The Batfish

By David V. Keeley
Loughborough, England

This article was inspired by one particular Long Fin Batfish, which was my pet for many years before it came to an unfortunate end. I use the word "pet" advisedly, because it is one of the few species of marine fish which can be regarded as a pet. Because it shows no apparent fear, it will readily swim at the front of any tank, and can easily be trained to hand feed. In fact, that last phrase rather disguises the truth, which is that the common Batfish is so constantly greedy that, at the first sign of an imminent meal, it is almost prepared to leap out of the aquarium just to get at the food a few seconds earlier.

There are three species of Batfish. The most common is the Roundfin Batfish (Platax orbicularis). In the wild they are widespread in the Pacific region. When they are imported, they are usually from 2-5 inches long, taller than they are long, and usually light brown in color. At this age, they resemble a floating mangrove leaf. Young Batfish are quite delicate and susceptible to bullying from more robust fish, but how this changes as they develop, Batfish grow in captivity faster than other species. In no time at all, the small 2 inch specimen can become a massive 20 inches long, developing a dark silver/brown color and almost circular in shape. At this age, they are one of the plainest, if not ugliest, of marine fishes.

How different is the next species, the Long Fin Batfish (Platax tiera). These can only be found around Indonesia and the Philippines. But, they are not rare, and are regularly imported. They are normally seen at around 3-5 inches long; but at this length, they

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Breeding
The Yellow Tailed Damselfish
(Glyphidodon hemicyaneus)

By P. D. Unwin

This small species of damsel fish, as well as being a colorful addition to the marine aquarium, is also a good fish to attempt to breed. In a relatively small aquarium of 20 gallons, they will spawn, at approximately 8 day intervals, always early in the morning.

The male can be seen chasing the female, then darting back to the nest site. Eventually, after several dry runs, the female follows and one to two hundred eggs are laid on the underside of the shell or plant pot. Four days later, at about 27°C (80°F) and within one hour of darkness, the young hatch.

This presents feeding problems. Being too small to take rotifers as a first food, green water culture must be fed for the first week, gradually introducing rotifers as the larvae grow. At about 21 days, the fish begin to take on their adult colors and can be transferred to an undergravel filtered tank. Powdered flake food can then be used as a staple diet, although the fish will benefit greatly from additional live foods, such as newly hatched brine shrimp.

My initial experiments were carried out some three years ago, using Instant Ocean® Salt, at a temperature of 27°C., specific gravity of 1.022. In a 20 gallon static larval tank, I reared 60 fish in one hatch.

I have also had success in breeding the Electric Blue Damsel fish (Abudefduf caeruleus). These damsels seem more secretive than the above, and I have never witnessed them spawning. The larvae, however, are very similar and can be reared the same way. They do, however, take much longer to obtain their juvenile coloration, 40 to 50 days. 

Red Fin Batfish (Platax pinnatus)
Photo: Aaron Norman
Control of Marine Parasites

In the late 1940's, use of copper was pioneered by Max Gelfand at Marineland of Florida for treatment of the two most common and hazardous marine parasites, *Amyloodinium ocellatum* (Oodinium or Marine Velvet) and *Cryptocaryon irritans* (White Spot or Marine Ich). Robert Dempster's classic 1955 paper popularized copper as a viable treatment, and over the years a number of alternate therapies have been tried along with modifications to the form of copper used. This article reviews various methods with respect to effectiveness and limitations.

Alternative Therapies

Quinine and similar synthetic chemicals (atabrine, quinacrine, chloroquine, primaquine, etc.) have been recommended as alternatives to copper for treatment of *Cryptocaryon* and *Amyloodinium*.

Quinine Sulfate or Quinine Hydrochloride (HCl) is often administered at 250 milligrams per 10 gallons of aquarium water. For *Amyloodinium*, parasites will encapsulate and fall off in 2-3 hours; however, they are not dead so a follow-up treatment with copper is necessary to prevent reinfection. Care must be taken because Quinine may injure live corals, anemones, and macroalgae, and multiple treatments without removal of initial dose can produce toxic conditions. Use of activated carbon after treatment will remove the yellowish residual compounds.

Use of a freshwater dip (three minutes) can be beneficial. *Cryptocaryon* trophons (parasitic stage) are beneath the slime, and are not affected, but the majority of oodinium cysts will encapsulate and fall off in three minutes. They do not rupture, however, and some will invariably remain trapped on the fish in the slime or between gill layers. Thus dips will provide valuable but only temporary relief. Follow up copper therapy is necessary.

When administering freshwater dips, be sure to: 1) de-chlorinate, 2) aerate, 3) adjust pH (pinch of baking soda), 4) adjust temperature, and 5) watch for acute stress.

Formalin is often recommended, either as a bath or added directly to the aquarium, along with copper. Sold commercially as 37% formaldehyde, it is primarily useful for *Cryptocaryon*. As a bath, use 1ml per gallon or one teaspoon/5 gallons seawater with aeration for one hour.

Copper Therapies

Among the copper medications, there are four main types: ionic coppers, copper/formaldehyde mixes, chelated coppers, and amine complexed coppers. Some features are common to all of these. All forms of copper are eventually deposited on the filter, whether administered as one large, complexed dose or many small additions.

In marine aquariums with carbonate filters, copper tends to be adsorbed by the carbonate filter. Inert filters, such as silica sand, to a lesser extent, also remove copper, but this is due to the high carbonate level in seawater. A bare or foam-filtered tank maintains the most stable copper level and is the best situation for effectively treating fish.

Copper is a toxic metal that, fortunately, is more poisonous to parasites than to fishes. Its toxicity, as well as effective concentration, are influenced by the chemicals used to modify the copper solutions. Those mixtures that are stable in solution require the highest copper concentrations for treatments.

Eventually, whether chelated or unchelated, copper is deposited on the filter, although strongly chelated or complexed coppers stay in solution much longer than ionic or free copper.

With any form of copper the questions of what to do with invertebrates must be faced. Either the fishes must be treated in a quarantine tank or the invertebrates must be removed to another aquarium. The second choice provides only a temporary solution, however, because invertebrates such as anemones and some mollusks will not tolerate high levels of copper on the gravel, even when the level in the water...
has been reduced to "safe" concentrations!

A major difference between the non-chelated (ionic) coppers and the chelated forms is in their ability to be removed from the water. The ionic form, which would be present at a low level (0.15-0.20 ppm), is readily removed by activated carbon. However, the strongly complexed types, which may be present at levels of 1.5-3.0 ppm will not be removed. Some types of specific ion exchange resins are effective, but large amounts may be needed. The most common removal method is massive water exchanges.

To be effective, exchanges should be well over 50% at a time, with 90% being preferred. Hobbyists often make several "large", 25% exchanges and are surprised to still have high total copper levels after using chelated copper. As an example, to reduce a level of 2 ppm copper to below 0.1 ppm would take one 90% and one 50% exchange; but eleven 25% exchanges would be necessary. Thus, for a 100 gallon aquarium, the first method takes 140 gallons while the second takes 275 gallons.

Ionic coppers include solutions of copper sulfate, copper citrate, and mixtures of copper sulfate and citric acid. Although citrate is a mild chelator (agent that binds with a metal), once dissolved in seawater, the copper is essentially totally ionic. The small amount of acid, used primarily to stabilize the solution in the bottle, is insignificant to the pH of the aquarium. As previously mentioned, copper ions tend to be absorbed by the carbonate filter material. Thus, depending on the amount of filter material, daily additions are necessary to maintain a therapeutic level of copper in an aquarium.

