

Beginning a Selective Breeding Program

Originally in "Livebearers", Journal of the American Livebearers Association . First published around 2003, this essay describes my introduction to selective breeding, and where I am today, breeding various livebearers, swords, goodeids and barbs. The initial experience with the fish I started out with established my respect for doing things with a certain approach, and those lessons are still fresh and appropriate to everything I do in my breeding programs today.

I had kept community tanks for over 40 years, and decided around 1995 to devote a few tanks to working with just one line of livebearers, hoping to develop something I thought looked good, representing better quality, consistent color, size and finnage than what I had. I knew I didn't have the knowledge of genetics I thought I'd need to introduce specific physical characteristics, but with all I had read about careful record keeping and observing fish closely, I thought I'd be able to "stabilize" a line toward its best looking fish. I believed that it shouldn't be too difficult to get a line to look fairly consistent, close to how I thought it should look, producing desired, attractive and healthy fish. I had seen the large IFGA delta tailed guppies back in the '60's and had always wanted to become involved with them. I also admired the large wild swordtails that I had only read about, but had never seen. I figured that what I learned could be applied to anything down the road, angelfish, barbs, etc. However, I naively believed that guppies would be an ideal, easy species to start with.

After maintaining at least one 55 gallon tank over the years, I managed to breed a few species since first keeping fish in 7th grade. I felt confident of my husbandry skills; I even took pride in my ability to maintain beautifully planted tanks. I had long been in the habit of testing my water, and did at least weekly water changes. I figured I knew what I was doing, and didn't anticipate any big surprises.

The entire journey to selectively breed my own line of fish proved to be both an exciting and humbling process. I found that I knew less than I thought, and was far less prepared than I could have been, primarily with respect to the number of tanks I'd need, and how they should be maintained. The process caused me to re-evaluate why I keep tanks and opened up the hobby for me to do things I never thought I could.

Today I've been successful at creating a distinctive line of *X. nezahualcoyotl*, a wild type swordtail that has been sold at fish conventions for about 8 years. I learned to change many long established habits, and wish to briefly share some of the information I spent so much time and money accumulating, so that you won't need to stumble and trip through the learning curve as I did. In combination with what others have told me, I learned to develop each step of the process based on my own experience. I took an "assume but verify" mindset, understanding that water qualities and husbandry, the two biggest factors in this process, generally differ between fishrooms. The result from this essay for you is that as I detail what I have done to develop out various livebearer, cichlid or barb lines, you will need to adapt my process to the species you have chosen to breed, and the limitations you may face due to the characteristics of your water. For best results (or any results) you need to be sure the species you choose will do well in your water, in that they are comfortable enough to express their desire to breed. Your tap water can vary widely depending on where you live, and you must choose to work with fish that already do well in your water if you are hoping to breed them, and if you hope to share the fish you breed with other hobbyists.

Find out what the basic preferred conditions are for the fish you want to breed. (Minimum size tank, recommended pH, hardness, temperature, water movement, amount of light, need for plants/ places to hide, whether they require gravel to spawn, do they require certain triggers to spawn?) Have they done well for you in the past? Even though many individuals appear healthy, do you find that single fish die occasionally for seemingly no reason? (This can indicate that the water parameters can be adapted to by some, but not others, and they probably will not breed readily) Have they bred for you in the past? And have you read everything you could find on breeding the fish you have chosen?

Before I started this process I had a well planted 100 gallon show tank filtered with a well aged wet/dry trickle

filter, a mature fluidized bed filter on the back and over 30 years experience at keeping fish. In this large tank I kept trays of peat beneath a ½" layer of natural pea gravel that supported large trunks of carefully trimmed Watersprite (*Ceratopteris*- they looked liked a maintained Bonsai forest) and *Vallisneria*, and I had moved out all of the fish. My goal was to have these beautiful surroundings with the big IFGA (International Fancy Guppy association) delta tailed guppies swimming between the plants. I was willing to set up a couple 20 gallon tanks for babies and for quarantine. So those guppies were my first choice, yet I knew nothing about these fish other than that they were guppies.

How hard can guppies be to keep? I hadn't talked to anyone, or read a thing about them, thinking I knew guppies. For the majority of my time keeping tanks I've always had a line or two, and I'd kept guppies pretty heavily when I was in high school. I had no idea what more there could be. Later in this essay I will address other fish I have worked with, but the basic process, organization, observation and attention to detail I first encountered with those guppies well documents what needs to be done with whatever species you decide to work with. Your basic tank sizes will vary depending on the size of the fish you will be working with. For Guppies, danios or dwarf cichlids you will be using 10s and 30s, with livebearer swords, barbs, angels and most cichlids the tank sizes may be 20s and 50s, though their functions in your breeding program will be similar.

I set out to buy the best IFGA delta-tailed Guppy stock I could find. Through the classified ads in the back of one of the fish magazines I contacted a couple breeders and even set up appointments to tour their fishrooms. One room involved a 7 hour drive to L.A. from where I was living, but it was entirely worth the effort. I explained what I wanted to do, and that I was willing to spend a little money to start with a few quality fish.

The fishroom in L.A. was mindblowing. This guy had close to 200 tanks, and most of them were 30, 50 and 90 gallon tanks. All stocked heavily with thousands of guppies. Entire rows with tanks on both sides, all filled with bright delta tails- dozens of tanks that in many cases were full of the same line of identical fish! With a great eye and years of experience he scanned the fish as they matured, looking for tiny advantages or flaws in any particular fish, carefully picking his next line of breeders.

I did my best to pick every corner of his brain that I could get into. "How extensive is your record keeping?" I asked. "I don't keep records. In fact I really don't write anything down." He told me. He had dozens of lines. Thousands of fish. 200 aquariums, and he doesn't keep any records. I was warned that my planted 100 gallon tank idea was probably not a good one, but I didn't understand why. Today I realize that those breeders probably figured there wasn't enough time in the day to explain what I needed to know.

I knew even less than I thought. And it seemed that that wasn't much.

The Mechanics of Selective Breeding

I bought 3 trios and ended up running into problems before the fish had even arrived. To prepare for their arrival I was told to totally clean everything with bleach. Tanks, filters, nets, siphon hoses, tubing, everything. All of the established biofiltration had to be destroyed, and for evermore any fish from outside of my fishroom had to stay outside of my fishroom. No more live plants or gravel. These top quality fish, at close to \$100 a trio back in 1995, were coming from what I was assured were totally disease free environments, and must be introduced to a similar setup. The breeders I visited even kept these cute little dipping buckets filled with a weak chlorine bath for dipping their nets, to prevent any spread of disease between tanks. Salt had to be added to the water at 1 tbslp. per five gallons of water. Everything had to be kept clean, clean, clean. With the salt in the water and careful, nearly obsessive observation of the fish I began to understand why I didn't see plants or gravel in any of the tanks of the champion breeders I visited.

Gravel harbors organic waste that can contribute to fungal and bacterial infections, and limits your control over the cleanliness of the overall tank environment. With hardier species, such as those that cost next to nothing at the fish store, all of these precautions may not be required to keep them alive, but to raise your fish to their potential and to be disease free, these practices are the way I needed to go. I could see that multiple bare-bottomed single species tanks would be easier to maintain, though they might not be much to look at, and how the tanks looked was long an important consideration for me. To be more accurate, looks were now in fact very important- in that the tanks were now bare, clean and functional. Today I add plants conservatively to provide hiding places for fry, and to address the need for security in some fish so that they are most comfortable, and more likely to breed.

I faced a dilemma. These expensive fish obviously need a cycled, ready tank. I couldn't cycle the tank until the fish- those fish- had lived in it for awhile- 4 months in the case of the big trickle filter on the 100 gallon. I also knew that in a new tank with fish, and food going in every day, the ammonia would spike in about 15 days. I would need to avoid "new tank syndrome", where the fish die off until the bacteria is built up, so I would need to do regular water changes the first couple weeks to remove toxins, until the needed bacteria had been given the opportunity to build up.

The mechanical and biological filters were no longer going to be the primary means of filtration. It had to be water changes and concern for the number of fish kept within a specific volume of water. Today I do 7% water changes every day with an automated system but that level of care isn't necessary for doing what this article is about. I found at least a single 25% water change a week will work after your water is fully conditioned/ cycled, but that is an absolute minimum.

Along with salt, I have also used Aquarisol as a disease preventative, dosing with my water changes. An ultraviolet sterilizer is not a bad idea, but it generally isn't necessary, and does begin to get in the way of keeping things simple and inexpensive. If you are selective breeding to eventually build out a large number of fish for sale, keep in mind that too much extra care could produce fish that when tossed into a standard, barely maintained community tank, your fish may not adapt. It is not always enough to provide fish that are healthy when they leave your facility, they must be hardy enough to withstand broad changes in water conditions and husbandry. No fish can handle much abuse for very long, but you want any extra variables that a customer must meet kept to a minimum. Fish raised with a UV sterilizer 10% daily water changes, prophylactic doses of salt with water changes and possibly regular dosing of something like Aquarisol are all done frequently by serious aquarists, but someone taking a fish from that environment and putting them into an established tank with other species, without the sterilizer, salt and preventative medications, at slightly different temps, diet and feeding schedule is not going to do well.

