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## SMALL FISH FEEDING IN A 212,000 GALLON CORAL REEF EXHIBIT

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The 25 foot (7.6 m) deep, 212,000 gallon (803 m<sup>3</sup>) Philippine Coral Reef exhibit at the Steinhart Aquarium in the California Academy of Sciences is populated by many species of small planktivorous fishes including groups of purple queen anthias (*Pseudanthias tuka*), shrimpfish (*Aeoliscus strigatus*), garden eels (*Heteroconger hassi*). Getting food to all of these smaller fish is difficult because 100-200 large fishes, mostly fusiliers (*Caesio* and *Pterocaesio* sp.) and surgeonfish (Acanthuridae), eat most of the food fed from the top of the exhibit before smaller fish can partake. A two-pronged approach was instituted in early 2012 to make sure all the fish on exhibit were getting appropriate amounts of food – an auto feeding system to deliver planktonic fish and coral foods throughout the day, and an injection feeding system on the exhibit's closed loop circulation system zones for small and medium sized fish feeds. So far, both systems are working well by delivering food to all areas of the exhibit as well as eliciting naturalistic behaviors that directly enhance the guest experience (photo 1).

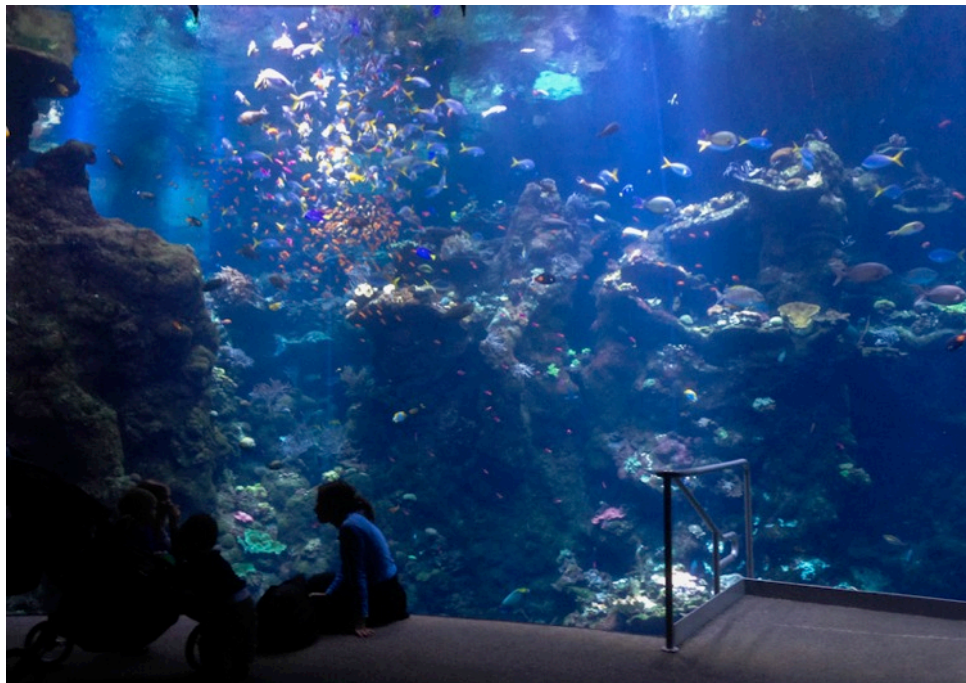


Photo 1: Display fish shoaling and feeding in the current where food is entering the exhibit. Photo –R. Ross



## Auto Feeding

To accomplish the goal of allowing the smaller fish to be eating zooplankton throughout the day like they do in nature, we installed an auto feeder to dispense planktonic foods (48 hour *Artemia*, Cyclopeeze®, fish eggs, rotifers, shredded clam, etc.) at the top of the exhibit. Since the top of the exhibit is viewable by the public, all associated equipment was installed inside a teak chest.

Four “Rola-Chem” 32 gallon/day peristaltic pumps (www1) were installed to distribute food to four locations around the exhibit drawing from a 7 gallon cone bottom reservoir; an air pump was installed to keep the food in suspension (Photo 2). A small centrifugal pump was installed in the exhibit and a line run to the reservoir so after adding the wet planktonic food slurry, the reservoir can be filled with clean tank water at the flip of a switch. Polyethylene tubing (0.25”/6.4 mm) was run from the peristaltic pumps into four entry points around the top edges of the exhibit in areas of fast flow to further distribute the foods – the longest run of tubing is approximately 60 feet (18.3 m).



