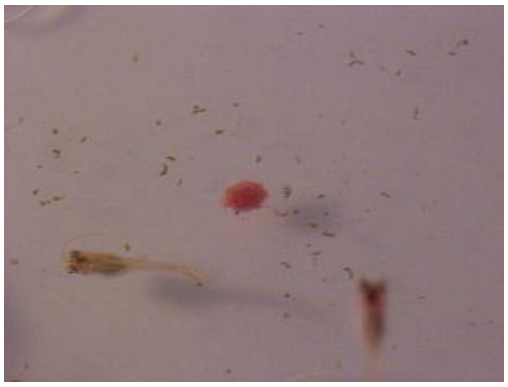
Co-Culturing Daphnia and Dero Worms: Symbiotic Harmony

In February of 2003, with funding of $100,000, Hawaii's freshwater ornamental fish industry sought to find "alternative food organisms that could replace brine shrimp in the larval and nursery stages, in light of increasing prices and variation in availability of brine shrimp cysts." They used swordtails, a live bearing relative of the guppy, and found that a small species of daphnia called Moina, *Moina micrura,* fit the bill. Also in the new millennium, a small relative of the tubifex worm began to see use as a live fish food. Known as a micro-tubifex, or Microfex, this little aquatic oligochaete has been known to science since it was named *Dero digitata* in 1773 by Muller.



Guppy fry eating a pea-sized ball of Dero Worms

Dero worms consuming a piece of fish.

Perhaps no other aspect of tropical fish husbandry evokes as much passion as that of what one shall feed. The pleasure an aquarist derives from seeing his or her fish in a feeding frenzy over newly hatched baby brine shrimp is only equalled by the sight of those bulging red bellies in the fry. With a 'we-are-what-we-eat' philosophy for a Holy Grail, the aquarist feels a sense of accomplishment knowing they have fed the best to their stock available. In competition breeding, the right "fuel" takes on an even greater meaning. Indeed, many feel they can feed their way to the top. Alas, this idea is only a half truth. Nutrition is the single most important environmental factor in an organism's development, but it takes a back seat to genetics every time. That said, it is a well-known fact that British conscription troops during WWI were of small stature owing to lack of meat in the diet of so many urban poor. This is a clear case in point where an environmental factor, or lack thereof, can place a damper on genetic potential. In his expose, "People of the Abyss", author Jack London in 1905 chronicled some of the squalid life in London and remarked that an American could be spotted in a crowd by virtue of the fact he would be a whole head taller than those around him. Unfortunately, the reverse is not true—we cannot exceed the limitations of the genetic blueprint. Nevertheless, the gullible consumer is always beset by glossy advertisements for a dog food, for example, showing this year's Westminster Champion with his handler receiving his ribbon, as if to say, "Feed our product and your dog, too, can be a champion."

With nutrition's scope of influence rationally defined, we as keepers of stock will still want to feed the "best". While the scientific research that goes into commercial feeds is above reproach, the special interests of Big Business are not. By lobbying to have the canine, for example, labelled an omnivore rather than the more correct appellation of carnivore, Big Business created for itself a huge built-in profit margin. You see, AAFCO, or the Association of American Feed Control Officials, operates within guidelines set forth by government agencies, and the government and Big Business are…well, bed fellows shall we say. Grain is a whole lot cheaper than meat—easier to package, too—and on paper these grain-based feeds meet AAFCO standards; but, in fact, phytates present in great amounts in grain-based feeds render the bioavailability of the meat/protein ingredients very poor. The guppy is classed as an omnivore, but I suspect insectivore would be a more accurate classification, and insectivores are carnivores.

How many times have you seen your guppies truly eat plant leaves? They do not. They may graze lightly on algae that grows on the surface of leaves and glass, but primarily they feed from the water column itself, or the water surface. This means insects, terrestrial or aquatic. Given a choice, the guppy will go after the mosquito landing on the water, or its larvae swimming *in* the water. That annelid wriggling on the substrate? He is lunch. What vegetable matter a guppy gets is pre-digested in the intestinal tract of insects. Some species of fish cannot even be induced to spawn without live food, thus the serious aquarist's fascination with live food. But the procurement of live food is difficult. Live portions of tubifex and daphnia were once commonly available in independently owned and ran pet shops—this can be seen to this day in other countries—but the "big box" chains have homogenized the American consumer into a one-size-fits-all mentality. We now get our Daphnia freeze-dried or frozen in little cubes. Though much of its nutrient content is left intact by freezing and freeze-drying, live foods that are no longer alive do not offer quite the same benefits to fish as the real article—plus, they are so expensive. A few struggle on with hatching live baby brine shrimp, but while undoubtedly a superior food, it is not a renewable live food source for the home aquarist, and its constantly rising cost has driven even commercial concerns to explore different avenues. Compounding the problem is the fact that so many viable live foods are difficult to culture and maintain, and those that are easy and idiot-proof, like the vinegar eel, are of dubious nutritional value. Well, that has all changed.

