

The Story

FROM HERBS TO FISH AND A DESIRE TO HELP

Mike Sipe

It was a warm March day at Lackland Air Force Base, and I was in the basement of our building in the Mail Room where I was in charge of sorting mail. It was just after lunch and I had just finished off a ham sandwich. I was alone in the Mail room for a few minutes, since my assigned help generally worked early and late and so would not arrive for an hour or so. So, I could get all of the other Airmen's Mail up and leave at 2:00 for tennis practice. It was only 12:30 and so I had some time to spare when I finished before I would have my helpers bopping in. As I sorted the mail into different piles I uncovered my new May issue of Scientific American. Since I was almost through sorting mail, I set it aside and finished putting up the rest of the mail, then I grabbed a coke from the fridge and picked up the Magazine, opened it to the table of contents, and leaned back in my chair, put my feet up on my desk and begin my trip through the new issue.

I had become addicted to reading Scientific American at around the age of 13 when I ran across it in the school Library. At first when I read it I understood only a few things, but I looked up any words that I did not understand and after a couple of years I began to understand more and more, although in some subject areas I am still as stupid as ever. I began reading, and immediately noticed an article titled The Cultivation of Tilapia. As I had a strong interest at the time in growing herbs and learning about each one as I grew it. I was eager to learn about new herbs and how to grow them and I thought this might be an interesting article to read. Of course when I turned to the article, having a quick mind, I realized it was not about plants, but was about fish, but as I had not yet been involved in growing fish, now, I was curious and began to read the article. The article told about the search for the best fish in the World to grow to help to solve the problems of providing a good protein diet to countries where people did not have enough protein even to avoid diseases associated with inadequate dietary protein.

The author of the article, Dr. C.F. Hickling described the history leading up to the selection of Tilapia as the best fish to solve the problem with and then told the story of how his team of researchers had discovered that the hybrid cross between two species collected from two different places in Africa produced a hybrid all male tilapia that he felt would solve the problem of too little protein or at least had the best chance of doing so. He described how the tilapia could eat almost anything as food and could filter feed algae as they breathed or processed water through their gills. The algae could be grown for less than one cent per pound of fish, by fertilizing the water with Triple Superphosphate. He discussed how the tilapia could breed year round and how it was resistant to low oxygen conditions that would kill most other types of fish and how tilapia were resistant to almost all diseases. He also explained that the major problem with tilapia was that when a few fish were stocked in a pond at an ounce or more that they begin breeding within a few weeks at very small sizes and produced a large number of babies which the mother protected from harm by holding them in her mouth while they were developing and letting them out to swim and feed after they were about a week old when dan-

ger approached. The problem was that from just a few fish hundreds of thousands could be in a one acre lake within just a couple of months using up all of the food and oxygen and that then none of the fish would grow. The solution he had discovered was that when the male fish from Zanzibar was bred with the female fish from mossambica that all of the hybrids were male. This all male hybrid then could be stocked in known quantities in a pond of known size and then the right amount of fertilizer could be used to grow the algae from them and a crop of 3,000 to 5000 one pound fish could be grown in each acre of water in under one year. In other words the all male tilapia gives control of the resources to the grower whereas breeding tilapia loose in a pond took away all control from the grower. I knew from reading other articles over the previous couple of years that other forms of agriculture were more expensive in terms of energy and cost per acre needed to produce a pound of protein. When compared with the cost of production of other forms of protein including soybeans, the cost per pound of protein was the lowest known.

I grew up fishing, fishing with my father who when I was born actually fished for a living by going out in small boats and catching fish on hooks. He loved to fish and some of my first memories were sitting in the boat with him while we waited for fish to bite on the line. I never seemed to have the patience for it and hardly ever really caught anything. My father however always caught fish and as I grew up we were always going somewhere every weekend to fish. But as the years went by I remember him showing me the articles of how many fish he used to catch. Some of them showed large fish he called JewFish which weighed as much as 300 to 400 pounds, in fact he had 4 or 5 whole scrapbooks full of pictures or newspaper articles of big fish like that that he had caught as well as many articles with pictures showing large numbers of trout or snook he had caught. When he was a young man in his early 20's he found it possible to fish for a living using fishing poles from a small motor boat. The many books he had full of pictures indeed showed that for him, fish were easy to catch and could be caught in large quantity. I also remembered that as I grew older that he caught less and less fish and that my father was very concerned about what was happening to the fishing. By the time I reached college age it was common knowledge that ocean fishing was declining and that there were no signs of this trend changing for the better.

As I read more of the Scientific American article I found myself more and more entranced with the idea that here was a way to begin to solve the problem of feeding people and at the same time maybe even reduce the need to bring fish from the oceans and continue the destruction. I read the article again and immediately got out some paper and wrote to Dr. Hickling in care of Scientific American and asked him how I could become involved in working with these fish and helping to save the World and mailed the letter before I went to tennis practice. We left the next day for a tournament at another Air Force Base, and I subsequently forgot about the article for some time.

I left the Air Force late in 1963 to attend the University of Florida where I majored in Agriculture. Approximately a year went by while I was absorbed in studying for my degree and I was beginning to really enjoy being in college. One day when I got home, I discover a foreign Air Mail envelope addressed to me that had been forwarded several

times. The return address was to Dr. C. Hickling and in all it had taken a year and a half to reach me counting the time since I had sent the original letter to Dr. Hickling. Even after this length of time the article came flooding back to my memory and I excitedly opened the envelope to read what he had sent me.

The letter was very brief and described how he had become more and more convinced that the f-1 hybrid tilapia he had discovered would be the solution to many poor nutrition problems, and told me how he had seen them at four to six pounds after a little over a year of growth. Dr. Hickling suggested in his letter that I try writing to several people in the US who could give me more help in finding the species of tilapia needed to begin in this area. I immediately took the letter to my Major Professor, Dr. G. and read it to him and explained why I was so excited to have received it. He suggested that I write the people listed in the letter and that I could use his office as the source of the inquiry so that the people would take my letters seriously. I then wrote the letters and went on with my college activities.

When I got the letter (1969) I was majoring in Fruit Crops at the University of Florida, with a minor in Minor Tropical Fruits, but by the time I got back some answers nearly another year had gone by and I had graduated in Agricultural Extension, and by then I was in graduate school with a major in Biological Insect Control. I then sent out more letters as the people who had answered the first letters had given me new references about where to try to find the fish. While I was waiting for more information I got the opportunity to go to California and work with a company which had pioneered Biological Insect Control with production of its own biological material such as parasitic wasp and predatory mites which could be used to control many of the pest on both green house crops, and on field crops.

When I returned to Florida I went to Mr. G, my major professor and told him of what I had learned about controlling insects and how I thought if I could build a suitable insect hatchery I could set up a business in Florida and begin offering a service controlling insects Biologically. He offered to help by investing some capital and we agreed to be partners. My mother also agreed to help by giving me the down payment to buy a piece of property in Archer just outside of Gainesville.

We began to build the insectory together and while we were getting ready to clear the area where the buildings were to go I got a letter back from one of the sources and was told that in a few months I might be able to get some of the brood stocks. So, I went to Dr. G. and proposed that while we were getting the land cleared that we ask the bulldozer operator, who was clearing the land, to dig us a small pond, and Dr. G. agreed. I had the pond dug 150 long and 20 feet wide and placed it alongside where two of the buildings were to be that we were going to produce insects in. The bulldozer ran into a clay layer at about six feet and so he used the clay to spread over and coat the whole pond, which meant that we could hold water even though we were digging in an area known for sand. We also had three greenhouses we built to produce predatory mites which we used to control spider mites on various crops such as strawberries and okra, and in greenhouses.

In late November of that year, while we were still constructing the insectory on my property in Archer, I received word that I would receive live tilapia from Theophilus D. Insley from a hatchery he was running in Tishomingo Arizona that had been one of the first to receive shipments of tilapia hornorum from Dr. Hickling in Malaysia.

KNOWLEDGE, THE REAL POWER STEPS IN

I guess that if someone was to write a descriptive account of who Mike Sipe was at this point of time they would probably see me somewhat as follows:

An energetic and persistent, person who pursues goals, unreachable in many ways, that allows him to both make a living and make changes in the way things are done.

In my history as an entomologist I had opened the first biological control business in the South East and had pioneered the use of natural organisms and methods to control insect populations on a variety of food crops. Dr. Willard Whitcomb, my former major professor and head of the Biological Control section at the University of Florida had once said about me that I had done more than any other single individual to reduce the amount of pesticides used in Florida.

I had made a reasonable income from that company and had been able to assist many farmers in the reduction of pesticide use.

My venture into the business of producing Hybrid all male tilapia was however still on hold due mainly to the resistance of the Game Commission and it now looked like they were possibly going to win and deprive the people of the state of the opportunity to grow tilapia, a fish that was easier to grow and more productive than any previous fish.

I thought a lot over the next week, and Bill called me several times to get phone numbers of the various people up and down the chain of command in the Game Commission. He got the number of Agent X, Mr. Fry, the Commissioner, Dennis Parker, Agent Y, Agent Antifish and Agent Freddy Langford who at that time was the agent in charge of Exotic Species. Bill called each and everyone in the chain of command in the Game Commission and asked them for their opinion on tilapia.

The following Sunday I received a call by several friends who told me to get a copy of the Tampa Tribune, that we were all over the newspaper. I rushed out to the 7-11 and got several copies of the Paper and found Bills article, which was in the Local Section. Not really front page, but still a very prominent position. He had a photograph of a Game Commission Officer, Gun strapped to his hip, carrying a box of tilapia out to put them in the Live Hauler. The Title of the Article was "State Seizes Sipe's Fish"

Another photo showed me looking up at a Game Commission Officer. Bill had devoted the front page of that section and two additional pages to his interviews with the various people in the Game Commission's chain of Command.

One comment made by Freddy was "no species of plant or animal that was not in Florida when the white man came should be allowed and if he had anything to do with it he would see to it that they were exterminated."

This single comment was possibly the one that helped me to finally get some consideration on my permit request.

Freddie's single comment about what was here when the white man came stands as the most stupid comment ever made by a person who believes himself or herself to be ecologically sensitive. Yet this man was actually in charge of the approval or disapproval of new species of plants and animals. In one statement he proved himself ignorant about the vast number of plants and animals that have over the years been introduced into Florida. He also seems to be unaware that well over 90% of all plant and animal crops produced in Florida were not here when the white man came. When Freddy said that he would lead the exterminators in their pursuit of nonnative species, Jan said "be sure to put yourself first on that list."

I was needless to say elated at the appearance of the article and the contents.

On that particular Sunday I had the urge to go smack some tennis balls around and try to reduce my anger a bit and so I decided to go to the Tennis Club that was on the way to my home on the beach. I parked in the small parking area at the Depalmer Racquet Club and went in.

As I walked up toward the Clubhouse I saw Ed Price, Jr., he said to me. "Hi! Mike. Would you like to be my partner for a doubles match, we need a fourth. I said sure, I would like that. Ed said "I see you have a little trouble from the boys, meaning the Game Commission Officers and the Commission itself" and I answered what do you mean and Ed said " I read the article this morning in the Tampa Tribune. But, lets play tennis now and you come to see me in my office on Monday morning and we will talk about it.

I guess my anger was helpful since Ed and I beat the other tennis players in our set of doubles that day.

I did not say anything to Ed about the Fiasco with the Game Commission that day, but I was steaming with intent when Monday morning came around and I gathered all of my correspondence which showed the potential of the tilapia as a new farm crop and the records that Dennis had brought me and everything else I could think of that I could show to Ed to help explain my problem with the Game Commission, put them in my car and drove to his office.

When I got there he was on the phone and I said to his secretary that Ed had asked me to come in to talk about the problem I was having with the Game Commission. The secretary said for me to bring all of my materials in and set them on Ed's desk. I did and soon Ed got off the phone and came back to his desk. He held up his hand and asked me to give him a minute to look at the materials. So, I let him read for a while and made sure he saw the copies of the letters and correspondence that Dennis had brought to me. After about 30 minutes or so Ed turned to me and said "Mike, it looks like they have really been mistreating you and I will have a talk with the boys and will get back to you in a couple of days.

I left his office with mixed feelings, I did not know if he could influence any one in the Game Commission or not. I knew from people I had been talking to that Ed Price was

on the governors Breakfast committee and head of the Democratic Party in the local area so I had some hope but was not sure what to expect next.

Then I got a call from Dr. Fry the Game Commissioner himself and he said to me that he wanted to make an apology to me and that my permit would be in the mail that afternoon. This was on a Tuesday and sure enough the Permit arrived in the mail on Thursday and I could not believe my eyes. I was permitted to work with t. hornorum, T. mosambica, and t. aurea and hybrids of these fish.

So, I had the right facility to work with the tilapia, a permit from the State Game Commission that allowed me to work with the fish and no fish because the Game Commission Officers had taken them all over to Boca Raton and put them in holding.

So, I called Dr. Fry back and asked him how I could get my fish back and he said I should just call Officer Antifish and ask him to bring my fish back or to arrange to have them brought back.

So, I called Officer Antifish and told him that I now had a Permit from the Commissioner, which allowed me to work with the fish, and I asked him if he would arrange for me to get my fish back. I had assumed that since they had taken the fish from me and hauled them all the way across the state that they would put the fish back in the Live Hauler and bring them back. When I asked Officer Antifish if he could arrange to bring my fish back there was a silence on the other end of the phone and he responded that I could have my fish back when hell froze over and then only over his dead body and God himself could not get him to do this, Jan was meanwhile yelling that that could be arranged, and then Officer Antifish hung up the phone.

I then called Ed up and told him what Officer Antifish had said and Ed said that he would get back to me. About an hour later the phone rang and I picked it up and Officer Antifish growled at me that I must know God himself and I could come and get my fish but it would not do me any good because when they came he had made sure that they were all mixed together and he knew that I would not be able to use them to breed hybrids now.

I was a bit shocked to find out that all of my efforts had been ruined by the actions of Officer Antifish, but I went ahead and made plans to go and get the fish since without the fish I did not know how I was going to move forward in my efforts to make the tilapia hybrids available to farmers.

The next week I rented a u-haul truck and got together some tanks and some bottled oxygen and a few friends and headed over to Boca Raton to get my fish. Officer Antifish was not there when we got the Facility where the tilapia had been dumped, but another Officer showed me where the fish were and got some nets and help to load them into our truck and I headed home with the tilapia.

When Dr. Hickling said that they were hard to separate once they were mixed together he could not have been more right. I stared at them for hours and examined them but

could not be sure whether I was putting the t. hornorum in correct tanks or whether they were t. Mozambique and at that time we did not have electrophoresis available to us, so there was really no way I could be sure and we ended up having to kill the whole batch of tilapia which by then was several thousand fish of varying sizes.

THE ADVENTURES BEGIN

So, now we had a proper facility, a very hard to get permit from the Game Commission and none of the correct species necessary to produce an all male hybrid. I was determined not to let the unknowledgeable, face to the wall bastards win, so I immediately went back to phoning various people and trying to locate somewhere I could get a new pure stock of tilapia hornorum.

The t. mossambica was available from Wassie Fish (or at least I planned on getting them from him).

I call to each of the people I had on my list quickly eliminated all of the potential sources of t. hornorum that I had investigated about a year earlier and finally got Dr. Lynn Loveshin on the phone in Fortealeza Brazil and told him our plight. He said he would look into it and I could call back the next day.

The next day I called him back and he told me that he had discussed my situation with the Brazilians and that they agreed to sell me some t. hornorum for \$5.00 each, but that I would have to travel to Fortealeza Brazil and bring them back with me as there was no one else traveling to the US from Brazil in the next few months and they might be doing away with the program in six months or so.

This was a huge step, when I got off of the phone I told Jan what Dr. Loveshin had said, and her first response was how much will it cost to go to Brazil and I said that it would probably cost around \$3,000 to go and bring back the tilapia hornorum. Jan thought for a few minutes and finally said that maybe we could pay for it by selling our newly acquired home on the Beach.

We discussed this back and fourth for several days. If we sold the house it would mean that Jan would be giving up her inheritance that we had both hoped would establish an equity fund that she would be able to build on and not just to spend the money but to build from it. So if she made the money available to go and get the fish, then she would be taking a big risk.

After thinking about it Jan came to me and said to me that she would gladly put up the money so I could pursue my dream of creating a tilapia industry. And that she knew things would work out.

After we started the Jungle which we were still operating we started buying birds and found that Macaws were close to the most profitable birds to handle, but were hard to get.

I had a friend at the University of Florida that worked in Shands hospital and he had told me some months earlier about an experiment where some experimenters were cutting holes in chicken eggs that were being incubated and removed the developing embryo and replaced them with mice embryos and sealed them and continued the incubation.

The result of this was that full term mice were born from the incubated eggs and from this information I got the idea that if we were to get bird embryos from rare birds and repeat the same process that we could possibly create an assembly line for the production of rare birds such as the Macaws.

So if we were going to Brazil where Macaws were found, perhaps I could arrange to bring a few really rare macaws such as the hyacinth back and then find a suitable bird veterinarian to help us stimulate the females to produce eggs, extract them, and then fertilize them invitro and meanwhile get the egg incubation going and coordinate the embryo removal so the transplantation process was synchronized.

So, I broached the subject with my mother the next day and asked her what she thought about our planning such a trip and I asked her if she could help us find a buyer for the house to get the money to pay for the trip.

She said she would think about it and she understood what I was saying about needing to get the correct species of t. hornorum after the Game Commission had messed us up by mixing up the fish.

Several days later she called me and said that she would buy the house back from us and she would give us the money in a couple of days and so we could make reservations and plans to go to Brazil.

So I contacted a Macaw buyer who said he would help and I even checked into obtaining a reservation for putting the birds in quarantine in Miami which was just opening up a station and they agreed to give me one of the first slots to bring in my birds. I did not of course have the birds but we knew that Manaus was one of the best places to find macaws and that we could meet with a member of the Brazilian government to convince them that we intended to improve the availability of macaws with our program if we got it started.

The Macaw project was taken on as a bonus project that would generate income to cover the expenses of the fish project, but was not given the number one priority.

We bought Round trip tickets on the Brazilian airline, Varig, and left out of Miami in mid January of 1976.

A HINT OF ELEGANCE ON A TRIP TO "HEAVEN AND HELL ON EARTH"

The trip on the airplane started out as exciting. It started when we were seated, the seats were a bit more roomy sort of like American Air is now offering, where you get more leg room.

One of the best parts of the trip started when we were treated by the airline as if we were all in First Class and were brought printed menus that welcomed us as passengers on Varig "the Brazilian Airline" The menu was in both English and in Portuguese and gave several choices of venue which included Veal tenderloin and pork chops, and several choices of vegetables.

Then before the meals were served the flight attendants brought around to each passenger what I at first thought was tea, but turned out to be small hand towels that were wet and steaming for us to use to clean our hands and face before eating.

Then after we had wiped off a little bit of the travel grime we were brought out the first course of what turned out to be a four course meal.

First we were brought Red or White wine, a salad, and hot bread. The hot buns were steaming and pure sweet cream butter was served with the bread and we were suitable very impressed and were only on the first course.

For the second course, we were brought the main course, which consisted of elegantly cooked Veal Parmesan or Pork with Rosemary, or fish in hollandaise sauce. Jan ordered the veal and I ordered the fish since I wanted to see what the Brazilians expected as fish, and we both savored mouthfuls of the others order as each one tasted and smelled delicious.

Then we were served the vegetables, which consisted of diced green beans, asparagus, potatoes and several other delectable items.

Then we were served dessert, which consisted of a choice of flan, a sort of orange cake with sweet whipped cream on top of it or a crispy cookie, and the last item was a sweet peppermint.

Then we were served hot coffee or hot chocolate and served another round of hot towels to clean up with.

We were on our first trip out of the country and were being treated like what felt like royalty and so our first trip began to take on an aura that lasted pretty much through the trip in that we began to see that Brazilians liked to be well treated and catered to and they live as if each meal was the most important part of each day.

The first part of the flight took us to Venezuela where we landed in Caracas and soldiers in trucks surrounded the airport and Jan was treated to the first chapter of Hell when we landed. The cowling over the jet engines was built, on the aircraft we were flying in, to lift up and off of the engine so that it served as sort of a parachute to slow the plane

down, but, if you did not know that was what it was supposed to do, then, it can be quite startling especially when your seat happens to be the window seat just above the engine cowling when the plane lands.

As we landed Jan's hand grabbed at mine and squeezed very hard (something I got very used to over the years) so that it hurt, and her feet shot out in front of her and I was a bit afraid that she was having a seizure or something. She did not say anything and by the time we were taxiing back toward what appeared to be the main terminal she had relaxed a bit and we could see the armed soldiers in the trucks surrounding the airport. When we came to a stop we were told that we would have to disembark and claim our luggage and wait in the lounge.

When we got back on the airplane, Jan (who had never explained her seizure) offered to let me sit in the window seat and not suspecting what she was up to, I agreed to the change in seating. Soon we were in the air again and headed toward Manaus.