Photo 2: The chest above the exhibit holds the wet feed reservoir, the 4 peristaltic pumps, trace elements and doser, electrical switches and a container to hold foods that are fed during presentations. Photo R. Ross

When food is delivered to each entry point fishes in the tank orient themselves into the flow and actively and naturalistically feed, though the larger fish seem to be hoping that food big enough for them to eat will come through. Besides actually getting food to the smaller fish throughout the day, this cloud of fish fanning out into the flow and actively feeding greatly enhances the guest experience of the exhibit.

The polyethylene lines from the peristaltic pumps will bio-foul over time so they are flushed monthly with dechlorinated water. Once a quarter, the lines are filled with 5% acetic acid, allowed to sit overnight, then flushed with fresh water (the little bit of vinegar going into the exhibit via this process is negligible). If a line clogs to the point where it cannot be cleared, the line is replaced.

### Injection feeding

As part of the water movement of the exhibit we have three 40 HP Fybroc® pumps that supply water to five 12 inch (30.5 cm) PVC pipe “zones”. Each of these five zones has an actuated butterfly valve; the volume of water that is moved through each zone is computer controlled and changes throughout the day. Existing 1 inch (2.5 cm) valves on each of the zone pipes seemed like perfect areas to inject food and let it travel to various parts of the exhibit. A large basket strainer housing, without the strainer, is used as a reservoir for the food to be injected. An Iwaki MD100-RLT pump is used to inject the food from the basket into the zones. The Iwaki pump draws water from Zone C, B or D and pumps the food to Zones A and E. (fig. 1 and photo 3).

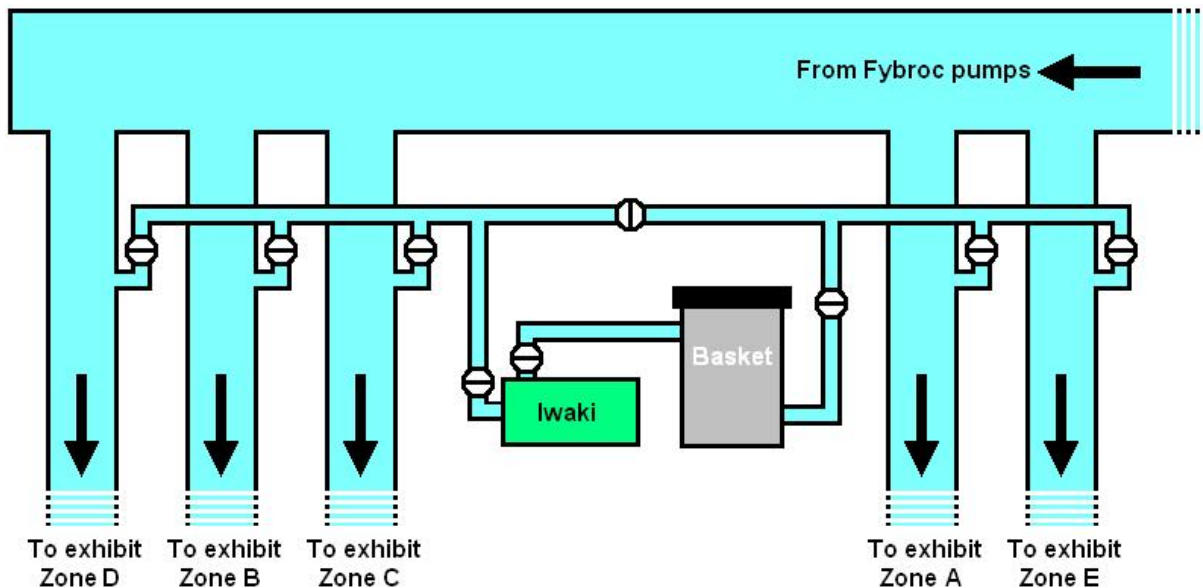


Figure 1: Diagram of Zone Injection Feeding System. Diagram M. Wandell

Foods injected daily include Hikari® Bio-Pure® frozen Mysis, Piscine Energetics PE Mysis, pacifica krill, superba krill, and various flake and pellet foods. The basket strainer has a valve at the bottom that leads straight to a floor drain, so the left over water in the vessel can be removed after the food has been injected.

Currently we inject food into two zones: one that enters the exhibit on the top and bottom of the main window, and another that enters the exhibit at various places spread around the exhibit. This feeding method fills the water column with food at all levels of the exhibit allowing less assertive fishes access to food they would otherwise be missing with a top feeding strategy.



