COMPLIMENTARY

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Advancing the Hobby of the Marine Aquarist

Captive-raised Marine Fish and Invertebrates

The Future of the Hobby/Industry

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On the freshwater side of the ornamental fish hobby/industry, well over 90% of the fish and inverts that we keep in tanks are commercially raised, primarily in the Far East and in Florida. Even though fishes still taken from the wild include such aquarium favorites as cardinal tetras, rummy noses, hatchet fish, elephant noses and the "L-number" plecos, if all of the wild-caught freshwater fishes were to disappear from the hobby/industry overnight, they would not really be much missed except by the really hard-core fishheads.

On the marine side, things are very different indeed. The marine hobby and industry depend on wild-caught fish and invertebrates for a very high percentage of the animals that we keep. If wild-caught marine animals were to disappear from the local fish stores, there would be lots of empty tanks—or tanks filled with only clownfish, gobies, dottybacks and seahorses.

Things Are Changing

Having started out on that somewhat negative note, for the rest of this article I am going to discuss the exciting progress that is being made with commercially farming marine fish. As the cost of freight from the Pacific Ocean area rises, the economic incentive to breed marine fishes commercially increases.

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Beautiful aquacultured corals from Saltwater City in Lynn, MA.

SPECIAL EVENTS

- **3rd Annual Marine Aquarium Expo**
  April 10, 2010
  OC Fair & Event Center
  Costa Mesa, CA
  http://marineaquariumexpo.com/
- **Midwest Marine Conference 2010**
  May 21-23, 2010
  Cranbrook Institute of Science
  Bloomfield Hills, MI
  www.midwestmarineconf.org
- **Regional Aquatics Workshop (RAW)**
  June 7-11, 2010
  Doubletree Hotel-Downtown
  Omaha, NE
  www.rawconference.org

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Above: Oceans, Reefs and Aquariums (ORA) proudly presents their own strain of clownfish. Below Left: ORA's vast holding vats and shipping area. Below right: A close-up of my baby common clownfish.

Some Farming Enterprises

Oceans, Reefs and Aquariums (ORA) (http://www.orafarm.com/) is one of the largest producers of captive-bred fish and inverts for the hobby/industry. They have a huge facility located at the Harbor Branch Oceanographic Institution in Ft. Pierce, FL. In addition to producing many varieties of clownfish, gobies, dottybacks and seahorses, ORA has some very interesting "sports" of clownfish, such as the "Snowflake" and "Picasso," and they are also developing their own hybrid dottybacks. Their coral propagation is now centered in a new, 5,000 square foot greenhouse designed and built by Dustin Dorton, the VP and COO of ORA. This greenhouse, put on line in 2008, is primarily producing hard corals, especially *Acroporas* and *Montiporas*, and it has worked out so well for ORA that they are going to build a second one, dedicated primarily to soft corals.

New England Marine Ornamentals (known cleverly by the acronym, NEMO) is a commercial venture that is an offshoot of the marine biology department of Roger Williams University in Bristol, RI. Their breeding facility produces a regular supply of ocellaris and maroon clownfish, some gobies and dottybacks, including a really nice strain of orchid dottybacks. Brad Bourque runs NEMO, and Professor Andy Rhyne is the academic support for the enterprise. Andy is also doing his own research on raising marine animals in his work with the New England Aquarium, where he has been harvesting eggs from the Giant Ocean Tank (GOT) and figuring out how to raise the babies. Some of the spawns he has gotten from the GOT include sergeant majors and queen triggerfish.

One other enterprise that should be mentioned here is the sustainable harvesting and "farming" of some marine animals, mostly invertebrates, in the oceans. Most of the *Tridacnca* clams in the hobby are being commercially raised on "farms" throughout the Far East, and there are many corals being "farmed" in sections of reefs.

New Breakthroughs

Everyone involved in raising marine fish agrees that the basic problem is to figure out what foods the larvae need at what stages, and how to commercially produce those foods. It is not really all that many years ago that we did not know what baby clownfish required, and now clownfish are raised in quantities, both commercially and by hobbyists. Dedicated hobbyists and professionals have made great progress, and I will mention a few.