After about 2 hours we were told that we were to land in Belim instead of Manaus due to very dangerous storms that were currently active in Manaus. As we landed on what seemed to be a short runway the cowling on the engine shot up away from the engine and seemed to be just hanging there while a loud roaring noise came from the engine. I looked over at Jan who was laughing out loud and she said she had wanted me to experience this for myself. No reason was given, but, was told to get off of the aircraft and for the next 30 minutes or so we were busy following everyone off of the airplane and finding our luggage and pulling it into the airport lounge.

None of the airline staff went with us and so there were no English speaking staff inside the airport to answer any questions. Time passed and after more than an hour had passed Jan and I were getting thirsty and I walked around looking for something to drink.

I met several young guys and a girl who spoke English and asked them how we could go about getting a coke and they offered to get two for us. They also told us not to worry that we had to land in Belim because of the bad storms in Manaus and that we would be leaving soon to continue our journey. The cokes were very cold and very welcome in that hot and humid airport.

Eventually we were escorted back on to the airliner and continued our journey to Manaus and three hours late we finally landed in the Manaus airport. From the airport we took a taxi to what appeared to be the downtown "Hilton" and got a room. After 20 hours of traveling we were finally going to get a chance to sleep. We took our bags and were escorted to our room.

Then I put down all of my luggage and looked at the bed which appeared inviting and you know-how when you are very tired you sort of fall backwards onto a bed and just let yourself fold into the bed clothes and bounce, well I leaned backwards and did the little push that you do to get yourself airborne and landed ka whack bang on a bed as hard as the hardwood floor. It seemed the bed was just a piece of hardwood with a thin

spread laid on top of it and when you hit the bed your head bounced like a rubber ball and it was painful if you were not expecting it.

I immediately got back up and went into the next room where Jan was sitting at a table and said I would probably try to take a shower.

The bathroom had a funny toilet in it beside a regular toilet. The funny toilet had a little thing in the middle of it that looked like it had an opening and when you turned a little valve located on the back of it water began to spray out of the little thing in the middle and the further you turned it on the bigger the spray got until it was spraying all over me and the floor.. We also discovered that the toilet paper was very hard and hurt when I used it to wipe.

So, I said" the little water sprayer was so you could wash off after you got through on the regular toilet so you did not have to use the harsh paper." So I proceeded to show Jan how to use it and after I was finished I used a small towel hanging on the wall to dry off. Seemed to work fine so we figured we had figured out what was what.

Then I got in the shower and turned on the water but there was only one handle to turn and so it seemed that cold was the only setting in the shower, but since I felt very dirty from the long trip, I quickly acclimated to the temperature of the water.

Jan, however when I informed her of the shower option burst into tears and said "you have got to take me home! this place is really awful." I held her and tried to console her and she quieted down and after a few moments she said well let me rest for a few minutes and then we will go down to the restaurant and see if we can get something to eat.

So, I let go of her and she headed for the bed and suddenly I realized I had not warned her about the hardwood and thin mat. So I said, "Jan, wait" but she had already started her fall toward the bed and I heard a loud "clunk" and a howl, and "what the devil!! " and I knew it was too late. After holding her again for a few minutes she stopped crying and finally said "well lets go down to the restaurant and lets see what we can get to eat".

She reasoned, "after all we should be able to get something decent to eat. and we would feel better when we had eaten"

So, we left the room and headed down to the restaurant. We did not speak any Portuguese, but we had hopes that we would be able to order some edible food, but for us that meant food that was well cooked and did not have any onions as I had been allergic to onions since I was very small and Jan just did not like them. We managed to get seated in the restaurant and were handed menu's and we tried to communicate with the waiter that we wanted some chicken since we figured that no one would put onions on chicken. We also ordered some wine and apollo which we understood to mean chicken.

When we got our order, it was roasted chicken with onions sprinkled over it and actually pounded into the skin. Needless to say we were fairly bummed out by this, but there was a couple sitting near us that heard our plight and offered to help. We moved to their

table and explained that we did not want to bother them but we needed to be able to communicate with the waiter and they very patiently explained to me how to order meat without onions. They said just say Carne de nada and nao se bolliã so the waiters would understand that what we wanted was meat without anything and especially without onions.

So, the rest of the evening went very well and with the help of the other couple we were able to order some food that we enjoyed eating and finally got to the point of being relaxed and easy. The wine of course helped this state of relaxation along.

The next day we decided to go on a guided tour where we could see some of the Amazon and some giant water Lillie's and possibly find someone who could help us find a bird trapper who could help us find the macaws we wanted.

So the next day we signed up for a tour and met our tour guide at the hotel lobby, she was a beautiful Brazilian girl and very vivacious and outgoing. We got along with her almost immediately and she made the tour through the Amazon into a very pleasant experience.

She took us into an area where the trees were really huge and we took pictures of the trees and compared them to ourselves in size. They were so large that eight or ten people could not link hands around the trees.

As we went to the various places in the Amazon area we saw different birds that were in cages. There were parrots and there were Red Macaws and Blue Macaws and numerous other small finch like birds. Our guide Melissa, told us that their are hunters who go and put a sticky goeey kind of sap from a native tree on a limb along with special treats that macaws really go for and wait until a macaw lands and then they just saw off the limb with the bird on it and take the bird back to their home and use a solvent that does not hurt the bird to get the bird off of the limb.

I explained to Melissa about my idea to get some rare macaws like the Hyacinth macaw and the Blue and Gold and to set up a chicken incubation unit and get a veterinarian to inject fertility drugs to make the macaw produce fertile eggs and to get sperm from a male and to then put the Embryos into Chicken eggs when they were at the right point in the development process.

Melissa really liked the Idea and volunteered to get us an appointment with the local Wildlife authorities and help us get a permit.

She said it would probably take several days and meanwhile she suggested we visit the floating hotel that was anchored on Lake January where the Rio negro and the Amazon met and intermingled. So Jan and I went to where they were selling tickets for the trip out to the Hotel and got tickets and checked out of the Hotel and got on the boat to take us to the floating Hotel.

The hotel was built on huge logs of Balsa wood which were tied together to form a series of huge platforms which together were nearly as big as a football field and was anchored in Lake January. At the time it was billed as the only completely floating hotel in the World. One side had about five rooms and the other side had another five rooms.

When we got there it was better than we expected. The doors and counters were all made from Teak and Mahogany wood and the wicker chairs and tables were all made from what looked like straw woven together and the floors were all hardwood and everything was well polished. The rooms had twin beds in them and huge closets and they each had a balcony on the outside that was a dock and each one had fishing poles so renters could fish just to the outside of their room. There was also a beautiful view of the river and the forest beyond the river.

I asked what bait we had to have to bait the hooks and was told that we could get crickets from the bellhop. I determined that when I got back to the room that I would definitely get some crickets and try the fishing there. That afternoon I baited a hook and dropped it into the murky water. There was a small cork, called a bobber, near the end of the line which allowed the hook with the cricket to sink a couple of feet and then the hook and sinker would make the cork bob up and down. If a fish came and grabbed at the bait it would pull the cork under the water and you knew then to jerk the pole up and try to set the hook.

A couple of seconds after I dropped the cricket on the hook over the balcony the cork suddenly disappeared and I jerked the pole up and pulled up a small catfish. When we catch catfish in Florida we know to be very careful to make sure we don't allow the catfish a chance to stick us with any of the spines it has which are located just behind the head. So seeing a catfish elicited some caution and since I did not have any pliers or heavy gloves with me I decided to let the catfish swim around on the hook while we went to find dinner. So, I propped up the pole where I thought it would be safe and not fall over and we left for dinner.

When we sat down we were given a menu in Portuguese and were confronted with the dilemma of ordering food without onions again. Even though we now knew a few Portuguese words the menu did not make much sense to us except for the part that said "Vino". Jan had signed us up to go on an alligator hunt which the hotel sponsored, and about the time we were getting ready to order they announced that the alligator hunt was about to begin. So, we had time to determine what a liter bottle of "Vino" cost and ordered a liter and paid for it and hurried to get into one of the two canoes loading next to the hotel.

Each canoe was about 30 to 40 feet in length and about 4 feet wide in the center. The one we got in was almost full but we found a seat near the rear where we could sit. Most of the other passengers were European and were dressed in nice outfits that could have been bought in nice clothing stores. The guide sat in a seat at the front and commanded a large flashlight. Several Brazilian men sat in the seat behind him and seemed to do most of the physical activity called for.

While Jan and I were getting a bit hungry, we had the bottle of red wine and were assuaging our hunger by drinking swigs from the bottle and were surrounded by a sort of warm glow as we watched the sun setting on Lake January and the sky was painted with bright pink and orange clouds and with the wine we were surrounded by a sort of ambiance that made the hunt take on a sort of special sort of surrealistic character.

The Tour guide on the Alligator hunt spoke understandable English and French and he took turns speaking one or the other and explaining what we were going to do and what we were doing. He told us that we would find the alligators once it was dark by sweeping the flashlight beam across the water and picking up the red glow of their eyes and reflecting the beam back.

Soon it was dark enough and the shadowy silhouettes of the forest trees at the edge of Lake January joined hands and faded into the general blackness of the sky and lake so that nothing but blackness could really be seen except for the few lights coming from the floating hotel which was now a fair distance to our rear.

The guide told us that he would turn off the outboard motor while he swept the area for gators. The silence blended with the darkness to create a reality of virtual nothingness and we could begin to hear the gentle lapping of the water against the side of the canoe and the gentle pushing of the paddles as the two Brazilians adeptly urged us forward in the water.

As a native Floridian I of course had seen many gator hunts on Television and was feeling a bit superior in my knowledge of alligator lore and so was able to view this show as a sort of critic rather than a true participant of the hunt. I gave Jan a running translation of what was happening even though it was being given in English and Jan responded with "shut up and listen" several times as the hunt progressed.

The Guide soon turned on the flash light beam and swept the area in front of our canoe with the beam, and soon we noticed flashes of red in a certain area as the beam was reflected back by the eyes of the alligator. He said we had to remain very quiet because if the alligator heard us coming it would submerge and then as it's eyes would be below surface we would not be able to properly locate it. He began to grunt sort of like a pig hunting for truffles and he said that the gators would come to that sound because baby gators made that kind of noise when they were disturbed and momma gators or older males for that matter would come to see what was disturbing the young.

The guide cautioned us all to silence as we stealthily slid through the Amazon night and one of the Brazilian paddlers rose up from his seat and extended a sort of pole with a rope on it that it turned out held a noose and slipped it suddenly around the head of an unwary gator.

The gator was summarily lifted wiggling and flopping violently around and pulled into a part of the canoe instantly vacated by several of the most eager to go on a gator hunt French people, and held down now by the rope collar.

Now that the gator was successfully caught and was in the boat several people asked what are you going to do with it now, possibly envisioning a gator barbecue or roast and the guide said we were going to let it go since they would need to have some gators to hunt on future hunts.

It seems that they used to butcher and cook gators that they caught and sell the skins and Heads to tourist, but in the last several years they had had to extend their hunts to longer and longer time periods until they had stopped killing the gators and could therefore capture them again and again and so what we had thought was a more or less "wild" gator hunt was in fact a show put on for the tourist, like the ones in Florida where the Gator had become the main attraction for tourist. So, Brazil was going the way of Florida so that, now, it was the show that counted and the real industry was in the creation of the special effects.

When we got back to the floating hotel we were pretty tired and were able to secure some candy bars and crackers and headed for the beds. When we got to the room I realized that I had forgotten to get any gloves or pliers and I went to the balcony overlooking the river and pulled up the line that I had left the catfish on and there was another kind of fish about double the size of the catfish I had left and so I pulled it up and looked at it. It looked like a silver dollar only bigger. I called the desk and told them that I had a fish and needed help to remove it and they sent someone to the room who told us that the fish was a piranha and had a very big appetite and very big sharp teeth. I cut the line and said good-bye to the nice fish.

CHERRY SNAPPER ARRIVAL IN FORTELEZA

When we arrived at the airport Dr. Loveshin's secretary Nancee, who apologized for him, saying that he had some important meetings to attend and that he had asked her to meet us, met us.

Nancee told us that she was from California and was married to a German expatriate Brazilian by the name of Schultz. She said she had been working for Lynn Loveshin about six or seven years, since he had arrived in Forteleza and she spoke fluent Portuguese and English so she was very good in her position.

We told her about the hotel that the Peace Corp. people had suggested and so she took us in her car to the hotel and we went in and registered and took our bags into the hotel and put them into our room and met her back downstairs to go over to Dr. Loveshin's Office which was located in Forteleza. When I got there she brought us into his office and introduced us and He said that I would have to excuse him while he finished something or other but that I could look through his books while I waited. As good files on aquaculture were hard to come by in most areas the opportunity to browse in his files really interested me.

I browsed through 25 or 30 journals and one that I found told of a Russian experiments where sturgeon were crossed with river minnows of a different genus and produced fertile offspring that grew to about 125 pounds and produced caviar. I had about 4 hours to browse and I used them to read as much from Dr. Loveshin's library as I could. Not that I could ever read all of what he had in his library or hope to catch up with all of what he was doing but I sought to learn whenever I could about what the limits and possibilities were in aquaculture.

Later that day Dr. Loveshin came back and said that he would like it if Jan and I could come to his home that evening, that he would pick us up and we could talk about what I wanted to do. So, Nancee took us back to our hotel and Dr. Loveshin came by and picked us up and Jan and I and five pounds of Danish Harviti cheese went to the house that Lynn was living in with his wife and young child.

I remember that he was very nice to us and that he had orange liquor that he served with the cheese and crackers. I told him again about how the Game Commission had behaved and he expressed his disbelief that they would be allowed to interfere in such matters with so little knowledge of the fish or of the need for aquaculture.

After a few hours of talk and drinks Lynn agreed to drive us back to our hotel and to meet us in the morning to go to Pentecost where we could see what they were doing and meet some of the Brazilian staff.

So the following morning Dr. Loveshin picked Jan and I up at the hotel and we went with him to where all of the test were being run with the tilapia male hybrids. We all went to where the ponds were and Dr. Loveshin asked some of the Brazilian staff to seine some tilapia from one of the ponds which they eagerly did. They seined up several hundred

one to two pound tilapia and let me look at them. They put some of the fish aside to cook for lunch.

We then proceeded to get a tour of what was going on in the different ponds at the growing ponds.

One of the areas he took us to had special breeding ponds where the male hybrid fingerlings were being produced. Dr. Loveshin explained that they were having a lot of different production rates as far as the number of hybrids produced each breeding cycle. It turns out that they generally stocked each new breeding pond with 100 females and 40 t. hornorum males. They would then leave the breeders in the pond for 6 or 8 weeks and then remove the breeders and the fingerlings and separate out the fingerlings and count them. In some of the breeding ponds there were only 2,000 or 3,000 male hybrid fingerlings produced and other ponds they produced 5 or 6,000 fingerlings, and in still others produced 15,000 to 20,000 fingerlings and that was the number they really needed to get because 15,000 to 20,000 fingerlings was the kind of number that made it profitable to allocate that many breeders for that much breeding time because they got a large enough number of hybrid male fry to justify it. These numbers stuck in my mind as did the construction of the breeding ponds.

He also took us to meet the Brazilian staff in several Office buildings located on the property.

Each new office and everywhere we went into we were invited to sit and were brought servings of coffee, which were served in tiny cups. The coffee was very strong and very sweet. At around eleven everyone pulled out hammocks and hung them on hooks and suggested we take a nap. Then at about noon we were called to eat lunch. This short snooze on the verandah with the gentle breeze blowing was one of the most pleasant customs I encountered on that trip to Brazil.

I remember that a whole steamed tilapia was brought out on a platter. It had been gutted and placed in the steaming pot and then surrounded with rice. I had never eaten any fish served like this and it was a very interesting experience. I watched as different people took portions of the fish by using a fork to pull the meat away from the bones with the skin attached and then laid the portion down on their plate and worked the meat off of the portion and ate it with rice.

Here I had been working on growing tilapia and trying to get to a point where I would be supplying fingerlings to others and I had never actually eaten large tilapia like this.

Soon the day was coming to an end and we were getting ready to head back to our hotel. We had come with about 8 days to stay in Fortealeza and so when Nancy asked if we would like to come with her husband and sons on a trip into the interior of Brazil both Jan and I jumped at the idea. Nancy took us back to our hotel and said that we should be ready at anytime over the next 24 hours to leave as her husband generally made the decision to leave at the last minute and so we needed to be ready to leave whenever she called.

We went back into the hotel and back to our room where we had hung up Brazilian hammocks since sleeping on the bed seemed to not be a good idea as there were some very large rats running around on the floor. I went to the kitchen to get a cup of coffee and while I was sitting there a large rat came up to my table and sat up and begged for food. Needless to say I was not happy about that and when I got back to the room and told Jan about it she was also a bit shocked.

We had on the advice of the Peace Corp. guys bought two Brazilian hammocks a day or so earlier and now saw the hooks where we could hang up our hammocks so they stretched diagonally across the small room we were renting for ten dollars a day, and got into them in hopes of getting some sleep and once we finally dropped off.

After what seemed like only a moment, someone from the hotel was banging on the door to our room and asking in broken English for one of us to come to the lobby because there was a phone call for us.

A COUNTRY TRIP TO THE INTERIOR OF BRAZIL

I went to the lobby and Nancee was on the phone and asked if we were ready to go. I was a bit logy, but I answered that we were ready and she asked us to gather our stuff and meet them in front of the hotel. I went back to the room and told Jan and we hurriedly grabbed everything including our hammocks and headed for the lobby.

Within about ten minutes Nancee showed up with her husband and a daughter who was about seventeen and a young Brazilian boy who was also about eighteen. We quickly threw our stuff where they showed us and piled into the Volkswagen and off we went.

Vaughn was a German Industrialist who had come to Brazil when World War II had broken out and had established a Volkswagen Dealership In Fortealeza and Nancee and he had met and married about 15 years earlier. He weighted about 350 pounds and was about 5'8" tall and a very brilliant man.

He loved to take trips to various parts of Brazil and had built the Volkswagen we were in for the purpose of going on these impromptu trips. It had a fold out camper roof and built in hammock hooks so he could lie in a hammock even when there were no convenient trees to tie a rope to.

While we were on this trip we visited a place called the turtle and about 6 or eight other natural wonders of Brazil and we got to know Vaughn and Nancee and their Daughter and her boy friend Vaugner. Jan really enjoyed talking with Nancee and told her about her infertility and why we did not have any children of our own. This conversation was the beginning of a real change in our lives. Nancee told Jan about the St. Mary's hospital in Fortealeza and how almost every day women were leaving babies on the hospital steps and why did we not go there and check it out. Jan could not believe her ears, she had been wanting to adopt a child but just could not bring herself to try through the American channels because of the courts and the inconsistency of the court system that would grant parental rights even to people who had voluntarily given up children for adoption and this in spite of any contracts that had been signed.

The idea that she might just be able to walk into a hospital there in Brazil and adopt a baby seemed very strange. We talked about it and decided that the next day we would go to the hospital and see what was there in the way of newborn babies and if there were any what could be done to adopt.

We got a taxi to take us to the hospital and found our way to the maternity ward and explained our situation to a nurse. She at first said there were not any newborns there right now that fit the profile, but that there was one woman who had just that afternoon given birth to twins and she would go and talk to her for us. She came back with an infant and put her in my wife's arms and Jan fell in love instantly.

The nurse returned to the woman and explained what we wanted and the mother was offended by the offer to adopt her child. She said she was going to give the children to her sister who lived on the beach in town because she could not afford to take care of

them. She had previously delivered 10 other children who were now living with her sister,

We returned to the hotel discouraged and later around 5 spoke with Nancee on the phone and told her what had happened. Then we went to have dinner and after dinner we put up our Hammocks and lay down. At around 11 pm we again got a call only this time it was from a Gentleman named Almir Leite who said that his son had returned home to his house and had told him and his wife about our desire to adopt a child and that if we would allow him he would like to help as he was a former city attorney and a practicing lawyer in Forteleza and he felt he could have a talk with the lady who had the baby and perhaps change her mind. He said that he loved America and because he loved Americans that if we would let him he would do all of the legal work we needed done, he would do for free.

Soooo... we gratefully and tearfully agreed to meet with him the next day and go to the hospital with him and see. When we got to the hospital we went in with him and met the same nurse and introduced him to her and she confirmed what had happened the day before. Almir said that if we did not mind he would like to have a talk with the mother and see if he could change her mind. So we said that was fine and off he went to talk with the mother. After about 30 or 40 minutes he returned with a smile on his face and said that he felt the talk had gone well and that she had said that she would consider his proposition and let him know on the next day.

So we all left the hospital highly elated and hopeful to wait for the mother's response on the following day.

When we got back to the hotel I asked Jan to go for a walk and while we walked down the street and stopped from time to time to have a Bramah we talked about the possibility of suddenly being parents and whether we really thought Almir could pull the adoption together in time for us to take the baby home with us. We also talked of the double responsibility if the mother said we could adopt both children as they were identical twins and we were a little bit doubtful about taking on that much, but if it was both or none, we decided that we would go for both baby girls.