Photo 3: The zone injection feeding system between the closed loop zones waiting for final plumbing and electrical work. Photo R. Ross

It should be noted that initially we used a 30 gallon (114 L) reservoir, visible under the basket strainer in Photo 1, which was filled via any of the zones, food was added to the basket strainer, and then a strong sump pump was used to inject the food into any of the zones. While we liked the practicality of being able to feed all of the zones, the reality of the long time it took to pump the food out and the amount of food that remained in the basket strainer due to the backpressure on the sump pump led us to abandon this approach. The system currently in place, as described above, is easy to clean, injects all the food into the closed loop system in minutes into Zone A and E which distributes the food throughout the exhibit. .

### **Conclusion**

The original vision for the Steinhart's Philippine coral reef was to recreate an actual living coral reef replete with a fish population representative of an actual coral reef. This meant that the majority of the fishes on display would be less than 6 inches (15 cm) and would be mid-water plankton feeders, in contrast to most coral reef exhibits in public aquariums that consist of artificial corals and larger species such as pomacanthid angelfish, grunts, batfish, snappers etc. It was quickly realized that providing enough food to several hundred small planktivorous fish was becoming a challenge. By utilizing the two methods described in this paper, the Steinhart team has been able to provide food in sufficient quantity to various regions of the exhibit, ensuring that enough food is available to all size ranges of fish. We hope these methods will inspire and stimulate others to develop similar systems.



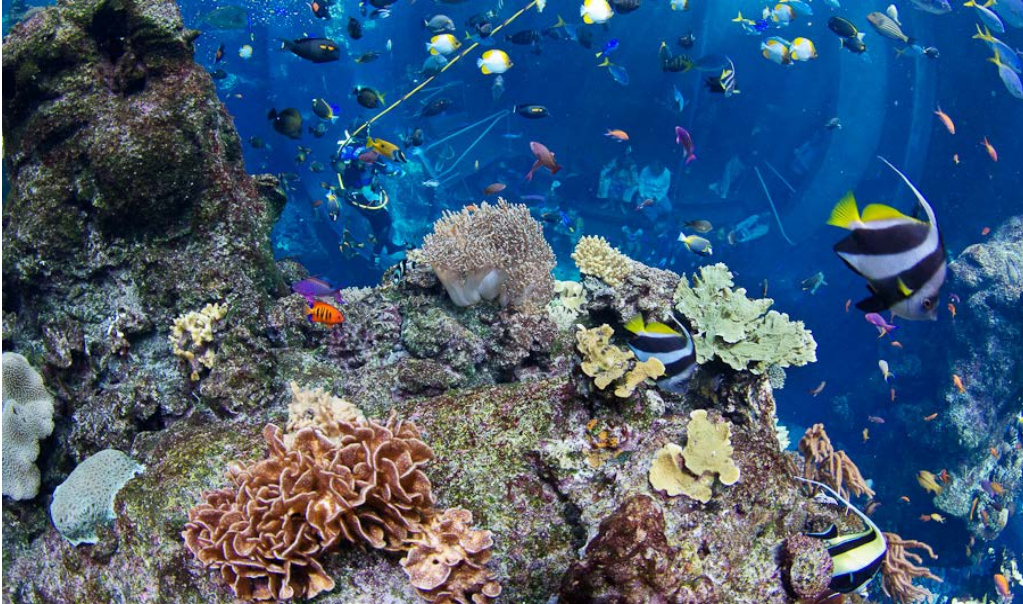


Photo 4: One small section of the Steinhart's Philippine coral reef exhibit. Photo B. Shepherd



Photo 5: View from the smaller window. Photo J. C. Delbeek

### **Acknowledgements**

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### **Internet Reference**

1. <http://www.discount-pool-supplies.com/rola-chem-rc103sc-32-gpd-120v-p-871.html>

## AQUARIUM CLEANING USING MELAMINE FOAM PADS

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### Introduction

Cleaning tank windows and plastic backdrops of algae is a daily task and anything that can make it easier, well, makes it easier. One of the best tools we are using at the Steinhart Aquarium for this purpose is melamine foam, sold by Mr. Clean® under the retail name Magic Eraser®. Pads of melamine foam should only be used on non-rough surfaces like acrylic and the smooth side of plastic backdrops, but they are safe for use in aquatic exhibits. The "magic" part of melamine foam is that it can clean very fine scratches in acrylic better than traditional scrub pads because of its hard yet porous micro-structure. Cleaning smooth surfaces is pretty much the extent of their usefulness. Using them to clean things like rocks, driftwood, tubeworms or calcareous algae won't work very well and will cause them to rip apart.