Breeding Mandarins

Matt Wittenrich of the Florida Institute of Technology is a well-known author, teacher and master breeder, and his most exciting work is what he has done with mandarins (*Synchiropis* species). In the Jan/Feb 2009 issue of *CORAL—The Reef Aquarium Magazine*, Wittenrich has a spectacular article, full of incredible photographs, in which he details his experience with these beautiful and desirable aquarium fish. He discusses the development of feeding protocols to successfully get dragonets to eat frozen mysis shrimp, and the entire spawning and raising process. One photo in the article says it all—three-month-old juvenile mandarins in the author's palm. It is very exciting that not only do we now know how to get mandarins to thrive on processed foods, but we clearly can look forward to being able to stock our tanks with commercially raised fish.

Green Puffers

Craig Watson of the University of Florida Institute of Food and Agricultural Sciences reports in a February 16, 2009 press release that his group has succeeded in artificially breeding green puffers, which are an attractive ornamental fish. This is especially interesting since these puffers are brackish fish that can be acclimated to a marine environment. The press release reports that, "Spotted green puffers aren't suitable for injection because they have little muscle mass and their skin is unusually elastic. So the UF team used a catheter to introduce the chemical directly to the female's ovaries. After several trials they reached nearly 100 percent success in egg fertilization and hatching."

Harlequin Filefish

In another issue of *Coral—The Reef and Marine Aquarium Magazine* (March/April 2009), Matt Pedersen reports on his experiences with Harlequin Filefish (*Oxymonacanthus longirostris*), again replete with wonderful photographs. Pedersen gives a very detailed description of the feeding protocol for conditioning the breeders, and the complete breeding process from eggs to prolarvae all the way through the baby filefish ready for hobbyists. This article breaks down the process by hours and days, and anyone who is interested and has the patience and determination could follow the process step-by-step.

Hobbyists Help Lead the Way

As has often been the case in the aquarium hobby and industry, individual hobbyists have paved the way in breeding and raising marine fish and inverts. Many local fish stores have sizeable back-room operations where they produce corals and sometimes fish. In my fish room, I have a forty-gallon breeder tank set up to test a new filter in a marine fish-only environment. In that tank, I have nine small common clownfish that I got from Saltwater City, an all-marine store in Lynn, MA that is near where I live. John Rodrigues, the owner, is a long-time friend, and he told me that the clownfish I have were bred by a hobbyist a few miles away in Newton, MA. Local fish stores will always be pleased to get fish and inverts that their customers have cultured, and this is becoming a significant source of captive-raised animals.

Mention must also be made of MOFIB–the Marine Ornamental Fish and Invertebrate Breeders. This rather young organization has members all over the world, and through the Internet, they share information on everything having to do with captive raising of marine animals. MOFIB caught my attention at the 2008 Marine Aquarium Conference of North America (MACNA) in Atlanta, where their exhibition booth had a small tank with...wait for it...baby mandarins. Yes, they were from Matt Wittenrich, as discussed above.

The Future for Captive-raised Marine Fish

As for the future of captive-raised marine animals, I am very enthusiastic. The economics of air freight are making captive-raised animals competitively priced with wild-caught, and if the industry does a little promotion, I am convinced that hobbyists can understand why it is best to keep captive-bred fish, even if the cost is a little more. What is most encouraging is that individual hobbyists, and those in organized groups such as MOFIB, are working at the cutting edge of figuring out how to breed and raise more different types of fishes, as are businesses such as ORA and NEMO. It is, in my opinion, only a matter of time before we are no longer going to be allowed to take fish and inverts from the reefs. And I am convinced that there are enough hobbyists and companies with foresight that when this happens, the marine side of the hobby will be able to carry on with captive-raised animals only.

SOURCES

Please note: in this article, when I refer to individuals and/or companies and organizations by name, these are just the ones that I have had the time to speak with. There are many more folks and companies out there doing excellent work.

Oceans, Reefs and Aquariums (ORA)
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Marine Ornamental Fish and Invertebrate Breeders (http://www.marinebreeder.org).

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For instance, trace elements such as aluminum, cobalt, lead and manganese, which are classified as scavenged types, have strong interactions with particles, which results in short residence times in the water column as the particles sink into deeper water (Kremling et. al. 1999).