The level of ionic copper is important. It should be maintained at between 0.15 and 0.20 ppm for 14 days. Use of an accurate test kit, such as SeaTest® for Copper, is necessary to insure a therapeutic dose without reaching toxic levels.

Several aquarium products combine formalin with copper. These mixtures may be somewhat more effective than traditional copper, especially for Cryptocaryon. Their limitation is, that in order to maintain therapeutic ionic copper levels for two weeks, multiple treatments generally are necessary, and the resulting formalin levels may impair the biological filter, and produce elevated ammonia levels.

The strongly chelated or complexed forms of copper, such as CopperPower® or CopperSafe®, are designed for use in one large dose, generally between 1.75 and 3.0 ppm total copper. Although some of these will register on test kits, the levels will be far beyond the limit of sensitive, low-range tests. Most of these products give a recommended schedule for additions but omit suggested treatment levels. Thus, they are not compatible for use with test kits. The high levels are possible because the copper is so tightly bound that it is detoxified. However, they may still be unsafe for many invertebrates, and are difficult to remove from the water after treatment. Neither of the above mentioned products can be effectively removed with activated carbon.

The final category, amine-complexed coppers, have characteristics that fall between those of ionic (free) copper and the strongly chelated types. These apparently can be more toxic to parasites than the chelates, but proper treatment levels for the various products have not been well established and documented.

In conclusion, we still must recommend ionic copper as the treatment of choice for control of Amyloodinium and Cryptocaryon infestations. Use of an initial freshwater dip for Amyloodinium or formalin bath for Cryptocaryon often improves survival since copper is generally effective only against the free swimming stage, thus preventing reinfestation. Improvement in fishes condition will usually take 4-5 days.

SeaCure® Copper treatment is a reliable source of ionic copper that can be especially effective when used in conjunction with the SeaTest® Copper Kit.

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**Book Review:** Butterfly and Angelfishes of the World, Volumes I and II

By popular demand, these highly acclaimed and fabulously illustrated books are available again.

The two volumes describe all known species of these extremely popular families, including rare marine hybrids. The text provides an abundance of information, including current valid species, names and synonyms, localities, habitats, dietary needs, and data on aquarium care.

Over 200 of the more than 500 color illustrations are underwater photos of fish in their natural habitat. Generally, juvenile, as well as adults, are shown plus many of the regional color variations.

In Volume I, Roger C. Steene surveys the 86 species found in the Indo-Pacific region of Australia and New Guinea. This volume is a revised edition, and includes many new photographs. Volume II, by Dr. Gerald R. Allen, completes the list with species from the Atlantic Ocean, Caribbean Sea, Red Sea, and Indo-Pacific regions.

For easy reference, a ten page table summarizes the habitats, aquarium care, and methods of feeding for all species for which data is available.

This beautiful, authoritative set is a valuable reference for anyone interested in marine fishes. It will be an asset to marine aquarists and divers, as well as ichthyologists, all over the world.

Available through your local pet dealer, the suggested retail prices for Volume I and Volume II are $30.00 and $36.00 respectively. These new editions are published by Aquarium Systems, Inc., manufacturer of Instant Ocean® Sea Salt.
The third species is the Red Fin Batfish (Platx pinnatus). This fish is even more exotic to look at than the Platx tiera. It is similar in shape, uniformly dark brown, but all along its leading edges it has a vivid red fringe, from the tip of the dorsal to the base of the caudal. They are to be found in the same regions as the Platx tiera, but are far less numerous, resulting in a paucity of imports and very high price. Perhaps this is to the good, because the Red Fin Batfish does not make a very good aquarium inhabitant. The majority of them just will not eat in captivity. It is very upsetting to own one of these magnificent creatures, and to see it slowly weaken and die just because of some seemingly psychological block against feeding.

One final point about maintaining Batfish in captivity is the ease with which they seem to contract White Spot (Cryptocaryon irrtans). Even if they did not eat invertebrates, Batfish could not easily be kept with them, since they may need repeated doses of copper in order to keep at bay this recurring problem. The White Spot attacks do not seriously affect the fish as long as he is treated, and the spots show up on the brown skin so that diagnosis should not be unduly delayed.

To sum up, a potential Batfish owner requires a large aquarium, preferably two feet deep, with a heavy cover glass, a careful mixture of companions, a large freezer, a good supply of copper (SeaCure®), and loads of patience. In return, the rewards can be very fulfilling, with an unbelievable ongoing “dialogue” between human and fish.

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 marine aquarium topics and are subject to editorial reviews that in our opinion are necessary. Payment will be made at existing rates and will cover all author's rights to the material submitted.

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Keeping Crustaceans: The Vulnerable Molting Period

By Pete Giwozyn

As a rule, decapod crustaceans (crabs, lobsters, and shrimp) are hardy aquarium specimens. Feeding them is no problem, they are disease free, and given their low metabolism, they do not require vast amounts of living space, making them well-suited to aquarium life. Once established in a well-maintained aquarium, crustaceans would be all but indestructible if not for their one great weakness — the need to molt periodically in order to grow. Molting or ecdysis is the Achilles’ heel of all crustaceans, and when an aquarist loses a crustacean, it is almost always during the vulnerable molting period.

A decapod’s exoskeleton is normally permeated with calcium salts to give it strength and rigidity. After shedding this hard, external crust, however, a crustacean’s uncalcified outer shell is nothing more than a soft, flexible layer of the chemical chitin. The soft-shelled crustacean is thus in grave danger until its newly-formed exoskeleton has fully hardened again, a process that can take from hours to days.

The process of molting actually begins weeks or months before a crustacean casts off its old armor. In preparation, a decapod begins to build up energy and mineral reserves. This build-up is vital because a crustacean is unable to feed for a considerable time before or during the molting process, and must draw on its bodily reserves both to maintain itself and to construct its new skeleton.

Dramatic internal changes also take place at this time. Much of the calcium carbonate and the organic material of its exoskeleton is resorbed and recycled, as a new soft shell is formed underneath the old one. This process leaves the outer shell much more brittle than before and considerably weakened along special lines where the exoskeleton has been more completely resorbed than elsewhere.

Once its new skeleton has reached a certain stage of development, the crustacean begins to take in water, eventually increasing its body weight by up to 70%. As it inflates itself with water, the swelling splits open the crustacean’s brittle outer shell along the lines of greatest weakness (known as the ephermul suture), forcing its limp body out of the slitlike opening. As its rubbery body begins to emerge through this narrow escape hatch, the decapod must then carefully extricate all its appendages, including its legs, antennae, eyestalks, abdomen, gills, and mouthparts. Even the lining of its digestive tract is cast, remaining attached to the discarded exoskeleton.

However, with the development of accurate pH tests, such as SeaTest™, designed specifically for salt water, hobbyists began to find that their aquarium water was actually in the 7.8-8.0 pH range, or lower. Initial skepticism about the accuracy of the kits was eliminated by comparison to accurate laboratory instruments; and comparisons of all synthetic sea salts showed that all behaved similarly. The filter medium was the only other possible significant variable.

