter for that application.

Each method of biological filtration has advantages and disadvantages that make it a good or bad choice for a particular application. One common type of nitrifying biological filter is the submerged substrate filter. This category includes rapid sand filters, undergravel filters, and sponge, canister, and box filters. Trick filters, wet/dry filters, and packed towers are also very popular, as are rotating biological contactors (RBCs), also known as biological wheel filters. Natural filter systems, including static sand and algae filters, are more recent developments, as are fluidized bed filters.

For a simple fish aquarium containing a relatively few fish an undergravel system will be a good, economical choice. For this kind of filter system to work really well, monthly hydro-vacuuming of the gravel is needed to prevent a build-up of detritus.

A wet/dry or trickle filter is a popular choice for a reef tank or community aquarium. If proper ventilation, this filter provides excellent opportunity for gas exchange. A trickle filter has the most efficient nitrification rates compared with other methods on a basis of filter medium surface area. However, the total available filtration surface area is lowered when using bio-ball filter medium. Thus, for heavily loaded systems a trickle filter system may not perform as expected. Aesthetically, such filters do have an advantage because they can be hidden in the stand under the tank.

Rotating biological contactors also utilize the high efficiency of thin films of water over a film of bacteria that is found in trickle filters. In this instance the bacteria grow on the surface of a rotating drum. RBC's also boast high gas exchange rates, but here again a principal shortcoming is the limited surface area available for filtration. Traditional RBC's are constructed by forming large discs on an axle. The discs are partially submerged in water and slowly rotated. Nitrification is accomplished by a film of bacteria that coats the filtering surfaces on the discs. In one popular aquarium filter version, pleated filter cartridges are rotated in water. Here the primary limitation is the small gross surface filtration area of the pleated cartridge. After bacteria form a film on the external surface, thus sealing off much of the internal surface of the cartridge. This particular filter has also been criticized for mechanical failure that keeps the wheel from turning, and the noise and salt creep that are the result of the splashing action.

Natural systems utilize organisms on the rocks and sand in an aquarium to process waste. Lee Chin Eng and Dr. Jean Jaubert have both proposed variations on this type of system. This is a more passive approach to filtration, and this method seems to be best suited to small reef systems where there are low feeding levels and natural recycling of available nutrients.

Reef systems have been in fashion for over a decade, but the fact is the majority of marine aquarists want to fish. Reef invertebrates generally do not thrive in aquariums with lots of fish. Many angelfish, butterflyfish, and triggerfish will eat the most desired invertebrates. Feeding large carnivores (groupers, eels, lionfish, bamboo sharks, and many others) results in a high level of nutrients in the water that is detrimental to the health of delicate hard and soft corals.

Fish aquaria, especially those with many or large fish, need a highly efficient biological filter to rapidly convert ammonia and nitrite to nitrate. This is true for both freshwater and saltwater aquariums. The new compact fluidized bed filters, such as the QuickSand® biological filter, meet this need very efficiently.

Properly conditioned, the compact QuickSand® QSA-1, with over 65 square feet of surface area, has been shown to handle the ammonia wastes produced by 20 pounds of Oscars over a 6 month period. Dr. Dallas Weaver of Scientific Hatcheries was an early advocate of fluidized bed filters. For many years Dr. Weaver supplied most of the Los Angeles pet market with feeder guppies from a facility the size of a garage. At conditions approaching one pound of fish per gallon of water, Dr. Weaver had to maintain oxygen levels by injecting pure oxygen into the water. However, his fluidized sand filters performed far better than any other system available.

This is the kind of filtration efficiency that has induced many of the major fish wholesalers to convert to fluidized bed filtration over the last decade. Public aquariums are also switching from trickle filters, submerged sand filters, and other methods, to the new commercial fluidized bed filters. Aquariums that have a heavy load of animals may require extra aeration. This could be supplied by means of an airstone, a protein skimmer, or an aerating back filter such as the Millennium® 2000.

SeaScope® was created to present short, informative articles of interest to marine aquarists. Topics may include water chemistry, nutrition, mariculture, system design, ecology, behavior, and fish health. Article contributions are welcomed. They should deal with pertinent topics and are subject to editorial reviews that in our opinion are necessary. Payments will be made at existing rates and will cover all author's rights to the material submitted.