When we got back to the hotel we got another call from Almir who told us to get all of our belongings and meet him outside of the hotel. We wondered what was up, but when he arrived in his car he was smiling and said that the mother had agreed to the adoption as long as Jan and I would agree to pick her up at the hospital and drive her to the favela where she lived.

Almir said that since we were going to be parents we could not be staying in a broken down hotel like the one we were in with a newborn baby. He said that he would appreciate it if we would go with him to his house where he would put us in his older daughters room, who was away at school while we were in Forteleza. He said that he had talked it over with his wife and she had agreed to it and they would like to help us in any way they could.

Almir was so sincere and so adamant that we felt we could do nothing else, so we went with him. The next day we went to the hospital and Almir had us stay in the car and he went into the hospital and after about twenty minutes he came out with the mother who was carrying one of the babies.

We asked where the twin was and they said that the twin had died overnight from diarrhea. We were shocked but since the other baby was healthy and we had brought a bottle of prescription Keflex with us to use just in case one of us got diarrhea we felt we could protect the baby with it. We also agreed that the quicker we got the baby in our hands the better because we felt we would improve her chances because we would be taking care of her.

So Almir came to the car with the mother and introduced Jan and myself to her and she immediately handed the baby to Jan, who started crying.

In the next instant we went from basically happy go lucky couple to a married couple with a child and the need to have diapers, baby food, baby clothes and numerous other baby items within easy reach at all times.

We were told that the mother had named the baby Christina on her birth certificate and so we named her Christina Macrae Sipe using Jan's middle name, as Christina's middle name, as Jan felt was the custom in her family.

The rest of the trip to Forteleza went by very quickly what with the necessary legal procedures we had to go through and very soon we were headed to the airport with 7 suitcases and 22 other boxes filled with t. hornorum breeder fish and every totally unique Brazilian item we could find to take back to Florida with us including several Brazilian hammocks and various baby items, and of course baby Christy.

BACK TO FLORIDA AND ACTUALLY PRODUCING TILAPIA

The trip to Forteleza was a true success in that we got the species of tilapia we had come for and a new world of the Brazilians wished us all the luck because as they saw it, if we were able to prove the tilapia business to be a success it would help them as well. They also provide us with several boxes of *T. nilotica* which came from the species they were breeding with the *t. hornorum* and were getting all male hybrids from.

We boarded the Airline in Forteleza and had a scheduled stop in Belgium, which was the point of Debarcation for us and what we did not know was where everything was looked at to make sure we were doing things properly.

When we got to Miami we came into the customs area with all of our bags and boxes at around 3:00 am just before the customs agents were due to change shifts. The customs agent was presented with all of the documents concerning Christy most of which were in Portuguese and was apparently overwhelmed and finally decided to just pass us through fish, baby and all.

So, now we were back in Florida with the right species of tilapia, a permit in our hands, a suitable facility and a lot of will to succeed. We last heard from ___ about the macaws when she called and told us she would require more money in order to get the birds packed and shipped out of Manaus, but due to the extra financial drain and the fact that we could not get anyone in Florida to back us up with additional funds we had to pass up on the birds. We later found out that just one of the Hyacinth macaws could in a proper sales situation bring more than enough money to recover all of our cost.

We arrived back in Palmetto and moved into a mobile home we had arranged to rent and have delivered to our "new farm" prior to going to Brazil.

Jan and I were of course well occupied with being new parents and Christy was a real handful. She had a touch of colic when we got home with her and she would stand on my lap and lift her whole body straight up and scream at me and I would rock her until she quieted down and fell to sleep.

After a few days at home, we got lots of advice and found that Christy was lactose intolerant and so switched her to a soy formulae and the colic gradually went away and holding her and rocking her became a thing of pleasure where she just enjoyed the ride and cooed whenever I took the time to rock her.

Right from the beginning Christie was very active and assertive, she could not be put down on a bed, even when surrounded by pillows, we found out to our surprise, when one of us placed her on the bed and placed pillows carefully on all sides of her. She was asleep at the time and so we went into another room so we would not wake her. Then a few minutes later Jan's voice comes from the bedroom...

"Mike, where did you put Christie?" I hurried into the bedroom and said, "what do you mean, where's Christie? I got on my hands and knees and looked under the bed which was a queen size and was shoved all the way up to the wall, on one side, but Christie

was not in sight on the floor, so I said "she is not on the floor," and Jan, who was literally flying around the room looking in the dresser drawers as if a 3 week old baby could have climbed into a drawer, and about that time we can hear a muffled cry coming from somewhere in the room.

So Jan ran over to the side of the bed and began pulling the bed out from the wall so she could look under the bed again, suddenly there was a cluck and a shriek and Jan ran around the end of bed and Picked up Christie from the floor where she had just landed, then let out a shriek as she lifted her up, at the fact that there was blood streaming down her little face. She rushed from the room with her and got some clean towels to wipe her off and then she could see that the injury was a very slight cut on her cheek, which quickly stopped bleeding as Jan held the cloth against her cheek.

What has obviously happened is that in the short time we were both out of the room, Christie had scooted from about a foot in from the edge of the bed that was on the open room side to the opposite corner of the bed and had fallen off the bed where she could not be seen and she was between the bed and the wall and when Jan had pulled out the bed she had fallen from where she was to the floor.

So we both received a lesson in the mobility of a 3-week-old baby and we never ever left her again unwatched.

We of course carefully placed each box of tilapia in its appropriate place in the building. I placed four of five young females in a tank and one male of the t. hornorum to breed for the next generation and I also placed a number of males in an adjacent tank to use for making the appropriate hybrid cross when I was ready. Then as each female produced young I milked the babies from them and put them in a new tank to grow. Within a couple of weeks I had increased the number of pure line t. hornorum to several thousand counting the babies.

Now it was time to begin getting the other species together to produce the all male hybrid. So I called Wassie Fish's farm. I went to Wassie's farm second time to get more of the t. mossambica and bring them back to my farm to breed. He was very sympathetic and again gave me about 25 t. mossambica, male and female.

I took them back to Piney Point and set up an area to use for breeding the T. mossambica and began to reproduce them too.

I was able to separate out about ten females from the t. mossambica and put them in a tank and found several t. hornorum males to put with them. At the same time I put 7 or 8 female t. nilotica in another tank and also put several t. hornorum males with them to breed. About six or seven weeks later I had several thousand of each male hybrid and I had to find tanks for them too.

While it was possible with the large number of tanks I had to allocate a few tanks here for one cross, another few tanks there for another cross and then 10 to twenty tanks

each for the pure lines which had to be kept in separate parts of the buildings to avoid the fatal flaw of the hybrid producer of mixing up the brood fish.

With all of these tanks allocated to producing various hybrids or pure lines there comes a point when one runs out of empty clean tanks where they are needed and that is what happened to me when I made perhaps what is the most important discovery I ever made with tilapia.

I had just milked out of several mothers mouths about 500 all male hybrids and I needed a place to put them and so I took them to a tank where I had placed around 300 all male hybrid fry about a week or ten days before. I had the new fry which were just over a quarter of an inch in a bucket and I began pouring them with the water into the tank and as I poured I noticed that the fry which had already been in the tank for about 8 or 10 days and were about an inch and a quarter long had come up to where the water with the fry was cascading into the tank and were picking off the fry as fast as they hit the water.

In a flash it hit me! The older fry were eating the smaller fry like candy so the tilapia hybrids were essentially cannibalistic when it came to eating small fry just out of the mother's mouth. This seemingly simple recognition explained many many things about tilapia hybrids and led to much more efficient breeding systems than anything I had in progress before that time.

TILAPIA RESEARCH BEGINS

Now that I had three different species of tilapia, an acceptable location for working with them and a permit from the state I began to actually study the production of tilapia hybrids and to begin to study them from the point of view of growing them as a crop.

The availability of hybrid fry gave me the opportunity to begin growing them in tanks and to supply them to others who wanted to find out how they could do.

One of the first studies I undertook was as a result of another visit by the boys in green, the State Fresh Water Fish and Game Commission who wanted proof that I was producing all male hybrids. I supplied them with a thousand or so hybrids from the t. mossambica cross with the t. hornorum males and with about 300 of the hybrids from the t. nilotica females and the T. hornorum males. They told me that they planned to take them to Boca Raton where they would set them up to grow and measure the rate of growth and how much food it took to get them to a size big enough to market. They promised they would make their results available to me.

They did not keep their promises to let me have a report on the growth of the hybrids and I found out several years later from another source that they had grown very rapidly to over a kilogram each and had had very good feed conversion, but that they did not want the information to get out because they did not want to encourage people to grow them.

As I was breeding the t. mossambica I soon had more than 5,000 and I produced a single male fish that had very little black coloration on it and a lot of orange and red.

I began producing this gene line of the t. mossambica and began to hybridize them with the t. hornorum.



The first mutation that appeared amongst my breeding stocks of pure t. mossambica were colored more like a calico cat, that is they had a mostly black body color with many patches of red, orange and yellow color scattered all over the fish. In their own way they were quite pretty but they did not quite have the color that I wanted in order to create a fish that was different so I could tell the species apart after I was done breeding them. The idea was to have a female that was one color and a male that was obviously different. I Picked the best calico male and bred it with its sister that was also calico and got several hundred fry which were about 80% calico and about 20% normal color or gray. Some of the fry proved to be more red and had more white on them and so I picked out

new a new male with some improvement, or reduction, in overall black color and 5 females that also had an improved appearance. I bred this group and got several thousand fingerlings, which turned out to be about 90% calico and 10% normal colored. This breeding gave me more fingerlings to go through to select for better breeders and low and behold I found a single male fingerling that was almost all white with a strip of red running from the tip of its nose to the tip of its tail. It had a splash of red on its fore head and then very sparse red markings running toward its tail which had several stripes of red in it. This single male fingerling became the major breeder for all of the subsequent red improvements and red butterball improvements that I was able to make. I took this male and placed it in a breeding tank and took around 10 well colored calico females and put them in the tank with him to breed and produced several thousand more fingerlings. The time that it took to go from the first Calico male breeder to finding this male and then to breeding it with 10 of the improved calico females was much less than a year. It took approximately 60 to 90 days to raise a fry to fingerling size so I could tell what sex it was and then to breed it and have it produce a new batch of fry and then another 90 days to get those fry to selection and to breeding new fry, so In my hatchery where the water was kept at around 92 degrees f. I could get them to grow and then produce fry or create a new generation every 90 days, which gave me four generations a year. So, in one year I found I was able to achieve up to 4 generations of improvement by selecting from a thousand or more individuals, one or two individual fish that had a change in the amount of that characteristic that was expressed and for the red color this meant that I could increase the number of sites on the skin of the fish that had red in them and by selection of fish that lacked black first that i could reduce the black and increase the red. One fortunate thing about the red genes that I was increasing in my selection process is that when the red fish are bred with normal grey fish almost all of the fry produced have red on them and almost none are a normal grey. So, I could select fish to cross with the red calico breeders and know that all of their offspring will express the red color genes. The fact that fish from this pure gene line carry genes that are dominant means that whatever improvements I make in the color will carry over to the hybrid cross.



The tilapia shown in this photo (Figure 15-2) was the best of about 10,000 from the fingerlings of the Red Red gene development line. Each photograph shown illustrates

gains in the selection of the fish for improved characteristics. The amount of Red pigmentation showing on the surface of this fish was very nearly 20% and it had virtually no black on it. This was one fish in 10,000. In order to explain as much as possible I will be moving forward in time and selecting photographs which help to illustrate fish that have improvements in the amount of red pigmentation that was been made over that period of time. I will try to explain what changes have been accomplished. By the time the photograph was taken of this red red fingerling I was about 7 and a half years into the selective breeding of the red red gene line. I now had 24 hatchery ponds that were 50 feet by 80 feet and about 5 feet in depth. I was able to stock each pond with approximately 10,000 red red fingerlings from the hatchery tanks where I was using the best-colored fish with the best color distribution from the previous gene developments. I was able to get the red red fingerling development fry up to about 3 or four inches, which made them easy to sex and ready to breed. When each group of red red fry were ready to sort I would ask my crew to seine all of them up and to eliminate or cull each fish that had more melanization on it than we were willing to accept for that particular selection at that time. So in the first five years I had set a goal of elimination of approximately 98% of the black markings. That is we would select females that still had as much as 10-12% black distributed on its skin but had red good color. For the males we would accept only males with as little as .5% melanization. We would then eliminate all but around 200 to 500 fingerlings out of the 10,000 and then we would sort through these and eliminate any with any other defect such as a missing left eye or a swim bladder malfunction or what we called dirty belly, which was dark color that showed through the belly. Any other defect that was recognized was also culled. The final selection was from around 40 or fifty females and 8 or ten males each of which had less than the amount of melanin showing for that sex and had an increase in red pigmentation, either in the amount showing on the whole body or the intensity or both. Each of the females, which were not selected to go on to become pure line breeders but was in the last 50 or so was put in a tank for use as a breeder to cross with a t. honorum supermale. The breeding that went into the production of fish like those in (figure 15-1) produced a large number of red development fingerlings which had basically a white body with as little as 4-5% melanization. Some of these were male and some were female. When I took the males with less than .5% melanization and bred them with females with less than 10% melanization many of the eggs proved to be non fertile. The interesting thing about this was that if some of these breeders were bred indoors in my hatchery under lights and some of the same breeders or at least some with the same amount of melanin on them were put outdoors in the sunshine to breed, the ones in the sunshine produce a lot more fingerlings but were still poor producers. Then I found that If I used females with at least 20% melanization indoors under the lights that I got a normal yield of fingerlings and good breeding success. So, then I decided to increase the amount of red in the fish (through selection) and when the amount of red on the fish got so that it covered at least 20% of the fishes body that somehow this helped to improve the fingerling numbers almost to where it had been with females with more than 20% melanization. In other words the amount of red pigmentation expressed in the fish mostly did whatever the black was doing to make the fish fertile or at least to not block the fertility cycle. this took about 5 more years and we then had red red development fish that look like those in figure 15-2.

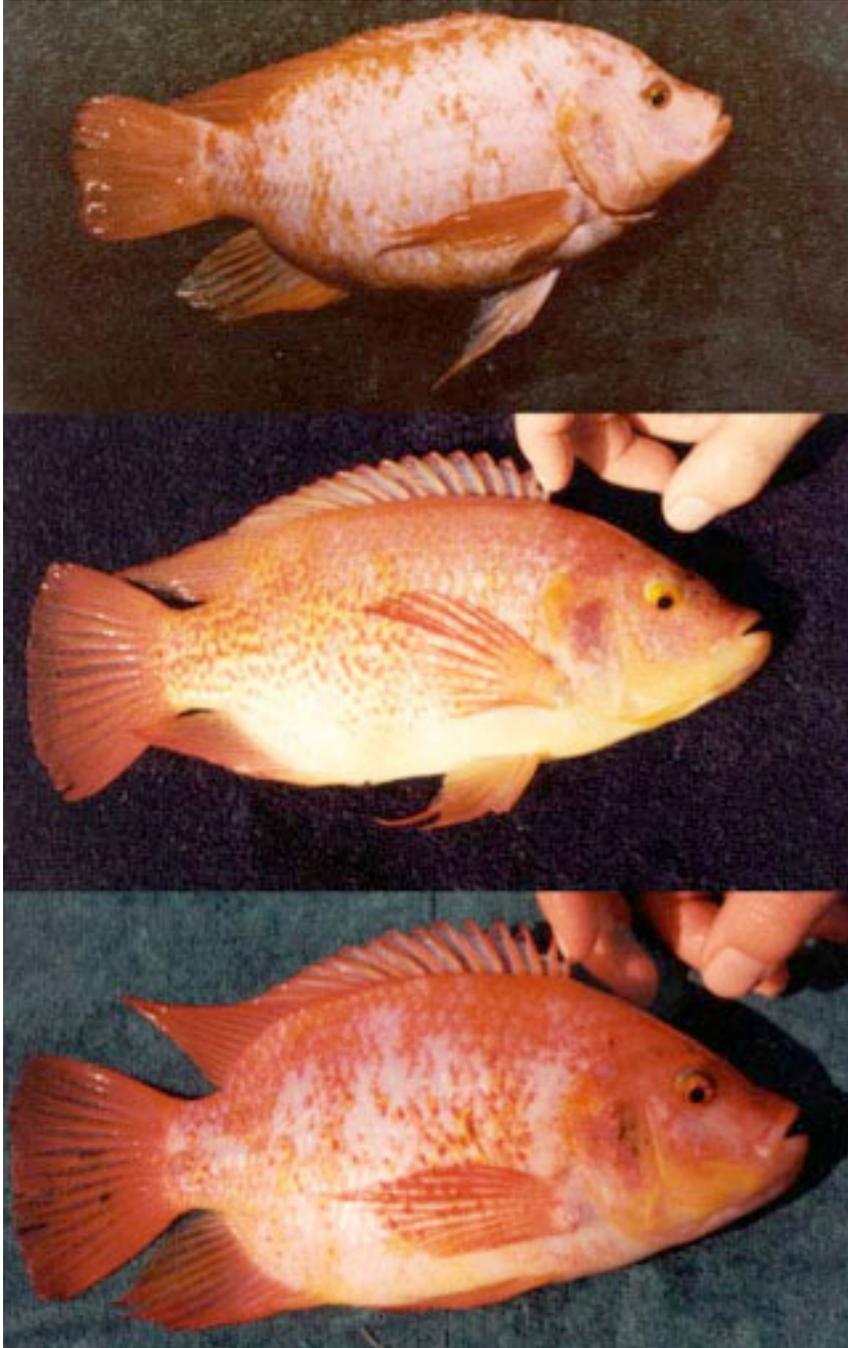


During the period of development of the breeders shown in figure 15-1 we produced and market fingerlings with t. hornorum as the father, which we called the Golden Hybrid. These fingerlings were essentially golden colored with differing amounts of melanization on their bodies. During this period of genetic development, which lasted about 10 years, We discovered several apparent mutations. One of these mutations was in the body form of the T. hornorum. I bred several t. hornorum in my indoor hatchery and came up with a single fry amongst several hundred that had a wide body form. I pointed out this fish to Jan and she said that it seemed to be all meat and why did I not try to breed more of them. So, I took special care of this one fish until it was about 3.5 inches long and almost as wide and I found that it was male. SO I decided to breed it with some of the females from the t. hornorum species. I put it with five females and produced several thousand offspring, and lo and behold half of the Offspring were heavy bodied like the father and so I almost immediately had increased this gene line. Some of the heavy bodied fish were female and some were male but all of them produced 50% heavy bodied fingerlings when bred with normal shaped tilapia of their own or of other species. What seemed obvious to me was that by breeding a large number of the heavy bodied t. hornorum, I could eventually select breeders in this gene line where 100% of the pure t. hornorum fingerlings turned out to be heavy bodied. So, I set up a breeding program to develop this heavy bodied gene line from which I could select males that produced an increase in the yield of the hybrids produced. This breeding program had many other specifications that had to be added in order to select the best breeders for the production of hybrids. the specifications included as cull indicators, crooked spine, slender body, diminutive growth and after these indicators were applied and we got down to less than a hundred picked fish that had the broadest body form in all directions and thicker fillet across the back so that if you were looking down on the fish and it was headed away from you, there would be a segment running from the nose back to almost the tail that was nice and thick. The other mutation that turned up about a year later was in the red red gene development line when a heavy bodied fish turned up and we decided to set up a new gene line for developing this heavy bodied fish. We named the fish the Red butterball. In the picture showing this gene line shown in figure 15-4 we have a heavy bodied fish with just slightly less color than the one in figure 15-2. I adopted this new gene line and dubbed it the Red Butterball. I then set up a breeder program, which involved breeding red butterball males from this pure gene line with red butterball females, which also came from this gene line and then selecting in this new

gene line using a set of criteria for selecting out both the red pigmentation and the improved body form.



Once we had the permits and were underway we began to be approached by many people who were interested in growing fish. The newspapers and television stations have always been very positive about the concepts that we were promoting and various people responded to my concepts and approached me from various points of view.



The one thing that everyone was concerned most about was the fact that we had to renew our permit each year and there was language in the permit that allowed for non-renewal.

As I began to run out of room in my hatchery I began looking for suitable property where I could build ponds and put tilapia in them and grow them. I found a piece of property about 5 minutes up the road toward Palmetto that was at the time owned by a Mr. West. Mr. West had been growing vegetables such as tomatoes and others on it for a number

of years and it was right at 15 acres and was located behind his vegetable stand off highway 41 in Palmetto.

I stopped at the stand and as I was talking to him I mentioned that I would like to buy or rent a piece of land that I could dig ponds and grow fish on and we got to talking and one thing led to another and he said that he would rent the 15 acres to me on a lease option and he mentioned an amount.

