CMFRI

Course Manual

Winter School on

Recent Advances in Breeding and Larviculture of Marine Finfish and Shellfish

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MODERN APPROACHES FOR THE REARING OF MARINE ORNAMENTAL FISHES : REEF TANK

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Introduction

A reef aquarium or reef tank is an aquarium containing live corals and other animals associated with coral reefs. These aquarium setups attempt to recreate marine life like that of the natural coral reef, often spectacularly coloured mixed reef that blend hard and soft corals from different parts of the world. Unlike the marine aquarium, which are built to house various types of fish, the main attraction in many reef tanks are the varieties coral and other invertebrates.

Some points to remember before setting up a reef tank are the following:

1. Power access

A reef tank requires a lot of power unless you use natural lighting, and even then it can be substantial. A 1000 L reef uses close to 30 amps peak, which means that you will need at least two dedicated breaker circuits of at least 15-20 amps each. One can also expect fairly hefty power bills for the tank.

2. Structural support

Make sure that the location where you plan on placing the tank will support its weight. As long as the tank is not too deep (greater than 30"), or you don't plan to place the tank in the middle of the room, you should be OK for loading. If either or both of the above mentioned conditions are true, and then you need to make sure the actual loading (total tank weight/unit area) is within your floor's capability.

3. Evaporation rate

A large tank evaporates a significant amount of water on a daily basis. One should try to have some sort of automated top-off system planned and plumbed unless you are ready to add this much make-up water to it every day or two.

4. Maintenance

Make sure that all pumps, outlets, filters, and especially the sides of the tank that need to be cleaned are readily accessible. Make sure that the tank layout and positioning allows you to reach most any point in the tank both for maintenance as well as specimen positioning. One of the keys to making the tank accessible for cleaning, as well as getting to specimens, is to have a canopy or lighting system that is easily removed, or constructed so as to not hinder access by allowing it to be opened or hinged in some fashion.

5. Redundancy/safety precautions

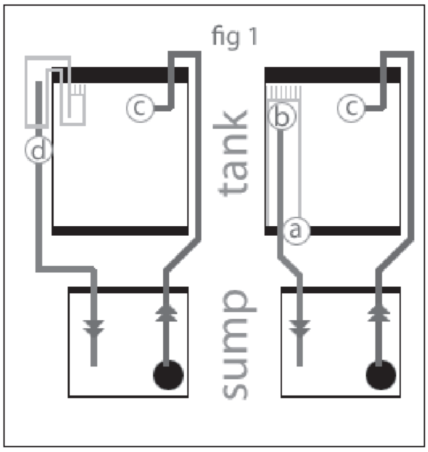
Try to have back-up systems wherever possible. The cost and effort put into stocking a large tank are such that you do not want a single failure in any one piece of equipment to cause your system to crash. Use multiple pumps from the sump as well as within the tank itself for circulation. Have multiple heater units. Place the various pumps and heaters, as well as lighting fixtures, on multiple electrical circuits (you have to for a large tank anyway), so that if any one circuit trips due to short or other failure mode, not all the critical equipment will be shut down.

Components

Aquarium, Filtration, Water movement, Lighting, Cooling

Aquarium

Regular glass or acrylic style aquariums are used for reef aquariums; these usually include an internal overflow made of plastic or glass which encloses holes that have been drilled into the bottom glass to accommodate a drain or standpipe and a return line (Fig 1a). Water pours over the overflow into and down the standpipe (Fig1 b), through PVC piping, into a sump, which generally houses various filtration equipment, through a return water pump and chiller and finally back via more piping through the second hole into the aquarium (Fig c). Alternatively, aquariums sometimes employ an external "hang-on" overflow with a U-tube that feeds water via continuous siphon to the sump (Fig.1d) which returns it via a water pump. Regarding size, for reef tanks usually bigger is better, the greater water volume of larger aquariums provides a more stable and flexible environment.



