



Production of Ornamental Aquarium Fish¹

Craig A. Watson and Jerome V. Shireman²

Ornamental fish production for the aquarium industry is a multimillion dollar industry in the United States. Annual sales from Florida alone are estimated at over 175 million dollars in retail value. Because the vast majority of fish varieties sold originate from tropical regions of the world, in the United States, the majority of production is limited to South Florida. The Florida industry dates back to the early 1930s, but its major expansion has occurred in the last 20 years. Farms in Florida now produce over 700 varieties of ornamental fish and ship them to wholesalers and retail pet shops around the world. In a survey conducted by the Florida Department of Agriculture, the farm gate value of this crop was reported to be \$33.7 million in 1989.

Besides the production on Florida farms, there are minor operations in warm water springs in the Western U.S. and numerous "backyard" operations throughout the country. In the Far East, production centers are found in Thailand, Singapore, Indonesia, Hong Kong and Malaysia. In addition, there are hundreds of species which are only available as wild-caught specimens, either because no one has found a way to produce them on farms, or economics prohibit production; except for a handful of species, all marine ornamental fish are caught from the world's tropical oceans. Major centers for wild-caught freshwater fish are the Amazon river basin, the Congo river basin and the major rivers of Southeast Asia. With modern advances in air transportation, fish from other areas of the world are becoming more available to the industry as well.

Production

Ornamental fish are produced primarily in outdoor, earthen ponds. In Florida these ponds are almost all water-table ponds in sandy loams. In extreme south Florida, ponds are dug into the coral bedrock. Relative to other aquaculture ponds, tropical fish ponds are very small, averaging 25'×75', with a maximum depth of about 6'. The water level in the pond is dependent on the existing hydrology, and during times of drought (springtime), they must be supplemented with well water in many areas. The water quality of a given site is dependent on the soil type, which can vary abruptly in Florida. Classically, ponds in areas with high organic matter are acidic, and their total alkalinity and hardness may be low. But in Florida, typical pond water has a total alkalinity in excess of 100 parts per million (ppm) and a pH of 8–9.

Ornamental fish comprise two broad categories: live-bearers and egg-layers. Live-bearers include guppies, mollies, platies and swordtails. Egg-layers include almost everything else; the major groups are barbs, tetras, gouramis, danios and cichlids. Live-bearers are grown almost exclusively in outdoor pools. The pool is pumped dry, hydrated lime is added as a sterilant, and an organic fertilizer such as cottonseed meal is added to start the pool. Once the pH has stabilized below 9 (lime sterilizes the pond by raising the pH to extremely high levels), the breeding fish are added to the pool. Stocking

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2. Craig A. Watson, Coordinator-Research Programs/Services, Tropical Aquaculture Laboratory; Jerome V. Shireman, professor emeritus, Fisheries and Aquatic Sciences, Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

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rates for breeding ponds vary greatly, from as few as 50 fish to as many as 1000. Selection of brood fish is extremely important, since genetic variation within a strain of fish can be great. Only the best specimens should be stocked in the breeding pool. Live-bearing fish are harvested almost exclusively with baited traps. The traps are placed along the edges of the pond early in the morning. Fish are often sorted and graded on the pond bank. Fish destined for market or stocking another pond are placed in buckets, while others are returned to the pond or discarded. Most live-bearers are hybrids or color variations, and many are discarded because their coloration, finnage or quality do not conform to the desired type. The number of discarded fish can exceed half the total production from a pond, especially in more exaggerated varieties, such as high-fins or lyre-tails. In addition, most live-bearers have extreme sexual dimorphism, i.e., males and females don't look the same, and buyers demand an almost equal male-female ratio in a given shipment. In most pond populations, the number of sexually mature males will lag behind the number of females, therefore, excess females are discarded because no males can be found to ship with them. Competition from the Far East is probably at its highest in the live-bearer section of the industry.

Production techniques for egg-layers would encompass an entire book on fish reproduction. Major divisions of this group include mouth brooders, bubble nest builders, substrate spawners and egg scatterers. Some of these fish are spawned in ponds, similarly to live-bearers, but the majority require a hatchery for commercial production. Some species, most notably members of the cichlid family, will mate for life, and therefore, pairs of breeders are maintained in individual tanks where they spawn continuously for as long as five years. However, the majority of egg-layers are paired up at random when the females are conditioned, either one pair per tank or in large spawning groups. Commercial production techniques for this group of fish are guarded closely by the producers.

Many producers today are starting to utilize information generated from food fish aquaculture, and reproductive successes with the use of hormones are allowing the industry to produce fish which were previously unavailable from farms. One such group of fish is the "sharks", members of the genus *Labeo*. The process begins when brood fish are conditioned in outdoor ponds where females are periodically checked for egg maturity. When a female is near ovulation (when most eggs have their nucleus near the micropile), she is injected with hormones (either human chorionic gonadotropin+carp pituitary or LH-RH analog+reserpine) to induce ovulation

and release of eggs. Males are injected as well, but at much lower doses. Groups of fish can be spawned together in circular tanks, where a circular flow pattern is developed. Eggs are collected from the overflow with a fine-meshed net. An optional method is to hand-strip eggs and sperm from the fish, using the dry method.

Eggs are then hatched in jars with a constant flow of water to keep them in suspension. At 78°F, the eggs will hatch in about 24 hours. The entire technique is similar to the reproduction of the chinese carps (grass carp, big head carp), and this is a classic example of how one aquacultural industry can benefit from another's success.