This is the path that John Burleson, an avid hobbyist from Maryland, followed. After investing in a laboratory pH meter and National Bureau of Standards pH standards, he tested four brands of salt using two 10 gallon tanks for each. After allowing pH levels to equilibrate by aerating several days, he added 2 pounds of crushed coral filter material to one tank of each salt mix. The original pH levels of all tanks were 8.2 or higher, but after operating for 24 hours pH values of 7.6-7.7 were obtained in all tanks with gravel. The control tanks were unchanged.

A search of the scientific literature reveals this effect has been reported. A paper by Carol Bower, D. Turner, and Stephen Spotte (1981) that tested the buffering of various filtration noted a rapid drop with certain materials. The authors noted a decrease in pH from 8.4 to 8.0 after 24 hours for crushed coral filter while silica sand remained unchanged. Oyster shell and dolomite were in between.

Effects of Filter Materials on pH

By Thomas A. Frakes and Edmund J. Mouka, Jr.

The choice of a filter material for marine aquariums has long been a topic of debate. Over the years many filtrants have gained or lost popularity, usually based on reports of pH buffering capabilities. Materials including silica sand, limestone, crushed oyster shell, dolomite, coral sands, and crushed coral rocks have been considered, but in recent years, coral materials have made large gains in popularity, mostly due to claims that crushed coral would maintain pH values above 8.0.

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(Continued on page 4)
Crustaceans (continued from page 1)

For the next several hours the animal continues to take in water, stretching the dimensions of its uncalcified exoskeleton. A period of rapid tissue growth occurs at this time, and an increase in size of more than 20% can accompany each molt. After ecdysis, calcification of the new exoskeleton begins, gradually strengthening and hardening it as the chitin is infused with calcium salts taken from the water and provided by the crustacean's body reserves. This hardening process can last from an hour to ten days or more, depending on what kind of crustacean is involved and how big it is.

During the actual withdrawal from its old exoskeleton, the animal is not only completely helpless, but it is expending an enormous amount of energy at a time when its respiratory surface is unable to function, cutting off its supply of oxygen. Should withdrawal be abnormally prolonged for any reason, death will result. This is a rare occurrence, however, and the crustacean almost always successfully casts off its old exoskeleton.

Nevertheless, a soft-shelled decapod is still in great danger. It can no longer rely on an armor-plated exoskeleton for protection, and its soft, flexible covering of chitin cannot provide its musculature with the solid anchorage and leverage necessary to execute normal movements. Energy reserves have been exhausted, and it is still quite helpless, often literally unable to raise a claw to defend itself. As a result, a newly-molted crustacean is an easy meal for the first predator to come along.

Worst of all, other crustaceans and invertebrates can detect the molting fluid released during ecdysis, and are in fact attracted to it. Often they will follow this invisible scent trail straight back to its source, with fatal results for the soft-shelled crustacean waiting at the end of the line.

The vast majority of losses are unnecessary and can be easily prevented if the following simple precautions are observed: (1) select compatible tankmates; (2) furnish the aquarium with suitable habitat material to provide plenty of safe hiding places; and (3) learn to recognize the unmistakable signs that indicate when a crustacean is about to molt so steps can be taken to protect it.

Selecting compatible tankmates simply means avoiding those fishes and invertebrates that normally feed on crustaceans. In general this includes filefish, triggerfish, trunk fish, boxfish, puffers, blowfish, moray eels, large wrasses, octopus, lobsters, mantis shrimp, large box crabs, stone crabs, and vicious swimming crabs like the blue crab.

Even small, non-aggressive specimens that otherwise get along splendidly with their decapod neighbors may attack and kill a newly-molted crustacean. Consequently, the aquarist who keeps crustaceans must take pains to see that his tank is heavily decorated with corals, shells, and rockwork to provide adequate shelter during molting. If they are given an adequate choice of hiding places, small crustaceans are very adept at seeking out some impregnable retreat in which to pass the dangerous molting period, and that is often all the protection they need.

Large crustaceans are not that lucky, since wherever they can go, potential predators can follow. Fortunately, when they are about to molt, the bigger crustaceans provide the aquarist with three unmistakable signals indicating that molting is imminent: (1) they refuse to feed; (2) they become inactive; and (3) they exhibit a marked change in appearance. Alerted by these signs, the hobbyist can then isolate his prized specimens for their own protection.

The most obvious of these indicators is a lack of appetite. Ordinarily, a crustacean is always hungry, but when it enters a premolt stage, its gastric lining breaks down, making feeding impossible. Thus, when one of these greedy scavengers refuses to eat, it is a definite sign it will soon molt.

A crustacean also becomes reclusive when it is going to molt. The observant aquarist will notice the animal's absence and seek out its hiding place so it can be tempted with a tasty morsel to determine if it has stopped feeding and is therefore about to molt.

Many crustaceans also undergo a marked change in appearance prior to molting. This is due to the premolt separation of the new epidermis from the old cuticle, breakdown of the pigmented layer of the old exoskeleton, and an increase in pigments in the blood. With experience, an aquarist can learn to tell at a glance when a crustacean is in its premolt stage.

Taken together, these three signals provide the hobbyist with unmistakable evidence that a crustacean is about to molt, allowing the aquarist to isolate it as a precaution. The easiest way to do this is to confine the crustacean behind a sheet of glass placed diagonally across an unobstructed corner of the aquarium. Include an overturned clam shell or piece of coral to give the quarantined crustacean a sense of security.

The length of time a particular specimen must remain in solitary confinement depends on what type of crustacean it is. A large crab or lobster can take ten days or more to recover fully, whereas a relatively "thin-skinned" shrimp may be back to normal moments after shedding. A good rule of thumb is to wait until the crustacean has begun eating again before returning it to the mainstream of the aquarium.

If the necessary steps to protect them are taken during the high-risk molting period, crustaceans can easily be kept for several years, and it is not unusual for them to live out their normal life span in a well-maintained aquarium.

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Water Management Aids

In addition to normal biological filtration, and periodic partial water changes, there are a number of supplementary products that may be utilized to help maintain good water quality. These include ultraviolet (UV) sterilizers, ozone generators, foam fractionators (protein skimmers), activated carbon, polymeric adsorbents, and ion exchange resins.

Foam fractionators, activated carbon, and polymeric adsorbents are primarily intended to limit concentrations of dissolved organic compounds. Ultraviolet sterilizers are used for disease prevention, and ozone generators are used for both purposes.

Organic material is introduced into solution through the metabolic wastes of aquarium inhabitants and, if unchecked, a significant build-up would result that is detrimental to animals and plants. Additionally, many organic contaminants are highly colored, and the presence of even small amounts may produce unsightly, yellowish looking water. Fortunately, there are a number of ways of removing these substances.

Foam Fractionators (Protein Skimmers)

Foam fractionators remove organic substances by concentrating them as a localized foam or froth that is trapped in a cup and removed. They are frequently, although less accurately, called protein skimmers, because many of the substances that they remove were once thought to be primarily proteinaceous.

Certain large organic molecules have two distinct ends. One end, called hydrophilic, has an affinity for water, while the other end, called hydrophobic, is repelled by water. Molecules of this type tend to congregate at the surface of the water where they become oriented with their hydrophobic end pointing toward the air.

Foam fractionators utilize this phenomenon to remove these "surface active" compounds from solution. In its simplest form (Fig. 1), a foam fractionator maximizes surface area by introducing air as a stream of fine bubbles at the bottom of a column of water. Maximizing the area of the air-water interface provides more locations for the molecules to congregate. As the bubbles rise, a film of surface active molecules forms on their surface and is floated upward. As the concentration of surface active molecules increases substantial foam develops on the surface and flows over the top of the column to be collected in a removable cup, thereby removing some of the molecules from solution.