Filtration

The primary filtration for reef aquariums usually comes from the use of large amounts of live rock which come from various rubble zones around existing reefs or more recently aqua cultured rock which is supplemented by protein skimmers. This method first came from Germany and is termed the Berlin Method. In addition, a refugium which houses many species of macroalgae, including *Caulerpa* or *Chaetomorphae* is sometimes used to remove excess nutrients such as nitrate, phosphate, and iron from the water. Some aquarists also advocate the use of deep sand beds. More usual combined mechanical/biological filtration is avoided because these filters trap detritus and produce nitrate which may stunt the growth or even kill many delicate corals. Chemical filtration is used sparingly to avoid discoloration of the water, to remove dissolved matter (organic or otherwise) and to help stabilize the reef system.

The following is an overview of the components for a modern reef filter

(1) Live rock, 0.5-1kg/10 L . (2). Large protein skimmer capable of turning over water in the tank 6 times per hour. (3). Easily removable drip plate and pre-filter material to clean or change once a week. (4). Large main pump capable of turning over water in the tank 6 times/hour. (5). Large sump box providing considerable turbulence, and capable of holding all the overflow of water from the tank, including the "working water." (6). De-nitrification areas.

Water movement

Water movement is important in the reef aquarium with different types of coral requiring different flow rates. At present, many hobbyists advocate a water turnover rate of 6x per hour, x aquarium capacity in litres. This is a general rule with many exceptions. For instance, Mushroom Coral requires little flow and is commonly found in crevices near the base of the reef. Species such as Acropora and Montipora thrive under much more turbulent conditions in the range of 30 to 40 times more flow, which imitates breaking waves in shallow water near the tip of the reef. The directions which water pumps are pointed within an aquarium will have a large effect on flow speeds. To create turnover many reef aquarists use an Overflow (internal or external) which drains water into a sump where it is then pumped back into the tank. Tanks that come equipped with an internal overflow and pre-drilled holes are known in the hobby as "Reef Ready" or simply "Drilled" tanks. Of the many methods of creating the required flow, one of the most popular is by using multiple powerheads which are simply small submersible water pumps. The pumps may be randomly switched on and off using a wave timer, with each aimed at the flow of another power-head or at the aquarium glass to create flow in the tank. Another method gaining popularity is the closed loop in which water is pulled from the main tank into a pump which returns the water back into the aquarium via one or more returns to create water turbulence. Only recently available commercially, submersible propeller pumps are gaining popularity due to being able to generate large volume of water flow (turbulent flow) without the intense directed force (laminar flow) of a power head. Propeller pumps are more energy-efficient than power heads, but require a higher initial investment. Another recent method is the gyre tank. A gyre tank encourages a maximum amount of water momentum through a divider in the center of the aquarium. The divider leaves an open, unobstructed space which provides a region with little friction against water movement. Building water momentum using a gyre is an efficient method to increase flow, thus benefiting coral respiration and photosynthesis.

Water flow is important to bring food to corals, since no coral fully relies on photosynthesis for food. Gas exchange occurs as water flows over a coral, bringing oxygen and removing gasses and shedding material. Water flow assists in reducing the risk of thermal shock and damage by reducing the coral's surface temperature. The surface temperature of a coral living near the water's surface can be significantly higher than the surrounding water due to infrared radiation.

Lighting

Many, if not most aquarium corals contain within their tissue the symbiotic algae called zooxanthellae. It is these zooxanthellae that require light to perform photosynthesis and in turn produce simple sugars that the corals utilize for food. The challenge for the hobbyist is to provide enough light to allow photosynthesis to maintain a thriving population of zooxanthellae in a coral tissue. Though this may seem simple enough, in reality this can prove to be a very complex task. Zooxanthellae are golden-brown intracellular endosymbionts of various marine animals and protozoa, especially anthozoans such as the scleractinian corals and the tropical sea anemone, *Aiptasia*. Hermatypic (reef-building) corals have zooxanthellae and are largely dependent on them, limiting their growth to the photic zone. The symbiotic relationship is probably responsible for the success of corals as reef-building organisms in tropical waters. However, when corals are subjected to high environmental stress, they can lose their zooxanthellae by either expulsion or digestion and die. The process known as coral bleaching occurs when the zooxanthellae densities within the coral tissue become low or the concentration of photosynthetic pigments within each zooxanthella decline. Color loss is also attributed to the loss or lowering of concentrations of Green Fluorescent Proteins (GFP) from the cellular pigments of the cnidarian itself. The result is a ghostly white calcareous skeleton, absent of zooxanthellae, with the inevitable death of the coral unless conditions improve, allowing for the zooxanthellae to return.