### How it works

Melamine foam is a foam-like material consisting of a formaldehyde-melamine-sodium bisulfite copolymer made by BASF under the names "Basotect® W" and "Basotect® V 3012" (BASF). It has a wide variety of uses owing to its high chemical resistance, high sound absorption, and flame retardant properties. On a small scale the structure of melamine foam is a very porous web of hard fibers, but it feels soft to the touch (fig. 1). Despite the scary sounding chemistry of melamine foam, it is chemically inert in seawater and does not release any problematic chemicals that we are aware of or have observed after using the pads for several years in live coral exhibits.

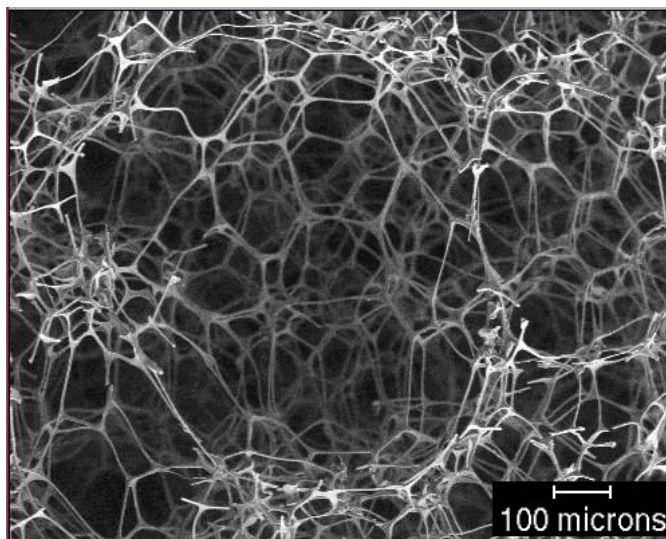


Figure 1: Melamine foam at high magnification.



We have used melamine foam pads in several different ways. The simplest way is to use the pad by hand for cleaning small exhibits. For larger exhibits, the pad can be attached to algae scrapers, Doodlebug™ heads, or cleaning magnets. To attach the pad to an algae scraper, we often bend the pad around a length of vinyl tubing and use a rubber band to hold it in place – although some keepers prefer to leave the plastic scraper blade in place under the magic eraser because it allows for a bit of extra leverage in deeper exhibits (fig. 2). To maximize the life of each magic eraser is important to bend, rather than fold, the pad when possible because it will tear easily at the crease.



Figure 2: Magic Erasers can easily be attached to a long handed scraper via a rubber band.

For Doodlebug™ heads and cleaning magnets, the melamine foam needs a backing that will mate with Velcro®. Melamine foam is too dense to stick to Velcro® on its own. Attempts to DIY a solution to this problem using super glue and adhesive tape met with failure; fortunately there is an off the shelf solution available from [www.spongeoutlet.com](http://www.spongeoutlet.com) that has a brown scrub pad bonded to melamine foam (fig. 3). The brown pad will attach to Velcro® and Doodlebug™ heads. If the pad is too thick to allow useful magnetic attraction though the tank window, removing foam carefully with a fillet knife can reduce the thickness of the foam. It should be noted that the brown pad will scratch acrylic badly, so if you reduce the thickness of the foam



pay special attention to the possibility of the brown pad wearing through the magic eraser foam over time.

Regardless of how they are utilized, all melamine foams will slowly degrade over time and become thinner, but they are still useful. At a cost of 25 cents per pad they can be considered disposable, but we have found useful lifespans up to several months if they are taken care of properly.



Figure 3: Part DBG60PK from spongeoutlet.com fits doodlebug heads and will attach to the Velcro backing of cleaning magnets.

### **Other considerations**

Using dry melamine foam on dry acrylic will create very fine scratches in the acrylic. A melamine foam pad should always be used underwater.

Mr. Clean® brand Magic Erasers® are sold in 4 varieties: “Original”, “Extra Power”, “Kitchen Scrubber”, and “Bath Scrubber”. “Original” and “Extra Power” are 100% melamine foam, with “Extra Power” being made of denser and more durable foam; both of these varieties are entirely safe for use in all aquariums including those with live corals. “Kitchen Scrubber” and “Bath Scrubber” are melamine foam pads impregnated with cleaning detergents, which makes them unsuitable for usage in aquariums.

### **Resources**

Mr. Clean Magic Eraser information:

[http://www.mrclean.com/en\\_US/magic-eraser.do](http://www.mrclean.com/en_US/magic-eraser.do)

Source for generic melamine foam products:

<http://www.spongeoutlet.com>

BASF Basotect information:

<http://www.plasticsportal.net/wa/plasticsEU/portal/show/content/products/foams/basotect>

Reef Builders blog about melamine foam usage:

<http://reefbuilders.com/2009/03/03/magic-eraser-clean/>