I went home and mentioned this to Jan and to my mother within the next few days and then At about this time I was approached by Tom and Marilyn. Tom said that he was a retired dentist and that he wanted to go into a partnership with me and Jan to grow tilapia. Marilyn was his girlfriend and helped him to orchestrate his projects and investments.

Tom and I talked a good bit and it turned out that he was willing to invest around \$50,000 in a project and I explained to him that my mother was at present my only investor and that what we would have to do is to form a corporation in which he would get some stock in return for his investment and I would get some in return for my input of know-how and brood stock and Mother would get a small percentage to cover her investment and to provide a swing vote in case of any deadlock in any issues that need to be voted on by the shareholders.

True to his word tom delivered the money in installments as we got the digging done on the West' property. At first I had hired a local heavy equipment operator who had a backhoe and agreed to dig the ponds 33 feet wide and 60 feet long and arrive at a 10 foot water depth in the middle, and to charge me \$100 for each completed pond. Then he took nearly three weeks and had only done one pond a week due to mechanical difficulties. Another backhoe man happened to drive by several times and stopped and asked what we were doing and I told him I was paying \$100 for each pond that was completed and he asked if he could participate in the project and so I talked to the first guy and he agreed to start on one side of the property and dig ponds where I had staked them out and the other guy agreed to start on the opposite side and I agreed to pay each one for the ponds completed and which matched specifications. I had just over 100 ponds staked out and between the two of them they had completed the digging of the 100 ponds within 30 days and the first operator did not have any more trouble with his equipment.

I used the money from tom to pay for the backhoe work and each week on Friday I would meet them and pay them in cash for the number of ponds they had done. I also had a fence company come out and put a 6 foot chain link fence with three antipersonnel barbed wire strands on the top around the entire property. Then I got the Game Commission to issue me a permit for this new property and I began putting breeder fish in cages and breeding f-1 hybrids.

Meanwhile I was breeding the new red strain of tilapia that I had located earlier and found by breeding the male with his daughters that I could bring out red and by selecting from the offspring for more red color and less and less black I could improve the

amount and intensity of red color inherited by the top 1% or so of the next generation of fingerlings.

By this time Jan and I had moved onto the West property into a doublewide mobile home that was placed toward the rear of the property.

My mother, Jan and I agreed that I needed a place to do proper research on the genetics of the tilapia and agreed to the placement of two aluminum buildings next to the mobile home which when put together would provide an area of about 24' wide and 40' long that could house 48 thirty gallon long aquariums that had florescent lights mounted above each tank in a sort of enclosed cabinet arrangement.

I designed the Aquarium display area so that when I or someone else was in the building with the door closed the only light would come from the top over each aquarium, and that light would be from two 48" florescent lights.

I also designed a curtain that went from the ceiling down to the top of each tank. When work needed to be done in each tank the curtain was lifted and clipped with clothespins to hold it up while the work was done. This made sure that unless a person were right in front of a tank and in motion that the mirror effect from inside the tank made it difficult to detect any motions or people outside of the tanks. This in effect created the illusion for the fish that except for the fish in their tank they were alone and so would go about the breeding process in a normal undisturbed process.

In an ordinary aquarium exposed to the conditions created by human traffic the fish are routinely exposed to the coming and going of the people who enter the building for whatever reason and so become used to interrupting whatever behavior they are engaged in to rush to the edge of the aquarium to see what is going on or to be fed.

The aquariums set up in this research room were set up to have a minimum of interruptions. While in a display tank where the object of the tank is to show off the fish so human traffic is necessary, in a breeding situation where disruption of the breeding behavior may result in lower productivity designing the breeding tanks for minimal disturbance and maximum observations a plus.

Meanwhile, without my knowing, Tom and Marilyn were plotting how they were going to get a tilapia growing operation going in Haiti without honoring our agreements to do the operation together.

The first indication I had that something was wrong was when Tom and Marilyn called a meeting of the Board of Directors at my house and Tom tried to present to my wife and my mother reasons why it would be better to vote me out and Vote him in as president of the Company. For reasons still unfathomable he thought that my mother and wife would go along with this. When I called for a vote my 48% and my mothers' 4% made 52% of the vote and his motion was defeated along with his plan to take over the company.

The next indication that something might be wrong was a week later when I walked into a small trailer we had put on the property both to house a young college graduate by the name of Mike C. that had recently come to work for us, and to hold various farm supplies.

I went into the trailer to find something and the phone rang while I was there so I picked it up and said hello. The voice on the other end said "Mike, is that You" and of course I said "yes" then the voice said "this is so and so with the blank travel service and we have your tickets ready for a one way flight to Haiti" and I said "tickets" and they said "yes, one for you and one for Katie to leave on Monday the 14th." So I said "thanks, I will be down to get them" and they hung up.

So, my first and at the time my principle employee and Katie who was also working with us were planning a trip to Haiti. I went immediately to Jan and told her what I had just witnessed and she said "how can they hope to get away with it!" and I said "I have no idea!"

Since Tom had said to me earlier that he wanted he and I to start a project in Haiti and that he would handle the agreement with the Haitian government and that there would be plenty of money to cover my salary and all of our expenses, but that we would have a written agreement before we planned the project.

So now, with my accidental discovery, I had indisputable evidence that he planned to steal my employees who I had trained in tilapia breeder management and take them to Haiti, and run the project himself. I did not know how he planed on getting tilapia to work with but I had a feeling that he had no qualms about taking them from the business.

Since I had no previous experience in business I was unprepared for this event and both Jan and I were utterly shocked that anyone would plan to do something like this. Since Tom had delivered all of his investment as cash as I look back on it I realize that I should not have been surprised at anything that he would do. Katie however was another matter; she was the sister of one of Jan's best friends and had grown up with her in Miami, so to find that she would participate knowingly in such a plan was a really unbelievable. But time and circumstance would provide us with many other equally stupefying examples of human behavior.

The next thing I did was to go to Mike C and ask him about his plans to go to Haiti. He said rather matter of factly that he planned to go down and to work for Tom and to take Katie with him and that they were to live there and make the project work. He also said that they planned to take some brood stock from our business and take it with them when they were ready.

I immediately called a meeting of the Board of Directors and moved that Tom and Marilyn be banned from the property (to prevent the unauthorized removal of any brood stocks.)

After this meeting Tom and Marilyn threatened to sue us, but Jan and I felt they had no grounds because of the unethical activities they had pursued. And I felt that as long as they were notified of any activities the Company was involved in and received proper notices of Board meetings, etc., as they occurred that there would be nothing they could do to us legally.

The next day Mike and Katie were gone and it is my understanding that Mike went to Haiti and started up an operation and that once they had some ponds built and some fish grown and ready for market the Haitian government came into the project with guns took over the property and forced their return to the US. So Jan and I felt like again that their was justice even if it took awhile to happen.

Meanwhile I was still separately breeding my new strain of T. Mozambique and my strain of t. hornorum that I had gotten from Brazil. Unfortunately the Game Commission had come to my Piney Point farm again and decided that they needed to kill all of the niloticas that I had since they had not included them on the list of permitted species. So as we watched they butchered about 500 of the males and female t.nilotica.

The facts were that I had earlier given them the all male hybrids from the cross produced by the t. hornorum and they had grown them out and found them to be all males and that they grew to over a kilogram each in about six months in a dirt pond, however they would not allow me to keep the nilotica because they still just did not want ordinary citizens to be in aquaculture.

FIRST SALE - A HARD LESSON

I had produced about 5,000 or so all male hybrids and I had run a small advertisement in Aquaculture Magazine advertising that I had all male tilapia that I was willing to sell. A gentleman by the name of Dr. Mathews who said that he had a group of people put together in Puerto Rico who wanted to stock tilapia in some ponds they had dug. He said he wanted 20,000 and he wanted me to come to Puerto Rico with the fish, As this was my first big order and I really wanted it to work I agreed and when I asked him about payment he said he would pay me when I got to Puerto Rico.

I called my mother and told her about the order and I told Jan and Addie, my grandmother and by the time we were ready to go there were three of us going, my grandmother, Addie, Jan and I. So we scheduled the trip so that I would have at least 30,000 fingerlings (20,000 with a 50% over count) and we packed the fish in boxes and had them brought to the Airport and we all got on the flight and went to Puerto Rico. Mother agreed to pay for the tickets and I agreed to reimburse her out of the proceeds of the male hybrids when I got paid which I was sure would happen when we arrived.

So, we arrived in Puerto and while Dr. Mathews took care of getting the fish into and out of customs Jan, Addie and I went to a Hotel in San Juan. One interesting occurrence happened at the hotel. I asked the Concierge how much the room were and he gave us a price and just after He gave me the price a man came to the desk and asked how much a room was and he quoted a price about \$25 lower than he had quoted me and when I asked him why he turned to me and said because he is from Puerto Rico and you are not. I felt that was unfair and I said so, but it ended up that we had to pay the original amount anyway.

The Casino's were quite an attraction to My grandmother Addie and Jan and Dr. Mathews took us to the Casino the first night. Jan won a couple of hundred dollars and politely put it all back in the slot machines that night.

Now when Dr. Mathews had called me and was responding to my Advertisement that I was producing fingerlings that should be predominantly male since they were the result of crossing male *t. hornorum* with female *t. mossambica*. I discussed with him the fact that I had just gotten set up to produce the male hybrid after a great deal of trouble with the Florida Fresh Water Fish & Game Commission, and I had not yet had time to grow any of the fingerlings to a market size so I could make sure that they would be all males. I was aware at the time of the use of predatory cichlids such as the Peacock bass, which if stocked at the right time and in the right numbers could help to control reproduction in the ponds and I said that I would highly recommend that he get some brood stocks or fingerlings of them and make sure he was ready to introduce them if the male female ratio was lower than needed to achieve good growth of the male hybrids.

Dr. Mathews response to this was that he knew all about the research on these predator fish and that he would take care of the problem if it came up. I then said that I would sell him the fingerlings he needed for 20 cents each but that I could make no guarantees as to the percentage of males that he would get and He said that that was OK, that he could do the any necessary checking and that he would take care of that. He said that

he had twenty or so dirt ponds that had been built with money from a group of businessmen who would be financing this project.

I had just that week set up a breeder pond for the production of all male hybrids and what I had done was to go through about 200 male and female *t. mossambica* and had selected only females to put in some special breeder cages I had just constructed that were 8 feet long, four feet wide and four feet deep. The cages were made from one inch by one-inch steel that was galvanized. The cages were put together with small clips used to make cages for birds and other animals. Anyway I put the 100 fish that I judged to be females into the cage and then I went through about 50 or so males and females of my *t. hornorum* strain and selected out 20 fish that I judged to be male and so I then had two cages with 50 females and 10 males in each. These cages were then placed in one of the small breeder ponds I had just had constructed which were 25 feet by 50 feet and about 4 feet deep in the middle. As they were just dug the bottoms of the ponds were mostly sand with a little muck, so if I pulled and pushed a small amount on the end of a cage the cage would sort of settle down into the soft bottom. This provided ample area for the males to dig little craters in and create their nest that they would entice the females into and mate with them.

The breeder pond with 2 breeder cages with 50 females each began to come alive with an estimated 5,000 to 10,000 fry in about ten days and I and one of my helpers then waded into the pond and lifted each of the two cages up into the air and dragged and carried each of the cages into the next pond. During the fourteen days the cages had been in the pond we had fed them twice a day with a high protein trout food and the ponds had begun to grow a fairly dense crop of micro flora and micro fauna, which meant the tiny fry, had a lot to eat. The fry had access to any leftover food that floated out of the cages and sunk and to the algae and dense cyclops that were swimming everywhere in the pond.

The fry could be seen swimming in swarms that appeared to be little balls that were each made up of hundreds of tiny fish that constantly rotated as the fish swam forward or up and down, each fish seeming to always be adjusting its position in relation to all of the other fish in a swarm so that the balls or swarms condensed and contracted constantly. I never tired of watching this behavior. Actually counting them was of course very difficult as they needed to be netted with very fine nets that would capture a whole swarm at once and dump them into a bucket.

Each bucket could then be counted and that is how we made an estimate of how many fish were being shipped. We would pour one bucket at a time into another bucket and count the fry as they went over the edge. Then the contents of a bucket would be poured into a plastic bag that held about 4 gallons of water and however many fry it was considered safe to ship alive for the distance they had to go.

We were on about our third pond of fry production when Dr. Mathews called and so I agreed to sell him approximately 20,000 fry at the price of 20 cents each which came to \$4,000.00 which Dr. Mathews agreed to pay if I would bring the fish to Puerto Rico. So,

we took an estimated 30,000 of the hybrids in plastic bags, inflated with oxygen, tied with rubber bands and packed in about 30 styrofoam boxes inside of a cardboard box.

So, here we were in a hotel in Puerto Rico and we get a call from Dr. Mathews and he says that he has had a meeting with his investors and they do not want to pay what Dr. Mathews has agreed to pay. And then he says that they will 50% of what he had originally agreed to pay and I can take it or leave it since I was already there in Puerto Rico, had a commitment to pay for a room and had already paid for our round trip tickets to fly there.

So I considered the situation and understood that I had already lost this round and agreed to take it, if he would bring the cash to my hotel room and with the understanding that if the fish did what I had said they would that they would pay the difference in six months.

So He brought over the money, signed the agreement and I considered myself lucky to have gotten enough to cover the cost of the trip and a little bit more.

We flew back to Florida having learned to get the money first and ready for the next round.

Before leaving Florida I had started working on the idea of changing the genetics of the fish so that no matter what I would be able to tell the difference between on species and another when it came to setting up the hybrid breeders.

One avenue I was exploring was that if I could find a single fish that was different in color from the rest that I could perhaps breed one of the two species so that one of the two fish required to produce the all male hybrid would be one color and the other would be another color.

CHERRY SNAPPER THE IDEA SWIMS

I had of course, by this time, begun the breeding process that would allow me to change the color of the *T. mossambica* pure lines. I created a selection protocol that codified the procedure for selection.

It went like this:

I would breed a group of the best breeders that I could sort out of my *t. mossambica* red red brood stock. These were sorted according to the degree of melanization that occurred on the surface of each fish. In the beginning of the selection for the 1st through the 4th generation, this meant that I was looking for males and females with less than 60% of their body with black on them and 40% white or red or yellow splotches.

I would select at least 5 females and one male, and put them into one of the breeder tanks by my house. I could control the temperature at 85 degrees f. By setting my timer to turn the lights on at 6 AM and off at 8 PM, I controlled the length of the day.

I would look individually at several thousand fingerlings that were 2-3 inches in length. I sorted them to find the fish that met the minimum melanization criteria, without any obvious genetic defects.

These included the following defects, which recurred from generation to generation:

A missing eye, where the eye socket was formed, but no eye developed.

A deficient or missing swim bladder, which made the fish, sit on the bottom when they were resting. (They could launch themselves off the bottom and swim around with the other fish, when challenged with some food, or scared by a net thrust at them.)

A dirty belly, which generally appeared in oddly torpedo shaped fish. This consisted of a black coloration on the underbelly. tail. Most of these genetic defects recurred frequently, from the 1st generation to the 25th, where they began to show up in fewer and fewer of the fish. By the 100th generation most of these defects tended to decrease in frequency.

An interesting note. Whenever I have had the opportunity to get my hands on fish, supposedly developed by others, and I bred the fish with one of my pure lines, I generally see most of these defects occurring in offspring from the first or second generations from the cross. This bit of genetic evidence indicates to me that the fish, which was claimed to be, say, a fish developed in Thailand, or Israel, actually came from fish taken or sold early in the history of the creation of the red tilapia, which was occurring on my farm.



17-1

The tilapia shown in this photo was the best of about 10,000 from the fingerlings of the Red Red gene development line. Each photograph shown illustrates gains in the selection of the fish for improved characteristics. The amount of Red pigmentation showing on the surface of this fish was very nearly 20% and it had virtually no black on it. This was one fish in 10,000.

In order to explain as much as possible I will be moving forward in time and selecting photographs, which help to illustrate fish that have improvements in the amount of red pigmentation that was been made over that period of time. I will try to explain what changes have been accomplished.

By the time the photograph was taken of this red red fingerling I was about 7 and a half years into the selective breeding of the red red gene line. I now had 24 hatchery ponds that were 50 feet by 80 feet and about 5 feet in depth. I was able to stock each pond with approximately 10,000 red red fingerlings from the hatchery tanks where I was using the best-colored fish with the best color distribution from the previous gene developments. I was able to get the red red fingerling development fry up to about 3 or four inches, which made them easy to sex and ready to breed.

When each group of red red fry were ready to sort I would ask my crew to seine all of them up and to eliminate or cull each fish that had more melanization on it than we were willing to accept for that particular selection at that time. So in the first five years I had set a goal of elimination of approximately 98% of the black markings. That is we would elect females that still had as much as 10-12% black distributed on its skin but had red good color. For the males we would accept only males with as little as 5% melanization. We would then eliminate all but around 200 to 500 fingerlings out of the 10,000 and then we would sort through these and eliminate any with any other defect such as a missing left eye or a swim bladder malfunction or what we called dirty belly, which was dark color that showed through the belly. Any other defect that was recognized was also culled.

The final selection was from around 40 or fifty females and 8 or ten males each of which had less than the amount of melanin showing for that sex and had an increase in red pigmentation, either in the amount showing on the whole body or the intensity or both.

Each of the females, which were not selected to go on to become pure line breeders but was in the last 50 or so was put in a tank for use as a breeder to cross with a t. hornorum supermale.

The breeding that went into the production of fish like those in (figure 15-1) produced a large number of red development fingerlings which had basically a white body with as little as 4-5% melanization. Some of these were male and some were female. When I took the males with less than . 5% melanization and bred them with females with less than 10% melanization many of the eggs proved to be non fertile. The interesting thing about this was that if some of these breeders were bred indoors in my hatchery under lights and some of the same breeders or at least some with the same amount of melanin on them were put outdoors in the sunshine to breed, the ones in the sunshine produce a lot more fingerlings but were still poor producers.

Then I found that If I used females with at least 20% melanization indoors under the lights that I got a normal yield of fingerlings and good breeding success.

So, then I decided to increase the amount of red in the fish (through selection) When the amount of red on the fish got so that it covered at least 20% of the fishes body that somehow this helped to improve the breeding numbers almost to where it had been with females with more than 20% melanization. In other words whatever caused the display of this same amount of red pigmentation to be expressed in the fish did whatever the expression of black was doing to make the fish fertile or at least to not block the fertility cycle. This took about 5 more years and we then had red red development fish that look like those in figure 17-2



17-2

During the period of development of the breeders shown in figure 15-1 we produced and market fingerlings with t. hornorum as the father, which we called the Golden Hybrid. These fingerlings were essentially golden colored with differing amounts of melanization on their bodies.

During this period of genetic development, which lasted about 10 years, we discovered several apparent mutations. One of these mutations was in the body form of the T. hor-

norum. I bred several t. hornorum in my indoor hatchery and came up with a single fry amongst several hundred that had a wide body form.

I pointed out this fish to Jan and she said that it seemed to be all meat and why did I not try to breed more of them. So, I took special care of this one fish until it was about 3.5 inches long and almost as wide and I found that it was male. SO I decided to breed it with some of the females from the t. hornorum species. I put it with five females and produced several thousand offspring, and lo and behold half of the Offspring were heavy bodied like the father and so I almost immediately had increased this gene line. Some of the heavy bodied fish were female and some were male but all of them produced 50% heavy bodied fingerlings when bred with normal shaped tilapia of their own or of other species.



17-3

What seemed obvious to me was that by breeding a large number of the heavy bodied t. hornorum, I could eventually select breeders in this gene line where 100% of the pure t. hornorum fingerlings turned out to be heavy bodied which should mean that 100% of the hybrids will also be heavy bodied which should mean a considerable improvement in the average size of fillets since the previous average sizes came from averaging together both the fish with the characteristic and the ones without it.

So, I set up a breeding program to develop this heavy bodied gene line from which I could select males that produced an increase in the yield of the hybrids produced. This breeding program had many other specifications that had to be added in order to select the best breeders for the production of hybrids. The specifications included as cull indicators, crooked spine, slender body, diminutive growth and after these indicators were applied and we got down to less than a hundred picked fish that had the broadest body form in all directions and thicker fillet across the back so that if you were looking down on the fish and it was headed away from you, there would be a segment running from the nose back to almost the tail that was nice and thick.

The other mutation that turned up about a year later was in the red red gene development line when a heavy bodied fish turned up and we decided to set up a new gene line for developing this heavy bodied fish. We named the fish the Red butterball. In the pic-

ture showing this gene line shown in figure 15-4 we have a heavy bodied fish with just slightly less color than the one in figure 15-2. I adopted this new gene line and dubbed it the Red Butterball. I then set up a breeder program, which involved breeding red butterball males from this pure gene line with red butterball females, which also came from this gene line and then selecting in this new gene line using a set of criteria for selecting out both the red pigmentation and the improved body form.

When I would start with about 5,000 fingerlings, going through this selection process generally would get me about fifty fish, 45 females and 5 males, that had improvements over the average fish in the previous generation.