There are many modifications of the simple design that serve to increase its efficiency. The main limitation of foam fractionation is that it removes primarily surface active molecules, and not all the organic contaminants.

Activated Carbon

Activated carbon functions both as a mechanical and a chemical filter. As a mechanical filter, for example, it is similar to sands and gravels of comparable size which function quite efficiently in removing particulate matter. However, as a chemical filter, it has properties that are of considerable interest.

These unique properties are primarily a result of the extremely high surface area (nearly a quarter of an acre in less than one teaspoonful) of some carbon varieties. Most of this area is due to numerous microscopic pores and channels that penetrate individual grains. These cavities are capable of trapping many dissolved substances so that they are effectively "plucked out" of solution and held to the surface of the carbon. This process is known as adsorption.

Activated carbon can adsorb appreciable quantities of organic substances, resulting in a level of dissolved organic material that is a fraction of what it would be otherwise. Thus, aquarium inhabitants are exposed to less stressful water conditions.

Activated carbon is also capable of adsorbing many inorganic ions. Higher water hardness is negligible for major ions (sodium, chloride, magnesium, etc.), but, for minor elements, especially metals, the effects may be significant.

Activated carbon filtration should be stopped while medicating an aquarium but can be resumed immediately if adverse reactions are noticed. Medications, such as methylene blue, malachite green, sulfa drugs, antibiotics, and copper, are effectively removed by carbon filtration.

Activated carbon is a most economical water management aid for removal of dissolved organic substances. It is readily available, effective for a broad range of compounds, and it is safe.

Many grades of activated carbon are available. Avoid "economy" grades, such as charcoal as they are of little value in a marine aquarium. Estimates of the useful lifetime vary considerably, and this is probably as much a function of the state of the aquarium as of the carbon itself. Under moderate conditions, activated carbon may function for many months. Decreasing effectiveness is usually easily noticed by the gradual yellowing of the aquarium water.

Polymeric Adsorbents

There are a number of synthetic materials that are prepared in such a manner that they have a highly porous structure similar to activated carbon, and also have high surface area. These polymeric, or plastic-like materials have an affinity for hydrophobic molecules in solution which are adsorbed on the surface of the polymer. Like activated carbon, polymeric adsorbents eventually become filled and must be renewed.

For removing certain materials, such as some types of chelated copper medications, polymeric adsorbents may be superior to activated carbon. This is a particularly useful application.

On the other hand, the belief that polymeric adsorbents can remove ammonia, nitrate, and particularly nitrite is totally unfounded. They appear to be incapable of removing such substances chemically. They will neither protect an unconditioned marine aquarium from the potential hazards of ammonia or nitrite, nor will they reduce accumulations of nitrate.

Ion Exchange Resins

In recent years, many formulations containing ion exchange resins have been marketed with various claims as to purification ability. Inspection of many of these will show activated carbon as a component. The actual resins may do little more than act as pH buffers.

Ion exchange resins do not function effectively as ion exchangers in salt water, because there are too many ions in solution that compete for active sites on the resin. Similarly, ammonia adsorbing clays (zeolites or clinoptilolite) are only effective in fresh water. In fact, many ion exchange resins and clays are actually regenerated by flushing with a salt solution. The selective removal of ammonia, nitrite, and nitrate, is not possible with current technology.

To be continued in Part 2 next quarter.

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The tests were run in typical aquariums with undergravel filters and normal fish loads that were followed for 90 days. In this study, the silica sand tank showed gradual drop to below pH 7.0, while the oyster shell, crushed coral, and dolomite were 7.85, 7.75 and 7.5 respectively. Their conclusion was that none of these carbonate materials could maintain pH values of 8.0-8.3, but they had some value by preventing pH levels from dropping to acutely critical levels of 7.0 or less as happened with the inert material, silica sand.

More recently Gary Adams and Stephen Spotte (1985) confirmed this, reporting an initial drop to 7.95 for a crushed coral material, with much of the drop occurring in the first few hours.

Additional tests were conducted on a variety of materials. Mr. Burleson provided samples of Philippine coral sand, "Puka" shell sand, and a high grade quartz gravel. Samples of crushed coral, coral sand (Bahama Bottom, Instant Ocean Hatcher's), dolomite (dolomitic limestone), and foam filters were obtained locally.

Eight miniature aquariums were constructed, each with a bottom plate and an airlift. They held 200 cubic centimeters of filter material and 1,600 milliliters of synthetic seawater, equivalent to having a 2½ inch deep filter bed in a 16 inch deep tank. The test water was aerated several days to assure a stable pH since imbalances in dissolved carbon dioxide can make up water can cause minor shifts. A research grade pH meter calibrated with certified standards was used to test water samples.

Each aquarium was filled with saltwater and aerated an additional 24 hours at which time pH was checked. The filtrants were added, and samples were checked at 2 hours, 24 hours, and 3 weeks. Instant Ocean salt and a popular German salt were examined.

It is obvious from the table that the two coral materials caused significant drops in pH, reaching 8.0 or less in 3 weeks with no biological loads. These represent drops of 0.3 to 0.5 units. Non-carbonate filtrants (quartz and foam) and the control dropped by only 0.06 or less. The other filtrants caused intermediate changes.

**Discussion**

It is important to place this information into perspective, and to do so a number of factors must be considered. No single filter material will be best for all applications. Aesthetics, desired initial pH, long term pH, and planned water quality maintenance must be considered.

Aesthetically, coral sands and Puka shells are the most natural looking because of the shell and coral fragments. Crushed coral is similar, but with a bright white appearance. Products like dolomite and crushed oyster shell are generally dull and grey.

Regarding initial pH, decreases reported here have been confirmed by many hobbyists and shop owners who consistently encounter pH levels of 7.8-8.0 in new aquariums when using coral materials. These levels do not appear to be hazardous. Long-term pH and other water quality factors are much more significant.

Long-term pH control involves a number of variables: buffering in the salt water, buffering by filtrants, algae growth, fish load, feeding level, partial water change schedule, and artificial buffering. Aquariums with no calcareous material can be maintained in the 8.0-8.2 range by making regular exchanges with new sea water and/or additions of carbonate buffers (baking soda, etc.), but pH must be monitored and adjusted frequently, and dangerously low levels are possible on neglected systems. Exchanges or additions of buffers are less critical in tanks with calcareous filters (dolomite, coral, oyster shell) because extremely low pH levels will be avoided, but moderately lower pH levels will most probably be maintained, unless "boosted" with additional buffers.

Long-term drops in pH are due to the metabolism of food to nitrate, which produces acid. Algae growth, on the other hand, uses nitrate and strips carbon dioxide (carbonic acid), and thus raises pH. Only systems with low animal densities and high densities of algae or other denitrifiers will maintain higher pH values without special care.

There is much discussion about what is the proper pH. Generally, readings of 8.0 to 8.2, the natural ocean levels, are considered optimal. Higher levels are not recommended because if ammonia is present it is more toxic at higher pH levels and, in fact, during a new tank run-in, the lower pH may be beneficial.

Whether levels of 7.8 are detrimental is not entirely clear and may depend more on the cause of the low value. Pristine, high quality water that drops to 7.8 because of a filter effect may be perfectly acceptable. However, older water that has been subjected to a heavy biological load causing the drop in pH along with a build up in organic wastes may well be stressful.