So now I have a couple of bare bottomed tanks, with the outside of the bottom glass plate painted black to bring out the colors of the fish, no plants, a 100 gallon tank empty except for the clear water cycling through the pristine filters, and a couple trios of very young, tiny, and what for me were incredibly expensive fish.

So I needed more small tanks. The books I read said livebearers require 4 tanks per strain; a male grow-out tank, a female grow-out tank, a baby raising tank and a mating/breeding tank. That's great until you have more than one female pregnant at a time, and if you breed your line in trios, as you should, tank space issues present themselves almost immediately. With barbs, danios, and similar egg scatterers you would also need a minimum of 4 tanks- a male adults tank, a female adults tank (where the females can be conditioned separately for spawning), a breeding/ new fry tank and a fry grow out tank. Most cichlids will require more tanks, because they are generally larger, can be territorial and don't breed in groups. Cichlids (where spawns can be 200+ fry) require a fry grow-out tank, grow-out tanks for young from about a month old until they pair off, and a separate tank for each mated pair to spawn in. All this also meant that as a rule, most all tanks will be species-only tanks, in that there will no longer be a reason to keep more than one species by itself in any aquarium. I do maintain a "cull tank" that looks great with fish that show off a little of what goes on in the room, but they are more tanks set up so that I have "emergency" fish to use as breeders if needed. Otherwise I don't mix species in the same tanks anymore.

I recommend keeping a collection of portable, lightweight containers on hand to serve as temporary "housing" as fish are born and numbers take off. I use the 10 or 12 gallon sized white plastic kitchen-type trash containers, and only use those made by Sterilite. This isn't a plug for Sterilite- some companies use softeners in their plastic that is toxic to fish. I have found this to be the case in the past with all of the Rubbermaid products, and lost many fish until I discovered what the problem was, having since found others with the same experience. The biggest drawback to using those white trash cans in a breeding program is that the bright white sides wash out the color in the fish when reasonably well lit- and the color quickly returns when put back into a normal environment. With some floating plants and an airstone or a box filter, fish will do well in those containers, with the only drawback being that you are not able to observe them, which keeps their use to a temporary basis. For the extra female about to pop they are perfect with a little Java moss to catch fry.

Some Guppy breeders will raise the sexes together, allowing already gravid chosen breeder females to drop before being mated, making the assumption that the influence of previous fertilizations from stored sperm will be minimal. (That thinking is generally no longer followed) Raising the sexes separately, however, has many big advantages. Male guppies develop a gonopodium by their first month. From then on their energy and time is spent chasing and courting females or competing with one another when you want them eating and building finnage. Separating them puts their energy into growth and the differences in size when the sexes have been grown out separately is substantial. The trick then becomes at what age to put the breeders together, at what point is it when the fish were as good as they were going to get, but not too old to breed? That is something I've simply had to learn as I've been doing this. When raised separately they get much larger, and when choosing breeders you can then see each fish at closest to its potential.

Then a fundamental aspect of breeding occurred to me. What happens to all of the fish that don't get chosen as breeders? As a hobbyist that enjoys and appreciates the fish I keep, I did not want killing them in large numbers to become one of my primary fishkeeping activities.

Successful selective breeding meant culling ruthlessly, which I do understand the need for. But intentionally killing fish wasn't something I wanted to do. Previously, when fish die it had always been a bad thing. I once heard a comic say that he liked to watch things die... so he bought a fish tank. There are far less frustrating, inexpensive and time intensive ways to enjoy yourself if your idea of a good time is watching things die. I was pleased to see, however,

that even some of the most macho breeders that shrug over killing hundreds of fish often have a pond in their back yard full of their culls, local petshops full of their culls, friends' tanks full of their culls... If you do meet the occasional breeder that enjoys killing things, forgive me if I choose to pass on spending my time hanging out at their place. No normal person enjoys killing things, but removing them, somehow, from your breeding efforts does come with the territory. Selling or marketing your culls is not always an option. Until the traits you are working to established are "fixed", in that the majority of the fish you produce carry the trait, you do not want to release poorly, inconsistently finned, poorly colored or "half-assed" versions of your final product out and around your eventual customers. When you are finally able to sell the finished product, you may find that there is no longer a market to fishkeepers who already have tanks full of inferior versions of the line you put so much time into. And they got them from you!

Another lesson is that when you buy fish from someone else to start a breeding program, the fish are coming from foreign water, husbandry, food etc. The goal from those first fish is to drop young born in your water. With most fish, especially the livebearers I have worked with, my experience has been that those initial purchased individuals generally don't live a full lifespan. Their young should grow out well, but my experience has been that getting fish into your tanks of the size and color of those you saw at the website or at the breeder's fishroom don't appear until the second generation beyond the original stock. So with guppies, for example, at 4 months per generation, assuming the fish you receive drop within a month after you received them, it will be another 8 months before you are working with fish that display the line's potential. The best way to extend the life of the fish you buy is to purchase young fish and raise them up yourself. Young fish adapt better and also survive shipping better, but it is important to work with fish that have fully adapted to your water, in part by having been born in your tanks.

I have also found that even with the fish being kept in essentially empty tanks beyond the water, fish, filter and possibly a heater, fish do best when they are moved as little as possible. Consistent breeders need to be allowed to stay where they are, even though the water is the same throughout the room. The single biggest circumstance where I lose fish is when I must remove a female and put her in her own (generally smaller and more heavily planted) tank to drop fry. Though it may be cleaner, and without issues of her being harassed by the males, with some species the fish may die shortly after being moved, or she's living, but only after having released her young, all dead. A few species seem fairly prone to this, and others it is not an issue. With species most prone to this, you can occasionally lose batches of young. (I have found that *Ameca splendens* is one species that can be this way). So if there is only a pair or trio in a tank by themselves I may leave the female and remove the others, then put in a cloud of plants until she drops her fry.

If there must be other fish in the tank, I will keep them well fed, put a bunch of plants in for the babies to hide in, and then check the tank mid- late morning for fry until they appear, as most livebearers generally give birth between sun-up and noon. Then I'll carefully remove whatever I can catch. Don't remove the plants, filter and heater and set about catching the young- all you are doing is exposing the young where the other fish can swoop by and eat them. Once you have caught as many as you can see, then gradually start removing the plants etc. until all of the young are caught. Clearly, a lone gravid female in a fine-leaved planted tank that she is comfortable in is the best solution. In any breeding program, one of the strongest components of your effort is your ability to save every single fry, for you never know which fish will carry the traits you are looking for, or a new mutation you will want to preserve.

The "rule of thumb" was that of a drop of 30 young, you may get one pair worth keeping to consider as future breeders, the rest will need to be disposed of, somehow. Out of a strained logic to go natural, I started keeping something big and carnivorous in its own tank to eat the culls, such as an Oscar. All I ended up with was a fish that went long periods of feast or famine, who took up a large tank and space I really needed for the breeding program. So I don't do that anymore.

I learned that the function of any particular tank can change often, and most problems can be solved by simply setting up another tank, which can cause your fishroom to get cluttered pretty quickly. I recommend only keeping as many tanks as you can effectively provide maximum care for, cull to keep numbers down, and keep the number of strains you choose to become involved with to a minimum. Don't let your strains multiply when you get a neat looking cull or two unless you are willing to increase the number of tanks. And if the females of two strains that you are keeping near one another look alike, the potential for an accidental cross by fish jumping between tanks is a real possibility- always separate tanks of fish that look too much alike. Allowing greater numbers within a strain also increases your odds for the appearance of a mutation you are hoping for. I found that to minimally maintain a strain, I needed to keep at least 3 breeding trios on hand.

Today, after many years of doing this, I find that my number of tanks per species changes, depending on where I am in the line's development. But I generally keep one or two tanks of breeding pairs, (more if I am only breeding them in single pairs or trios), one tank for each pre-sexed batch of fry, and a single tank for male grow-out and for female grow-out. Currently I have a number of swordtail species I continue to selectively breed, and except for the batches of new young kept in groups of approximately 30 at a time in 10 gallon tanks, the rest are in 30 gallon sized tanks.

The biggest mistake a breeder can make is to accidentally mix two similar looking species that may cross, or lines that must be kept separate. If a mix continues and goes into the next generation, all must be destroyed or given to someone that will never give them to anyone else. Also keep in mind that crossing two species is not always an easy thing- a deliberate effort to cross two Xiphophorus species, for example, is not generally a case of putting two of the opposite sex together, particularly when one or both species have others in their tank of their own species to choose from. But it does happen. Breeders trying to cross two fish such as that may take months of many pairings before it finally takes place, but a mix of two lines of the same species- however different in appearance- will easily result in an unwanted fertilization.

