Spawning and Production of the Lemon Tetra *Hyphessobrycon pulchripinnis*

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INTRODUCTION

While more than 60 species in the genus *Hyphessobrycon* have been identified, very few are available on the ornamental market despite their popularity (Baensch1993). *Hyphessobrycon pulchripinnis* (Lemon tetra) is just one of many fish in the group of tetras or more accurately, Characins, traded in the ornamental industry. Lemon tetras are peaceful and nonaggressive to other fish and do well in community tanks. Like many of the other tetras, they can be considered a schooling fish and do better in groups of five to twenty individuals.

Although Lemon tetras are fairly easy to spawn, they are not as colorful as many of the other tetras and are not widely spawned or imported in large quantities for economic reasons (Axelrod and Schultz 1983). As of 1992, the Lemon tetra was listed as number 69 in the list of top 100 fish imported into the United States with just over 5,300 imported per month (Chapman et al. 1997). The historical estimated farm gate prices producers could expect for a group of various one-inch *Hyphessobrycon sp.* are summarized in Figure 1. These prices were taken from a series of price lists published every five years by one Asian trans-shipper. A one-inch fish was used to serve as an easy reference point, although many can be sold at smaller sizes. The Lemon tetra could be considered what the industry refers to as a "bread and butter" item.

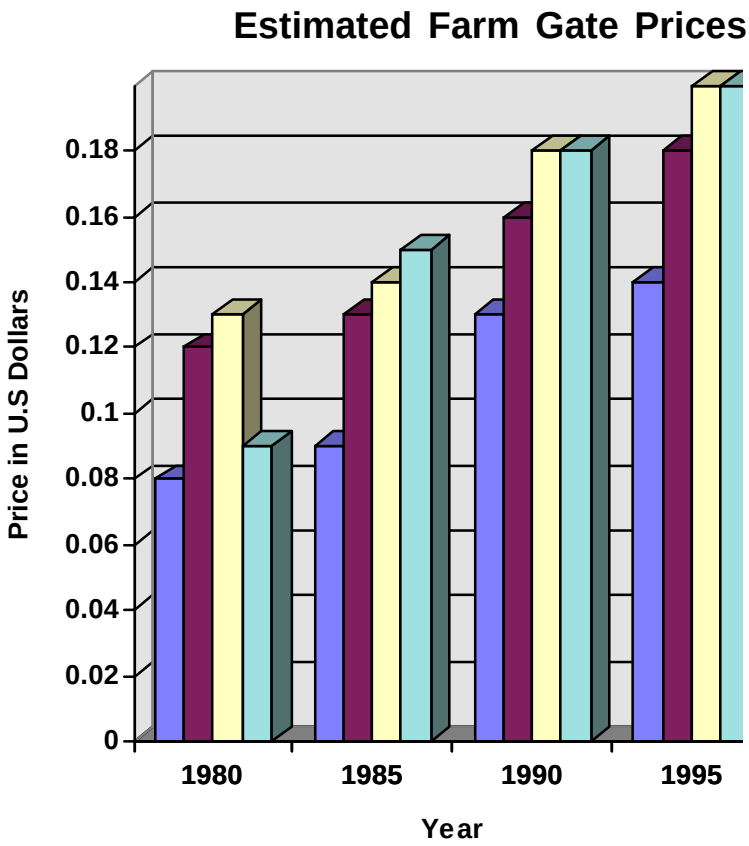

Figure 1. Estimated average farm gate prices for selected one-inch *Hyphessobrycon sp.*

TAXONOMY

The Lemon tetras, unlike many tropical fish traded on the ornamental market, have not gone through reclassifications and numerous name changes as have others. This fish was occasionally called *Hemigrammus erythrophthalmus* but is not valid scientifically (Axelrod et al. 1977). J. Gery discovered that the generic name for the more common species was possibly incorrect but since it was in such common usage he did not assign a new one and suggested that a review of all South American *Tetragonopterinae* be undertaken. To date this review has not occurred. The Genus *Hyphessobrycon* was established in 1908 by Durbin (Baensch 1993). To date, the taxonomic classification remains; Family: *Characidae*, Subfamily: *Tetragonopterinae*, Genus: *Hyphessobrycon*, Species: *pulchripinnis*.