In conclusion, aquarists can be successful with any of the materials, but they should understand what to expect from the one selected and plan their schedule accordingly.

**References Cited**


Longevity of Marine Tropicals at The Nancy Aquarium

By B. Conde, Nancy, France
Photos: D. Torver

(Reprinted from Revue Française d' Aquariologie: 9 (1982), 4, March 1, 1983. The fishes marked with a star (*) in the tables were still on display in May, 1986.)

One will find excellent longevity of marine tropicaIs here. With few exceptions, longevity is greater than five years.

The tropical tanks at the Nancy Aquarium are all automated. They work on a semi-closed system with the addition of new synthetic sea water by means of a drip system, regulated by the level of nitrates in the water, which are not permitted to exceed 20 milligrams per liter NO₃⁻. Filtration is by means of polyester foam, and the water circulates through an ultraviolet lamp after passing through the filter.

Particular attention is given to stocking the tanks, a good equilibrium between the inhabitants appearing to be a condition affecting the longevity of the inhabitants and their resistance to parasites. The quarantine procedures, the first phase of a successful acclimation, are given a great deal of attention. Nets are used on the fish only when capture proves to be impossible with traps or other vessels; if a net must be used, the fish is released under water in the transport vessel.

The first tropical marine fishes came to Nancy on October 21, 1967. The longest surviving fish are Dascyllus carneus (10/21/67); Forcipiger flavissimus and Rhinecanthus rectangulus (6/14/68); Anurwetta asfur, Zebrasoma desjardini, Abudelfal edessociatus, and Dascyllus marginatus (6/20/69); Amphilopetus ocellaris, A. clarkii, and A. frenatuz (6/27/69); Platix teira and Balistapus undulatus (7/15/69); and Naso annulatus (10/24/69). The last three species were in homes for a year before being offered to the aquarium by their owners. The longevities represented by 8 families are the subject of the following tables. The natural-looking aquariums are more attractive than those with sterile-looking, bleached or artificial decor, and many recent articles in popular aquarium publications have given rise to the so-called European "reef look." However, upon reading those articles, one could easily reach the conclusion that such displays are possible only through utilization of advanced technology that relies primarily on sophisticated filtration systems.

A visit to these public aquariums quickly dispels that notion. Both rely on conventional systems and regular partial water changes to maintain water quality.

Filters consist of simple external chambers filled with a single medium to remove particulate matter and provide a large surface area for growth of nitrifying bacteria. The Aquarium in Nancy uses foam filter blocks, and in Stuttgart silica gravel is utilized.

Many aquarists would be critical of the use of such materials in salt water, but recent disclosures about some of the detrimental effects of carbonate filters indicate that inert media, like foam or silica, may be preferable for use in well-balanced systems, like those in the Aquarium. Proper balance between plant and animal densities helps to maintain stable pH, and there is no need for the protection against extremely low pH that carbonate filters provide. Tanks contain only a thin layer of coral sand, primarily to enhance their natural appearance.

The mechanical and biological filtration functions are supplemented by the action of Ultraviolet (UV) units and efficient foam fractionators (protein skimmers).

Both aquariums rely heavily on regular partial water changes to maintain water quality. At Nancy exchanges are accomplished by a "drip" method. Small quantities of unused, synthetic sea water are metered to each tank continuously through an adjustable valve, and the overflow from the tank is discarded. The incoming flows can be increased or decreased to accommodate variations in the populations, but average 40% each month.

Water exchanges at Stuttgart are accomplished in a more conventional manner by removing 10% of the old water each week, and replacing it with freshly prepared water.

The directors of both aquariums were questioned about the possibility of utilizing systems that supposedly eliminate the need for water exchanges. The answer was a resounding no, as the plants and animals have thrived on such systems in the past. These are precisely the sights that greeted us on a recent visit to two of Europe's well-known public aquariums, "The Aquarium at the Museum of Zoology in Nancy, France, and The Aquarium at the Wilhelma Zoological and Botanical Garden in Stuttgart, West Germany. "

This Regal angelfish (Pygolopes diacanthus) has been a guest at the Nancy Aquarium for 15 years.

European Aquariums

Imagine a collection of marine aquariums populated with fishes from every tropical ocean region; many unusual species, rarely available to hobbyists, existing happily among more common varieties; tanks filled with lush growths of algae and frequently, numerous invertebrates, including hard and soft corals, sponges, plumed worms, anemones, and numerous crustaceans.

Animals and plants are all flourishing. Conditions are so ideal that algae, such as Caulerpa species, often overgrow the tanks and must be trimmed. Some small anemones reproduce and become so plentiful that they can be harvested and used as food for Butterfly- and Angelfishes. Even sponges, which are often difficult to maintain for extended periods, reproduce, grow, and almost overwhelm some exhibits.

These are precisely the sights that greeted us on a recent visit to two of Europe's well-known public aquariums, The Aquarium at the Museum of Zoology in Nancy, France, and The Aquarium at the Wilhelma Zoological and Botanical Garden in Stuttgart, West Germany.
The maximum longevity of a representative of the genus Chaetodon is 14½ years for a C. raflesi. C. semilarvatus survived nearly 13 years and died accidentally when polluted fresh water was accidentally poured into its tank. The C. epiphium (14 years) was the dominant one of a pair captured as a pair in nature. The less dominant fish died 10/5/77.

**Longevity (continued from page 1)**

<table>
<thead>
<tr>
<th>Angelfishes — Pomacanthidae</th>
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<tr>
<td>Aristea asfur (Red Sea)</td>
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<td>Euphichthys naurchus (Blue-faced angel)</td>
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<td>Euphichthys xanthometopon (Yellow-faced angel)</td>
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<td>Pomacanthus semicirculatus (Semicircle angel)</td>
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<td>Pygolipites diacanthus (Regal angel)</td>
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<tr>
<td>Euphichthys septretus (Six banded angel)</td>
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<td>Chaetodontopus mesoleucus</td>
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<td>Apolemichthys trimaculatus (Three spot angel)</td>
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<td>Pomacanthodes imperator (Emperor angel)</td>
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<tr>
<th>Chaetodontidae</th>
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<tr>
<td>Forciger flavissimus (Long-nosed butterfly)</td>
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<tr>
<td>Chaetodon nasus</td>
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<td>Heniochus chrysopterus (Pentant bannerfish)</td>
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<td>Heniochus varius (Humphead bannerfish)</td>
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<td>Chaetodon epiphium (Saddled butterfly)</td>
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<td>Chaetodon lineolatus (Lined butterfly)</td>
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<td>Chaetodon punctatus (Spot-banded butterfly)</td>
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<td>Cheilinus rostratus (Copperbanded butterfly)</td>
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<td>Hemirhamphichthys polylepis (Pyramid butterfly)</td>
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<tr>
<td>Chaetodon lunula (Raccoon butterfly)</td>
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**Butterflyfishes — Chaetodontidae**

| Forciger longirostris was only at Nancy for 2 years and 9 months, but it did not appear to be any more demanding in its care than F. flavissimus. |

**Surgeonfishes — Acanthuridae**

| Zebrasoma desjardini (Sailfin tang) | 17 yrs.* |
| Naso annulatus | 16½ yrs.* |
| Acanthurus xanthopterus | 15 yrs.* |
| Naso lituratus (Naso tang) | 12 yrs. |
| Zebrasoma xanthurus (Purple surgeonfish) | 10 yrs. |
| Acanthurus japonsis (Whitefaced surgeonfish) | 11½ yrs.* |
| Zebrasoma gemmata | 10½ yrs.* |

Our two Acanthurus leucosternon, which lived for 11 years and 3 months and 10 years and 11 months, respectively, showed towards the end a loss of weight and violent attacks of cutaneous parasites, responding little or not at all to the usual treatments. Moreover, one of them ingested quantities of quartzite before dying.