Contamination between tanks often occurs by fish jumping, or by being put there accidentally by you, or inadvertently riding along as a fry in a bunch of plants or between the folds of a net. Years ago a friend noticed I had obtained some heterandria formosa- one of the smallest vertebrates on earth, the males are full grown at 3/4ths of an inch. He commented "They are a great fish, but they are like mice. Soon you will have them in every tank- their fry are very small and easily get swept up in nets". Even a tank that has little in it has a surprising number of places for fry to hide. When I believe I have removed all of the fish from a tank, I let it sit, then check back in 10-15 minutes, when any hiding fry will have come out into the open. And I may do that more than once, yet when fish do appear where they should not it is almost always due to their having avoided having been caught in the past.

So I am very leery of following closely related species with one another in the same tank. For example, I have to be very careful not to let Xiphophorus alvarezii and Xiphophorus mayae near one another. Until they are sexually mature they can be very similar in appearance.

Keep in mind as well that it's a good idea to establish two lines of each strain you are working on that can be crossed about every 5th or 6th generation to maintain some genetic diversity and vigor, which unfortunately will double the number of tanks you will be using. I was told that a trait establishes itself- in that selected traits will consistently present themselves in every individual of each successive drop, at 11 generations. That may simply be an axiom to keep working with a line until you consistently get what you are looking for, but the point has merit. A guppy generation is 4 months. A swordtail generation is 8 months. Angelfish- 10 months. My experience has been that that I will start to see some consistency in the fry (More than 50% displaying the trait) by the 5th generation.

As my breeding program grew I began to look for ways to seek help with the water changes as it seemed to me that when raising young fry, particularly egg layer fry, that consistent, clean water was everything. But keep this in mind- when changing water on the containers the fry are in, if possible your fresh water that you add should come from the tank they were born in, or the eggs were first laid in, then add dechlorinated tap water to the original tank, possibly still containing the adults later. With new fry of most fish I will have them spend their first few days in a bare container with a few sprigs of Java fern or moss, 2x per day brine shrimp feedings (siphoning up what wasn't eaten after 10 or 15 minutes) and 50% per day water changes.

When establishing your water change routine, it took awhile for me to determine what amounts should be changed for the best effect for the fish. Though 35% a week is good, 5% a day is both far better but much more work. Over time I have settled on about 10% per day. How can I have a system where I can set exactly how much water each tank gets, whenever I want to put it in? And then to have it done on its own, so I can spend my time siphoning off bottoms and moving fish around, doing the many other things that standard, quality husbandry requires? Over 10 years I eventually created an automatic water changing system, entirely made of PVC that does not require any drilling of tanks, is relatively portable in that tanks and the PVC drain and fill tubing can be moved easily, and both the draining and filling happen on their own. I have given many talks to fish groups on this system, and plans can be purchased at my website, selectaquatics.com or by emailing me at selectaquatics@gmail.com.

I cover each tank with plastic "egg crate" style lighting cover sheets, cut to size with standard 4 ft. shop lights or homemade CFL fixtures hanging over the tanks. I try to save money where I can, and when buying all of these filters, heaters and air pumps (or a blower), I research the local pet shops, hardware stores, mail order companies, etc. Tank lights can be made from plastic home gutter stock with a light socket and cut wooden end pieces, filter floss can be bought in huge bags as polyester stuffing from hobby stores for only \$2 or \$3. I patronize local fish stores whenever possible, buying blackworms, frozen foods and my immediate needs whenever possible, and belong to a number of fish clubs where I can share my efforts, equipment, and failures, while getting new ideas and approaches in return.

Diseases

This needs to be mentioned, but is not much of an issue when you are doing things correctly. When keeping bare bottomed tanks with some plants, regular feeding of occasional live food, consistent water quality and non-crowded conditions, you will see very little disease. In fact, over the last 10 years, I can count my disease outbreaks on one hand, and they can nearly always be traced back to a tank whose care suffered for some reason- it became too full of plants, some fish that weren't able to be seen easily then died, leading to an ammonia buildup in the tank, or a live food introduced something the fish couldn't defend themselves from. Or a seasonal change came about and I

was too slow to get heaters in the tanks that sat too close to windows, or a new fish brought something in with it. With proper care you simply will not see disease very often. With the husbandry program I am describing here, when there has been disease, it has generally been a touch of fin rot or body fungus. Once (in 10 years!) I had a small appearance of ich in a couple fish that was easily remedied. For all of those things, following the recommended course for treatment with Aquarisol, (Dose 12 drops per every 10 gallons daily for a week) in combination with raising the temperature slightly cured the outbreaks.

I never experienced outbreaks that were genuinely serious, but I have known other breeders that due to an introduction of fish or some other reason they didn't foresee had to deal with multiple tank outbreaks. The breeder I mentioned earlier with the 200 tanks once had an outbreak he attributes to a bad batch of brine shrimp eggs that introduced something that wiped out over 40 tanks of fish.

When an outbreak occurs, your first avenue is to isolate those affected. If the disease is simply a fish or two with a couple of ich spots I will raise the temperature to around 82 degrees and treat daily for one week with Aquarisol, keeping a close eye on the rest of the tank. Any other available ich medications are also effective, inexpensive, and easy to use. If it is something more serious- say a fish or two in a tank with fin rot starting, I'll correct any issues with that tank (clean off the bottom, do a water change, possibly raise the temp slightly), and remove the affected individuals to a separate tank to recover, treating both tanks. I will label the tank affected until the issue is resolved. If it is something more serious, I may destroy the affected individuals, and treat the rest of the tank. Aquarisol is cheap, which is a big advantage. It takes care of most minor afflictions, is a great preventative, is very mild by most medication standards, but a course of treatment can take 2 weeks. Treating a 30 or 50 gallon tank full of fish with many of the available medications can become very expensive. But as mentioned, with proper care your occurrence of disease should be minimal.

In the case of an outbreak that got out of hand, or some truly terrible outbreak of something occurred that wiped out a lot of fish, you will need to follow a few steps to get that particular tank up and running again. For example, something known as "The livebearer disease" can take hold, and it is a small parasite that feeds on the skin of the fish, causing them to become thin, weak and eventually die, and it can easily take over an entire tank. I have had it in the past, but have not seen it in many years in my tanks. I treated it by destroying the fish that showed signs of it, increasing feedings and heavy water changes and patience to wait for the fish to come through it, of course never mixing fish with it with any that had not been exposed to it. Some fishkeepers will use Levamisol (procured through a local vet) to treat it with some success. But if you have a group that has been heavily hit (Say you came back from a vacation and it happened while you were gone), here is what needs to be done. If you choose to treat the tank, then do at least a 50% water change, raise the temp to 80 degrees (assuming there are no goodeids- they do not tolerate warmer water) and begin treatment, removing all fish that look as if they will no longer be used as breeders, or that are most likely going to die anyway. Follow course of treatment, and the remaining may recover and you'll be fine. Most likely the disease may linger and you will lose most or all of the fish.

If your breeding program can afford to lose that tank of fish, then discard all of the fish and the plants, removing everything from the tank. Change the filter floss and filter mediums. Then add 1 cup of bleach per 10 gallons of water to the tank, wiping down all of the sides of the tank inside, especially around and above the water line after the bleach has been added. Let sit for a couple days, then change all of the water. Let it run for a day or two until the smell of the bleach is totally gone. Then do a total water change again, putting in 20% or so seasoned water to head toward getting the tank going again. You should be able to reintroduce fish again at this point, but I will often let the tank go a few more days, usually putting a few culls in to see how they do before fully reintroducing fish.

Inbreeding and Appropriate Choice of Breeders

As I got more serious and meet other hobbyists, I'd ask for advice, and found I was entering into territory where otherwise sensible, reasonable people will differ on an aspect of husbandry or procedure. Someone who believes in one theory can quickly become thought of as a nutcase by someone else, so it became important to listen to everyone's opinion then figure out where I stood. To be honest, with many issues, no one really knows the answers, which may vary given different water conditions, and altitude (A big issue for breeding where I live in Denver), so that "the truth" may vary from one fishroom to another. What you feed, how often, your water qualities (pH, hardness, temperature and how often you do water changes), in combination with the characteristics of the species and line of fish you are working with often negate hard and fast rules that will work equally well for someone else. The result is that there are a number of theories that are held hard and fast by some people that you may need to ignore, while other well-meaning fishkeepers are guilty forming their thinking and beliefs using the old axiom that once is an occurrence, twice is a coincidence, three times is a rule. And there may be no validity to them whatsoever, and the strongest opinions seem to be held regarding inbreeding.

Much has been said in heated discussions over inbreeding. Does it weaken or strengthen the line? When should you ou if ever? At the Xiphophorus stock center in San Marcos Texas, Dr. Gordon collected wild lines in the 1930's that have be

inbred consistently for many dozens, and in some cases even past a hundred generations, and they are doing well (with careful, extensive record keeping). So why do fish that are inbred often show bent spines and such after just a few generations?