Strangely, we have come almost full circle back to the days of Innes and Axelrod when Tubifex and Daphnia were King, the be all and end all of live foods. Of course, tubifex fell out of favour when it was discovered to contain harmful parasites. But tubifex has a very close, albeit smaller, cousin that is *not* plagued with such problems when cultured in controlled conditions, it is known as the Dero worm, or *Dero digitata.* Also known as the Microfex due to its resemblance to a small tubifex, the Dero worm is a prayer answered for those wanting an idiot-proof, nutritionally-unsurpassed, renewable source of live fish food. While quite long, and sizeable enough to interest any adult guppy or Betta, the Dero worm is quite thin and readily taken by fry as well. What is more, it is usually cultured alongside an old friend, Daphnia. It is an undisputed fact that nothing puts colour on a fish like Daphnia. By creating favourable conditions for one species, we are by extension making things favourable for another species; a true symbiotic relationship—two for the price of one. In this case, one merely feeds the Dero worms, and they, in turn, excrete waste favourable to the

proliferation of infusoria which the Daphnia feed on. The need for multiple large containers of green water grown under 24 hour lighting is eliminated.

The typically suggested cast of characters for this biotype is as follows: Dero worms, one or more of a species of Daphnia, java moss, and snails. This author cringes only at the snails, for they will leech calcium necessary for the Daphnia's carapace or exoskeleton from the water. This could be offset, I suppose, by the additions of shells to the tank. While either can be cultured separately, Daphnia and Dero cultured together makes for a productive and compact set up.

Essentially, all one is doing is setting up a cycled fish tank without fish. As aquarist and Daphnia culturist Dave Koran states, "My advice to those wanting to culture daphnia is to first think about how you are going to control water quality. Remember, you won't get 100% conversion of food to daphnia. You need oxygen, circulate your water or facilitate oxygen exchange. Second, you want something that generates protozoa like food. You will either get that by adding a protozoa soup to your culture or possibly by reconstituting dry yeast. Many things are capable of generating protozoa, from a co-culture to a separate culture of fish or worm manure, cow dung, sweet potatoes, peas, dry baby formula, etc. but do it in a separate container and feed that to the daphnia." Another writes, "Overfeeding a daphnia culture is very easy to do. It almost always results in oxygen deprivation. However, I believe the notion that "daphnia cannot tolerate aeration is a misnomer. I have found that one of the best ways to stabilize a culture and prevent the described scenario is to add a sponge filter.... the kind that do not require an airstone." In the statements made by these two gentlemen, you have the core reason for success or failure: water quality. By using the Dero as our source for protozoa, we eliminate one cause of poor water quality, overfeeding. By using a seasoned sponge filter, we stabilize the tank and insure water quality. As previously stated, there is no need for separate cultures of green water, manure teas, or elaborate concoctions to feed the Daphnia, as it is built-in with the Dero worm, garbage-disposing, protozoa-emitting vermiculturist that he is. The Dero worm relishes algae wafers, pieces of fish, entire dead fish, decaying leaves, mulm siphoned from your tanks (my food of choice), and even leftover vegetables from your plate—in small amounts, of course.

Several pitfalls do await those wanting to start this type of culture. First, if you have ever had a drop of just a very few fry, you know how difficult it is to feed a half dozen creatures in a 10 gallon tank. Regardless of how sparingly you feed, you are probably overfeeding. Second, every seller I have seen on Aquabid insists this culture can be maintained without filtration or aeration; indeed, I cannot recall even one seller stressing the importance of having cycled quarters for the culture. And so, your culture arrives, a pathetic parcel with a pea-size ball of worms and what looks to be a half dozen Daphnia.

Seasoned aquarists all, we are astute enough to fill a gallon-sized vessel with *aged aquarium water* and proceed to empty the contents into their new home. We drop a piece of algae wafer on top of the worms and hope for the best. Here is what, in fact, happens. First, while present in the aquarium, infusoria are not to be found in great enough numbers in the average aquarium to satisfy a filter feeder such as Daphnia, which will not actually seek or prey upon infusoria; but, rather, merely take in water with the "hope"

infusoria is present. Second, I question the idea that Dero worms eat algae wafers. It is my belief they eat the bacteria from *decaying* algae wafers. You have an ammonia spike ready to happen, certainly so if you add any green water or activated, reconstituted brewer's yeast under the correct assumption the Daphnia do not have enough to eat. In a small vessel with no aeration or filtration conditions are unstable at best—it is why goldfish in goldfish bowls never really works without constant water changes. The whole thing crashes. Even the Dero worms, which essentially feed off sewage and have developed a way to produce haemoglobin (thus their red-orange colour) for oxygen supply in less than well-oxygenated waters, suffer and die. As Paul from Sachs Aquaculture writes, "The worms are not dependent on water changes for growth. However, if the water becomes too stale (my guess is Oxygen goes out the door), the culture will fail." So to anyone wanting to try this culture, I advise saving all the mulm you siphon from your fish tanks and place it in another tank of at least 10 gallon size, fill with aged aquarium water, and use a sponge filter well-seasoned with helpful bacteria *before* starting this culture. This way you can feed the daphnia reconstituted, activated brewer's yeast (2 teaspoons sugar to ¾ teaspoon yeast well mixed in 2 cups of water) until you get over the "hump" and there are enough Dero worms to take care of the Daphnia. You feed just enough to make the water slightly hazy. The Daphnia should clear the water up within 24 hours.