One Ctenocephalus hawaiiensis, acquired just as it was changing from the juvenile coloration (chevron tang) to the adult pattern (the chevrons resolve into fine longitudinal lines of metallic blue-green), died after 10 years 2 months (7/11/72-8/28/82). Its sudden death, in the night, was not preceded by any symptoms, and it is possible that it was the victim of a trauma.

**Damselfishes and Anemonefishes**

| Dascyllus aruanus (Bammbug) | 18½ yrs.* |
| Amphiprion frenatus (Tomato anemonefish) | 17 yrs.* |
| Amphiprion clarkii (Clark's anemonefish) | 14 yrs. |
| Amphiprion ocellaris (False clown anemonefish) | 14 yrs. |
| Abudelfuf sexsasctas (Chinese sergeant-major) | 14 yrs. |
| Dascyllus marginatus | 17 yrs.* |
| Dascyllus trimaculatus (Three-spot damsel) | 16 yrs.* |
| Pomacentrus amboginensis | 11 yrs. |
| Chromis caerulea (Blue chromis) | 12 yrs. |
| Paraglyphidodon melas | 10 yrs. |

**Scribbled angel (Chaetodontopus dubouleyi)** 12 years old

In the case of C. meyeri and C. ornatus, these closely-related species (apparently hybrids from Palau) generally accept ground attractiveness was lessened by cooking, and it made up the bulk of the food.
European Aquariums
(continued from page 1)

changes, and both expressed similar sentiments. Such systems continue to rely on only a single component of the water, such as nitrate, and ignore the possibilities of other changes that may be occurring. Water changes are the only way to be certain that all detrimental components are being diluted, and all beneficial components are being replenished. Lighting is also an important factor, and again simple, conventional systems are employed effectively. In Stuttgart plastic shielded, fluorescent fixtures with "Daylight" bulbs are used. In Nancy, "Gro-Lux" fluorescent bulbs or the equivalent are utilized exclusively, each tank being equipped with a bank of five, 4-foot tubes, protected by an acrylic plate.

Light intensity was higher at Nancy, and algal growth was correspondingly more extensive. At Stuttgart, aquarists were experimenting with alternative, high intensity light sources, and all agreed that the variables involved in evaluating lighting made experimentation difficult. There appeared to be a correlation between light intensity and plant growth; however, we are unable to comment on the spectral qualities of the various light sources.

In general, the most important observation that we made was the realization that the so-called "European" style of aquarium is the result of more differences in philosophy than in technology. Miniature reefs can be created and can flourish in systems that rely on simple, conventional filtration methods, regular partial water changes, and fluorescent lighting. More important than the technology, however, is the understanding that all of the living elements of a system must be in balance. Fishes, invertebrates, and plants must be chosen with care to compliment each other. Fishes, especially, must not dominate the aquarium as is frequently seen in America.

These public aquariums are museums that think of their acquisitions as additions to their permanent collections. They possess some of the oldest known captive marine specimens. (See the article on Longevity of Fishes in the Aquarium at Nancy, elsewhere in this issue.) Home aquarists who are willing to adopt similar philosophies should be similarly successful.

Water Management Aids
(Continued from Spring 1986 Issue)

Ozone
Ozone is a highly active molecule that reacts readily with many organic compounds converting them to progressively smaller fragments. The end products are relatively harmless — carbon dioxide, water, and nitrate.

Ozone is often used with foam fractionators to break large molecules into smaller, charged ones that are more readily stripped, thus increasing the efficiency. For maximum safety, ozone treatment is frequently followed by activated carbon, which adsorbs many intermediate reaction products, and also helps to neutralize any excess ozone, which is potentially harmful to fish.

Ozone is an excellent decolorizer; it's action is similar to that of bleach. Water treated with ozone should remain sparkling clear.

Ozone also has anti-pathogen properties and is effective against a wide range of organisms, including the bacteria and protozoa that cause many diseases of fish. However, the primary effect of ozone is on parasites that are suspended in the water, so it has little effect on organisms that have already infected the fish. Its usefulness is to prevent re-infection, and thus help animals to overcome the disease naturally.

The main risk of ozone usage is that excessive amounts are dangerous and capable of causing severe injury, and even death, to aquarium animals. Manufacturer's instructions for use of ozone generators should be followed closely because there is no convenient method of monitoring concentrations in the aquarium.

Ultraviolet Sterilizers
Ultraviolet (UV) sterilization units emit high energy light radiation that is deadly to many micro-organisms. Their effectiveness is a function of numerous factors, most notably, power of the lamp, temperature of the lamp, exposure time of the water, turbidity (cloudiness) of the water, cleanliness of the lamp sleeve, and size of the organisms exposed to the light.

UV units are most effective against the smallest organisms, such as bacteria, and less effective against larger organisms, such as protozoa. Still larger organisms, such as copepods and other small crustaceans, are almost completely unaffected by the exposure likely to be encountered from aquarium units.

The term "Ultraviolet sterilizer" is a bit of a misnomer, because an aquarium will never become truly sterile. UV units may restrict growth of certain disease-causing organisms, but they do not eliminate them.

If fish are stressed, there is always the possibility of disease, even when UV units are in use.

Summary
No water management aid is a cure-all. There is no product or combination of products that eliminates the need for attention to water quality, which should be the first priority of every aquarist.

Regular partial water changes are the most important means of maintaining water quality. There are changes that occur in closed system aquariums that cannot be compensated for in any other way. Water changes replace deficient elements while simultaneously they dilute excessive compounds, thus imbalances are avoided.

Water management aids serve a useful purpose in supplementing, or extending the benefits derived from the partial water changes. They may allow a slightly greater margin of error than would otherwise be possible, or perhaps the interval between water changes may be extended without serious consequences.

Reducing concentrations of dissolved organic substances by use of activated carbon, other adsorbents, or foam fractionators is undeniably of benefit. Reduction of potentially pathogenic organisms by use of ozone or Ultraviolet radiation is also of proven value. But remember, nothing will eliminate problems completely.

Water management aids are nothing more than methods for improving chances for success. They can never insure success.
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Keeping Crustaceans: Compatible Tankmates

By Pete Guwojna

In order to successfully keep crustaceans in a community tank, they must be maintained with compatible tankmates. This is a very basic point, but it is easier said than done. At present, there is little information available in the literature regarding compatibility of decapod crustaceans (crabs, shrimps, and lobsters) with various fishes and invertebrates. Instead, the aquarist is left to learn the hard way, frequently a long, painful process, usually resulting in the loss of specimens. A little knowledge can easily prevent losses.

To begin with, those fishes that normally feed on crustaceans should obviously be avoided. In general, this includes snappers (Lutjanidae), triggerfishes and large filefishes (Balistidae), moray eels (Muraenidae), trunkfishes (Ostraciidae), puffers (Tetraodontidae), large wrasses (Labridae), and many bottom feeders. Like seafood lovers everywhere, these fishes have discovered that crabs and lobsters are good to eat. Many have powerful jaws equipped with specialized teeth that can crunch through the most heavily-armored crustacean.