The reason may be non-intuitive, but can be easily understood. As you narrow the genetic variety within a line of fish through close inbreeding of similar, consistent, related individuals, unwanted traits within the fish will gradually show themselves as they "rise to the surface"- in other words, as each aspect of the genetic diversity in the fish is expressed over time, over a large number of fish, undesired traits that are simply present within the genetic makeup of some individuals will eventually present themselves. As the breeder you must cull those individuals, essentially removing that "negative" trait from the genetic makeup of the line, as you would do with any fish that did not appear as you would like, toward "purifying" or stabilizing the look of the line you are working with. Bent spines are just another trait. If you were looking to develop a line of fish with debilitating deformations, you would use those fish as breeders. (Balloon mollies, anyone?) Fish with deformations or sometimes dramatic changes in appearance (such as albinism) occur routinely in the wild, but simply do not survive as they often present as a target to predators. So the appearance of those negative traits is not a response to the inbreeding "causing" a negative trait, it is simply the normal expression of traits the fish carries that eventually express, as a line loses its variability and becomes more homogenous. Inbreeding allows you to spot and remove the fish with these unwanted traits most quickly from a population. So where some argue that inbreeding is harmful, others argue it is beneficial, and for the same reasons! One problem with inbreeding however, is that without careful observation and appropriately choosing the breeders of your future stock, the line can in fact weaken away, as anyone who has ever put a great line of pet store guppies into a tank to community breed will find out after a year or two. They will generally revert toward their natural coloring and smaller size.

Choosing appropriate breeders is addressed later, but ultimately comes with experience to choose for the largest, healthiest fish. You would not choose a male guppy to be a breeder with poor body shape or a weak overall physical character entirely because the tail is a particularly attractive color you had never seen before. You will do overall harm to the line with no guarantee that the color you desired will even reappear. With that situation, I would take that male and breed him to his best sisters. By doing so I have chosen to offshoot another line. Then raise up their young, looking for a better combination of color, conformation and health than the original father had. If a new male does show up that carries the minimum characteristics- and chances are one will not- you would then cross that male over to a female of the original line to begin the long process of fixing that desired color.

Breeding to develop a specific line requires some discipline not to become sidetracked by each new minor mutation, also keeping in mind that every differently colored or lushly finned fish is not necessarily a healthy fish. To see a mutation in a single fish is some distance from a batch of young carrying that trait, and pursuing it may ultimately be a poor decision for the vigor of the line. But that is why I find breeding so enjoyable- I get to decide to pursue something, and then get to see what the fish does with my choices.

I do not breed for a single trait at a time. I choose breeders from among a collection of traits I am looking for, aware that to have something often requires a compromise of something else. The biggest fish may not have the best color. The fish with the longest fins may not be the largest fish. Etc. By having three or four pairs or trios going at a time you can, over time, gradually nudge the line toward the proper collection of traits you are looking for, maintaining the overall size, health and vigor of the best fish in the line.

I tend to believe that the energy against inbreeding has begun to subside, though there are many that reasonably argue the benefits and essential place that outcrossing with wild lines, etc. plays in any serious breeding program. It comes down to what you are looking for and the species you are working with, (Discus breeders I've known can be truly obsessed with the latest wild fish they'd paid to have caught and shipped to outcross with) but I have come to believe that inbreeding (brother to sister and parents to offspring) by itself does not ruin fish when breeders are chosen appropriately. When an outcrossing to a wild fish occurs, however, it must be done carefully as you are introducing any number of characteristics that may need to be gradually bred out of the line.

How is it that you are reading this essay by another hobbyist on what is right or wrong with regard to keeping fish? Aren't there universities full of professors with doctorates in biology that know this stuff inside and out? Besides my own fish room I am also the fish lab manager at a large well known university, and surprisingly, many well educated people that can sequence fish DNA, or are experts in their fields of taxonomy, having identified or published works on fish issues are often unable to keep fish alive in a fish tank. A leading expert on Xiphophorus taxonomy that I know well has admitted to me often that he can't keep a fish tank, and when I offered to set up a tank for him, he ultimately decided against it. The tips and knowledge I provide here can only be accumulated through experience, and there is much room for conflicting opinions in the hobby.

An Overview of the Process

Work to keep things simple. All that tanks require is a strong and consistent air stream to a large box corner filter with charcoal and floss, kept reasonably clean. Heaters are an extra expense, but I want to enjoy working in my fishroom.

I don't want to have to keep the room at 80 degrees, so I do use heaters with fish that require warmer water, generally raising fish that are most comfortable closer to the ambient fishroom temperature. Most breeders I have met don't use heaters if they can, primarily to save on electricity. I have also found that fry should be raised at a higher temperature than the adults to stimulate feeding and growth. (80 degrees seems to work best, and with colder water fish the fry temp should stay around 75 degrees) I've explored nitrite removers, black light sterilizers and constant trickle water changing setups, and in nearly all cases they provided far more intellectual stimulation for me than they helped the fish. A simple, organized setup and consistent approach, appropriate tank space, keeping only fish together that you want together without overcrowding, a focus on saving and raising the young carefully by keeping the tanks and water fairly clean, consistent air and temperature, moderate light, covers to prevent adults from jumping out, quality food and lots of it, a few fine-leaved plants for security and water quality, careful observation, controlled breeding with properly chosen breeders, and patience. Those are the basic guidelines.

The Guppies taught me much of what I needed to know, but the reality was that I left my total devotion to Guppies after about 4 years, concerned for what I felt was compromised immunity in the fish, frustrated that I couldn't give my fish to anyone else and have them do well.

Many become involved in the show circuit, sending their fish off to various shows, and that didn't interest me. It seemed to me that the people who saw the best fish the hobby had to offer at fish shows were usually other fishkeepers. The fish were spectacular and breathtaking to look at for anyone not familiar with them, and I felt that it was the moderate hobbyist that had never seen them that most needed to raise and enjoy them. I felt that the younger people coming up needed to experience these fish so that they might become involved in the hobby.

The immunity issues I perceived in the fish I kept could have been due to my husbandry, the strains I worked with, or an inherent immunity weakness, though disease was never a problem for me in my tanks- the problems arose when they my highly controlled and near hospital-like setup. Too often, I'd given fish to friends, they'd take them home and the fish then died almost immediately. But today, 2010, the strains have improved, and though those other fish certainly exist, there are a number of lines bred in Moscow, Israel and by members of the IFGA that are every bit as impressive as the big delta tailed guppies I wanted, a couple lines that today I breed and sell on my website.

In 1998 I began working with a line of *Xiphophorus nezahualcoyotl* that I had rescued from being used as feeders in an Oscar tank owned by a member of the San Francisco Aquarium Society. She didn't know what she had, and wanted to get rid of them- the Oscars weren't fast enough, and she always seemed to have a few that wouldn't disappear. Few opportunities to work with a line could be more virtuous than that! They were a cool little fish with a medium, slightly upturned sword, decent color and a beautifully patterned dorsal. But they were small and thin with an elongated shape. From having wrestled with Guppies the previous couple years, there were habits I'd gotten into that convinced me that I could do a lot with that fish. I separated sexes as early as possible and bred out high numbers with substantial water changes and frequent feedings of varied foods. I selectively bred for a high, thick body conformation, thick caudal peduncle (the part of the body just before the tail- just as you do with guppies to develop tail strength) and best color. I removed the females as soon as they dropped to save every young I could, and then carefully raised them up. Today that fish is still distinct from other nezzies available in the hobby and when fed well in a larger tank they will get very large and breathtaking. I easily raised many thousands of fish over 4-5 generations before I felt the look was "set", my fishroom was almost entirely nezzies in every tank and in buckets on the floor. Later, I stopped keeping them for awhile, but others continued my effort, and I have since begun working with them again, selling that same line at my website, selectaquatics.com.

Though I have never bred angelfish or discus over the long term, I have worked with a number of other cichlid species, currently working with an all blue mutation of the Honduran Red Point. Whether to remove one or both parents, or leave the young with them and for how long depends on the species, but my practice is to remove the majority of the young as soon as they are old enough to be moved. It is important to leave some young with the parents, for just taking them away stresses the parents and too often results in one parent often killing the other- the male generally being the aggressor. The young are then raised up separated from the adults, culling for deformaties, etc. as they grow up. Then I will choose the best 15 or 20 as they reach sexual maturity and let them pair off naturally.

Obstacles

So what are the obstacles? Unfortunately, there are a few to consider, most that are overcome through experience, patience and persistence.

Here is a rundown of my experience with each of the aspects I have learned that must be overcome for a successful breeding program to work:

1. Equipment setup. If you are occasionally running into problems with the electricity going out, big temperature fluctuations, a tank that leaks, filters that stop working, etc., get those resolved first. Use covered, moderately lit, bare bottom tanks that stay at an appropriate, consistent temperature, and simple floating plants (Java moss, Java

fern, Najas grass, riccia, water sprite etc.) to keep things simple, stable and consistent. The focus must stay on the fish.