17-4

Then I would pick the final breeder group, by looking for the fish with the best distribution of red color. Finally, I would select the fish with the deepest red color, such as the one shown in the photograph from the 17th generation, which did not have the distribution I sought, but made up for it by having the depth of color.

These 6 or 7 breeders would then produce several thousand fry over the next few weeks. I would put them into one of the 12 small growing ponds I had at the front of the property. They would grow quickly to the 2-3 inch size. I would then trap about 5,000 of the fingerlings, and, as I sorted them, I would apply my selection criteria to them. This was one of the most exciting things about the tilapia. The time it took from the fry, to fish that could be selected for the next generation, was only 8-12 weeks. This gave me the chance to select the best fish, and see the results, within a short period of time.

The percentage of black used in the selection process, had to be adjusted almost immediately after I created it. The percentage of fish with less than 60% melanization, grew rapidly in succeeding generations to 80% or 90%. I had to change the criteria to less than 50% melanization over the surface of the fish, and then to less than 40%, and by the second year to less than 20%, of the total surface area of the fish. The changing of the color of the fish was proceeding very rapidly when viewed from the point of view of the average fingerling.

Too bad I couldn't have used time lapse photography to record this change. If the pictures were taken six months apart for 25 years, and viewed at 1/15 of second intervals, the swiftness of the change would be breathtaking. The underwater ball of day old fry

moving around the pond, would change in a few seconds: from dark gray, to dirty pink, to dull orange, to bright orange, and finally, by the hundredth frame, to a brilliant red, as the ball of fry neared the surface, and disintegrated into waves of red color, which spread out just under the surface. The experience would be similar to watching the sunrise, when the sky turns from black to gray, then over the horizon.

The color changes came so fast during the first ten generations, I had to keep adjusting each of the selection criteria upward, as improvements continued to occur rapidly in the overall breeding program.

This part of the breeding program, was only one portion of the entire project I was working on. The purpose of the color improvement, at first, was to create a different color in the *t. mossambica*. This initial goal rapidly changed into creating a fish that could rival the Gulf red Snapper (*lutjanis* sp), as I discovered how easy it was to change the appearance of the fish. It so happened that during the time I was setting up and breeding the first several generations of red development, I was also breeding the *tilapia hornorum* so that I would have males when I needed them to produce all male hybrids. Lo and behold, a small fat fish suddenly appeared in one of the hatching tanks. This *t. hornorum* was unusually deep bodied, so I captured it and moved it into an aquarium in my house. I showed it to Jan, who said, "Boy, that fish will have a lot of meat on it when it is grown!"

I then fed the fish until it was about 3 inches, and determined that it was male. Then I went and found a female with robust body characters, and put the male in with her to breed. The first generation of fry from this pairing produced fry that were about 50% heavy bodied, and about 50% normal body form. This indicated that the gene group responsible for this shape, was probably only on one side of the sets of chromosomes.

And so began the development of the gene line of *t. hornorum* which quickly replaced my original gene line. From this, I selected males to produce hybrid tilapia that averaged well over 40% skinless, boneless fillets (instead of the older fillets, which averaged under 28% skinless, boneless, fillets (Hicklings article in the May 1963 issue of Scientific American.)



I also set up a group of selection criteria to determine which fish to keep as breeders and which ones to cull. First I would go through at least 1,000 2-3 inch fingerlings, picking those with the proper physical configuration. I looked for a thickening of the body, which included wider shoulders. I also chose fish with shoulders that continued from the midpoint of the back, horizontally backward, toward the tail, and frontally toward the head. This way, when the fillet knife slid along the backbone, it would get a continuous amount of fillet from the upper portion of the tilapia.

I also had to include a special selection process, to avoid choosing fish with deformities in the backbone. These result in a twisted or oddly shaped fish. In the early years we ran into problems with fingerlings, supplied from fish with effective spinal columns, passing it on to hybrids. Later toward the 50th or 60th generation, we eventually reduced the problem, so where we seldom saw hybrids from the cross with bent backbones.

So, in less than a year of breeding, I was able to find a body form that improved the fillet yield, reproduce it, and create a new gene line that bred true for the characteristic. This dominance of the body form in the hybrid cross was and is a very fortunate accident. When I bred a selected body form *t. hornorum* to a female tilapia of another species such as *t. mossambica* having a normal body form, I got hybrid fingerlings in which more than 50% had improved body form. It was the average fillet from these fingerlings, when they were mature, that provided the 42% skinless, boneless, fillet ratios.

So in less than two years, I had the ability to produce 100% hybrid fry, with good color characteristics. When filleted, they would yield up to 40% skinless, boneless, fillets- an improvement of 33%, in terms of gross yield of fillet. The benefits from this improvement can effect the bottom line, for people who want to produce and sell fillets for the market. Because, it takes the same amount of food and time, to raise a one and a quarter pound fish which yields a 30% skinless boneless fillet, as it does to raise a one and a quarter pound fish that yields 40% skinless boneless fillets. Fifty tons of normal sex reversed tilapia, yields 33,000 pounds of skinless boneless fillet after feeding 75 tons of feed at a cost of \$49,500, it cost another 27 cents a pound to process or \$29,700.00 for a total cost of \$79,200.00 in feed and processing cost. So, our total cost for feeding and processing the tilapia was:

Fifty tons of improved body form all male tilapia, can process into 44,000 pounds of skinless boneless fillet Cost = \$79,200.00. Fifty tons of normal body form tilapia can process into 33,000 pounds of skinless boneless fillet Cost = \$79,200.00

With The fillet selling at \$3.25 a pound then the normal body form will bring in \$107,250.00

At the same price of \$3.25/pound the improved body form will bring in \$143,000 a difference of \$35,750.00

This extra income is there just for choosing the right fingerling to grow. This just takes into account the feed and the processing cost, and if all cost are considered we have to take into account the method of raising the fish and if the method of raising the fish can

be accurately estimated to be say \$.50 per pound of whole fish then the cost of raising the two choices are as follows:

Fifty tons of improved body form all male tilapia, can process into 44,000 pounds of skinless boneless fillet will Cost = \$ 134,200
Fifty tons of normal body form tilapia can process into 33,000 pounds of skinless boneless fillet will Cost = \$ 134,200

With The fillet selling at \$3.25 a pound then the normal body form will bring a gross of \$107,250

At the same price of \$3.25/pound for the 44,000 pound yield of the improved body form will bring in a gross of \$143,000

Then the final analysis of the yield of marketable product is that with a production of 50 metric tons of whole tilapia the grower that produces a fish that yield 30% instead of a fish that yields 44% will be borrowing \$26,950 to run his operation while the grower that produces the 44% yield improved hybrid will be profiting \$9,000.00 after the expenses of running his farm and growing the fish.

So, if I could convince people of the truth of these facts, I would be offering them hybrids that would grow faster, and produce a profit where none existed before.

So I had, early on, the basics of a true revolution in the world of tilapia economics for fillet producers But, I have failed, by not getting this message across to growers.

Even so, soon, I had people coming to buy hybrids that had a lot of red color, who apparently, and unfortunately, did not really care about production economics. Another really fortunate thing that happened, when I crossed any of the increasingly red hybrids with any other color of fish, (such as black or gray), the red was dominant. So all of the fingerlings had some red on them, and none were gray or normal looking like the color of the other parent. In other words, the White or red were totally dominate in all crosses. None of the hybrids were colored like the other parent, no matter what color the parent was. This color phenomenon had considerable effect on my sales. All anyone wanted to buy from me, after I ran the Golden Hybrid advertisement in Aquaculture Magazine, was hybrids that had color.

Whether the color was red, which everyone seemed to want, or yellow, or white, they would buy any fingerlings offered that had color-even when I pointed out that they could get better profits and better fillets from the improved body form hybrids I could produce for them. I began to sell a lot of hybrid fingerlings thereafter, but the hybrids were produced by crossing the colored red t. mossambica with the improved body form of t. hor-norum. They were almost 50/50 male and female hybrids. I recommended that the growers stock predators, or try the new method of feeding fry testosterone feed for the first 30 to 45 days, in order to get a crop out of their production, without having over-reproduction ruin their bottom line. Most buyers promised to not breed these fish, but of course, many did. The 2nd generation of the hybrids proved to be a relatively fast growing fish and so did several more generations. The "new breeders" were then selected

for red color- or body form, since I had used the improved body form of the t. hornorum, to produce the original f-1 hybrid fingerlings I had sold.

By selecting for all of the criteria that were used to select out the strains of tilapia, these "new breeders" created a great deal of difficulties for the would be genetic fiddlers.

What I did was to select a number of gene lines. Once I set up selection criteria for a particular gene line, I made sure that I did not allow any of the selected gene line fish to breed with other gene lines or species. Each gene line was bred, using 8-10 females and 2 males, selected from an approximate 5,000 to 10,000 fingerlings of the same gene line, to represent the best of that gene line. This allowed me to take advantage of several numeric or statistical phenomenon's.

One of these statistical phenomenon was the number that represented the probability of a crossover event occurring to a specific gene site, say, the one responsible for red color, or the one that controlled the distribution of the red color. My understanding of a crossover event was that when during the process of meiosis a particular gene site (say the one that influences the number of chromatophores on a portion of the surface of a tilapia) is copied it would normally line up with the gene that it was copied from, but somehow gets hung up in the process and ends up side by side connected to the original gene and on the same chromosome, and so one of the fish ends up with a final set of genes that is larger and therefore has more influence over the characteristic controlled by that gene or set of genes.

Lets say that out of 5,000 meiotic events in the formation of a reproductive cell, there is the possibility that the genetic material separates within the cell that is going through meiosis, and the material responsible for controlling the amount of red color gets stuck, and remains behind in one portion of the meiotic event. In the case of a gene that controls the amount of red to be distributed, this could end up with one of the two egg cells or two sperm cells that form having double the genes that control the red color. Of course, one of the two cells would end up with less of the color-controlling gene.

So, I have an event that occurs once out of 5,000 events that will improve the color of the final fish. All I have to do is find it, and use the fish I find it in to as one of the new breeders in my gene pool. I now have this new double set of red expression genes in my gene pool.

Now that I have an improvement in my red gene line, I will now do the genetic processes needed to increase this improvement, so the improved gene is in most of my fish. Now I have another gene that affects the body form of the fish. It too, is in the red gene line. I estimate that the number of meiotic events needed to produce a similar event in the gene or genes needed to create a good distribution of meat, is also 5,000. So I have to breed at least 5,000 fingerlings, to have a chance of finding a gene that affects the body distribution of meat. That is if the magic number is 5,000. Now, how many fingerlings will I need to find a single fish that has both an improved body form, and an improvement in the amount of red, or red distribution?

Here is the number that works in my favor. That number is 5,000 X 5,000 fingerlings will have to be produced to create an improvement in both the gene site that controls the amount of red produced, and in the gene site that controls the distribution of meat on the fish. That means that the number is 25,000,000 fingerlings will need to be bred, and I, or someone, will have to examine each fingerling and select the single fish that will have both improvements.

So the "new breeders" trying to improve from a hybrid with two dominant characteristics will have to breed a lot more fingerlings to improve the color and the body form, or they will be forced to start two gene lines, and breed enough of each gene line (say 5,000) to select for one criteria or the other.

If they concentrate on selecting for color, then the body form goes by the way. If they select for color, without screening for black and avoiding misfits, then their inbred hybrids begin to slow down in their growth rate since they are not working with f-1 hybrids now. The interesting thing about this is that, that was my plan; but it took so long to have any affect on the customers of the "new breeders," that I lost great deal of the potential business I was trying to create, by the time people realized how little progress was being made trying to improve on a hybrid produced in this fashion.

The strain that eventually was sold as the Jamaican or Caribbean strain, arose or was produced by breeding some of these red hybrids, (produced from Red t. mossambica and improved body t. hornorum), that I sold to a guy by the name of Sandy Harris. Sandy assured me he would not breed them, and then turned around almost immediately and set up a guy by the name of Ray DeWandel in a hatchery in Jamaica, to breed the hybrids and produce a line of hybrid hybrids derived from breeding the "red" hybrids of t. mossambica and t. hornorum with t. aurea and producing a strain that was salt tolerant. (mainly from the Mossambica and harmonium genes. There are a few references in the literature, which acknowledge me as the originator of the Jamaican Strain.

I understand that Ray then sold a lot of fingerlings from that gene line to Jamaica Broilers, who have continued to work on that strain for many years. The pure t. mossambica (red) that was used to produce the original cross, of course, became a thing of the past, as soon as the hybrid offspring were bred together. In the 200 or so generations that have followed, the ontogeny of the strain has been lost. This process of selection of the best out of each generation, for over 120 generations, has taken in excess of 30 years. Each generation in the male takes only 45 days to go from a newly hatched fry to a mature breeder, as long as the growing temperatures are in the 80's.

If someone were to try to develop a true breeding gene line, that would give predictable results, they would have to start with fish, which were pure t. mossambica, and as far as I know, I am the only holder of a gene line of pure t. mossambica (red) that exist on this planet.

I even went to an artist in Bradenton (Frank Whitney), and asked him to paint a picture of the Cherry Snapper®. At the time I asked Frank to do this painting, I had only had a single fish that had come out of one of my sizing ponds, that had any color like what I

was aiming for, and was an approximation of this painting, which was later to become my logo for the Cherry Snapper®. I had the idea of breeding a fish that could be a replacement for the fish known as Red Snapper. This led me to pick the name Cherry Snapper®. One of the perks of the selection method I was using, was that about one fish in about 5,000 would achieve a percentage of expression of a gene or group of genes that was so much better than the previous best, that it could only be explained by a doubling of the genetic material responsible for it.

This process even has a name (Summation). Anyway, about the time I began to lean on the process of Summation, I began to use it to create what I foresaw as the replacement of the Red Snapper, which I believe to be an endangered species, with what I would call, Cherry Snapper®.

In other words, the development of the fish was proceeding rapidly toward the goal which I saw in my mind, and could explain to an artist who painted a picture, which then became an embodiment of the concept of what I wanted the Cherry Snapper® to look like. In fact, it would be nearly ten to twenty years before I would see in my own breeding ponds, a fish that looked as good as the painting done by Frank.

I even applied for a patent on the various improvements I was able to make in the tilapia's performance and looks, but was unable to get a patent on the various changes I created. I had to settle for a copyright on the name Cherry Snapper®, which I copyrighted, and now own the lifetime copyright on the name.

Meanwhile, back at the business, I was proceeding steadfastly toward what I thought was the dream of building a business, based on offering a supply of the right f-1 hybrid male tilapia. I had taken a very good photograph of the first nearly all white male tilapia I had produced in my breeding program, and had featured it in an advertisement in Aquaculture Magazine. I had crossed this male t. mossambica with several female t. horonorum and had produced a hybrid that was 100% gold colored. All of the fry were variously colored, white to bright pink, with varying amounts of black pigmentation scattered randomly over the surface of the fish.

When several hundred fingerlings were placed in a bucket and viewed from a couple of feet away, the general effect was a kind of golden appearance, so I called them Golden hybrids and offered them for sale as f-1 hybrids. This was the first of my widely publicized "colored hybrid tilapia", offered for sale anywhere, and which was published in any widely read publication anywhere in the world (Aquaculture Magazine). After this picture was published, I began to get people showing up at my farm wanting to buy hybrids from many other countries, including Taiwan, Israel, and the Philippines. I sold these hybrid fry and fingerlings to anyone who came, and since they were the opposite cross from the one that produces the all male hybrid, there were both male and female fingerlings. Of course, within a couple of years, there were fingerlings being made available from Taiwan, Israel, and the Philippines. These were being billed as the produce of their own local ingenuity, and yet there are no records of any colored tilapias being made available prior to the publication and sales that I made.

In the first generation, I had about 60% of the fish, with less than 60% of the body covered with black; and probably only about 5% to 8%, with orange to red spots on about 10% of the body or less.

In the second generation, the number of fish with less than 60% black color on its body went to about 63%; about 6%-9% with orange to red spots on about 10% of the body surface. So it went from generation to generation, until the 10th generation, when I found a single fish that had deep red over about 30% of its body. I had to produce and grow up to a size for selection, 5-10,000 for each generation. When I selected from that generation, I replaced the breeders from previous generations, to produce the next generation. Since each generation only required from 60 to 90 days to go from egg to breeding fish, I could get a minimum of 3 generations each year.

Unfortunately, finding a fish with the same or better quality of color only occurred in about one out of 1,000, from the 100th generation, and there were 999 which scored lower on the criteria list, so I really needed about 5,000 fingerlings to make a selection for a fish that always better than the best of the previous generation.

Also, the way that improvement of the group of fish in each generation worked was, when I found an exceptional fish that was one in a thousand; it would take at least ten generations to boost the number or percentage of individuals exhibiting this improvement so that 10% of the individuals were as good overall as the improved one was ten generations earlier. As the appearance of the fish got better and better, and redder, the difficulty of getting to this improvement so that it was exhibited in a high percentage of the fish, seemed to increase.

So now, instead of it taking 10 generations to get 10% of the fish to be as good as the best from the current generation, it may take 12 or 13 generations to get to 10% being as good as the best from the 100th generation. That is 3 to 4 years under normal breeding conditions.

People who say they prefer a fish that has a brilliant red color with no spots, may know what they want, but have no idea of the genetic efforts it takes to get there. It appears that the difficulty lies in the number of gene sites involved in the development of color. I believe there are at least 6 sites in each set of chromosomes and possibly several more. I believe that under normal conditions, each site causes or prevents color development, and when the tilapia mossambica is being bred for color, the selection process must deal with the probability of inheriting each of the 12 sites in a single fish.

I had always known that people would be able to produce inbred hybrid gene lines, from the mixed sex fingerlings I was selling, but never quite expected for them to all claim that they had come up with the colored tilapias on their own. After all, I was, and still am, in the process of developing a really go odd colored strain within the pure gene line t. mossambica.

I knew, no matter what, that as long as my gene lines remained pure (which I have taken great pains to be sure of), that the value I was building into the developed strain

would continue to increase. I feel that until I sell the last pure t.mossambica red, with the most improvement in color and body form, that I am building a sort of genetic treasure.

I followed up the "Golden hybrid" photo advertisement with new photo advertisements, in Aquaculture Magazine. These appeared almost annually, and showed the rapid improvement of color, that I created with my selection methods.

When I ran the first advertisement, I got a small number of inquiries almost immediately. (The day it ran, or within a few days after the mailed copies of the magazine had time to reach subscribers. Then I would get inquiries that came as much as a year and a half, or two years after the Advertisement had appeared.

The later inquiries were usually from government or fisheries departments in various countries, who were apparently conducting research in their libraries, and uncover old issues of Aquaculture magazines that they had on file.

AN ANGEL APPEARED

Another kind of development began to happen. Various people who wanted to learn about tilapia and how to breed them approached me. In April of 1978, one of the people who wanted to learn about tilapia was a very beautiful young dark haired girl who was the daughter of a Greek Restaurant owner. She said she wanted to work with me and learn all she could about how to work with tilapia, she asked if I would teach her what I knew about how to raise tilapia, in return for her being free labor, she said she would do anything and what she wanted to do was to take the information she learned and find somewhere she could go, such as an orphanage or group of people who needed better nourishment and pass on what she had learned to them so she could be a part of spreading the word on what tilapia could do by allowing people to feed themselves.

Her name was Diana Popolous.

Diana is a very pretty woman, and when she first came she was in her early 20's. She said that she wanted to become knowledgeable about tilapia, how to breed them, how to grow them, and how to prepare them. She said that, after I felt she was ready, she would appreciate it if I could tell her where to go, and how to put her knowledge to use.

She said that she could not pay me, but that she would get a job and work to earn what money she needed. She said she would come to work with me in her spare time, in exchange for the training. Since she was a waitress, she felt that would leave her plenty of time for working on the farm.

So, Diana Popolous got a job as a waitress, on Bradenton Beach, at a restaurant by the name of Pete Reynards. Then there was the question of where she would live while this was all taking place. I talked it over with Jan, and at Diana Popolous' suggestion, we prepared a place in the attic of the big fish building.

I told her that I would be very willing to have the help, and that I would teach her how to tell male tilapia from female tilapia, so she could set up or check her own breeders when it came time for it.

We went into South building, and went up the stairs located on the back wall, and then we faced South. There was a space about 14 feet deep and about 40 feet wide. Only about 12 feet, or so, had enough headroom to stand up in, but the whole area could be covered in plywood, and then we could lay down a carpet, which would cover a little over 100 square feet. We found a sleeping bag, and a nightstand that held a small lamp, and managed to string up an extension cord that reached to where the lamp was. Diana thought that would do just fine for her to stay in, since she would only be sleeping there. We also got some 4 ft x 8 ft plywood to make a floor, and used some to partition off this space from the rest of the attic. It was very much like a small room, and since it was located above the fish tanks on the backside of the building, the room got a lot of warmth from the moist heat that rose from the tanks.