The best alternative is to grow one's own coral reef. Many desirable reef species have evolved through eons and have adapted to life in certain specific water conditions. One cannot expect most of these species to survive if maintained in unnatural conditions. Yet, by considering the needs of the organisms, and using environmental simulation, an experienced marine aquarist can reproduce a coral reef environment in a home aquarium.

To design or simulate a nonflexible reef environment in an aquarium, one must first choose which of two general categories will be reproduced, deep water or shallow water. The deep water part of a coral reef may vary from 50 to 300 feet in depth. Many Asian species seem well suited to deep water conditions such as mild blue light, clear moving salt water, with lots of crushed coral, and with little water agitation. We can duplicate these conditions in an aquarium as small as 15 gallons. It should be filled with several inches of clean crushed coral placed over a subsand filter, to simulate the reef floor where lots of coral and crushed coral mineralize the water and protect against any extreme pH drops.

Two external power filters with filter floss, and three airstones will provide water movement and aeration. Good ultrafiltration will help to avoid water stagnation and to remove organic materials. The aerators should produce a light foam on the water surface.

Sheets of nonflexible blue plastic from a department store, when cut to size and placed over the top of the tank, will filter tank light and produce the blue found in the ocean depths. Deep water species are adapted to live in weak light and may develop the light related disease Photosyndrosis if exposed to even normal light.
Advice on Selection of Aquarium Heaters

As winter approaches the problem of maintaining proper temperature in tropical aquariums must be considered. In homes with air conditioning, the need to maintain suitable temperatures in aquariums may exist throughout the year. The question of what is the most suitable size and type of heater is often asked, but is frequently poorly answered.

For many years the only heaters available were the partial immersion type that were hung on the edge of the aquarium. Many were not sealed against moisture, such as spray from aerators, and frequently caused shocks even if they were unbroken. They interfered with most hoods, often requiring modifications, and required a constant, high water level. If evaporation allowed the water level to drop below the internal thermostat, the heater would sense only the room temperature and continue heating until the fishes were "cooked".

Some of these problems were avoided by the development of total immersion heaters. Typically, the top of the glass tube of such a heater was covered with a waterproof plastic cap that sealed the unit. This cap also covered the temperature adjustment stem, and many aquarists found that squeezing through the plastic cover to hold and turn the knob inside was difficult and annoying.

Both of these older styles have another limitation. In order to set the desired temperature, a series of trial and error adjustments are needed. The heater must be installed and watched until the desired temperature is reached, then adjusted until the indicator light just comes on or goes off. Because of the time it takes for a body of water to equilibrate, numerous adjustments over many hours are usually necessary.

The new Marine Design™ Visi-Therm™ aquarium heater from Aquarium Systems uses a newly patented design to solve all of these problems.

Internal seals eliminate the need for an external second rubber cap and allow direct and easy turning of the adjustment stem. The unit has a thermometer-style thermostat that is pre-calibrated so the aquarist can pre-set the desired temperature quickly and easily. It has both Fahrenheit and Centigrade scales so conversion tables are not necessary and, of course, has an indicator light to tell when the unit is heating. Unlike older designs, maximum and minimum stops prevent accidental adjustment to dangerous levels below 65°F or above 90°F.

The Visi-Therm™ automatic aquarium heater is an ideal choice for all situations that require both convenience and reliability.

Once the decision to purchase a particular style of heater has been made, the aquarist must decide what size of heater is needed. Many tube lengths are available, but the important factor is the wattage of the heating element.

Here is a case where bigger is not necessarily better. Certainly on a cost per watt basis, the larger units are less expensive. However, other factors are often overlooked. The normal life expectancy of a heater should be many years, but is somewhat dependent on the number of heating cycles that the unit experiences. Frequent cycling decreases a heater's useful life. This situation is typical where a large heater is installed in a small aquarium. A properly sized heater will run longer each time it is on, cycle less frequently, and have a longer life expectancy.

Secondly, if an oversized heater is used and malfunctions while the heater is on, the water can heat to dangerous temperatures in a short time. A properly sized unit may never reach a critical level, or at least take much longer to do so.

As an example, consider a 75 gallon aquarium equipped with a 75 watt heater in a room where the ambient temperature is 72°F. The heater is set for 76°F, a difference of 4°F, and maintains that temperature by heating 50% of the time. Then, by crude extrapolation, if the unit heated 100% of the time, the aquarium would be heated to about 8°F above room temperature, or 80°F. The same aquarium with a 150 watt heater running constantly would theoretically heat to 16°F above room temperature, or 88°F, which is quite stressful, and a 200 watt could exceed 93°F, and would probably result in the loss of the aquarist inhabitants as well.

Finally, presettable heaters, with calibrated thermostats are adjusted for normal aquarium conditions. Use of an over-sized heater can result in temperatures running 1°F to 2°F higher than the set temperature. In this case an adjustment will be necessary to compensate for the differential.

Calculating exact wattage requirements is generally not practical or necessary. There are several other factors that affect the heat budget of an aquarium, including airflow in the room, hood design, heat from lights and pumps, etc. However, the accompanying graph for Approximate Heater Requirements can be used as a general guide. It is based on standard glass aquariums at three ranges of temperature differentials.

Consider a 50 gallon aquarium in a home that is normally kept at 70°F while...
Coral Reef
(continued from page 1)

room light. The tank should have the back and sides blackened on the outside to avoid stray light penetration. Thus, most factors can be duplicated with the exception of water pressure.

The shallow water reef is constructed to reproduce a surf or near surf zone with lots of foam, crushed coral, some organic materials, and strong light. Again fill the tank with several inches of crushed coral, but use 1 water pump, and 5 aerator stones.

The light, particularly in a small tank, still requires filtering but to a lesser extent since many shallow water species thrive on light. Yet, strong light may increase growth of algae, which colonize on objects in a tank and possibly kill corals, sponges, and other stationary invertebrates. The aeration from the many airstones provides water movement, bubbles, and surface foam, nicely duplicating what one sees at the beach or in a surf zone.

Saltwater fishes should not be kept in a small tank with invertebrates. These “economy” tanks will not allow the balanced interactions that occur in a reef with many species. With the possible exception of some gobies most of the fishes quickly gobble up the new growths that should be encouraged. Another problem arises because fishes require feeding, and even with the best clean up efforts, some food is bound to go uneaten and will quickly decay. This material inside an aquarium of 10 gallons, as opposed to the ocean with unlimited water, encourages bacteria growth to which many invertebrate reef species, such as coral, have no resistance.

Feeding in these tanks for the invertebrates is best done with liquid nutrients or very slight amounts of sieved baby brine shrimp or other microscopically small foods. The really adventurous can try feeding small amounts of blood from fresh liver.

Overfeeding encourages corals to extend their tentacles and look alive, but one may quickly find that the scum developing around the tank attacks and kills many species. An infection is usually a whitish film on a coral, that spreads from day to day leaving dead material behind. The infection is best treated with Chloramphenical which can stop infections in progress. Water changes will help prevent infections. Changing 25% of the water every 3-4 weeks is usually adequate.

Temperature in either the deep or shallow water environment should be kept in the 65-79 degree range, but should be fairly constant. The deeper water corals will tend to prefer cooler waters.