2. Get good initial stock, and be sure you can keep them healthy before expecting them to breed for you. Poor stock may not look as you prefer, and may not breed consistently, or may even throw junk until you get the line stabilized and predictable. That takes a lot of time- months- when getting well bred, genetically stable fish from a reputable breeder in the first place avoids those issues.

3. After the fish you receive are settled in, their young- the ones actually born in your water, are the all important fish to focus on. Because it is the first generation in your water, there may be some losses, and how prolific they are will depend on how well they are raised, when they are bred, and how optimal they are able to become for you. More will survive, reach their potential and breed readily with each successive generation as they acclimate to your conditions. Until the line is stable- 2-3 generations, the numbers of young that survive throughout the grow-out will gradually improve.

Losing an occasional fish as they grow out is not a big reason for concern, unless the losses continue to a point where you know that something is fundamentally wrong with their care. How do you know? I tend to follow that losing more than 15-20%, over the course of raising fry to full adulthood is a reason for concern. Today I have a number of species that have spent numerous generations in my water, do well in my water conditions, and breed and grow easily and consistently. There are others that after many tries do not do well, or only adjust poorly. I have learned that choosing fish that do best in my water offers the greatest success when trying to selectively breed them.

Some species populations will truly seem to explode with young when they like your conditions. I have also discovered that if I really want to keep a particular species, I may find that by trying a number of different lines that have come from different conditions may eventually find a line that will do well in my water. On four separate occasions over a period of 3 years I finally came across a line of Zoogeneticus tequila that would breed in my water. But continuing to try stock from a variety of sources is no guarantee that you will eventually find what you are looking for, though patience and continued effort may pay off if your water conditions are appropriate.

Predicting and Planning for Egg Layer Output

Predicting the output of a species can be tricky. Assume we are talking about a small egg layer- a barb, rasbora, danio etc. How many young reach adulthood will be very different than Cichlids, where the parents guard the eggs and young, or most livebearers who have set broods of 10-40 young that are fairly well developed when first born. Assume you have 3 pairs of barbs. The books tell you that of this species each female will produce 300 eggs per spawn. So you condition them, and the fully mature females are full of eggs and ready to go, the males have been kept separate and are also ready to go. You put them together under all of the correct conditions and they eagerly spawn. My experience has been that you will never grow out 900 fish. Your actual number of fry reaching adulthood, if you do everything right, in my experience, will be closer to 150. Livebearers are an entirely different issue, where fewer young being born means fewer casualties. But if you set out assuming that 2 pair of fish that can each lay 300 eggs every 2 weeks is going to produce 1200 fish a month for you, you would be mistaken. Here is why, and I will start from when they first spawn:

1. Parents will eat some of the eggs. In the process of releasing eggs during spawning some of them will be eaten, that's just the way it is. You can place a screen below the breeding pairs (which is what I do), but it will be need to be deep enough in the water to allow the fish to swim freely and comfortable darting about. They also need to be able to get to food easily so that it does not simply fall through the screening and foul the water, but the screening should not be so far below them that eggs are eaten as they are released. About 2.5-3 inches seems to work best.

2. An effective setup for having caught the eggs (a mesh bottom the eggs have fallen through, or large stones the eggs fell between, or marbles) can minimize predation by the parents. When those methods work as they should, the eggs will begin to hatch, but a fair portion will be infertile because they simply weren't fertilized, they were immature or are simply defective. These factors account for about 15-20% of the eggs released.

3. Once they hatch, the fry need to get to the infusoria you have provided, and bunches of plants- say Java fern- are very good through their leaf surface area at providing infusoria, while helping to cultivate the infusoria culture you have introduced. Hard boiled egg yolk sifted through a cloth or some yeast water can also be fed. Unfortunately, snails often get transferred into the tank with the plants, and they will eat as many eggs as they can- a snail explosion from a couple adult snails hidden in the plants can easily wipe out a substantial portion of the spawn. The small algae eating shrimps available in the hobby, if they get into an egg layer breeding tank will really chow down. We'll assume you have very few young snails or none at all, and no shrimps, and that you only lose about 10% of the fry who do not get to the food they need soon enough or in large enough quantities. This is the aspect of breeding where I am weakest, due to a relative lack of experience. Though I have bred egg layers for many years, I have only been breeding barbs in a commercial context where efficiency and effectiveness is key for about 2 years, and admit that I am still fussing and experimenting with the most practical and effective process to turn out the greatest numbers.

4. The period following their hatching in their fragile lives does not need to be an uncertain time of losses until they begin to eat regularly. Frequent feedings, clean water and appropriate, gentle aeration are all you really need. The filtration should be low or entirely the result of massive daily water changes (I do 20-50% daily water changes for new fry for the first week or two with my smaller 5 or 10 gallon fry rearing tanks) done so that few new fry are drained away, until they are ready for brine shrimp and can be put into larger tanks to grow out.

5. Assume you leave the egg scatterer pairs together for a week. Some young may hatch in 2 or 3 days, others may take up to a week longer depending on when they were laid, overall health, etc. Some that hatch immediately will be exposed to the wealth of the environment before any of the others, and will grow quickly, others that hatch later may survive, but not in as robust a manner. Since they will need to be a few weeks old before they can be moved, the difference in size, though not substantial, may be enough that the larger fish may feed on their newly hatched siblings, and from that you will lose a few, quite possibly a substantial portion of the overall spawn.

6. Some will be born with issues that keep them from thriving. At first I was breeding barbs in a tank that was too deep, and easily 50% of my first spawns that managed to make it to ¼" developed swim bladder problems. They were un to stay off the bottom and spent their days struggling to swim up, using their energy that should have gone into growth. I was able to cure the majority of them by raising them in hanging net breeders where they stayed within 2-3 inches of the water surface, removing them one by one as their swim bladders developed properly. This took about 2 months, and resulted in undersized fish with some that never recovered. Under the best of circumstances, there will be those born defective, some with swim bladder issues (often called belly sliders), bent spines etc.

7. Then, as they are moved to larger grow-out tanks and fed heavily to push their growth, in a 50 gallon tank of say 75 fish- at about a half inch, I have found that I remove 1-2 fish a week that die for one unknown reason or another. This process seems to continue until about 3-3.5 months, when they stabilize and I generally don't encounter more regular deaths.

8. Lastly, you may do all of the things right, but with some species in a normal location where they are exposed to daily light cycles and seasonal temperature changes they will naturally stop breeding from about October to April (depending on species), and there will be no young, or very reduced spawns.

9. And all this has happened before the fish have matured and sexed out, before you have yet seen what they actually look like. Then you will need to cull a substantial portion of those left that don't express the traits you are looking for.

But there is a way to get around much of this while producing large, healthy spawns. Have as many breeder pairs going at a time as possible, knowing ahead of time about what can be expected, providing enough tank space to breed many pairs. If you want 1200 fish a month, you may then have to have at least 18 pairs going- breeding all at once in a large breeding tank, making sure that you are able to keep up your water quality and feeding needs for the large group of young you will be creating. And it may also be that your losses will increase once again, until you work out the space and feeding responsibilities so that as many young as possible are able to survive. Fish that breed seasonally can usually be tricked into spawning year around in a fishroom that does not get natural light, or when the light timing in the room stays consistent throughout the year.

You will breed and produce a lot of fish, but it will happen as a result of your mastery of making it happen, not the mathematics of what you assume is possible based on their reproductive rates. You can make money at this, or produce a lot of great fish, but like everything else, it doesn't just happen, at least not at first. The obvious advantage of greater numbers are the number of new mutations that will occur, and careful choice of breeders becomes far more interesting when there are a far greater number of fish to choose from.

Choosing individual breeders can be challenging. With fast moving, schooling fish such as the barbs I work with it can be particularly difficult to pull out a specific fish, particularly when they will "wash out" when stressed, so that you can no longer select for color. I move groups of about 10 at a time to a separate temporary tank to settle down and get their color back before choosing the next generation's breeders, maybe going through 4 or 5 selection cycles to find the best fish possible.

With the proper mindset you can avoid disappointment and stay enthused for what you are able to accomplish. It is said that frustration is the simple mismatch of reality against expectations. That surely applies here. With egg scatterers, if you are able to produce 300 fish a month, that is quite an achievement without access to ponds and hundreds of fish to start with. Always take confidence from what you are able to do, knowing that as you get better the numbers will continue to improve.

Lastly, keep in mind that when a setback occurs, you must be comfortable getting past it as soon as possible and continuing on. On 4 separate occasions I lost hundreds of *P. padamya* barb fry, all separate issues, as a normal

part of my learning curve. All it meant was that after the females were conditioned up new pairs were put together to start all over again. Also, remember that those who make a living breeding large numbers of fish do not do so with near the complexity that you as a home aquarist are forced to contend with. They breed their fish in long outdoor concrete runners, seeding new populations with breeding pairs pulled from a previous batch. They generally don't look for mutations or study them with near the intent that you will. Today I am selectively breeding a very brightly colored barb in numerous tanks, separated sexes etc., yet the wholesalers I might turn to for advice are not in a position to help, for with access to ponds they are doing things entirely differently. So you could easily be encountering new ground with each step in the process that you discover works for you.