MORPHOLOGY

Hyphessobrycon pulchripinnis are not as colorful as many of the other Characins unless well maintained and given feeds with the proper level of available carotenoids to enhance and maintain their color. They do make an excellent contrast fish due to the bright yellow color and the bright red upper part of the eye. As shown in Figure 3, mature adults are fairly easy to sex. The females have a deeper body contour and the black edge of the anal fin in the males is more pronounced than in the females. Fully grown Lemon tetras are from three to five centimeters (cm) in length with a five cm specimen being unusually large.

Figure 3. Photograph of *Hyphessobrycon pulchripinnis* male (top) and female (bottom).

DISTRIBUTION

Distribution is throughout South America (Figure 2) except the southern part and arid Pacific slope of Chile (Axelrod and Schultz 1983). The native habitat comprises the small tributaries of the lower Amazon basin, primarily brooks emptying into the Rio Curua do Sol and the lower and middle Rio Tapajoz between Itaituba and Jacare Acanga (Gery 1980).

Figure 2. Natural distribution of *Hyphessobrycon pulchripinnis*. (Modified from Baensch 1991).

WATER QUALITY

Proper water quality is one of the most important aspects for success in spawning Characidae. Most prefer soft and acidic waters. Table 1 provides the ranges in water chemistry considered acceptable for the production of *Hyphessobrycon pulchripinnis*.

SOURCE	TOTAL HARDNESS	pH	TEMPERATURE
Rundle (1994)	80 mg/L	6.5 - 7.2	24 - 26 C
Baensch (1993)	60 mg/L	5.5 - 8.0	24 - 26.5 C
Axelrod (1983)	80 mg/L	6.6 -8.0	21 - 29.5 C

Table 1. Ranges in important water quality parameters for the reproduction of Lemon tetras.

Water chemistry can vary greatly in Hawaii due to the wide range of environmental and geological conditions encountered there. While water sources that fit within these parameters can be found in the State, in some cases, the water chemistry may have to be altered to successfully breed some fish. For many tetras, hardness and pH are the most important parameters to consider. Hardness is the total concentration of alkaline earth ions expressed as an equivalent calcium carbonate ($CaCO_3$) in milligrams per liter (mg/L), with the principal components being calcium and magnesium carbonate or sulfate. Hard water contains high concentrations of alkaline earth ions while soft water has low concentrations. Other ions contribute to hardness but are usually present in such minute quantities that their effect is minimal. Hardness is usually expressed as temporary or carbonate hardness and permanent or non-carbonate hardness. The sum of these two components is total hardness and is usually expressed as mg/L $CaCO_3$(Boyd 1979). The term "temporary hardness" is commonly used because carbonate hardness can be removed by precipitating the calcium and magnesium cations or salts by boiling.

The most common method to reduce hardness is to dilute the hard water with distilled water. Other means include use of a commercial water softener such as reverse osmosis units or ion exchange gel filters if large quantities of soft water are needed.

The pH is a measurement of a water's acidicity and indicates a change from a neutral pH of 7.0. Neutral water contains an equal balance of hydrogen ions and hydroxide ions. A higher proportion of hydrogen ions results in a more acidic water (lower pH) while a higher proportion of hydroxide ions results in a more alkaline water (higher pH). If small quantities of water are needed, reduction of pH is generally a simple matter and can be achieved through peat filtration. If large quantities of water are needed, a strong inorganic acid such as phosphoric, sulfuric, or diluted hydrochloric (muriatic) can be used to reduce pH. There are also commercially available compounds sold through retail pet stores in the form of solid tablets, granules or liquid drops.

When using a strong acid to reduce the pH, be sure to run several tests to determine how much acid is required to reduce the pH of a given amount of water to the desired level. When handling strong acids, review and observe all safety precautions to prevent accidental spills or exposure to eyes and skin.