Diana got the job working at the restaurant, and she went to work every day, and was there every day to learn and work on the farm. Working with me, she began to learn

about tilapia, and how to tell males from females, and how to select the best breeders. I taught her as much as I could, about how to grow them, and take care of them. She gave us a small amount of money each week, to cover groceries, and ate with us at breakfast and dinner.

Diana showed up at our farm in the spring of 1978, and by January she had learned as much as she needed to know, to go out and find a group that could benefit from her knowledge.

The day before she left my farm, she asked me where she should go, to bring what she had learned to people who needed it. I told her that I did not have anywhere specific in mind, but that if she could go to someone who sponsored an orphanage, or an orphanage itself, that maybe they could pass on the ideas and knowledge she had learned.

She left the next day, and I did not hear from her for several months, until she called to say she had registered at the University of Arizona. She had met someone there, (a professor), who was writing a book about an orphanage in Mexico. He had offered to take her with him to see it, when the semester ended.

Several months after that, she called to tell us that she had gone to the Orphanage in Mexico, in Quernavaka. She had told them about her ideas with the tilapia, and while they had not decided on anything yet, with respect to the fish, they had offered her a job teaching the children. The name of the Orphanage was Las Nino's Pequinos, and was run by father Wasson, who had started the orphanage, when someone had left an infant at the gate. They had taken the baby in to care for. Once the local people heard about Father Wasson adopting the baby, other people began leaving children, and the Orphanage grew in numbers. Other people volunteered, and within the next couple of years, the number of children grew to over a hundred.

Early on, father Wasson decided that, once they accepted a child, they would provide each child with an education, and would not allow the children to be adopted out of the orphanage. So they developed an internal school system, which schooled the children, up through high school. The school became very exceptional, and attracted many people to it that wanted to help. One of these was the author of the green revolution. By the time Diana joined them, there were 1,800 students, and over 100 people helping.

So Diana was very impressed by all of this, and eagerly accepted the job. She told me that first, she would live there until she learned enough Spanish to be fluent. We did not hear from Diana again for almost a year, and then she called me one day, and told me that the Orphanage had agreed to allow her to build a fish breeding and growing system.

Diana called me, and arranged to visit us several times over the next year, as she drew up her plans for the project, and then when she began construction. She brought me drawings of the hatchery design, and the breeding ponds, and 3 one hectare growing ponds. We went over the plans, and I was able to make several suggestions, on how to construct the drains, and how much aeration would be needed. I had agreed to supply

the breeders for the project, and was waiting until she had everything in place, for her to tell me to send the fish. We had agreed to supply her with 100 female t. mossambica, and 20 supermale t. horonorum. These were the natural grey to black fish, and produced an all male hybrid, which would yield a good size fillet from a one-pound fish.

When we designed the project, we had included the all male hybrid, so as to give them the best chance of producing enough large fish to feed the kids a couple of meals a week, out of their own ponds.

In September of 1979, in the evening, on a Friday, Jan answered the phone, and a voice on the other end said that she was a secretary in the Department of Fisheries, with the Mexican Government. What she said was, that she worked in the Departamento De Pesca, and that the Mexican Government wanted to buy 5,000,000 fingerlings. Jan shook the phone and said, "I'm sorry but there seems to be something wrong with the phone."

MEXICO THE DEPARTAMENTO DE PESCA

Sometime around August of 1979 I was called by a gentleman who said he was with Charter Oil and could I supply them with some photographs of the pure gene lines of tilapia that I had along with some information about each one so they could sell a client on a project that they were working on. They said that if I would call a gas station located in Hillsborough County that the owner of the gas station would pay me for the photographs as soon as I could deliver them. I said sure, but they would need to send me the money first and then I would get the photographic work done. I called around and found a Photographer by the name of Ted West who could come to my farm and would take the photographs that I wanted. He gave me a price and I called the number left to me by the gentleman from Charter Oil and told him what the price would be. He then had the people at the Gas Station Deliver the cash to me the next day and I had Ted come to my farm and we took a series of photographs that included my red butter-ball strains and my red strains and my t. hornorum strains. We took about 100 photographs and when they were ready I went to the studio and went over the proof shots and picked out the best photos, and had Ted make several copies and put one copy of each photo in an envelope and mailed them to the address that the man from Charter Oil had given me. On September 5th of 1979 on a Friday evening, Jan answered the phone and a voice on the other end of the phone said that she was a secretary in the Department of Fisheries with the Mexican Government. She said that she worked in the DEPARTAMENTO De PESCA and that she had been asked by the Director, Dr. R to call me and get a price, and that the Mexican government wanted to buy 5,000,000 Red hybrid fingerlings. The lady asked Jan if she spoke Spanish and Jan said only a little and the lady began to rattle on about fish, and told her again that the Mexican Government wanted to buy Five million fingerlings. Jan shook the phone and said I'm' sorry but there seems to be something wrong with the phone and she handed me the phone and the Lady said to me that my wife had heard her right, there was nothing wrong with the phone and that they really wanted to order Five Million red hybrid fingerlings and could we supply them? I thought about this for about ten seconds, I remember some of the thoughts that went through my mind, They wanted a large supply of fingerlings, they would not want to pay the cost of transporting that many fingerlings, but if I could talk them into buying F-1 parent stocks and setting up their own breeding program and provide training for hatchery managers, that would give us time to could build up our supplies of breeders and provide them with enough brood stock to produce five million fingerlings and more.

I then said to the Lady, "Sure, we can supply you with five million fingerlings, no Problem." And she said "when can I have someone visit them in their government offices in Mexico City," and I said "I will have someone at your office on Monday morning, on the 10th of September, " and she said "fine, we will be expecting your representative," and then she hung up the phone.

Jan and I just looked at each other for a few minutes and she asked me if I was crazy, because she knew we did not even have ten thousand much less five million. I explained to her that what the Mexican government obviously wanted was a supply of fingerlings to put into growing ponds and that it would take a couple of months to close the

deal anyway and that my plan was to convince them that what they wanted and needed was a good breeding operation and that I could produce enough breeders if I could get us at least six months to breed them and that what I had to do now was to get hold of Diana and Allen and see if they could go to the Department of Fisheries office in Mexico City so we could have them make a presentation using the information I had furnished them to show to the people in the orphanage.

I said we need to call Diana and Jan agreed, so I tried to call the number Diana had left me on her last phone call, it was a place where both she and Allen could be reached. I was unsuccessful in getting through so I asked Jan if she had any ideas and she came up with an address that Diana had left that we could reach by telegram and so I called Western Union and asked them to send the message that I needed to talk to Diana about a pending contract with the Mexican Government. So we went to bed that night hoping that I had gotten a message through. Then at around ten am the following morning the phone rang and when I picked it up,

Diana was on the phone and I said "so, you got our western Union and that is why you are calling us?" Diana said "What message?" and so then I explained what had transpired the day before and that I had hoped that she could, or her and Allen could get in their car and go to the department of Fisheries in Mexico City on the following day and see if they could make sense out of what the Government wanted and to see if they could make an offer that would be acceptable. She then said that she had just had a feeling that she should call me and so they had gone to the pay phone where they were calling from. I explained that I had sent her the Western Union and she said that they had not gotten that message, but had felt the need to call and so there we talking when I had had no way to reach her if she had not called. I told her that what we needed was for someone who understood about how to breed the fish and what the fish could do to go to the Mexican Department of Fisheries and tell them about what our fish could do. She said "wait a minute, let me put Allen on the phone and you explain it to him" so she handed the phone to Allen and I explained again how the lady from PESCA had called and asked for Five million fingerlings and I had told her "no problem" and that I would like Allen and Diana to go to Mexico City as representatives of Natural Systems and see what kind of a deal they could strike for us. Allen said "let Diana and I discuss your proposition, and we will call you back." So I said "by all means, just call me back tonight so I can have everything to you on time if you do it." Allen said OK he would call me back and they hung up the phone. I paced nervously as I waited for their call, and after what seemed like hours the phone finally rang and I answered it. Allen said "we will do it but we have several request to make" and I said make them. What he asked for after that was just that we supply the fish that Diana would need when she was ready and that they could come to Florida, together, if the Mexicans decided to make an agreement with us. And I said that I had one condition to make too and that was that if there was any money to exchange hands that I would pay Allen and Diana 5% of the proceeds that were paid into Natural Systems from the Mexican Government. I told Allen that I would feel much more comfortable asking him to do whatever needed to be done if I knew we would be paying him for his help. He agreed that that would be fine and he was willing to work under those conditions. We then worked out how we would commu-

nicate the next day and they signed off. Now, Jan and I had a lot to get done and one of the first things was a call to my mother to tell her about the request for a price from the Mexican Government for five Million fingerlings. I realized that what I had in my hands was an opportunity. I had trolled the international market for tilapia and one of my photographs of the red tilapia had gotten a Hugh nibble so now I had to figure out how to turn the nibble into a catch. I told mother about the call and that I would possibly have to go to Mexico to work out the details of how to make an offer to the government of Mexico. Mother said she would have to think about it for a while and she would call me back. She had been virtually supporting almost all of what I did now for almost 5 years and so it was important for both of us that we did this right. A day or two went by and then she called me and told me that she knew of a Law firm in Tampa by the name of Shackelford & Farrier and that she understood that they had several lawyers who were skilled at doing contracts with foreign firms. She had made an appointment with Jake Dyal and we (Mother, Jan and I) all went up to Tampa and we sat down with Jake and explained what we had been doing and what we thought we wanted to do with Mexico. Jake was interested and said he would take us on as client and would work out payment from the proceeds of the project, but he would like to learn as much as possible about the fish before proceeding with negotiations. Jake then came down to our farm and we showed him around and explained the various aspects of tilapia to him and showed him the gene lines from which our breeders are produced. He then grilled me about how you put a male from one species with a female from another species or gene line and that was how a hybrid was produced. I also explained that there was only one way to breed the all male hybrid and that was using the female t Mozambique and the male t honorarium. The opposite cross gave male female ratios of 50/50 and while the hybrids all had a red color because of the dominance of the red genes the sex of the fish was half male and half female. This hybrid was a good growing hybrid and had the robust body form of the t. hornorum and a faster growth rate (both male and female) due to the effect of producing a hybrid, which benefits from the phenomena of heterosis. Heterosis is that extra oomph that a plant or an animal has that makes it grow faster, get bigger and be stronger than inbred animals. So, if a hybrid fish has the advantage of heterosis a sample of the fish will grow faster get bigger and be stronger than a sample taken from the inbred gene line.

In general when two lines of fish that are separate species are bred, the offspring exhibit heterosis, but not in all cases. The hybrids produced by crossing t. hornorum with t. mossambica does show considerable heterosis. This means that as long as the fingerlings are prevented from breeding that they will produce edible sizes much faster than fingerlings from the pure lines that do not have heterosis. This is true even for the female hybrids, but if breeding is allowed the offspring will divide the available nutrition by the total number of fish produced. So, by preventing breeding or creation of a situation where offspring are eaten by other fish the total growth rate of the f-1 hybrids can and will be considerable. What this meant was that we could set up a series of hatcheries for the Mexican Government. The Pure line hatcheries would produce the males and females of each of two gene lines, which we would sell the starters for. My idea was that we would set up a hatchery in one location to produce the Red gene line and in another location to produce the pure gene line of the t. hornorum. We would also include in our sale a training program for the technicians and technical items. In all we would sell both

gene lines and the training for two million three hundred thousand dollars. Much of the work to make the sale was done by Jake Dyal, my attorney but also a great deal was done by Allen. In all it took just a little over a year to complete all of the agreements and get everything decided on and signed. Jan and I took twelve or so trips to Mexico during the negotiations and the Officials and technicians took a number of trips to our farm in Palmetto during this period. There were several interesting events that occurred during the negotiations. The first incident occurred when Allen and Diana attended a fisheries conference about 2 months after we began negotiations and while they were at the conference some people with sets of photographs of pure line tilapias that they wanted to make a contract to sell to the Mexican government. Diana called me from the conference and said they were pictures just like the ones they had and wanted to know what that was all about and I thought for a minute and remembered that I had sold the photographs to Charter Oil a few months back before the negotiations started. So, I told her, don't worry, because they don't have any fish and have not made any arrangements to buy any and if anyone in the fishery ask about it tell them to ask the people to show them the fish. That seemed to take care of that problem for a while. Once when we were about four months into negotiation and were in a meeting in Tampa that was attended by the fisheries people, Jake Dyal and myself, I got a call from Jan who had just had a visit at our farm by a very strange individual. He had arrived at my farm on Highway 41 in a Lincoln Continental, which he referred to as a Jewish Canoe. He had talked his way onto the farm by insisting that he be allowed to speak to Jan and when he got to her he announced that I needed to hear what he said and should hurry home from my meeting. We had almost finished our talks for that day and so I headed home. I told Jan not to let him onto the property until I was there and then we would call him. When I got to the farm, I drove back to the mobile home we were living in and went inside and Jan told me that the guy was a real weirdo. Just after I arrived he called and Jan put me on the phone. He introduce himself as Mr. Rollins and he said to me that I would really want to hear what he had to say and could he come back to the house and talk. I agreed to meet him up front by the trailer we had bought to turn into an office so we would have a more official look and I walked up to the front of the farm and his chauffeur drove the Lincoln up to the gate and I greeted him and he invited me into his car to ride back to the mobile home. I got in the back door on the passenger side and he sort of rolled toward me and extended his hand to shake mine. I shook hands with him and he began to ask me questions about whether I had made a deal with the Mexicans yet or not and to tell me that he hoped not because they were a bunch of commies and it would be very bad to make a deal directly with them. About when he got going we arrived at the house and I got out and Mr. Rollins sort of rolled out his side and waddled up the stairs to the front door. He must have weighed 350 to 400 pounds and was only about 5 "6," He was still going on about how risky it would be for me to make a deal directly with the Mexicans. I offered him a chair that was between the dining area and the Living Room to sit in and he sank gratefully into it. He motioned to his driver to sit on the couch located on the front side of the room, Then I asked him what he thought I should do if I did not make a deal and he said that he had just the answer.

I asked in as polite a way as I though possible just what he could do for me that would be better than two million dollars in my hand? And he said this as he pulled out of his

pocket a package of matches. He asked me for a glass of water and I got one for him and he submerged the matches in the glass of water and then took them out and pulled off one of the matches and attempted to light it on the side of the match pack. He tried three or four times and could not even get a spark, at which point he said that it had always worked before and that he had the patent on the only waterproof matches in the world and that he would share the patent with me in exchange for selling my fish to him and allowing him to sell them to the Mexican Government. Our mobile home was located toward the back of the farm and was surrounded on all sides by ponds that we had stocked with various tilapias. We had problems keeping the birds out of the ponds and one of the ways I dealt with the birds was to fire a 38 revolver at them out the front door or the back door using shotgun bullets that were filled with small pellets that would not even break the skin when and if it hit them but the loud bank helped to send them on their way. Anyway while he was talking, I noticed that quite a few birds had landed in the pond just to the front of the house and so I asked him if he would excuse me for a minute and I walked around the corner into the dining room and got my pistol and walked back around the door carrying the gun with the barrel pointed down at the floor to be safe. As I walked into the room the driver looked over at me and leaped into the air at such a speed that the large gold necklace around his neck almost flew off and ducked behind the couch and Mr. Rollins took on a look that I will probably never forget. Then I realized that they were frightened by the gun and did not realize what I was doing so I explained that the gun was to scare the birds away from the pond and I walked to the front door and opened it and fired about 3 or four rounds. Anyway, after that I simply said to Mr. Rollins that I would think over his offer and would be in touch in a couple of days. I of course was not interested in his waterproof matches and since he did not want to come up with any amount of cash that would be of interest to me I was not interested in speaking with him again and strangely we did not hear from him again. I went back to the meetings on the next day and for several days after that and we were able to work out the basic details of how the contract would work. Basically we would charge the Mexican Fisheries Department for each breeder fish that we sent and they would authorize an irrevocable letter of Credit payable on a site draft invoice which meant as each box of fish was shipped that we would be paid a portion of the total on the contract and we agreed to include in that total all of the cost for training and for hatchery supplies that we sent to Mexico. The next incident occurred on a trip that Jan and I made to the fisheries department in Mexico City where we met with the director and his staff. We went over the details of the contract and I answered every conceivable question and we got to the day when the final signing of every one was to occur and I woke up sicker than a dog. I was hurling and I was loose as a goose, and on top of that I had a raging headache and felt weak as a piece of spigot, and I did not see how I was going to make it to the signing. Jake Dyal, came to my room and observed my condition and since he had put this contract together piece by piece, he was not going to let me blow it at the last minute and so he called a Doctor to come up to my room to treat me and I wondered aloud how anyone could do anything when I felt that bad. The doctor came in and looked at me between hurling sessions and took a big hypodermic out of his bag, filled it with a clear fluid, (I still wonder what it was) and had me turn my butt up to receive the whole dose. In about 7 minutes I was wide awake, my diarrhea and my throwing up had stopped and I felt like I was on top of the world, and I went to the sign-

ing and enjoyed the process immensely, although I sort of felt like I was moving in slow motion and kind of swimming through the whole set of meetings. Whatever the Dr. had given me was like a miracle and if I ever get the chance to find out what he gave me I will be grateful for the information. Then we all went back to Florida and waited for the final approval of the Mexican Government and we continued to make ready for the project to begin. After about two months I got a call from someone in the accounting department who wanted to know if I had authorized any release of any funds because they had a copy of a piece of paper which seemed to authorize release of about \$200,000.00 to a Mr. Robins and I almost screamed no, but I held my temper and said that I had not authorized any such release and that they should send someone to see his fish before believing any such paper. The people at the Fisheries Department asked that they be flown to where the fish were and when they got there were no fish. A few weeks later we finally go the go-ahead to begin shipping and I thought our money problems were over.

SERENDIPIDTY AT WORK



This picture shows four small ponds lined with concrete. Each pond has a built in drain. The small pipe to the left inside the pond is standing inside a fitting and water is put into the pond until it reaches the top of the pipe and spills over. The water then drains to the ditch, which is to the left of the pond and is below the bottom of the pond. A screen is placed around the drainpipe to prevent fry from escaping. Diana who came to my farm and went over them with me did the design of this pond and then the ponds were built to her specifications by the local help. Ten cages with groups of breeders were placed into floating cages in the pond and the fry that were produced inside of each cage each week left the cages and were fed and allowed to grow in each pond until the end of the fourth week and then the fry were harvested by removing the pipe, draining the ponds to about four inches and then using a net to seine the fingerlings which were then moved to one of the growing ponds located to the left. By the end of four weeks the fry had become fingerlings that were about 1.5 inches each and weighted 2 or 3 grams. The pond was allowed to dry out for several days and then the water was replaced and the cages containing the breeder stock were moved back into the pond so the fish could breed again. The tanks located to the right toward the back of the picture were used to put the fingerlings in so they could be counted and sexed if need be before they were placed in the growing pond. Upwards of 10,000 fingerlings could be produce in each of these ponds and one of each of the ponds was emptied and put in the growing ponds each week. This meant that this small simple hatchery could produce up to 10,000 fingerlings to be grown each and every week during the breeding season.





Now that we had made numerous trips to Mexico and had participated in numerous negotiations all of which cost a lot of money because while we were negotiating we were doing so with people who mostly had government salaries and whenever we met we almost always met in nice upscale restaurants and we always paid the bill. This was expected of us because of the fact we were negotiating the contract and of course the people we were negotiating with simply for the most part had little or no money to spend. The only reason we were able to do this was because my mother had expanded a mortgage on her condominium that allowed her to borrow and make available to us over \$100,000 over a period of a year or so, using that money I had made a deal with the attorney, Jake, and had hired several other people who were very helpful in getting the contract. Diana and Allen agreed under protest to take 5% of the contract when they first agreed to help us, and I made an agreement with everyone I hired that they would be working against an agreement that would allow them to be paid when the contract started yielding money and would be contingent on an amount that could be covered by the actual cash flow and that they would be getting only expense money until then. Allen and Diana both agreed to this and even signed an agreement to that effect. I insisted that they agree to an amount and I told them that I did not care if they donated it all to the orphanage, but that I wanted them to have the money if they did the work. From my point of view this made it much easier to ask them to go the various Offices of the Mexican Government that it was necessary to go to in order to pursue the various parts of getting the contract done. It was during this first year of getting the contract that Diana completed the two hectare growing ponds and the hatchery at the orphanage and was ready to receive the Breeder tilapia. We had to ship the breeders to them and go through customs to get them there and that proved to be a very tricky process. Here were the string of events that operated sequentially to create the situation that culminated in us getting the contract with the Mexican Government. If Diana had not come to my farm and had not talked me into providing her the proper training (1), which I did,

and then had not gone to Arizona (2) and met Allen (3), and if Allen had not taken her to Mexico and the Orphanage (4) and if she had not agreed to work for free for the orphanage she would not have stayed for the year and a half it took to convince the orphanage to allow her to set up a breeding and growing operation (5) and she would not have been prepared and available to go with Allen to the Department of Fisheries (6) and they would not have been available to represent themselves as agents of Natural Systems Inc. (7) and Mike Sipe to Pesca. Looking back on the contract. On top of this if Diana had not called me the very next day after we had gotten the call from Pesca and had not been with Allen and Allen had not agreed to go to Pesca and represent us I believe there would not have been a Mexico contract.









