

PACIFIC AQUACULTURE

Robert D. Royer

5 Julian Lane
Yerington, Nevada 89447

Pacific Aquaculture began operations on February 1, 1991. We are still in operation, but we have been basically holding down the fort until reinforcements arrive. We purchased a colony of 400 adult axolotls from George R. Barnes, which were originally collected by Dr. Louis DeLanney. We also purchased various items of equipment for holding the adults, spawning them, and growing out the juveniles. We sell the juveniles at an approximate size of 3 1/2 to 4 inches. We offer dark, white, albino, and golden albinos to our customers. Our customers are predominately tropical fish wholesalers throughout the United States, who, in turn, resell the axolotls to pet shops or other distributors. That, in a nutshell, is our current situation.

A Little History. On February 1, 1991, when operations began, we itemized our problems concerning the axolotls, and we did a market analysis of their profitability. We did the market analysis first and discovered, to our surprise, that the axolotls were profitable. With this established, we listed the problems concerning the animals:

1. Most of the original colony had been replaced by other animals without any documentation as to who the parents were. This, combined with an overall lack of other genetic information, presented us with the choice of starting from scratch or weeding through 8 years of very cryptic record-keeping.
2. There was only enough production equipment to produce approximately 6,000 4-inch juveniles for sale per month. In our first month we had established a potential market for 15-20,000 animals per month.
3. There was minimal spawning in hot weather.
4. Diet. We fed baby brine for the first 2-3 weeks, tubifex worms at the 1-4 inch size, and salmon pellets from Rangen

Corporation for axolotls larger than 4 inches. The problem was the tubifex worms. At \$7 per lb., this was our largest expense.

What we did to solve the first problem was a nightmare. We decided to write a computer database program to track current information on the axolotls and to decipher what historical information we did have and add it to the database. We developed a second program that would analyze the information found in the database. Both these projects were extremely time-consuming, but the end results are:

- a) We now have a comprehensive tracking/monitoring system for the future of the colony.
- b) We were able to track many of the adults back in time.
- c) We were able to determine which animals came from the same spawns so that now we can prevent inbreeding
- d) We can obtain various other information, such as which males or females do not perform, which animals to breed to get 100 percent albino spawns, etc.
- e) The program accurately tells us which animals to spawn together, what to expect, and gives us a fast list of how each animal did in other pairings, etc.

Our second problem was and is a matter of capital. Without investors or financiers, we are able only slowly to increase our volume. However, this year we expect large amounts of capital, which will enable us to increase not only the volume of axolotls we produce but also to develop other animals for sale.

Our third problem has been resolved with the use of air conditioning in the room that houses the adult axolotls and the use of a chiller for the spawning tanks.

We are still working on resolving our fourth problem. In fact, our attempts to find a less expensive diet created new problems for us. After a year of trying other options, we are finally back to tubifex worms. The axolotls grow fast on these worms and are ready for sale 8-10 weeks after hatchout. The major problem with tubifex worms, other than ex-

pense, is keeping them alive and keeping them clean.

The entire first year has been quite a learning experience for us. We do not have any background in biology or related subjects. I have a background in electronics, a degree in business, and a degree in structural engineering, hardly prerequisites for working with and managing an aquaculture operation. My message here is bear with me and my lack of background.

Our biggest lesson learned the first year is to do things or make changes on an experimental basis. Work with a group of animals when something new is tried, not across the board with all the animals. To a person oriented to the scientific method this may seem obvious, but to me it was not so.

Layout and Procedure. We maintain 1,000 adult axolotls in an insulated, air-conditioned room. Each adult has its own tray marked with pertinent information. They are washed and cleaned on a daily basis. They are maintained in Holtfreter's solution.

From this adult pool, pairs are computer-selected for spawning and then placed together into a 20-gallon glass aquarium. We currently spawn 14 pairs at a time, but we will soon move this up to 40-50 pairs at a time. The male is removed after laying down spermatophores and the female, if she lays, is allowed approximately 2-3 days to lay all her eggs. Plastic garlands are used for her to lay on. When she is finished, the entire garland is removed and placed in a tray. The tray is put into a heated room (75° F.) where the eggs incubate for approximately 12-14 days. At the end of that period, any eggs that have not hatched of their own accord are manually assisted. The spawns are then placed in 30-gallon laundry tubs, where they are fed three times daily with newly hatched brine shrimp.