Hornwort, or any other fast-growing floating plant, will greatly help with conditioning the water as well. Further, it does not hurt to start an infusoria culture in a mason jar filled with pond water and some lettuce leaves, which is then placed by a window to both properly inoculate the tank with infusoria and have as a standby.

Another problem that might confront you is the species of Daphnia typically sold with these cultures. It is *Daphnia Magna*, a species native to Great Britain. For starters, they are too big for all but the largest females. Second, like their American cousins, *Daphnia Pulex*, a smaller species, their populations will "pulse" under even the best conditions; that is, you will experience a boom or bust cycle with these. Not so with Moina. According to researchers at the University of Florida, "High population densities of *Daphnia* can result in a dramatic decrease in reproduction, but this is apparently not the case with *Moina.* The egg output of *Daphnia magna* drops sharply at a density as low as 95-115 mature individuals per gallon (25-30/L). The maximum sustained density in cultures of *Daphnia* reported is 1,900 individuals per gallon (500/L). *Moina* cultures, however, routinely reach densities of 19,000 individuals per gallon (5,000/L) and are, therefore, better adapted for intensive culture. "

Moina has consequently replaced newly-hatched live baby brine shrimp in Singapore's aquaculture industry. Realistically, it is claimed that a bare 10 gallon aquarium will *at least* provide a feeding of Moina for 5-7 tanks of fish every other day. I have seen claims of this set up feeding up to 7 tanks *daily.* This does not even factor in the harvest of Dero worms, which double their number very 3-4 days. One of the original Aquabid sellers of these worms claimed to pull 2lbs a week from the several tanks of them he kept! The bottom line is that this combination culture is getting rave reviews.

From personal experience, I can attest to the ease of culturing the Dero worm. I had received a starter culture a few months back. I made the mistake of supplying no aeration or filtration and had fed the Daphnia green water. Of course, the thing crashed—or so I thought. Long story short, I found the one remaining healthy clump of Dero worms and

threw it in a tank of guppies. A month later, the bottom of the tank was *covered* with them, feeding off the bottom mulm. I had done nothing but feed the guppies.

Nutritionally, the protein content of Moina is 50% of dry weight, fat 20-27% in adult females. They are considered as good as, if not better, than newly-hatched brine shrimp. Moina are associated with an unparalleled 95-99% survival rate to ¾ of an inch in ornamental fry. The Dero is nutritionally similar to the tubifex of bygone days, with a protein content of 46.1% of dry weight according to Mary Allen, PhD, of the Smithsonian Institute. The fat content of the Dero is 15.1% of dry weight, similar to the earthworm's 17.7% of dry weight. By comparison, the protein content of brine shrimp nauplii is 41.6-47.2, according to the University of Gent in Belgium. According to the same source, fat content of brine shrimp nauplii is 20.8-23.1% of dry weight.

This combination live food culturing system is very new and largely still unknown, thus questions remain. As the University of Florida states, "Unfortunately, there is very little information concerning practical mass culture methods of *Moina*, and the available information is in mimeograph documents, foreign journals or other scarce publications." Already, many are using the principles behind this symbiotic culture and co-culturing California black worms, Tubifex, and Nais worms with Daphnia. The killifish and betta breeders are largely leading the charge in new developments. Competitive guppy breeders are encouraged to at least explore this new avenue of live food, as only through the innovation of many will advancement come. For guppy enthusiasts with less than, say, 50 tanks, the co-culturing of Dero and Moina will offer immediate freedom from the labour and expense of hatching brine shrimp nauplii. For the hobbyist with 150 or more tanks, this system of live food culture offers at least a substantial reduction in the reliance on live baby brine shrimp. The sceptical aquarist will scoff at this discovery, but it is only through trial and error that advancement will occur. The Dero worms, alone, are worth the price of admission. As I so fortunately learned by accident. Dero worms rival Vinegar eels as a maintenance free culture.
As with all endeavours, patience is the key to mastery.

To close on a final thought, the Dero worm does not have to be kept in mulm. So long as it has something decaying to eat, such as a piece of fish or algae wafer, it would thrive equally well in a bare-bottom tank. This leads us to the possibility of growing them in each guppy tank along with the guppies, or even in breeding traps suspended in each tank. For some reason, the guppies do not prey upon the worms balled up in their feeding clumps. This gives the hobbyist with a hundred or more tanks options for culturing enough live food for their fish without designating huge amounts of tanks or space to the project. Who knows what techniques will evolve?

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