Mutations and Some Basic Genetics

I have been asked why I seem to get so many mutations, such as albinos and white individuals with black eyes-leucistic- among some of my fish. I've been told more than once that I must have something strange in my water. But I have been successful at producing mutations over three addresses in both Colorado and California. I'm currently breeding a line of albino Xiph. Alvarezii (from a wild line), as well as a line of high fin Xiphophorus mayae, a species that had never before expressed the trait. I did have a line of leucistic nezzies (Xiphophorus nezahualcoyotl) for awhile, but even though they bred to a third generation they were simply too weak, and gradually died out. I currently have 5 other species I am working on of color morphs that have begun here.

My getting the incidence of mutations is simply the result of observing every young closely, then separating the mutations from the others to be raised individually as soon as possible. They are then bred with one another, or if only a single individual, I will breed that fish with a normal colored sibling, (or even back to one of the parents if possible). The next section here refers back to the Punnett square from High School biology class, which more clearly expresses what I am about to describe. This basic initial introduction to trait genetics is all that I have needed to be familiar with. However, you can certainly explore this subject further- into sex linked characteristics, for example, with a decent text of basic genetics.

The first spawns (The F1s) of the mutation with a normal appearing sibling or parent will be all normal colored, but the mating of two of those fish will produce spawns where 25% will show ("express") the recessive trait (This would be the second, or F2 generation). They will hopefully produce enough that express the trait to breed with one another, starting your line where 100% express the recessive trait. The recessive fish when bred to one another will produce all young carrying the trait- albino to albino will produce all albino young. 50% of that F2 generation- the other siblings, however, though normal colored, will be heterozygous ("Het") for the recessive trait, and those, when mated with one another will produce a percentage of young that will express the recessive trait.

The remaining 25% of the F2 generation will be pure dominant, not carrying the recessive trait (the mutation) at all. So 75% of the F2 spawn is normal in appearance, and 25% will show the recessive trait. Of the 75% normal in appearance siblings, 25% are pure dominant and 50% carry the recessive trait, but do not express it. They will all look dominant, however, and it is not possible to determine which carry the recessive trait, and which do not. Some breeders (with reptiles, for example) will often sell all of the F2 generation not expressing the mutation as Het for the trait- but when in fact a third are not. If you happen to lose the fish expressing the trait, you can then breed the F2 siblings with one another, hoping to cross two that are het for the recessive trait, to once again produce individuals that express the recessive trait, and you can recover the line. However, if your recessive line is doing well, it is best to destroy or put out to pasture the F2 siblings- for you can never know who carries the trait, and who does not.

As an interesting aside, I took two pair of the albino alvarezii to an American Livebearer Convention before anyone had ever seen them, and they took best in their class. I sold those two pair to other hobbyists at the convention, and one bred them out. Now they are available in many places on the internet, all from those first four fish. Since then I have had another occurrence of albino alvarezii, and I've been slowly breeding those out who are smaller, but a much brighter red than the first group.

Generally a new mutation will be weaker, undersized and possibly even born with swim bladder problems. Some of you may go to the trouble to treat these individuals with the special "aquatic hydrovortex transition tool" (flush them), but something different can be interesting, attractive and desired by other hobbyists. These fish occur as natural mutations, having appeared without being crossed with anything else. But I don't develop them unless they prove to be fully healthy.

To strengthen the phenotype- the look of these recessive traits- I'll sometimes breed a particularly healthy individual expressing the trait to a healthy normal brother or sister (or back to one of the parents), repeating the process outlined above to exploit its potential to strengthen the size and constitution of those expressing the mutation. The high fin mayae were at first very undersized and weak, but through generations of choosing the largest, healthiest individuals, and crossing back, their size and constitution after about 4 years and 5 generations has begun to approach the size and vigor of what the normal fish exhibit.

With the “nezzzy” swordtails, from a batch of roughly 30 young I would get three or four whose growth would take off, both males and females, and they would grow into large, husky, healthy fish. I selected for those individuals.

Their color and finnage might not have been the best but their size and health was what I was looking for at first. Then there would be a couple fish with great color and finnage, healthy in all other respects, but not as large, and they got put aside to later cross with the largest individuals. Then, as with most swordtails, there will be 3 or 4 “early-maturing” males in a drop that sex out early and are undersized, an evolutionary development that allows for some individuals to pass on their genes early. Those must be removed from your breeding stock. When the sword develops, the overall body growth stops and sexual maturity continues. The best males are those that sex out late, looking similar to females until the secondary sexual characteristics (The gonopodium and sword) develop . One fishkeeper that should know better swears that some swordtails are born females and change to males later in life, so these early beliefs die hard. No swordtails change sex and are then fertile, they are simply seeing late developing males. I have read that a much older female fish may develop some male characteristics (such as a sword), but they are never fertile. I'd then set aside the remainder of the spawns as a “reserve” if anything were to happen to the breeders. Rarely, there will be fish in that reserve that will grow into big, nice looking fish, outpacing those I had originally chosen. When picking breeders, I selected for a blocky, muscular shape and big finnage. As I mentioned before, the interesting challenge was choosing and putting together the best breeders after they had fully developed, but before they had gotten too old.

Eventually I bred hundreds of those nezzies, stocking the ponds of a couple tolerant friends and giving them to pet stores since every stage of the process produced attractive, interesting fish.

Myths, Non-myths and Possibly True Odd Beliefs

If you are to carry your head high as a breeder who claims to know what you're doing, you need to be aware of the issues where expressing your opinion may get you into an argument, so that everyone will still get along with you and let you see their setups. The problem with these theories below is that both sides have a point, and it is easy to see why the discussion continues. Only your own experience will determine which side of the arguments you end up on.

Theory #1- Immunity Compromise

Addressed earlier, selective breeding with a line that has been dramatically developed over a long period of time beyond its wild form in finnage and color, you may notice that the fish are prone to fin rot and other bacterial infections. They may be less prolific or produce a greater percentage of unhealthy young when kept as you would other, non-line bred fish of the same species. Guppy breeders I have spoken with are generally convinced that immunity stays intact in the line-breeding programs they use, and that tying any inherent weaknesses of their fish's immune system to line inbreeding and good clean living is nonsense. They believe that like ourselves, the fish are exposed to pathogens they fight off routinely, regardless of water quality, and the infrequent fin rot occurrences can be controlled with the use of salt in the water, careful attention to cleanliness, quarantine of outbreaks and choosing breeders that are healthy and strong. In fact, simply culling the fish that become sick strengthens the immune system of your line by preserving the healthiest fish. They claim the fish are perfectly healthy, thank you very much. The long finnage has obvious circulation issues, and a carefully bred fish with proportionate size and musculature will have no problems with disease outbreaks.

The other side concludes that a long multigenerational history of being raised in exceptionally clean, bare bottomed tanks, selectively bred for finnage and color produces fish that lose some if not much of their ability to fight off infection. The fish never face genuine challenges to their immune system, and over many years of this husbandry it is no surprise that a sincere challenge to their immune system results in quick deaths. Some guppy breeders even claim they “don't have any diseases in their fishroom” further compromising their argument that fish are exposed to all diseases all the time as a normal condition of aquarium water.

My experience tends to support the latter belief, but I have seen lines of Guppies in the last couple years that are much improved, and will grow out luxurious full delta tails, even when kept in planted, gravel bottom tanks. Those I have seen most frequently have been from European or Russian stock, but it does indicate that the issue is being addressed effectively as can be seen in some of the quality lines that are now available.

Is it necessary to outcross a carefully line bred fish, or possibly face the eventual destruction/ collapse of the line? I have been told that an outcross should occur by no later than the 11th generation, and generally by the 6th. Many breeders will separate a newly acquired stock into two lines, line breed them separately, then later cross them with one another every 5th or 6th generation as sort of a compromise between the two schools of thought. The genetic diversity is slight, but many feel that following that practice is the best way to maintain a strong line.

The other side claims this is all unnecessary, and that a carefully bred line will stay just as healthy, if not more so than a line that has been outcrossed. In fact, outcrossing is a risk that introduces unwanted traits, flaws etc. into a line that has been carefully developed to remove much of what you are re-introducing. This is what happens when a breeder decides to cross a highly developed fancy line with a wild form to “strengthen” the line.