REPRODUCTIVE BIOLOGY

Many species of fish produce eggs only once a year while some others produce eggs repeatedly over the course of a spawning season. Lemon tetras fall into the latter category. Female Lemon tetras will ovulate on average about once every four days as shown in Figure 4 (Burt et al.1988, Nakatsuru and Kramer 1982). During each ovulation, a female will spawn an average of 23 times producing an average total of 160 eggs. Ovulated eggs are sinking and slightly adhesive with diameters of 0.74 mm that swell to 0.90 mm after water hardening. Spawning is promiscuous and males will spawn every day that receptive females are available (Nakatsuru and Kramer 1982). Fertile eggs hatch in about 24 hours and there is no parental care given to the eggs or fry.

This may lead many aquaculturists to believe that there may be an unlimited ability for males to fertilize eggs. However, Nakatsuru and Kramer found that there may indeed be a limitation to the males' ability to fertilize eggs. The percentage of developing eggs declines as a function of the number of spawning acts by the male. The decline is most easily explained by a reduction in the quantity or quality of sperm released at successive spawnings (Nakatsuru and Kramer 1982).

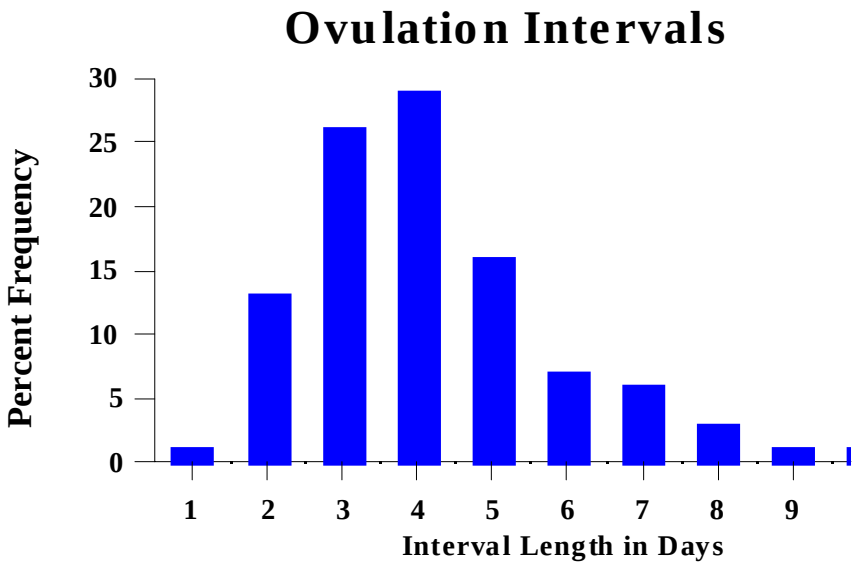

Figure 4. Percent distribution of ovulations since previous ovulation for *Hyphessobrycon pulchripinnis* under controlled conditions (n=245). (Modified from A. Burt. 1988)

The rate of external fertilization is maximized only at sperm concentrations of 1,000,000 sperm per milliliter (Nakatsuru and Kramer 1982). After ten spawning acts, male reproduction is limited by sperm supply. After 20 spawning acts in a one to one sex ratio, reproductive success could be enhanced by restoring the fertilization rate rather than by gaining additional spawning. After 30 spawning acts, reproductive success is limited almost entirely by fertilization rate. If females are not limited, males could be expected to fertilize about 136 eggs per day, an almost identical number to the number of ovulated eggs produced by a female every four days (Nakatsuru and Kramer 1982).