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Internet Home Page: http://www.aquariumsystems.com
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Aquarium Culture and Reproduction in the Sea-Cucumber genus Synaptula

by Robert Day

Sea-cucumbers of the family Synaptidae (Phylum Echinodermata, class Holothuroidea, order Apoda) are rarely studied and somewhat unusual in their appearance, movement, and reproduction. Most are small transparent worm-like creatures that creep ceaselessly around their habitat, propelled by gently undulating tentacles and the peristaltic movement of their bodies. Within the Apoda there are tropical, temperate, and deep water species that range in size from less than three to more than thirty centimeters (1 to 11.5 inches). Synaptula h.fdiformis, the most common species to appear in marine aquaria, rarely exceeds 9 centimeters (3.5 inches). Most specimens are a dull gray or brown color, although some show delicate hues of green, red, or pink. They feed on detritus, microalgae, and the mucilaginous secretions of the macroalgae through which they creep. The food is scooped up by the feathery tentacles and slurped off as the tentacles pass through the mouth. Tiny, calcareous hook-like structures called ossicles are embedded in the skin and help the fragile creatures remain attached to the substrate even in quite strong currents. Because of their atypical appearance they are often misidentified as worms. A number of misleading common names have been applied to them in aquarium stores where they sometimes appear (e.g., "Medusa worm", "velcro worm", and "worm cucumber").

Reproduction

Their mode of reproduction is unusual in that they are viviparous, protandrous hermaphrodites; that is, they start life as males, but later convert to females. Mature females brood developing offspring in their body cavity where the offspring can sometimes be seen with the naked eye. Eventually a rupture or outpouring of the mesoderm and gut tissue allows the offspring to离开 via the anus, which may not seem like much of a start to life but seems to work for them. The young are born as well-developed miniature versions of the adult and immediately take up a lifestyle similar to the parent.

The Razorfish, Family Labridae

by Robert Feuer

Within the great group of fish we call wrasses are the razorfish. Most marine aquarists are familiar only with their most prominent member, the dragon or Indian wrasse, Hemipteronotus indiensis. As demand for novel specimens has grown, more species of razorfish are making their way into the trade. As aquarium fish, razorfish are a mixed blessing. They all grow to appreciable size and are moderately aggressive. They are also intelligent, come in odd shapes, and have interesting swimming and behavior patterns. Razorfish provide endless fascination for aquarists with large systems containing tough tankmates.

Taxonomy

The systematics of the Labrid family and its razorfish members is very messy. There are at least sixty genera and six hundred species of wrasses. Razorfish are confined mainly to the genera Hemipteronotus and Xyrichtys. However, in many razorfish species the male, female, and juvenile stages have distinctly different color patterns and shapes. Furthermore, intermediate female-to-male sex changes occur, and different types of males of the same species have been observed.

Characteristics

Razorfish have the "standard" wrasse profile: laterally compressed body, thick caudal peduncle, large cycloid scales, and square tails. They have some distinct peculiarities, such as squarish heads with often a sharp leading edge. They also bite. They have a prominent pair of enlarged, razor sharp canine teeth. Razorfish also possess one or two flexible anterior dorsal spines.

Selection of Specimens

As is the case with many wild-caught fish, most razorfish die from rough handling and crowding in the period between collection and reaching a retail shop. Almost all razorfish that survive to reach a shop will live in an aquarium. Razorfish are strongly territorial and don't do well when crowded with members of similar species. Look for full-bodied specimens without tear marks. Normal feeding and swimming behavior is also important.

Behavior

These aggressive, territorial fish should be added to an aquarium after all other livestock. Do not worry if your razorfish seems to stay under the sand or in the shadows a good deal of the time. Unless aggression from a tankmate is observed, this may be natural behavior for...
A Comparison of Metal Halide Bulbs

by Richard Harber

A hobbyist planning the lighting for his reef tank is confronted by a bewildering number of choices. He has to choose between fluorescent and metal halide bulbs. Once he has chosen, he is faced with choosing among the many bulbs of each type that are available. This choice is even more difficult because of a lack of information. Manufacturers publish a limited amount of information about their bulbs, and little of it directly applies to how well each will perform over a reef or plant aquarium.

After discovering how little objective information is available about metal halide bulbs, I decided to conduct an evaluation of the most common brands. This will be the first of a series of evaluations I made of a total of 13 of the most popular bulbs available in the aquarium hobby today.