The tank can contain dead coral to enhance its beauty, and to allow new growth a place in which to root. What eventually grows on the dead coral or tank sides depends on what organisms and larvae are on the rocks and corals that you purchase.

Most corals, live rocks, sponges, and other invertebrates that are purchased in marine pet shops, originate in the Pacific Ocean. They are gathered by collectors and transported to wholesalers who ship them to your local supplier. In many instances one can obtain the specific coral desired. In other instances a particular specimen may include other animals or their larvae which spread themselves around the tank and grow on the dead coral.

The new growth usually begins within 60-90 days, and typically appears on the bottom of objects away from the light. Many of these corals can only be seen when examined with a field stage microscope. The first species to become visible to the eye will probably be either a primitive sponge or a pinkish coral known as Stylosterna. There will be many unidentifiable and odd things that grow and then vanish while others grow and spread. Over a period of years this new growth will colonize and adapt to your tank to form a living reef.

Except for minor maintenance and feeding, your reef is designed to be left alone to grow. Growth isn’t fast or sudden but, nonetheless, the specimens you buy will provide many hours of enjoyment, and there is always the excitement of trying to identify what a particular growth will become.

The mystery, beauty, and fascination of a reef can be in your home and with a minimum of effort you can own a piece of Tahiti to visit anytime you like. Editor’s Note: This article was written in 1980, well before the introduction of sophisticated “miniature reef” systems. It was based on successes the author achieved in maintaining the two described environments. It dramatically illustrates that exciting results can be obtained with even simple systems.

Heaters continued

The aquarium is to be maintained at 78°F. The temperature difference, \( \Delta T \), is 8°F. Following horizontally from the 50-gallon mark to the middle line (6°F12°F), then straight down to the wattage scale suggests a 100 watt heater. Other situations can be evaluated similarly.

In conclusion, by properly sizing the heater to the aquarium and normal conditions, the life of the heater can be greatly extended and, at the same time, provide a margin of safety for the inhabitants — a double savings.
Crustaceans
(continued from page 1)

Luckily, most aquarium fishes pose no
danger to decapod crustaceans. The
following is a partial list of the families
of fish that generally do well with crusta-
cceans: Moorish Idols (Zanclidae), but-
terfly and angelfishes (Chaetodontidae),
anemones and damselfishes (Poma-
canthidae), surgeonfishes or tangs (Acan-
thuridae), jawfishes (Opistognathidae),
cardinalfishes (Apogonidae), gobies
(Gobiidae), seahorses and pipefishes
(Syngnathidae), small wrasses (Labridae),
and ribbon eels. If your community tank
includes small fishes, it is best to consider
only the smaller crustaceans as
tankmates.

Some fishes cannot be categorized so
easily. For example, many sea bass or
groupers (Serranidae), such as the Golden
Striped grouper (Grammistes sexlineatus),
are very aggressive feeders that will attack
anything they can swallow, while others
such as the Spotted Panther grouper
(Chromileptes altivelis) are relatively
docile and do fine with crustaceans. And
the brightly-colored sea perches (Anar-
thinae) and basslets (Bramidae) —
smallest of all groupers — make excellent
tankmates for the smaller crustaceans.
This includes the Royal Gramma (Gram-
ma loreto), the Blackcap basslet (Melaca-
ra), and related species.

Lionfishes are much the same. The
smaller species (Pterois radiata, Den-
drochirus zebra, etc.) make good
neighbors for crustaceans, whereas
mature individuals of the larger species
(Pterois volitans and P. lunulata) can
sometimes be a problem. They are among
the few fishes that occasionally prey on
cleaner shrimp.

As for crustaceans themselves, the
aquarist must beware of two groups of
crabs — swimming crabs and box crabs.
Swimming crabs, such as the Blue crab,
are extremely aggressive predators. They
can be recognized by their last pair of legs,
which are flattened into paddles for swim-
ing, and they must be avoided at all
costs. Secondly, large box crabs,
sometimes called "shame-faced" crabs,
should be avoided. They specialize in
feeding on mollusks and hermit crabs,
and are accordingly equipped with a pair
of massive, powerful claws that they use
to rip apart the shells of their victims.

With the exception of mantis shrimp,
virtually all of the other commonly
available shrimp can safely be kept with
other decapods, fishes, and invertebrates.
This includes the Banded Coral shrimp
(Stenopus hispidus), Scarlet Cleaner
shrimp (Lysmata grabhami), Blood shrimp
or Peppermint shrimp (Lysmata wurd-
emanni), Peterson’s Cleaner shrimp
(Periclimenes petersoni), Purple-Spotted
Anemone shrimp (Periclimenes yucata-
nicus), Harlequin shrimp (Hymenocer-
ous picta), Camel shrimp (Rynchocinetes
sp.), and many others. Hymenocerous picta
needs strictly on starfish, and must,
therefore, be restricted to invertebrate
tanks that do not contain these
echinoderms, except for feeding purposes.

As for other invertebrates, decapods
will get along well with most of the
commonly-kept species. Anemones,
bivalve and univalve mollusks, feather
dusters and tubeworms, sea urchins and
starfishes of all kinds are suitable
tankmates for crustaceans.

Although marine snails, scallops, and
the like are generally good neighbors
for decapods, there is one class of mollusks
that is the deadly enemy of crustaceans.
This is the class Cephalopoda, of which
the octopus is the worst offender. The so-
called devilfish is an incredibly intelli-

gent, aggressive carnivore, and crustaceans
are the food it prefers above all else. Clearly
the two cannot be kept together in the
same aquarium unless the crustaceans
are intended as food for the octopus. The
same holds true for squid and cuttlefish.

Besides providing them with compati-
tankmates, there is one other basic
rule to follow when keeping crustaceans
— the smaller the better. The larger a
crustacean is, the more aggressive and
destructive it is likely to be. An overgrown

crab or lobster can do an unbelievable
amount of damage inadvertently, just by
excavating gravel, overturning coral,
uprooting sub-sand filter plates, and so
forth. So try to select smaller specimens
for your community tank.

Above all, remember that selecting
compatible tankmates for crustaceans is
largely a matter of common sense. As
long as you keep them as tank-mates, and
protect them when they molt, crustaceans
are very hardy, and it is not unusual for
them to live out their natural
life spans in a well-maintained aquarium.

SeaNotes
SeaScope was created to present short,
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Aquarium Systems, Inc. to be added to the
mailing list. Telephone 1-800-822-1100 (in Ohio
call 1-800-822-1300). Aquarists interested in
receiving copies directly should send their
name and address, along with $1.00 for postage
and handling (four issues) to SeaScope,
Aquarium Systems, Inc., 8141 Tyler Blvd., Men-
tor, OH 44060. Address comments, questions
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Large mantis shrimp (Squilla, Lysio-
quilla, Odontodactylus, etc.) present a for-
midable threat to their tankmates, in-
cluding other crustaceans. The last pair
of mouthparts of this shrimp has
developed into razor-sharp raptorial ap-
pendages used for hunting their prey.

Remilising switch-knife blades with saw-
toothed blades, they can slash a finger or
slice a small fish in two. Striking with
lightning speed, mantis shrimp are sur-
prisingly fierce predators that have
earned the name "thumb-splitters" from
commercial shrimpers. Needless to say,
these destructive diggers could destroy a
peaceful community.

Photograph by A. Marbach

Harlequin shrimp (Hymenocerous picta) feeding on a starfish.