Lemon tetras are egg scattering spawners like many of the other Tetra sp. and Barb sp. Usually either pairs or groups of brood stock, with one male to four or five females, are set up in tanks that are no larger than ten gallons and as small as three gallons. This ensures that there is at least one female ready to spawn. Pairs can be used but the percentage of tanks that contain eggs after the spawning run will be reduced. A substrate of brushes, nylon yarn, fine strips of plastic tied to a base or fine plastic grass is placed into the tank by itself or on top of an egg collector. Egg collectors should be constructed to fit the tank edges snugly so that the brood stock does not hide in any crevices. Collectors should have a minimum depth of about one inch, although deeper collectors work very well. It should be covered with a screen large enough to let the eggs sink through but small enough to keep the brood stock out. The use of collectors also allows the moving and consolidation of the eggs so that the spawning tank is not used for larval rearing and development and can be set up immediately for another spawning run.

For spawning, three- to five-gallon tanks are adequate and ten-gallon tanks would be the largest that is practical. The larger the tank the greater the chances of the eggs being scattered throughout the tank making it more difficult to collect and consolidate the eggs for larval rearing. The pairs or groups are placed into the tank usually in the afternoon. Spawning will occur the following morning and will start at sunrise and last two to three hours. After spawning is complete, the brood stock or egg collector is removed to prevent cannibalism of the eggs.

Eggs will hatch in 24 hours and in about five days fry become free-swimming and able to take a first feed of infusoria or a commercial micro diet of 50 microns or less, although some success has been achieved with live freshwater zooplankton. By the eighth day, fry will take newly hatched brine shrimp and by day ten to twelve the fry are large enough to move into a grow out tank or pond. The fry can then be weaned onto a commercial production diet starting with a fine powdered swim-up or starter diet.

GROWTH

Lemon tetras were stocked in an above ground tank, six feet in diameter, at a density of 1.9 per gallon (0.5 per liter). Fish were weaned for the first two weeks using a combination of live brine shrimp and a fine powdered commercial trout swim-up diet containing 55% crude protein, 16% crude fat, 3% crude fiber, 12% ash, and 1% phosphorus. After the initial two-week weaning period, the fish were fed to satiation once daily, strictly on the commercial diet. During the grow out period (August through mid-November) temperatures were in the optimum range for the first 60 days of the trial and then began falling under the optimum range for the last 60 days as shown in Figure 6.

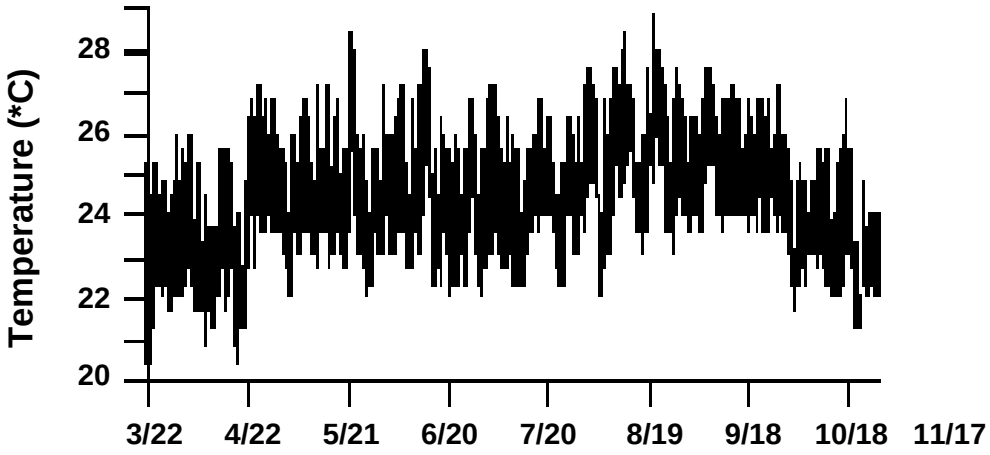

Figure 6. Temperature range at Windward Community College during the spawning and grow out period for *Hyphessobrycon pulchripinnis.*

Figure 7 represents the growth of *Hyphessobrycon pulchripinnis* cultured over a 120-day period during the fall and winter months in Hawaii. Lemon Tetras are sold both domestically and from foreign sources at a variety of sizes, starting at 1/2 inch (12.5 mm) and ranging up to 1.25 inches (31.25 mm). In this grow out trial, 1/2-inch fish were obtained in less than 30 days and one-inch (25 mm) fish were obtained in about 60 days. The regression formula given in Figure 7 applies to growth at 15 days of age and beyond at the temperature regime given previously in Figure 6. The weight of individual fish at the end of the trial ranged from 0.21 to 0.82 grams with an average weight of 0.60 grams.