The measurements presented here were taken with a LiCor DataLogger fitted with a PAR (Photosynthetically Active Radiation) sensor. PAR units are the most commonly reported units of light measurement used in biology, because they show the relationship between light and photosynthesis. They are reported in Einstein (E) or micro-Einstein units (µE). The light over a tropical reef can reach 2000 µE per second per square meter (µE/s/m²). Maximum photosynthesis by the zooxanthellae contained in symbiotic small polyp stony corals occurs between 300 and 600 µE/s/m².

Comparing bulbs by PAR values is superior to using the more common lux measurements. Simply put, lux meters match the sensitivity of the human eye, giving higher readings to green and yellow light and lower readings to violet and blue light. Bulbs that produce more green and yellow light appear brighter to our eyes and so have higher lux ratings than those producing violet and blue light. However, violet and blue light is just as important to the photosynthesis procedure as green and yellow light. This is why PAR sensors are more appropriate for the reef aquarium situation.

**Procedure**

Each bulb was purchased new and burned for 100 hours to purge it of impurities, as recommended by the Illumination Engineering Society. All bulbs of the same wattage were tested using the same ballast. The sensor was mounted about 60 centimeters (23 inches) from the bulb, simulating the distance to the bottom of a typical reef tank. Light levels were monitored until the light intensity reached the maximum, generally 7 to 10 minutes. Once the intensity had stabilized, the meter automatically recorded 60 readings and calculated an average. The 60 readings rarely varied more than 0.5 µE/s/m².

**Results**

Results of my testing are divided by bulb size. A table comparing all brands tested follows the discussions of different wattage bulbs.

### 175 watt bulbs

The ballast used for the 175 watt bulbs was manufactured by Custom Sea Life of Carlsbad, California. I tested an Iwasaki 150 watt bulb in addition to the three 175 watt bulbs. It is commonly claimed to be interchangeable with a 175 watt bulb, but its low-intensity suggests that a special ballast may be needed to obtain maximum output.

**250 watt bulbs**

The ballast used for the 250 watt bulbs was manufactured by Magnetek of Nashville, Tennessee. The German 20,000° Kelvin (K) bulb did not show the name of the manufacturer on the bulb or the box. The poor performance given by the Osram bulb suggests that, as with the Iwasaki bulb, a special ballast is required for maximum performance. Results of both are included in this report because both bulbs are sold in the aquarium trade with assurances that no special ballasts are needed. Each bulb lights normally without any indication that it is not performing properly.

**400 watt bulbs**

The performance order of the 400 watt bulbs mirrored that of the 250 watt bulbs, with the lower temperature bulbs producing the most PAR. This supports data previously obtained showing that white bulbs (6500° K) produced as much or more blue light as blue bulbs.

### Efficiency

Most hobbyists want to light their tanks properly, but not spend more money than necessary to do it. Metal halide bulbs are expensive and produce a great deal of heat that often requires the use of a chiller to keep water temperature within acceptable limits. Consequently, the practical hobbyist wants a bulb that produces the most light for the fewest watts consumed.

As expected, higher wattage bulbs produced more intense light than lower wattage ones, but some were more efficient than others. Dividing the PAR of each bulb by its power consumption permits comparison of bulbs across wattages, showing which bulbs generate light most efficiently. As expressed by micro-Einsteins per 100 watts of power (µE/100W). The most striking aspect of this efficiency rating is the poor showing by the 250 watt bulbs. Several of the 175 watt and 400 watt bulbs were tested.

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**Continued on page 4**
Water Changes

by Mike Paletta

To change or not to change; that is the question. As the methods of filtration progress in the saltwater aquarium hobby, and overall success rates along with them, more and more claims are being made that there is no longer a need for water changes. I remember vividly the claim of a manufacturer of an early trickle filter that this filter would “eliminate the need for water changes forever.” Unfortunately, experience has taught us that these claims were not only untrue but were actually harmful to the animals in our aquariums.

Better filtration methods permit cleaning a tank without completely dismantling it, but the task of changing water still remains. I would love to say that it is not necessary to change water, and I am sure there is someone who has not changed his water in a long time and still keeps animals alive. However, for most of us hobbyists who occasionally overstock and overflow our tanks, this strategy will not be successful in the long run.

The reason for this is simple. Despite all the progress in chemical and mechanical filtration, no method I know of can remove all the harmful substances that accumulate in a closed system. Changing water removes compounds that filtering will not, and dilutes any harmful compounds that remain.