You will find that this is certainly one of those topics that brings out the color and finnage of the fishkeepers. My experience has been that “hybrid vigor” is certainly a real thing, and outcrossing an established line to something else will produce fish that are often more robust. But a careful program of line breeding should be able to maintain and continuously improve a line when done properly. The Xiphophorus stock center with their line bred fish that go back over a hundred generations would seem to prove that strict line breeding can be done properly. Keeping two lines of a strain is certainly a good means to outcross, and I imagine that some hybrid vigor should result if the two lines had been allowed to develop independently for a long enough period of time. With my nezzies I never felt the need to outcross. But if I were simply not aware that outcrossing was an option, the line doesn't appear to have been compromised from being strictly line bred, and the need to outcross to “strengthen” the line hasn't presented itself.

Theory #2- Growth Hormone Inhibitors

This theory holds that the largest “alpha” males in a tank of single species fish secrete a substance that functions as a growth inhibitor against other, younger developing males, ensuring the physical dominance of the largest male. This becomes a very important bit of information with male grow-out tanks. Because of this, selecting for the largest males for breeding is skewed toward one or two individuals that had experienced a growth spurt at a young age and then may have suppressed his siblings. Choosing for other traits such as color and finnage then becomes even more difficult.

Frequent water changes to dilute this chemical must be done, as well as possibly separating out the promising younger, but smaller males to other tanks so that they can grow out to their potential.

The other side holds that there is no such thing- after all, such a substance has never been isolated and identified- and that normal random growth advantages provide quicker access to food and bullying of younger fish, continuing the growth advantage.

It is accepted by most fishkeepers that something exists that has a clear affect on the fish, in a manner that a growth inhibitor would exhibit. However, when you are trying to raise up young Xiph. Swords, a fish that can get fairly large with the right feeding and water quality, it would certainly be nice to know if such a substance exists and it would certainly answer a lot of questions fishkeepers have wondered about, but its existence has yet to be proven. Like other breeders, the assumption of its existence works well when developing large fish, so I'll play along because assuming that it exists does work. Heavy water changes and raising the largest males away from the others does produce the greatest percentage of large fish.

And other theories exist. Some believe that young males may stunt their growth in response to visual cues received from seeing larger males in their territory. others insist that only a relatively small percentage of males are ever meant to be exceptionally large fish, and though we can develop a line of predominantly large morph fish, the presence of a range of smaller males is to be expected in the wild population.

Theory #3- That Females will Absorb Their Young.

I am still on the fence on this one, as I cannot imagine the “mechanics” of this happening, though it would make sense from a standpoint of benefit for the mother. This simply states that with some species (often goodeids), when an obviously gravid female becomes stressed, such as happens when you move her to have her young in a separate, small container, she will somehow absorb back the developing fry into her system. When you check on her progress, waiting for the young to be born, she instead appears less gravid with each day and ultimately does not bear any young. With some females it can be easy to believe that an older female, who's a big eater, looks gravid after being fed. Or some females are large and robust anyway, though not gravid, who will then thin down after being stressed by being moved. Though the absorption of fry may occur, many of the instances thought to be due to this are probably due to broad changes in physical appearance a fish will exhibit after being stressed.

Theory #4- That Swordtails will Change Sex

No livebearer commonly said to possess this ability will ever change from a sexually mature male or female into a fertile, sexually mature member of the opposite sex. Most species of fish mature at reasonably set rates that can be predicted without problem when taking temperature, feeding, and light cycles into consideration. So when a fish does not fall within those rough parameters we assume it is a very special circumstance. The types of fish I have most often heard as being able to change sex- after having been previously sexually established- are the swordtails, and sometimes the other main livebearers people have greatest exposure to, the guppies, mollies and platies. Swordtails, in fact, will

sexually mature over a fairly wide period of time, with early maturing males often maintaining their presence in a population through simply mating earlier than those who grow into the large showy fish we desire.

Theory #5- Community Breeding to Maintain the Wild Form

This holds that opposite the intent of selective breeding, a line allowed to breed randomly in a single species tank will strengthen natural, wild characteristics, ensuring that the fish will become as close as possible to their original, wild form. Sort of a selective breeding by "natural" means. This is often cited by those breeding rare or wild type fish who personally hope to divert the fish from its wild type as little as possible, thinking this approach will yield the closest to the continued appearance of the wild population.

The other side holds that an aquarium is an inherently artificial environment, and that every effort to selectively breed the healthiest, strongest individuals should be done, as these are the fish most likely to survive in the wild and breed naturally, and are best suited to continue the line. When allowed to breed indiscriminately, the artificial confines and lack of predators picking off the weakest fish in the aquarium encourages unhealthy fish to incorporate themselves into the population, while selecting for traits that provide an advantage within the aquarium, but not necessarily in the wild (such as smaller size). In both cases, in my opinion, there is the flawed assumption that we know how to develop a fish that best represents its wild form, as a result of choices that we make for the fish in our home aquariums.

My experience on this is that many fishkeepers holding to the former stance rarely provide an environment that addresses a number of aquarium inherent modifiers. Keeping a larger, single species tank that populates randomly is certainly easier particularly when your biggest concern is providing enough plant cover to keep the young from being eaten. I wonder how great an influence ease plays in the process. A genuine effort to replicate a wild situation would require at least a hundred gallon tank for a species that reaches an inch, and then there would need to be the occasional introduction of predators, cyclical live food, day/night temperature swings and seasonal variations to begin to head you in the right direction. We can only do our best to raise healthy fish, but we can't claim that the fish we keep are exactly as they would be in the wild.

Theory #6- Sell them so they Die!

This thinking is that when you have to go to great lengths to carefully, selectively develop a line of nice looking fish, and you are ready to sell those fish to someone else, it becomes their responsibility to keep them as they need to be kept and telling them the lengths they may need to go to will only discourage the sale, so it's best to keep quiet. What they don't know is a lack of their research, not your providing a lack of information. If they die (as they often will), they'll have to come back to you for more fish anyway. Essentially, if they leave your care and they look great and are in all other aspects perfectly healthy fish, the fact that someone else may not meet their needs is not, as the breeder making those fish available to them, your problem.

On this I could not disagree more. The same applies to breeders that feed color hormones to their fish before being sold so they look better, not especially concerned that the fish could be made sterile in the process, rationalizing that the customer probably won't breed them anyway. As a breeder you have a responsibility to provide fish that meet the customer's reasonable expectations in as many ways as possible. Some people can't keep certain fish, due to their water or inexperience, granted. But I strongly believe that it is up to the breeder to provide any and all information the customer needs to keep them going, as I would expect when I am on the other side of the fence. I keep what I do today in large part because of the information those first guppy breeders gave me. Those original fish are long gone, but the information has stayed with me, allowing me to continue keeping them today.

Actually doing it. What steps are best right away?

Over time, experience selectively breeding new species has led to a process that has established itself. With a new species that is unfamiliar, what the new line has to offer needs to be determined. Do the fish you possess have the potential to be developed into what you have in mind? the process isn't infinite- either the "fancy" traits are in the genome or they are not (color and finnage), so at first you need to see which traits the fish you are raising already carry, and that can be exploited. Much of the initial work to improve the line occurs by simply focusing on the traits that are already there. For example, if I were to buy a pair of normal pet-shop helleri swordtails with the intent of developing a high fin swordtail, I could be breeding them by the thousands for many years before ever seeing a fin mutation that could be carefully selectively bred into a high fin fish. But if it were a commercial red colored swordtail, I could assume that a fish with excellent red color and size is in the makeup that could be developed. By carefully watching every young that is born, any mutations that do occur should be easy to spot. Grow them out and decide whether you want to pursue it. An albino may appear, say with rare, highly desired bright white color. The wise fishkeeper then

grows that fish out and develops it into a line. You will have developed a new line of albino fish- though that may not have been what you had initially set out to do.

Once the best you can get your line to look has been accomplished, then it becomes an issue of spotting often slight mutations, pulling those fish and breeding them. At the same time you are looking for secondary traits that may appear- traits you may not want, but may have to either live with or work to breed out. In my breeding of the HF mayae, individuals showing new fin mutations often were smaller in overall size. I would then have to incorporate the new fin improvements in the young I was raising, then breed them to one another, selecting for size to get that back. With each swordtail generation taking 8 months, it can be seen how a breeding project can go on for many years.

Besides time, selective breeding requires space. the only way to increase your odds for beneficial mutations is through breeding in large numbers. Only through breeding a fish out by the many hundreds will you increase your odds enough to create genuine, spontaneous mutations. When first keeping Xiph. mayae, I was in the process of making the line consist (breeding out the tendency toward early developing males, for example), and was breeding them out 3-400 at a time in 41 gallon breeder tanks. Eventaully I got my first albino. I did grow it out, breed it, then breed its young, but unfortunately other albino young were not produced. I now know that it happened once, and it is only a matter of time before it happens again.

I have had other hobbyists tell me that an albino cannot be created spontaneously, that a previous cross with an albino fish had to have occurred. This is not true. Some species are more prone to produce albinos than others, but in my experience, most species have to potential to produce occasional, spontaneous albinos. The health and color of the fish produced can vary widely, and some may be too weak to survive.