Temperature changes have provided the most stress to the zooxanthellae-coral relationship. A rise in temperature of 1-2° C for 5-10 weeks or a decline in temperature of 3-5 ° C for 5-10 days has resulted in a coral bleaching event, and shock to the zooxanthellae and cause them to suffer cell adhesion dysfunction which sees the detachment of the cnidarian endodermal cells. Some corals such as the Mushroom Coral and Coral Polyps require very little light to thrive – conversely, LPS coral such as Brain coral, Bubble Coral, Elegance Coral, Cup Coral, Torch Coral, and Trumpet Coral require moderate amounts of light, and Small Polyp Stony Corals (SPS) such as Acropora Coral, Montipora, Porites, Stylopora and pocillopora require high intensity lighting. With the advent of newer and better technologies, increasing intensities and a growing spectrum, there are many options to consider. Of the various types, most popular aquarium lighting comes from metal halide, very high output or VHO, compact fluorescent lighting systems. Recent advances in lighting technology have also made available a completely new technology for aquarium lighting: lightemitting diodes (LEDs). Although LEDs themselves are not new, the technology has only recently been adapted to produce systems with qualities that allow them to be considered viable alternatives to gas- and filament-based aquarium lighting systems. The newness of the technology does cause them to be relatively expensive, but these systems bring several advantages over traditional lighting. Although their initial cost is much higher, they tend to be economical in the long run because they consume less power and have far longer lifespans than other systems. Also, because LED systems are comprised of hundreds of very small bulbs, their output can be controlled by a microcomputer to simulate daybreak and sunset. Some systems also have the ability to simulate moonlight and the phases of the moon, as well as vary the color temperature of the light produced. The choices for aquarium lighting are made complicated by variables such as color temperature, (measured in kelvins), colour rendering index (CRI), photosynthetically active radiation (PAR) and lumens. Power output available to the hobbyist can range from a meager 9 W fluorescent lamp to a blinding 1000 W metal halide. Luckily, the choice of lighting systems for a hobbyist can usually be narrowed by first determining which types of corals the hobbyist plans on keeping, since this is the primary factor in determining lighting needs.

Heating and cooling

Most hobbyists agree that a reef tank should be kept at a temperature between 25 and 27 °C (75-80 ºF). Radical temperature shifts should be avoided as these can be particularly harmful to reef invertebrates and fish. Depending on the location of the tank and the conditions therein (i.e. heat/air conditioning), you may need to install a heater and/or a chiller for the tank. Heaters are relatively inexpensive and readily available at any local fish store. Aquarists frequently use the sump to hide unsightly equipment such as heaters. Chillers, on the other hand are expensive and are more difficult to locate. For many aquarists, installing surface fans and running home air conditioning suffice in the place of a chiller. Fans cool the tank via evaporative cooling and will require more frequent top off of the aquarium.

Challenges associated with reef aquariums

Because of the delicate inhabitants in reef aquarium, extra attention to water quality is essential when compared to usual marine fish only aquariums. Many experienced reef aquarists recommend testing the water fortnightly, with partial water changes at least every month. In particular, ammonia, nitrite, nitrate, pH, salinity, alkalinity, calcium and phosphate levels should be monitored closely as slight fluctuations can be problematic. Reefs also require extra care in the selection of occupants and major factors such as biological load i.e. the ability of the tank to process the wastes produced by the occupants, and species compatibility are to be considered. These issues, though present in normal tanks, are magnified in the reef tank. Species considered reef safe and able to coexist in larger tanks may not do well in smaller reef tank due to their close physical proximity. For this reason, smaller species of fish such as gobies and clownfish are popular choices due to their relatively small size and ability to coexist peacefully with other tank inhabitants.

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