The axolotls are removed from the tubs after two weeks and placed in raceways, 8 feet long by 2 feet wide and 2 inches deep. Here they are switched to a diet of tubifex worms, grown out to a length of 4 inches, and then sold. They are packed into plastic bags, oxygenated, placed into insulated boxes, and shipped via air freight. We have found that they can survive well in the boxes for up to 72 hours. In the summer, we pack the boxes with ice bags to help keep them cool in transit.

Health problems. We have had only one major health problem for the entire year of 1991:

death caused by *Aeromonas*.

When I assumed ownership of the colony, the adults were healthy, and they still are. The entire inventory of juveniles was healthy. Other than a low production level and poor record-keeping, all things were in order.

The first thing I found was that the tubifex worms were kept in square trays. The worms were kept about 1/2-1 inch deep barely covered by water in a refrigerator. When new worms arrived they were treated with 2-methyl-5-nitroimidazole for 48 hours, then thoroughly washed and put back in the refrigerator (about 35-40° F.). They were then washed daily. The worms would last 5-6 days and then start to rot. There was always a high loss depending on when they would begin to rot.

I was informed that nitroimidazole was for the health of the worms, and it prolonged their life. I therefore decided to begin keeping the worms in 50-gallon tubs with running water and unrefrigerated. This worked well; the tubifex worms lasted until they were used up. I was able to buy for the month and keep them alive and healthy for the duration. Therefore, I discontinued the medication, seeing no need for it. This was the big mistake.

What I didn't know at the time was that the tubifex came in loaded with various parasites and bacteria. The purpose of the nitroimidazole was to clean out the parasites. Approximately two months after I discontinued the medication, all my inventory had perished. Symptoms: red lesions, occasional bloating, pale color, loss of appetite and sudden death.

For the next 8 months, I tried numerous methods of solving the problem, including the following (keep in mind none of these procedures worked):

1. Improvements in husbandry techniques (frequent cleaning, less crowding, etc.)
2. Infected animals were sent out to disease labs in Washington, California, and Nevada. It was determined that the axolotls were dying from *Aeromonas*, and it was recommended that we use antibiotics in the water, so we began with nitrofurazone.
3. After getting no results with nitrofurazone, we tried kanamycin sulfate.
4. After several months getting no results with antibiotics in the water, we tried medicated salmon pellets.

5. We cut out the tubifex completely and shifted to small salmon pellets. This was a problem because of very slow growth and inconsistent eating, causing extremely high rates of cannibalism. This also created a much dirtier environment for the juveniles.
6. We tried giving the axolotls baths in formaldehyde.
7. We tried keeping the axolotls in water close to freezing.
8. We tried feeding finely chopped beef heart, but began getting digestive blocks, swelling, and poor eating, along with an extremely dirty environment.

Approximately the first of January of this year, we were informed that the nitroimidazole that I had discontinued was used for cleaning the worms. If they weren't cleaned, the parasites would attach internally and externally, causing the animals enough stress to open the door for *Aeromonas*, which would kill them. Beginning February 10th we began feeding the axolotls on tubifex again, medicated and refrigerated. The animals are currently eating very well, and cannibalism has stopped. However, at this date, animals are still dying from *Aeromonas* in large numbers, keeping them from being sold. We hope to see a change in this within 4-8 weeks. We still need to develop a technique for keeping the tubifex alive longer.

There are several things we'd like to try in order to improve the situation:

1. a diet of adult brine shrimp instead of tubifex.
2. growing our own tubifex.
3. keeping tubifex in flowing, chilled water.

The Future of Pacific Aquaculture. It was not our original intent to acquire an axolotl colony. It was our intent to develop the 2300 acres on which we are located for tropical and food fishes. We have a geothermal resource, which makes it possible to grow tropical fish outdoors in ponds year-round. We also have sufficient ponds supplied with cold water to grow out food fish year-round. We are currently building up a brood stock of Central and South American and African Cichlids. We are working on a fish known as the Sacramento Blackfish (*Orthodon microlepidotus*) for the food market. Our plans are to include channel catfish, white bass, and silver carp as other additions for the food market.

Regarding the axolotls, we plan to increase the brood stock to approximately 1500 adults. Once we are able to meet the demand from our current buyers, we intend to make axolotl embryos, as well as adult animals, available to the scientific community. Prices will be negotiable.

We are hoping soon to purchase a colony of Spanish newts and possibly a colony of Ring salamanders later in the year. We plan to continue working with rare and endangered or threatened species in the future, and we are willing to be considered by any institutions looking for a facility to unload colonies of reptiles, amphibians, or fish they can no longer support.

Our address is 5 Julian Lane, Yerington, Nevada, 89447.

Our telephone number is (702) 463-5986. You are welcome to make inquiries at our 800 number: (800) 346-8011.