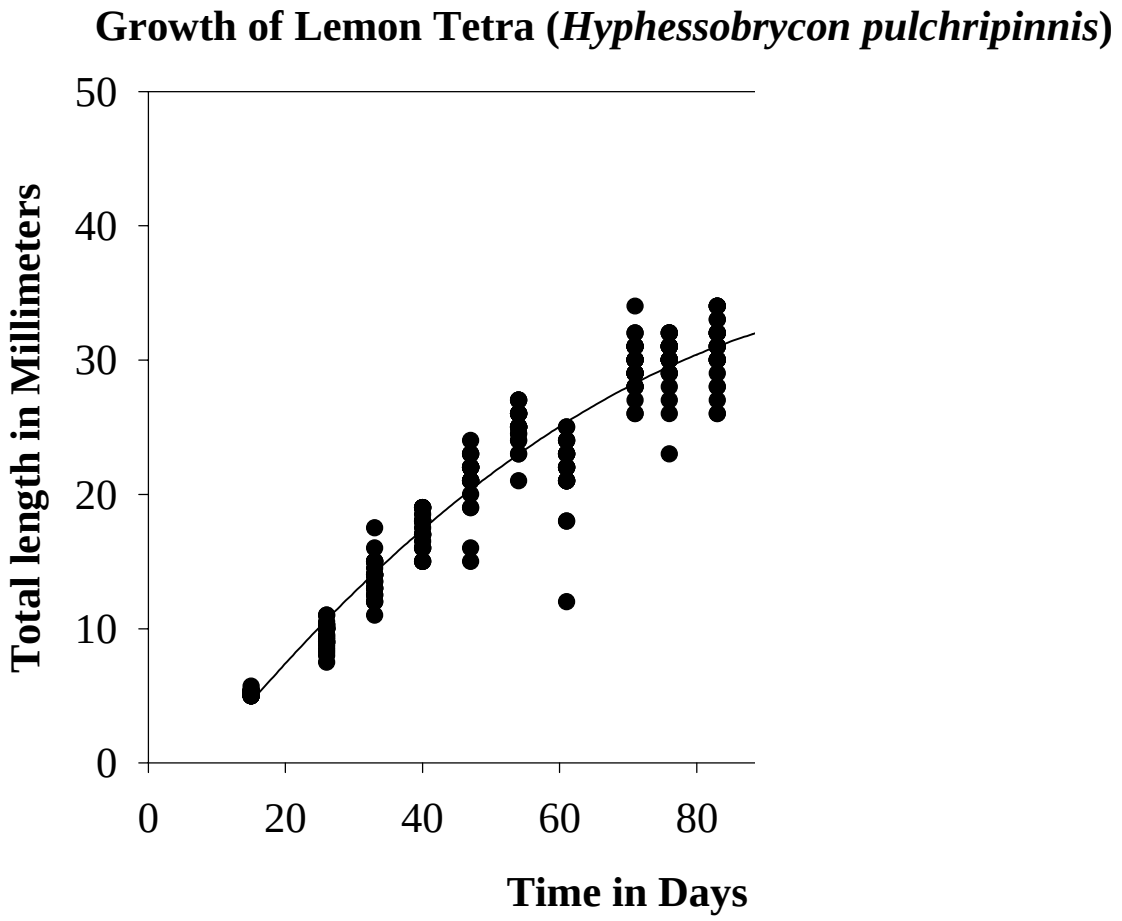

Figure 7. Growth of *Hyphessobrycon pulchripinnis* cultured in tanks. Total length in millimeters = -4.867 + (0.0671 x Age in Days) - (0.00288 x Age in Days^2).

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