So completing my agreement with Diana to get the breeders to the orphanage in Cuernavaca was very important to us. We got the breeders there with Allen's help to get them through customs and into the breeding ponds where Diana then took over the breeding and stocking of the breeder ponds and the growing ponds. Four months after we got the breeders there, The students of the fisheries class harvested enough fish to provide a fish fry where everyone in the orphanage got at least one fish to eat and we have pictures of the event which show an eager young boy holding up a thoroughly fried fish with a huge smile on his face, getting ready to bite into the thoroughly fried fish. We have checked back with the orphanage from time to time and are told that the fish project is still supplying an essential portion of the protein part of the diet of the children at the orphanage and that several students have been sent on to college to study fisheries.





PUTTING A TEAM TOGETHER

Once the cash flow started we quickly sought out and hired a team of around 25 technicians to help us do every thing that we needed to do to fulfill the contract.

The actual contract called for us to put in 18 hatcheries in various Mexican States and to house and train 22 technicians that would be responsible for breeding the tilapia and growing the fish. I looked for people who had experience with fish and fish farming and who spoke fluent Spanish.

We hired in all about 23 people to help us do this contract and we hired each person for the duration of the contract.

There were several stipulations or requirements written into the contract which we found to be a bit off track but since the Mexican government was concerned with them we were concerned with making sure that we could prove that we had complied.

One of these was that the tilapia shipped to Mexico was disease free and had no parasites. None of our tilapia that we had raised over the past 4 or 5 years had ever had any disease and the presence of parasites was determined by factors such as the age of the fish and whether any other fish had been in the water used to raise them.

Early on I realized that just the fact that we had not had any diseases and so had no concerns was not proof that our tilapia were disease free and so when we found someone who specialized in fish pathology who was willing to join our staff and verify that our fish were disease free and obtain any necessary paperwork needed to guarantee this to the Mexican government, we decided to hire him and offered him a good salary that was a good deal higher than he could make working as a private fish pathologist.

My studies in entomology had given me a little insight into what could be responsible for the lack of diseases and parasites in tilapia bred and grown in The United States. Since the origin of the tilapia was Africa and the people who originally imported the Brood stocks from which these fish came held them in quarantine to be sure they were not diseased or carrying any disease and then shipped them in water that was clean and medicated to make sure no pathogens were present should have shipped disease free tilapia, then when they arrived at their new home they would be basically free of any diseases that might exist in their native habitat and which they might have carried with them had they been simple shipped without screening.

Of the millions of species of plants and animals that make up the Flora and Fauna of this world of ours, almost all have evolved simultaneously with very complex relationships that exist between them and the various bacteria, amoebas, viruses, fungi, hydras, crustaceans, nematodes, helminthids, and flagellates and any other pathogenic agents that inhabit the environment from which the species have been taken.

In part the fact that native species of animals and plants (NAP) for Native Animal or Plant, have diseases which have evolved in many cases, special adaptations that allow the disease to be able to infect that particular organism and probably not others that are

not closely related to the infected animal or plant. I would call this disease organism an adapted pathogen-control agent (AP), for Adapted Pathogen. Once a (NAP) is moved to a location that is far enough away from the evolved pathogen (AP) so that accidental exposure to reproductive organisms of the (AP) can not occur, the (NAP) is then safe from the AP. the (NAP) is not immune to the (AP) but because it will not be exposed to any reproductive spores or cells of the (AP) or other mobile infectious agent it simply will not have the chance to become infected since it now lives in a new neighborhood that does not have the disease.

Since most (AP) spores are dependent on wind or waves or direct contact or transmission from an intermediate host, in some manner, with a new host for the infection in order to attach itself and create an infection in the (NAP), moving the (NAP) from one island to another creates a situation that is almost insurmountable to the (Adapted Pathogen) since its transmission agents simply do not travel that far and this fact is therefore very difficult to overcome.

So, mankind's movement of various plants and animals away from areas where they can be described as part of the local environment and have had the evolutionary time to have created it's own set of (AP)s to a new location where agents of the (AP)s cannot easily reach and probably not evolve for a millennium or two, have created situations which are "better" at least better for the moved (Native Animal or Plant) which is by then a Moved Native Animal or Plant or an (Alien Animal or Plant or AAP) and the (AAP) can be reproduced and grown without the bother of fighting off the pathogen which is now no longer in the neighborhood.

Most Farmers use the yield In terms of pounds per acre or other volumes of yield when measuring the quantity of yield. An (AAP) generally yields many more pounds per acre and at a much lower cost, than a (NAP) because the Native Animal or Plant needs to be protected from those parasites and diseases which exist in the same area the (NAP) is being grown in, where as with an Alien Animal or Plant the parasites and pathogens simply are not in the neighborhood.

A successful (AAP) movement to a secure location means a possible increase in production of enormous proportions if the (EP) was successfully controlling the (NAP) in the old neighborhood because in the new neighborhood the Animal or Plant now has no effective pathogens and so can grow without the grower worrying about any need to protect it and still produce enormous yields.

Many examples of (AAP) explosions exist in entomology because insects are one of the best (AP)s that are able to almost totally control the overgrowth of a (NAP). Generally the (NAP) is a plant and the controlling agent or adapted "Pathogen" is a specific insect that has evolved specialized methods of eating the plant so that when the insect is allowed to go to it or reproduce without limit, the plant on which it is reproducing can be almost totally decimated. When this happens the insect that is responsible is called a pest and due to the fact that there are no good parasites or diseases in the neighborhood that are controlling it then attempts are often made by growers of the Alien Animal

or Plant to control the insect which is now controlling the (AAP) being grown by the human grower, with some sort of chemical such as DDT.

In other words the grower of the Plant or Animal that has been moved to an area where the Plant or Animal is not native which makes it Alien to its present area of cultivation, and because of that has not had any pest or parasites which exerted any measure of control over the growth, and because of that the Plant is yielding good crops, but now an insect has managed to travel where the plant is and is reducing the yield a lot. What then happens is that the grower attempts to apply a chemical such as DDT to control the insect that is now a pest.

When a chemical such as DDT is applied in sufficient quantities to kill most of the insects that are destroying the Alien Plant, they often present other hazards to the environment.

Since the Insect is taking away all of the advantage the farmers created by moving the (NAP) away from its native habitat and thus away from the Adapted "Pathogens" that control the (NAP) in its native area this is viewed as a serious threat and the application rates of the chemical are generally increased until the survival rate of the (AP) is very low. The farmers generally keep applying the chemical as often as necessary to keep the production of the (NAP) in the profit zone.

Unfortunately this application of a chemical at the rates necessary to create a 98% or better control of the insect or (AP) creates an environment where the 1% to 2% of the surviving insects have slightly higher amounts of whatever it takes internally to overcome the effects of the chemical and so when they reproduce they pass on the genes that create the extra survival ability of the insects and then the next generation of (Insect Pest)s have a slight increase in the number of individuals with the right stuff and each generation becomes stronger and stronger when measured by the survival in the presence of the chemical.

So, it is a long way around to explain why my tilapia were disease free, but the best explanation was that because they had been removed from Africa in a manner which would allow for very little opportunity to bring out of Africa with them any of the organisms that had evolved over eons and millennium in close proximity to the ancestors of the fish and in the new environment there were not many opportunities to expose the tilapia to any diseases which had any chance of going through the complex process of becoming a pathogen that could specifically infect any of the tilapia that I had.

In other words the tilapia were moved well out of the neighborhood where they would have any diseases or other control agents that could create a high mortality and so they would simply not have any diseases.

Another reason why my fish would tend to stay clean with respect to the potential pathogens in the Florida environment is that they were and are kept in tanks where the only source of new water is and was from a well that came from 300 to 500 feet in the

ground and had no opportunity for pathogens to release any spores into the water before it reached my growing and breeding tanks.

In other words my tilapia were not immune to catching diseases if they were exposed to any which had adapted over time to be infectious on the tilapia, they were simply not living where there was any noticeable amount of risk of exposure. In time the risk of disease could increase especially if people were continuously bringing new tilapia out of Africa and any of them arrived with active disease organisms and then the tilapia were exposed to those organisms.

In any case the gentleman who, was a pathologist and was available to work with us goes by the name of Ralph V. Ralph was and is a gentle soul and now works with a large retail outlet that deals with tropical fish and other animals, as their chief pathologist and is available on line to answer questions about the care and treatment of many kinds of tropical fish to both prevent and cure the myriad of diseases which attack these fish.

When Ralph came on board, he asked me if I had any information about potential or current tilapia diseases for him to read up on and I told him that I did not have anything that related specifically to tilapia but that I could supply him with several small books that I had on pathogens in tropical fish. He said he already had those, but that he would do a search with DiSearch, which at the time I believe was offered as a log in service by Lockheed, and see what he could bring up on his computer.

So, we agreed on a price for his services and he came to work at the Farm located on Highway 41 in Palmetto. What we agreed on that he was to do was to create a book or operations Manual from whatever he could find on the pathology of fish that would relate to tilapia and to make this book available for training and reference in Natural Systems.

We would then use this reference manual to train the Mexican Technologist who would be taught to use the manual as a reference to identify various organisms that existed in the tilapia and to be able to tell if any of them existed in the fish we supplied to them under our contract.

Now, since we had no known diseases in our tilapia, and to diagnose a disease in a tilapia the technician would have to find the organism in the fish and present this as evidence to prove that we had violate the contract, so in a way we were teaching their technicians the methods for keeping us straight but were supplying them with the reference material needed for doing so.

It took Ralph several months to put together the information for a reference manual to use to teach the Mexican Technicians, but it was note book size and had about 2 inches of printed and photocopied material in it and quite a bit of interesting material to read.

Now once we had agreed on the facts as they were for us then that there were no know diseases caused by other organisms we needed to present the technicians with methods and tools for determining any of the other conditions the fish would be exposed to.

To do this we decided to buy analytical kits from Hach which could help the technicians to determine the levels of minerals, nitrogen byproducts and other elements in the water so they could make sure that the proper conditions were always present when the tilapia were in the water.

We also bought a compound microscope capable of enlarging images up to 3,000 times so that individual microscopic organisms could be seen. Each technician was to be trained to prepare slides and to use the Hach kit to determine water chemistry as needed.

Also include in the Pathology Manual were charts for the use of various chemicals such as formalin which when mixed with water so as to create a solution of 2 - 25 parts per million, would kill such things as Trichodina which is a tiny Ciliate which commonly infects the gills and skin of young tilapia fry and fingerlings and which is very common in any of the waters which have had any fish in them. They cause death in small fish primarily by disabling the ability to remove oxygen from water by attacking the gills of young fish that have not as yet developed enough skin or epidermal layer to make it hard for the Trichodina to effectively attack.

While infection of the gills from Trichodina of tilapia fry is not technically a disease, but is really more like fleas on a dog, still, knowing what to do when it occurred and understanding when that is I felt was important and so we included a section on that to teach in the course.

By mixing commercial Formalin so as to end up with around 25 parts per million of Formalin and then putting the tilapia in a net and dipping the net with the fish into the solution and allowing the fish to stay in the mixture for around five minutes or so up to 98% of the Trichodina could be knocked off and would die in the solution. If this was followed up in a couple of days with another dip the Trichodina could be reduced to a level that was or is not a concern to the fishes good health and they would be virtually undetectable if the fish were checked for the parasite.

When we shipped breeder fish, we made sure that the Trichodina were at levels below which they could become a problem.

The shipment of breeders of the t. hornorum improved body form gene line (black butterball) and the improved red t. mossambica and the red t. mossambica butterballs was done at sizes where we could get the maximum number into each box and insure the best survival when the boxes got to Mexico even if they took a couple of days to clear customs.

So, if we categorize what we were selling to the Fisheries Department of the government of Mexico we would be selling them: Training Program: 1. A training program for 22 technicians and supervisors which would include: A. training in the basics of handling fish and packing them for shipment. B. Methods of breeding fish and selection for improvements C. Building cages and breeding pen for breeding both the pure gene lines and the hybrids. D. Use of the Dhl -22 Hach kit for determining chemical levels in the

water E. How to perform maintenance on the air pumps sent with each hatchery package.

2. Design program: Program for learning the design criteria for building cages and pen

3. Selection Program: Program for teaching the selection criteria for each species so that the improvement process would work for the Mexican government after the breeders were moved to their locations in 18 States in Mexico and to two central stations.

When the technicians arrived for training we had one person assigned to take care of them who spoke fluent Spanish and we had a training supervisor who met with them each day and saw to it that they were each at the place for that day learning whatever we had assigned for that days experience.

Meanwhile we were using many of the 100 ponds located on highway 41, breeding pure lines and increasing the number of Red Red, Black and Red butterball brood stock we had available and making plans to ship them to Mexico.

One of the things that Jake arranged for us was that we would get paid on the whole contract based on the actual number of fish we shipped. The reason for this was that contracts for services are difficult to write and proving you have delivered the service can be difficult so he included the payment for all of the services and equipment in the price charged for the fish, so, if they took all of the fish then we could be sure of getting paid for everything.

Each batch of fish that we shipped would be worth a certain value and each time we shipped the airline would furnish us with a cite draft invoice which stated the number of fish and we would then fax this to Mexico and they would send notice to a bank in Miami where they had put the irrevocable letter of credit, that they were to pay us the amount called for on the invoice.

The first time we faxed the invoice to Mexico, we were told that the Bank in Miami had been sent the notice to pay us, but for almost two weeks we were unable to get confirmation that they had the money. I called Jake and the Department of Fisheries in Mexico and they both said that the money should be there. As can be imagined I was very concerned about the inability of the people at the bank in Miami to locate our funds. I had Jan take me to the airport and took a plane to Miami where I got a taxi and then found the bank that was supposed to be handling the letter of credit.

I went into the bank and asked if they could help me and they sent me to someone up stairs in a back office who sent me to someone else and I finally ended up at the desk of a woman who was very put out and who finally located the documents after I gave her all of the references that were supposed to help locate it.

The amount of the first draft of the \$2.3 million dollars was over \$100,000 for the fish that had been shipped and had been in their office for most of that time, so I asked her what was the problem that she could not locate the letter of credit for nearly two weeks

and she said that I should be very grateful because they handled hundreds of letters of credit in a weeks time and most of them were for \$10 or \$20 million dollars so locating my little letter of credit at all was a very good thing. I explained to her that mine was a small company and we needed the money to pay our help and to pay for all of the items we had to put together to get the whole \$2.3 million. She backed down a bit and said for me to call her the next time and I would not have to go through all of what we went through on the first payment. She then wrote me a bank draft for the amount owed to us and I took it and got back in the taxi and went back to the Airport and then flew back to Sarasota and then went home.

So I came home with the first payment for our contract with the Mexican Fisheries Department and we went to the bank and deposited the money. At that time I went into the Bank and had a talk with the President and explained that I wanted each check I brought him to be divided into 3 amounts, one part to go into an operational account which would be used to pay for the various components we were putting together to send to Mexico and to pay salaries out of, Another that was essentially a savings and a third which was supposed to be calculated so that by the time we got the whole 2.3 million, I would have paid off the Mortgage taken out by my mother to help us get the contract. I was very careful to explain what I wanted and I asked the bank to take care of that process and they agreed to do so.

The subsequent payments were all handled much better and even though we did have to fly to Miami to get each installment, their Bank had no more difficulty in locating the Letter of Credit or paying us.

Over a period of about six months we delivered all of the hatcheries and did all of the training we agreed to and we went to Mexico and even sent groups of our people to each State where the hatcheries were to be installed and worked with the technicians to get everything going.

THE FRANKENSTEIN FACILITY

While we were taking care of getting the contract with the Fisheries Department of Mexico, and doing everything that led up to it, we were proceeding with other options in our business. One of the things we did was to make a contract with several people who lived in Miami, who had been considering buying a facility in Lantana, Florida that had been built about 10 years before by some investors who had hired German engineers who had conceived, designed and built a system that used all kinds of equipment to grow catfish. The two guys that contacted me were partners in the nursery business and had a lot of contracts with the city of Miami and others to deliver various things such as potted palm trees, and many other ornamentals, which they grew and delivered from various sites they owned in the general area. They had been offered this property to purchase and they wanted to hire me to go look at the facility and come up with a feasibility study that would tell them whether or not it would be financially feasible to upgrade their facility to produce tilapia. What they said they were interested in was the idea of growing our Hybrid tilapia and marketing them as "Cherry Snapper". At that time I was promoting the hybrid I called the "Happy fish" which was produced by breeding my best red t. mossambica males with t. horonorum females. This cross produced a lot of baby hybrids most of which had the body form improvement from the t. horonorum and decent red coloration which was fairly good on about 60 % of the hybrids and passable on another 20% and another 20% were splashed with a fair amount of black. The growth of the hybrid was excellent and we were getting good results out of our own tanks. The only thing wrong with this hybrid was that the fingerlings were mixed sex instead of being all male but growing them in high concentrations helped to insure that the females grew nearly as fast as the males and they were hybrids too and so they had the hybrid vigor. We had hired several new people who were in training at our farm in Palmetto, FL. There was Robert had a Masters in Aquaculture from Texas A & M. His name was Robert B and the other guy was Chris. Both Chris and Robert were bright and both had some background in Aquaculture but neither had a background in tilapia. One of the things that I was doing to grow fish on our farm was to use Dr. Hickling's suggestion of using Triple super phosphate to improve the algae bloom and to stimulate the growth of the tilapia and improve on the conversion. Robert had a bit of an attitude about his knowledge and so it took a bit of demonstration to show him how various things worked. He had studied the use of fertilizer in one of his classes and so when I told him how much to put in a pond, which was a two gallon bucket full of triple superphosphate, put into a cloth bag (burlap bag) and floated in the pond. I told him that this quantity was what was needed to turn a pond green, that is to stimulate the algae growth to the point the pond was nice and green. I told him this much was needed for a 33 feet by 80 feet by about six feet average depth. He indignantly said that was way too much according to his what he had learned at Texas A & M. The article by Hickling, in The May 1963 issue of Scientific American, said "We are thus able to produce all-male populations to stock the raising ponds, with no waste of female fish and none of the trouble and risk of sexing the fingerlings. To cap these advantages, our hybrids exhibit hybrid vigor, growing twice as fast as either parent stock. Generally they grow to a weight of about one pound in six months and yield a crop of about 1,200 pounds per acre per year with no other encouragement than the fertilization of the pond with 20 to 30 pounds of triple superphosphate per acre." So, even Hickling would not know to use 30 pounds of triple

superphosphate per pond instead of per acre, but my experience had led me to gradually increasing the amount until I reached the level I was suggesting. Rob, however choose to differ and even though I was his boss I felt it was better to lead him to the correct solution than to force it on him. So, I said you take this pond and I will take the one over two rows away, and you put in it what you think will work and I will do my pond my way and we will see who's works first and/or better. I put the fertilizer from the 2 gallon bucket (which weighed about 18 pounds) into a bag and floated it on the pond by tying a string around the burlap bag and tying the string to a piece of Styrofoam. The bag was then attached to a 1/8th inch nylon That way when the wind stirred up waves the Styrofoam would go up and down and the bag would be pulled up as the Styrofoam was lifted up on a wave and then it would drop as the wave passed on, this constant up and down motion would make the Triple superphosphate inside of the burlap bag dissolve. Also I had been told that if we just threw the fertilizer into the pond and it settled out on the bottom that a good portion could be locked into the soil and never dissolve and provide phosphorus to the algae. Rob got out his books and his calculator and went and put in several pounds. By about the 3rd day my pond was turning rapidly green as the phosphorus was sucked up by the algae floating and multiplying in the pond, Rob's pond still showed no change. So rob went back to his calculations and put in another couple of pounds. After about a week my pond had reached a point where you could not see your hand when you stuck your arm in the pond up to your elbow, his pond still showed no progress. By this time Rob was very upset and he came to me and asked me why my pond was doing so much better and I told him that when I fertilize a pond here in Florida where the soil was essentially coarse sand the water that saturated the sand stretched out for many feet in all directions and the fertilizer had to be enough to fertilize not only the pond but all of the area below and surrounding the pond that was saturated with water. After this Rob went and put the rest of a 2- gallon bucket into a bag and floated it on his pond. His pond then turned green within a couple of days. Another area where Rob chose to differ with me was in the amount of oxygen we were dissolving in water. I had told him that we could go up to 16 parts per million and beyond under certain conditions and he said that it was physically impossible to do that. I then demonstrated that we could supersaturate water with up to 20 or more parts per million by showing him an oxygen meter that quickly reached its maximum reading of 16 (the oxygen meter company must have agreed with him because they built their meters to only go to 16 parts per million. We pointed out that since the meter had pegged out, that we were above 16 PPM but he still stuck to his belief. Even when we divide the water we were measuring and put water back into one of the buckets (the reading on the water put into the split bucket was reading 5 parts per million) we put an equal amount of the 5 ppm water in with the 16 parts per million and the average of the two amounts of water was then around 14.5 parts per million which means that the water reading over 16 ppm had to have at least 4.5 parts per million for the average of the two buckets to read 14.5 parts per million. Putting it another way if we have a cubic meter of water and a reading of 16+ parts per million and we take half of that cubic meter out and replace it with water reading 5 parts per million and the average reading of the cubic meter of water we are left with is 14.5 then we have added enough oxygen to the half a cubic meter to raise the reading from 5 parts per million to 14.5 parts per million. This means that the original volume of water, which was reading 16+ ppm, had enough oxygen above that reading to