Many larvae in this group are extremely small at hatching, and survival rate is often very low in the first days of their lives. The situation can be improved by providing massive quantities of live foods (i.e., rotifers and daphnia) year-round; this is one area where research has benefitted producers. Many fish can be fed artemia as a first food, but there are just as many which are unable to eat such a large particle during their larval stage.

Once hatched, egg-layers are either fed in the building for the first few days, or more commonly, they are transferred to an outdoor pool which has been prepared in much the same manner as for live-bearers. The timing of this transfer is critical to the success of this stage of the operation. If the pond's cycle is in its early stages, it will not contain enough food to support the fry; but if the cycle has advanced too far, predators which feed on the pond's food source may also feed on the newly stocked fry. Insect larvae (dragonfly nymphs, glass worms, etc.) can account for losses up to 75% of new stock in the first few days. Currently, there are no labeled chemicals on the market to help solve this problem, therefore the farmer must be an expert at timing the stocking.

Grow-out time in the pond also varies considerably with the species being produced. Some species have a market for small individuals, and the farmer may harvest the pond after only two to three months of grow-out. When fish grow much slower or there is no market for small individuals, grow-out can take an entire year. Again, the extreme diversity of the industry prohibits gross generalizations in this area.

Marketing

Competition for a limited market is perhaps the greatest driving force in this industry. Florida's farmers must compete with importers whose fish come from the

tropics, both wild caught and farm raised. The Far East is viewed as the major competitor, because its strong production centers produce many of the same varieties which United States farmers try to market. Often, imported fish are cheaper, due to the reduced cost of production (i.e., lower labor costs) in the Far East. Not only must United States farmers compete with overseas producers, but they must also compete with each other. Choosing a fish variety which will be in demand at harvest time is very difficult when so many competitors may choose the same variety. Therefore, one must enter this market cautiously. A certain amount of expertise in the industry is almost a prerequisite to success.

The tropical fish market is international, and prices are controlled at the retail end. Most Florida producers sell to local buyer/distributors who resell the fish to wholesalers and retailers. Inventories can shrink dramatically at each stage of distribution; this results in a series of price increases aimed at recovering these losses. Those interested in producing ornamental fish should not regard retail price as an indicator of what producers earn. A fish which sells for \$2.89 in a northern pet shop may bring as little as \$0.15 to the Florida producer. Marketing ornamental fish is extremely competitive in the United States, and this prohibits many newcomers from entering the market.

While large numbers of fish are sold in this industry, the key to a region's success is possession of a large selection of varieties. An isolated producer with a small selection will find it difficult to market large numbers of fish because buyers demand variety. Although tropical fish are produced elsewhere in the United States, Florida still controls over 95% of the supply, mainly due to the selection to wholesale buyers find here.

In addition to the farm-raised fish, Florida is also a major transshipper of wild-caught fish from South America and Africa. As with any aquaculture enterprise, success depends on thorough investigation of the market PRIOR to beginning production.

Water Quality Management

The level of expertise required in water quality management is higher for ornamental fish production than any other type of aquaculture, again because of the variety of fish species in culture. While all ornamental fish come from tropical regions, the quality of water they come from varies greatly. Fish from the Rift Valley of East Africa live in some of the world's most alkaline water, while fish in

the Amazon may tolerate pH as low as 5.0 with total alkalinity and hardness less than 5 ppm. Successful production depends on the producer's understanding a given fish's requirements, and manipulating available water to meet them (site selection can play a key role in this respect).

Tropical fish are generally sensitive to poor water quality. Many tropical fish will perish in situations where more robust food fish species can survive. Modern farms incorporate many expensive systems, including continuous pond aeration, to diminish water quality problems.

Ornamental fish are also kept in tanks more than their food fish counterparts, and under tank conditions, water quality is most critical. Where large numbers of fish are inventoried in small spaces, the buildup of nitrogenous wastes, most notably ammonia, requires the producer to implement expensive measures to manage it properly. Flow-through systems are the standard, but with increasing regulations on water usage for all aquaculture, recirculating, biologically filtered water is becoming more common in the industry.

Diseases

Except for species-specific viruses, all major diseases of food fish occur in the ornamental fish industry plus a few unique to the tropics. Because the ponds and tanks in which ornamental fish are kept tend to be small, and because of the large variety of fish in any one facility, disease management takes a considerable amount of a manager's time. Fish in a container, whether pond or a tank, can be viewed as an isolated population. As the number of these populations increase, so do the chances of encountering a disease problem in one of them. A 50-acre channel catfish farm may have 10 ponds which must be monitored for diseases, while a 50-acre tropical fish farm may have over 250 ponds and 1,000 tanks, each one requiring separate disease management.

Summary

Tropical ornamental fish comprise a varied list of species, each with their own peculiar requirements for commercial production, and markets for these fish are as varied as the fish themselves. A considerable amount of prior knowledge is recommended to anyone who wishes to enter the field. It is extremely difficult for new producers to get good information on how to produce tropical fish; although many production techniques and management skills required for tropical fish are similar to those in a

food fish operation, the specific methods for producing a given species are usually closely guarded secrets.

While not unique to Florida, tropical fish production is concentrated there. This results primarily from the climate, but the historical strength of the industry is also a factor. Tropical fish marketing depends on having a wide selection of fish to offer, and no other state in the nation can compete with Florida in this area. For all of the above reasons, we anticipate that the industry will remain centered in Florida, nevertheless, successful entry will be limited to those individuals who possess some prior knowledge of the industry.