Table 2. The Mean Concentration and Type of Distribution of Some Common Trace Elements in Seawater (ppm)

Element	Conc.	Distribution
Aluminum (Al)	0.000270	mid-depth minima
Antimony (Sb)	0.000146	?
Beryllium (Be)	0.0000002	nutrient, scavenged
Cadmium (Cd)	0.000079	nutrient
Chromium (Cr)	0.000208	nutrient
Cobalt (Co)	0.000001	depleted at surface
Copper (Cu)	0.000254	nutrient, scavenged
Lead (Pb)	0.000002	high in surface waters
Manganese	0.000027	depleted at depth
Molybdenum	0.010	conservative
Nickel	0.000470	nutrient
Silver	0.0000027	nutrient, complexed
Thallium	0.000012	conservative
Vanadium	0.002	slight surface depletion
Zinc	0.000392	nutrient

*adapted from Pilson 1998

Unfortunately, no research exists on the potentially positive effects of low amounts of various trace elements in aquaria. Indeed, for many years, several manufacturers of synthetic sea salts, in order to provide a complete formula, added or separately provided trace elements to their basic formula (Anonymous 1985, 1990). In recent years, however, this practice has been greatly reduced by many manufacturers as it was realized that many trace elements are naturally present in low quantities in the major chemicals compounds, such as sodium chloride, magnesium chloride and sodium sulfate, used to make synthetic sea salts.

In fact, recently the pendulum has swung from "experts" claiming SSS are bad compared to natural seawater (NSW) because they lack trace elements to "experts" saying SSS are bad because they have too high a level of many trace elements.

A CONTINUING SERIES

Part 6: Science Behind Synthetic Sea Salts

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6. Trace Elements in Natural Seawater and Synthetic Sea Salts

a. The subject of trace elements has been controversial since synthetic sea salts (SSS) were first made. But before delving into the pros and cons of trace elements, they first must be defined, because many hobbyists and writers confuse trace elements with the major ions in seawater. All chemical elements in seawater are grouped into three general categories: major, minor and trace. In Section 4, the eleven major ions were introduced, and are those that, according to Pilson (1998), occur in concentrations greater than 1 ppm (1 mg/kg). But this is, admittedly, an arbitrary value.

The distinction between minor and trace elements is also arbitrary and not clearly defined in the scientific literature. For instance, Morel and Price (2003) define trace elements as those at a concentration of <0.1 µM, while Kennish (1994) states that the average concentration of 22 trace elements ranged between 0.05 and 50 µmol/kg.

What is perhaps more important when distinguishing major elements from minor and trace elements is that major elements are almost all conservative while most minor and trace elements are not. Conservative means that the relative amount of the major ions to each other is constant everywhere in the ocean (calcium, strontium, bicarbonate and boric acid being the exceptions).

Trace elements are non-conservative and may be classified as recycled, scavenged or both. For instance, depending upon water depth, copper and iron are recycled or scavenged (Kremling et. al. 1999). These two elements are depleted in surface waters due to the high productivity (meaning high growth rates of algae) associated with this zone of maximum sunlight penetration. But the concentration of these elements increases with depth as the algae die, sink and decay, which releases and recycles the elements. Also, the concentration of most minor and trace elements varies greatly in the water column from one oceanic region to another and over the course of the year. The main reason for different concentrations of the same element over space and time is that many minor and trace elements are nutrients. Algae, bacteria and other planktonic organisms, along with corals and other invertebrates, remove these elements from the water in the processes of respiration and growth. Elements such as cadmium, chromium, copper, nickel and zinc, to name just a few, are needed in small amounts by many organisms for normal cellular function.

At higher concentrations, however, these same trace elements are toxic to marine organisms. The problem is that there are few studies showing toxic concentrations of specific elements to a wide variety of the organisms kept in marine aquaria. While some authors would like you to think that any amount of a trace element is harmful, that is just not the case.

Table 2 lists the average concentration and distribution of some common trace elements in the ocean. One has to realize that these "average" values are hypothetical and that they are not typical of what one would find in the near-shore ocean environment.

Another phenomenon that must be considered when discussing trace elements in seawater is the interaction of some elements with particles in the water column.

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PUBLICATION INFORMATION

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

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