Making a water exchange is not complicated, and certain techniques can make it even easier than it first appears to be. Turn off any power heads to reduce the current. Use a bulb baster to blow any detritus or waste material off live rock. In the absence of water currents this waste will settle to the bottom of the tank. Because the primary goal of changing the water is to remove wastes, siphoning this material off the bottom should be part of every water exchange.

Physically removing detritus from a system usually improves overall health. Organic phosphates, nitrates, and algal spores are present in the detritus that accumulates in the nooks and crannies of every tank. Algal blooms get much of their nourishment from detritus. In this respect they have an advantage over corals. Corals are not as efficient as algae at utilizing such detritus as food; they are more efficient using primary waste products such as ammonia and fecal pellets. Allowing detritus to remain in a reef aquarium will encourage the growth of algae.

Once the detritus and a certain percentage of water is removed from the aquarium, new water can be added. This new water should be mixed so it matches the old water in terms of temperature, salinity, alkalinity, and pH. The closer the new water matches the old water, the less shock there will be to the animals in the tank. Additionally, the water used should be as pure as possible. I strongly urge anyone who keeps a reef tank to use deionized or reverse-osmosis filtered water to make the saltwater mix. I have seen several tanks fail when the owners did everything correctly except use filtered or deionized water. They used tap water that had high levels of nitrate and phosphate. Algae seems to proliferate after a water change using tap water, and corals look less healthy than more healthy. Even carbon filtration is not sufficient to remove nitrate and phosphate.

One other factor that should be considered is that freshly made synthetic sea water is caustic, and will irritate invertebrates if it is added to an aquarium right after mixing. The water should be mixed at least two days prior to the actual exchange. I usually mix it three days before use and aerate it with an airstone until I am ready for it.

I hope that I can convince more hobbyists to do water changes. The next questions to be asked are how much to change, and how often to change. For two years I have been running a little experiment, trying to determine the best method. I had two similar Berlin-style reef tanks. I made no water changes in one, and changed 10% of the water each month in the other. After six months it was easy to see that there was much stronger growth of slime algae and microalgae in the tank that had no water changes. Next, to see if more was better, I started to change 10% of the water each month in the tank where no changes had been made, and 25% each month in the tank where 10% changes were made. After another six months both tanks looked equally healthy. There is still little difference between them after two years.

For these small Berlin-style aquariums, increasing the size of the water exchanges beyond 10% did not seem to increase the benefits obtained. Dramatic benefits could be seen, however, between the tank receiving 10% changes and the tank receiving no changes. Even with this simple experiment, the results support the practice of regular water exchanges.
A Comparison of Metal Halide Bulbs

Continued from page 2

The Razorfish, Family Labridae

Continued from page 1

the species. They may themselves show aggression toward smaller delicate tankmates. All razorfish species are territorial with their own kind. Thus, the aquarist must observe every fish in an aquarium containing razorfish. He should also take care feeding and netting around those sharp teeth.

Habitat

Razorfish live in coral reefs around sandy and rocky areas. They are secretive, with cryptic coloration and a long thin shape for slipping into cracks or beneath the sand. An aquarium should have broken rock and coral areas and fine sand where a wrasse can tunnel and bury itself to sleep. These not good fish for an aquarium.

These large active fish have big appetites, and stir the sandy bottom by their tunneling. Vigorous, efficient filtration is necessary.

Feeding

Razorfish are omnivorous, feeding on a mix of molluscs, brittle stars, and crustaceans in the wild. In captivity they will consume meat and all sorts of shrimp, molluscs, and worms, as well as live, frozen, and dry-prepared food. The family name, Labridae, is derived from the Greek word labros, meaning greedy. This describes their love of eating. It is best to develop a feeding routine with these fish. Some food could be placed in a corner for the most aggressive feeders while other food is put at the opposite end for less greedy tankmates. Take care if feeding by hand. These fish bite.

Disease

Razorfish seem to be remarkably resistant to infectious and parasitic diseases. As other wrasses do, these fish rub or scratch against aquarium decor and the tank bottom. This is normal, and in the wild is probably a means of revealing food.

Summary

Razorfish are not for everyone or every aquarium. They grow to be large and nasty. An aquarist might want to have one in a fish-only aquarium containing other large, aggressive fish. These wrasses will reward the aquarist with constant daytime rearrangement of the aquarium gravel and decor and theft of as much food as possible from all other tankmates. Then they will go to sleep under the sand.

Suggested Reading


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