Recently I grew out a nice pair of longfin green dragon plecos. The line had been hybridized, and though there were mar spectacular young being produced, many of the first batches were a hodge-podge of various lines- albino, calico, short fi and chocolates. The line needed to be made consistent, and the quality of that consistency needed to represent the best the line had to offer- excellent finnage and the best green color that could be selected for. As a result, there are now 11 tanks of green dragon plecos here. Currently in use just for the plecos are a 55, a 40, a 30, and 8 10 gallon tanks growing out fry.

Currently I am breeding fish of the third generation, working to continue refining the line. The second generation batches (from a single pair of the best fish from the initially obtained fish) had improved to roughly 20% short fins, and 5% ones that were too dark, or of another line. Of the longfins with appropriate color, about 5% have fins that are about halfway between short and long fin, but the vast majority are surprisingly consistent. About 5% are extremely long finned with the lonfin mutations exaggerated. Secondarily, their size is smaller, they grow slower, they are a different body conformation longer and slender with long, curling back first ray spines. their tails are extreme, especially when smaller, and can be longer than the entire rest of the fish, so that the overall length of the fish is more than half tail!

It is those fish I wish to develop. Ironically, the breeder that had the line previous to me (and may have caused the hybridization) told me he routinely culled those undersized, misshapen fish. I feel I am getting to the heart of what the line had originally been- the long spines and lush, flowing finnage exemplify the "Green Dragon" moniker. All of the curr consistent majority of the batches are excellent fish, and are being sold, but future generations are going to reflect the extreme look of those I am now growing out to breed by next summer.

As well, a recent crossing of two albino young from an original batch 18 months ago produced a large group of fry, of whi three are pure white, as opposed to the amber/pink color of the the other albinos. They are undersized, and one is not he and may not survive. Currently about 3/8ths of an inch long, fingers are crossed those two will be a pair. If not, future batc from those fish will be watched for others that can be raised and bred out to possibly develop an entirely new line.

The effort right now is to cull and sell the line down to the few best future breeders. Because I know that truly breathtaking fish are in the pipeline, I am able to sell them for less than other competitors right now, and will charge full price for the better ones when they become available.

Other fish here that once took up 10-15 tanks are now stable and bred in 2 or 3 tanks, keeping an eye to maintain their quality, and pull any individuals that may show new promise to improve the line.

So, what is "Selective Breeding?"

1. You start out with a pair of fish in a small bare-bottom, filtered tank with a few fine leaved plants by themselves (The tank being small so that you can always see them easily, and they are able to find food easily as they adapt to their new home), and at least 3 other tanks to be used for that particular line of fish (see #2), the size of the tanks appropriate for the species you choose to work with. I have livebearers such as guppies and swordtails in mind as I describe this process, but the overall process for any species of fish would be similar.

To provide security for young, this first tank should contain a moderate number of plants that fry can easily hide in. (Java moss, Java fern, najas grass, riccia and water sprite are some of the best.) The male, when the female becomes gravid, is moved to a second tank, leaving the "home" tank to the female, that the pair have become accustomed to. This way she can have her young without the added stress of being moved.

2. Fundamentally, for each line of fish you will need a minimum of 4 tanks. One for the breeder pair, trio or pairs, one for pre-sexed new fry, one for males grow-out and one for females grow-out. This assumes that you will cull all of the fish that don't qualify as breeders, bringing your entire stock of that line down to the few breeding pairs with each generation. Keeping your culls, at least for a while is best, for occasionally a fish that had been passed over as a breeder matures out into a huge fish or one you want to breed after all. If you have a loss of your breeders, it is also nice to know that you still have fish you can use. But 4 tanks will get the process started.

3. When the young are born, remove the female right after she drops, and put her in with the male. Then remove the plant and put them in with the breeder pair so the female can hide and recuperate. Leave in a sprig or two of Java fern or moss for the new fry to hide in, and to help maintain water quality while also being a source of infusoria to pick on. That now becomes the fry tank, and the first tank is the breeder tank. Feed baby brine shrimp lightly 2x a day to the new fry.

If the fry tank is 5 gallons or smaller, change 50% of the water daily. Do heavy water changes often if tank is larger for their first 2 weeks. If possible, use aged water from the tank where they were first born for their water changes, then add dechlorinated tap water to the parent tank. Around three weeks guppies can be sexed, other species can be watched close for first signs of sexing out. Move the females first to their own tank, leaving the original tank to the males to begin grow-out. This will ensure that few of your females will have been fertilized. For livebearers where the mature males possess a gonopodium, separate sexes as soon as the gonopodium development begins, or a darker "gravid spot" begins to appear on the females behind the "belly" area. Once a working gonopodium is in place the males can mate, regardless of whether other secondary sex characteristics have occurred (such as the development of a sword). Raise male and female groups separately up to sexual maturity. By separating the sexes you are not only preventing unwanted breeding, but you are also substantially increasing the growth and size of the fish that are not expending energy chasing one another around trying to breed and competing with one another.

4. Raise them up to determine which will be early maturing males, undersized or otherwise unhealthy fish. Move bigger, later maturing males and all fish that may become breeders to a tank of their own to provide more space and better water conditions, or if maintaining just 4-tanks, cull inferior fish. Continue the process with the females as well, choosing for size, color confirmation, etc. Save the culls if possible (in case something happens to the better ones). It will be at this point that you will need to make decisions such as: should I choose one fish that is larger and more robust, whose color isn't so great, or should I choose this other fish, whose color is spectacular, but is undersized? If you have the spare tanks, you would do both, and then possibly cross the best young each mating produces. Without the extra tanks, the decision is yours, but overall size takes a long time to reclaim when lost.

5. Raise them up to when size, color, finnage or whichever other traits you are looking to breed for are set enough to compare one against another, and choose the best fish. With guppies this is at about 3.5-4 months, with swords it can be substantially longer- 6, 7 months. These are your breeders. Generally, a rule of thumb is that of a batch of 30 babies, you will get 1 pair that will be breeders.

6. Continue the process until your breeder pairs are producing young that consistently carry the trait you are looking for. I have been told that it takes 11 generations to fix a trait so that it becomes as consistent as it is going to get- where ideally every young in the brood expresses the trait. With guppies a generation is 4 months, with helleri swordtails and platies, a generation is 8 months, with angelfish and most cichlids it is closer to 10 months. My experience has been that I start to see acceptable consistency (70-80% of young carrying the trait) by the 6th generation.

Do things right the first time, and don't compromise or take short cuts. Often I felt I could make an exception when all I was doing was satisfying my need to have things proven to me. Change the filter floss every couple weeks, and everything else comes down to regular water changes, types of food fed in small amounts as often as possible, proper temperature, aeration, critical observation and patience. I also read constantly from every book and magazine I can find on any and all of the fish I am working with.

You must feed newly hatched brine shrimp to the fry and a good dry food daily, possibly with beefheart or chicken liver mix a couple times a week. I also use the "Golden Pearls", produced by Brine Shrimp Direct, and often feed smaller new a mix of powdered dry food dissolved in water. I also feed live daphnia and chopped red worms. With the swords I keep them on a vegetable flake and drop in an occasional slice of blanched zucchini. And of course, be careful of any aquatic live food that can carry disease or parasites, such as tubifex. An introduced pathogen can quickly wipe out a lot of fish. Keep the bottoms of the tanks fairly clear of uneaten food.

When culling down to your best fish, choose for overall size first. Then select for form, finnage, color and level of

activity. A beautiful fish that rests on the bottom isn't really of any value and lowers the quality of the strain.

I am now at nearly 120 tanks, and I still use the same 100 gallon as a grow-out tank for the male nezzies, as I had with male guppies before them. The nezzies are sexed at 2-3 months, and are culled down to 2-4 fish per spawn, then put into male or female only tanks. From there the best ones are mated in 10 gallon tanks, with java moss added when the female is ready to drop. Males are removed before young are born and the female is removed immediately after spawning. I feed the female heavily before she drops to better ensure healthy young, minimize the number she'll eat, and do daily mild water changes the few days before she drops to keep her overall health up. I never, ever put females of the larger swords in breeding traps. After 2-3 days babies are carefully caught and put in net breeders for their first two weeks and then released into 10 gallon fry grow out tanks until they are at least a month old. I sex out the fish as soon as possible and grow them out in separate sex only tanks until the breeders for the next generation are chosen. I found that earthworm flake or chopped earthworms specifically increases brood size and the health of the resulting young. I do use plants with the swords and guppies today, usually Java moss, Najas grass and Java fern, and only use salt when I see a problem developing (clamped fins, etc.) to get them back to normal health.

I find that I'm constantly challenged, and pleased with new and interesting things that seem to happen almost daily. I often wondered if focusing on just a couple lines could become boring or a burden, but the secret is to keep it simple and within your time, energy and budget, and it stays fresh and challenging. Today I happen to think that the bare bottomed tanks look great- I don't miss the gravel and landscaping. The emphasis is now totally on the fish. And what I ended up with is certainly a long way from what I had expected, back when I thought I knew what I was doing!

Greg Sage
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