raise the amount of oxygen in the combined water to 14.5. In grams we have 5 grams in the whole cubic meter of low oxygen water and we take half of that or 2.5 grams and add to it the 16+ ppm water and the total oxygen now in the one meter is 14.5 grams so 12 grams had to come from the high oxygen water (since $2.5 + 12 = 14.5$) so the actual weight of the oxygen in the high oxygen water was 22 grams per cubic meter because when we mixed the two quantities of water the total is of $26 + 5 = 29$ divided by two which equals 14.5 when averaged in the mix. Rob insisted that there was some sort of error in the process which could account for the inference that the oxygen was higher than 16 parts per million. Rob and Chris were essentially learning about tilapia at our facility when the contract for Lantana materialized. They both had a lot to learn yet. We started by taking a trip down to Lantana to see their facility. When I saw the facility I was practically overwhelmed by the structure. It was truly a technological monstrosity, a real Frankenstein Facility. There were at least 8 tanks that were constructed from Stainless steel and were at least a quarter acre, each which meant they were approximately 100 feet by 100 feet. The walls were attached to a concrete base and were sealed to the concrete with silicone and were braced to the outside by 2 inch angle iron which was attached to a bottom piece which laid down and ran to the bottom of the wall. These braces were about 3 feet apart and went all the way around the tanks so that the interior of the tanks were free of any impediments that could catch a net or be stepped on if one were in the tank working with fish. As I am describing the facility based on almost no knowledge of just how it was supposed to work this description may be less than accurate. Each tank had rows of air releasing flaps that were either inserted in grooves or were precast into place that ran all the way across the concrete to the other side. Their had to be at least 33 flaps and each row of flaps was attached to the Hugh roots blowers which were rigged to supply air through the flaps by creation of pressure under the flaps which were under water when the tanks were being used. The air pressure had to reach a point where the flaps were forced open to allow the fine bubbles of air to boil to the top. We counted the number of 15 horsepower blowers and added up the horsepower and each tank had about 150 horsepower of blowers attached to it. When the tank was filled with water and all of the flaps were releasing air the water must have appeared to be boiling throughout the tank. Each tank was plumbed to a large out of tank filtration system that was driven by a 20 or 30 horsepower pump that lifted water from the overflow area and sprayed it into a large filter that looked like a large metal box filled with PVC. Then there were the return pumps, which pumped the water from the filtration exit back into each tank, and the pumps that supplied fresh water from the wells. Altogether there were 10 three horsepower roots blowers two 3.5 horsepower water pumps, 1000 feet of air lines in the concrete, all to run each tank. So each tank required 37 horsepower to produce a crop of fish in one tank and there were 8 tanks so the total horsepower to run all eight tanks was 296 horsepower. With 3 phase power the total kilowatts to run the system was probably around 200 KW which at 8 cents would have been \$16.00 per hour to run the whole system. To run the system for 24 hours that would have been at least \$384 per day, which would mean, a month (30-days) would be \$11,520.00. When the system was built, power costs were around 1 cent per kilowatt and at that cost it would have cost $200 \times .01$ or \$2.00 per hour to run the system. Which would have been about \$48 dollars per day or \$17,520.00 per year. So, you can see that to start up the Frankenstein facility up and run it profitably would be a real chal-

lenge. Since the system was put together to grow catfish then the production in pounds of catfish per day would need to bring in the amount of money needed to pay the power bill plus the labor and other overhead cost. In the above facility a major cost would be maintenance and repair of the equipment, which would need to be done frequently to avoid down time. The annual production of catfish at a wholesale price of \$1.20 per pound would have been at least 112,500 pounds just to pay the power bill with no other overhead. If the overhead to run and take care of the facility could be brought down to 20 people the cost would be at an average rate of \$40,000 per person would be \$600,000.00 which would bring the cost of running the tanks up to \$735,000 which would be a total production of 882,000 before any feed was purchased. So if the fish eat 2.5 times their weight gain to grow each pound that would mean that the production per year would need to be 1,393,750 pounds of catfish before a profit would even be visible. Just to be sure I would recommend a production goal of 2 million pounds per year of tilapia, to reach breakeven with a lot of luck. So the total production minimum to turn the facility on in 1982 would have been two million pounds with no room for error. That would mean that 8 tanks would have to produce at least 250,000 pounds each to reach the production goal. Since the tanks were 100 ft x 100 ft and about 32 inches deep the concentration of catfish in each tank at harvest would have been ten pounds per cubic foot. This kind of a goal for a facility to produce catfish is not only pushing the limits of known technology, it is dragging the technology down the street screaming in protest. We have since running into this monster facility estimated for instance that we can get a good performance from a system we have now designed to raise 250,000 pounds, but we do this by a combination of methods. One method includes mixing all of the different sizes of fish that because the species and hybrids of those species are not predatory once they reach about 3 inches and so different sizes can be mixed and grown in the same basic water space. Then partial harvesting of each tank each week, allows us to move out of the system a large percent of the total weight of fish growing in the tank and thus multiply the total weight gain per year by at least three, and to reduce the total poundage down to 4 pounds per cubic foot. For instance lets say we have a cubic meter or a cubic yard of water that is being refreshed and reoxygenated constantly and in that cubic yard of water we have hybrid tilapia which we are supplying feed to and therefore are growing at approximately 2% of their body weight per day. The total number of all sizes of tilapia that can be in the cubic yard which is 27 cubic feet is 1,600. The water would have to be cleaned and filtered and reoxygenated at least once every 20 minutes which would require the pumping capacity of the tanks as built, which is over 1,250 gallons per minute. To say the least, the successful operation of the facility in 1982 would have required nearly perfect functioning of all of the equipment for 24 hours each day 7 days a week every day of the year, and a lot of luck, and a good price of at least \$1.40 per whole pound of catfish. To be fair, the Germans had created a design that could if properly maintained and supervised, could accomplish the 24/7 functions. But no amount of equipment can make an operation profitable if the price for the product is not higher than the cost. So, if the price for the catfish fillet, and the by-products does not total more than the cost of producing them then the project is doomed. The price for the catfish dropped to \$0.90 cents a pound and the value of by-products never got over 20 cents per pound. Projecting the cost of production of tilapia at 85 degrees f. allows us to get a growth of up to 3-4% per day, which means you can have a lot less fish in the tank

and achieve the appropriate production poundage. This was essentially what we presented to the prospective buyers of the Lantana facility, and we recommended the installation of pure oxygen capability to achieve a backup capacity for raising the oxygen quickly in an emergency and a 24 hour monitoring system with personnel available at all times to respond to alarms produced by the system. I felt we could have a shot at making the system work by substituting Hybrid tilapia which have higher yields of fillet per fish and faster growth rates than those for catfish which need to be kept at temperatures of 70 to 78 degrees for optimal growth and survival.

At these temperatures catfish are more hardy and have fewer problems with disease . They grow at an average rate of about 1% of their total body weight per day, which means that the growth period is close to a year for harvest. What was generally done was that each tank was fully stocked with the number of catfish that were intended for harvest plus about 20-25% which were expected to die for various reasons, and then the tank full of catfish was grown until they were all close to or over market size and then each tank was harvested and started over. My idea of how to make the system profitable was to stock it with tilapia hybrids. The growth rate of these hybrids is such that a 10 gram fingerling which can be stocked with 100 to 500 gram tilapia with no worry about them getting eaten since the tilapia from about 20 grams up are 99% vegetarian and would have no propensity for eating tilapia over ten grams. Catfish are generally more predatory and stocking of different sizes in a system would result in a lot of cannibalism. Smaller tilapia might be a problem, but, it is not difficult to size them either in cages or in small tanks or ponds so that they are ten grams or more before stocking with the larger fish, In fact the breeder ponds that we use to produce hybrid fingerlings can be used to grow them to 10 or more grams from fry and the breeders can be moved on to other ponds in the series without disturbing the rhythm of the breeder process. I discussed some of my ideas with the nursery guys and they said they would do the project if I would accept a joint venture with them. They proposed that I provide my two employees that I had just hired as the core of the project and that I supply the breeders and start producing the hybrids to stock the first tanks with and they would be responsible for the payroll and upkeep and maintenance of the facility and they would supply the feed and any new equipment needed in the project. I had just recently applied for a patent on the use of the name "Cherry Snapper" and The Nursery Guys really liked that name. The Nursery Guys drew up an agreement and we all signed it. The agreement said that Natural Systems and Jan and Mike Sipe owned one third interest in the project and that we would get a third of the market size fish or their equivalent in return for our investment and that the Nursery Guys would get the other 2/3rds of the market size fish. They would be able to use the name under the agreement. The contract helped me to feel good about the prospects of growing and selling the fish and so we started setting up breeders and producing fingerlings to stock in the facility. Before long (less than 60 days) we had around 50,000 fingerlings and around a thousand breeders all set up in cages and moved into a tank in Lantana and we arranged for and moved Rob and Chris down to Lantana and got them settled in. I drew up a schedule of what I thought should be done in terms of checking out the equipment on site and in terms of what I thought should be done each day to make sure that everything was functioning properly. It took about 6 weeks to get all of the fingerlings moved onto the property and to set up the

breeding for the tilapia hybrids. On or around the 7th or 8th week I received a letter from the Nursery guys in which they said they were canceling the joint venture and that we no longer had any interest in the project. To say the least, I was dumbfounded and I immediately took the contract to an attorney and asked him if the contract was legally binding. He said that it was and that the Nursery men could not just cancel it as they had done, then he said that if I was prepared to sue them to enforce the contract that he would be glad to help me and if I would put up a deposit of \$5,000.00 that he would get started right away. As neither I nor Mother had \$5,000.00 and we still had the expense of running our farm there was nothing I could do right then except to warn them that without my help and supervision there was little chance they could succeed. So, I notified the two employees that they would need to move back to Palmetto and was quite surprised when they said they would stay there in Lantana rather than come back to our project. I told them that they were being unprofessional and that they were breaking their agreements and without their help the Lantana project would be without an possibility of succeeding and that for them to stay under the circumstances was not only unprofessional, it was also dishonest since they were helping the nursery guys to steal both the hybrid fingerlings and the breeder stocks that Natural Systems had supplied. If we had sold the Breeders and the fingerlings, at the then going price, for brood stock the price would have been at least \$35,000.00 and if they aided and abetted the Nursery guys by taking care of them they would in effect be a part of the rip off that was happening, but if they came

back to Palmetto, I could offer them positions in the other contracts which were then beginning to surface. Something else then happened that I never would have guessed when one of the two guys said that he would not come unless the other one did and he actually began crying at the thought of leaving his new friend behind. I could see then that there was more at stake to him than just a job and realized that I could not force any agreements by depending on any loyalty from either of these two guys. To them, working with me was just a job and somehow the Nursery guys convinced them that they would have a better future with them than with us. I had to let go of the project, but before I did I wrote them a letter saying that because they had canceled the contract without cause, that I was withdrawing any permission for sharing the Trademark of "Cherry Snapper". I heard through various sources that they got all of the Intensive tanks started up with lots of pretty tilapia, had not chosen to install liquid oxygen, but had a lot of fish growing and were riding high on their success. Approximately 8 months later I heard that they had a big fish kill. This was just what I had predicted would occur, but the way it happened was like a bad soap opera. There were then 3 technicians with shared responsibility for overseeing the facility. These three guys liked to play in the Florida Keys on the weekend. They had all decided to go scuba diving in Key West one weekend, only, none of them wanted to be left behind and so they all decided to go and did not leave anyone on site that knew what to do in an emergency and apparently did not leave any means for finding them or getting in touch. Naturally, that was when alarms sounded and pumps froze up. There was apparently only one older man on site when the alarms went off and he called the Nursery Guys but they were too far away and the old guy did not know how to turn on the alternate pumps to keep everything going and by the time the 3 guys returned from holiday trip, nearly all of the fish were dead and the owners were waiting there with their pink slips. Since they had no fish, they had

no harvest and without any harvest, there was no money and without any money the guys had no job. Poor Guys, Poor Nursery Men. Boo Hoo... While I was eventually happy that the Nursery Guys got their due because they were too short sighted to realize that I was the only hope they had that their project would succeed and they thought they had stolen what they needed to make it work by stealing the two employees and stealing the breeders and almost stealing the name "Cherry Snapper" that they had an Aquaculture project. What was true was that they were a long way from having what they truly needed and by stealing they went away with only the idea and not the knowledge to make it work and by doing that they also stole away a good possibility that we could have made it work together and by MAKING IT WORK TOGETHER, we could have changed the World.

TAKING THE BULL BY THE HORNS

When the dust settled a bit after the Nursery Guys had pulled the rug out from under us when they reneged on us we were still interested in getting a project going where we could not only provide a demonstration of how the fish could be grown, but we would also be able to actually produce some fish in a situation where I would have more say in how it was done. By this time, my older brother who is 111?2 months older than me, had started to get an interest in seeing what could be done to raise what we were now calling "Cherry Snapper". Pat, my brother was in Real Estate and he was a broker and had several contacts in the investment world. One of them was a Lawyer who among other things specialized in putting together projects. Some of these projects were what he called Limited Partnerships and Pat told me that If I would like to put together a Limited Partnership that he could find at least 10 people who would be willing to invest in one. He suggested that I go to His Lawyer and talk to him about it and so I made an appointment to discuss this with the Lawyer. The Lawyer liked the idea and said if I would help him to put together a proposal of what I would like the money to be used for, what we would do with it, and how the limited partners would be able to earn money from it that he and Pat had a few people who would be very interested in looking the proposal over. So, I sat down with him and outlined what I would like to do with the money. I proposed that we install a system to dissolve pure oxygen into about 20 of my ponds located on Natural Systems Property. I then used part of the \$100,000 that was invested by the ten people to have a tank of Liquid Oxygen put on the property at Natural Systems. I had plumbers come in and put together pipes that took the oxygen out to each of the twenty ponds. I had them put a valve at each pond and I got some very fine spargers

that allowed only micron sized bubbles to get out of the hoses, which were dropped into each pond and then I bought an oxygen meter to measure the oxygen in each pond periodically. I then made a deal to trade some hybrid tilapia fingerlings for some post larval shrimp that I got shipped in from Hawaii, and stocked them behind some 2 inch tilapia hybrids that I had stocked in one of the ponds. The pond had a dense growth of anachrosis and so I felt that the postlarvae would be able to use the 3 dimensional surface area to increase their ability to occupy the pond space by not eating each other and I wanted to see if that was true. I then also released 250 predatory African Cichlids that would not grow to more than about 6 inches into the pond. I hoped that the cichlids would eat any of the offspring of any of the hybrid females and so they would reduce any reproduction of the tilapia to insignificant levels. After about 90 days the water temperature started dropping and simultaneously the level of oxygen I could maintain began dropping, even with several spargers in the pond and pure oxygen bubbling. I monitored the pond very closely and kept track of the growth of the Macrobracheum and the Hybrid Tilapia. I stocked 2,500 tilapia and approximately 30,000 Macrobracheum post larvae in the pond. Finally after 60 days, the anacheris begin breaking up due to the activity of the Macrobracheum (they were eating it and cutting it loose). and the water began to turn murky and so I called a halt to this experiment and drained the pond. We counted the Juvenile Shrimp and the tilapia and weighed them, and moved 2,000 of the juvenile shrimp to each of the other 10 ponds and stocked those ponds. The survival of the shrimp from less than an inch to the average length of 2 inches was 95% and the survival of the hybrid tilapia was 96%. The average weight of the hybrid Tilapia was right

at 100 grams each and the average length of the Macrobracheum was about 2.5 inches. As it turned out my decision to pump the water from the pond and take out the tilapia and the shrimp was a very good one since the oxygen began bottoming out that day and we had to throw in several extra spargers to keep the fish and shrimp alive. We now had 10 ponds stocked with 2,000 Macrobracheum each and each pond had pure oxygen fed into it and had varying numbers of tilapia hybrids stocked in these ponds. Also our contract with the Fisheries Department of the Mexican Government was beginning to happen and so we were faced with a decision about whether we should go on with our attempts to learn how to use oxygen to grow tilapia or turn the whole farm in to a production unit in order to fill the contract with Mexico. We put off the decision until after we began getting the money and then I talked it over with Mother and Jan and we decided to have a meeting and make an offer to buy out all of the investors in the Joint Venture rather than take a chance of not making a go of producing hybrid tilapia economically enough to make a profit. As I recall we basically paid back each investor \$1.50 cents for each dollar invested which cost us a good bit but avoided a conflict of interest, and freed us up to concentrate on the contract with Mexico. Now what I learned from this Joint Venture was that getting Oxygen to dissolve into water was a lot harder than it looked. I learned that if I was going to base a profitable tilapia project on the use of pure oxygen that I needed to acquire some better methods than any of the ones I had tried so far.

CITRUS WASTE AS A FOOD SOURCE

Another momentous event that occurred during the same time frame was when we received a call by the Director of Operations at Tropicana in Bradenton, Florida. He said that he had been doing some Research on the use of tilapia as a means of cleaning up water and had run across my name, possibly in the newspaper, and wanted to know if I knew anything about that subject.

Tropicana was at that time probably the largest single employer in Manatee and Sarasota County. So, I reasoned that it would probably be a good idea to pay some attention to what they wanted and so I told the Director that tilapia could be a real asset to managing wastewater if they were used correctly. He jumped on that idea and asked if I could come over to the Plant and look at their situation and see if I had any suggestions.

I said I could and would and made an appointment for the next day to meet with him at his office. Going to his office I was inundated by memories that I flooded back to me about Tropicana.

For instance the time Ed Price had gone to bat for me with the Governor and had straightened out my problems with the Game Commission, it was from his Office in Tropicana.

One of the most interesting memories of Tropicana and the man who started it was made one day when I was just a little guy, about 8 years old. My father had a meeting with Mr. Rossi, the President and founder of Tropicana.

I was along on the trip with my father because he had agreed to watch me for the day, and he said to me that I needed to be quiet while he talked with Mr. Rossi, but I was a very active guy and did not enjoy sitting quietly. I was writhing around my fathers legs and whining that I wanted to go, and Mr. Rossi just looked at me and said "children should be seen and not heard", then he looked me in the eyes and said "Would you like for me to seal you in a big tin can so you won't be so noisy?" I remember visualizing myself squatting in a high tin can while the top was mechanically sealed and I remember really believing he would do this that. For the remainder of the visit I stared at him from behind my father's trousers without making a peep, and hoped he would forget all about my being there.

This memory and the others about Ed's helping with the Game Commission flooded my mind and I remember that I was very careful to listen carefully and not to say any more than necessary while I was there. I spoke with a secretary who seemed to know who I was and why I was there and she made apologies for The Director who would be along shortly.

The Director arrived shortly after that and I laid out some of the information I had on the use of tilapia as nutrient reducers in wastewater and how if things were set up properly they could be used in most situations that were set up to reduce the nutrient flow.

The director called for a technical person, Barry, who was in charge of the wastewater treatment plant to come and give me a tour of the waste water ponds. Barry explained that part of his job was to do readings on the amount of solids that were in each of the there two-acre waste water ponds that were being used to treat the solids from the citrus plant. They took me for a tour and showed me where the fruit was washed and the rotten fruit was separated from the good fruit.

Much of the solids began in this area from the spilling of fruit that was soft and squishy and the detritus, which was washed on to the floor from the scrubbers. They then showed me machines where the fruit was sliced and then squeezed to extract the juice.

The scrubbing and washing equipment each went through a cleaning cycle where water was used to wash of any juice or debris sticking to the equipment. All of the juice and other solids were washed onto the floor and flowed to pipes that led to a small pond just outside of the squeezing plant.

The effluent waste from this operation flowed constantly during the day out into the pond and then into the first waste water treatment pond. The percentage of the solids made up from the juice being mixed with the water was fairly high and when the water carrying all of these materials reached the pond it averaged as high as 500 to 600 parts per million of suspended solids.

Barry showed me the ponds that day and the first pond had about 10 large aerators that were 25 horsepower each and looked like giant fans that sucked the water up and sprayed it into the air. I called these the blender aerators. The purpose of this was to mix the water with air and dissolve as much oxygen as possible into it.

The waste water flowed into the beginning of this pond and flowed by and under the large aerators which helped to add oxygen to the water. The distance in the pond was about 250 feet and then the water flowed into an exit pipe and into the beginning of another aeration pond and flowed another 250 feet and then flowed into a third aeration pond and flowed to the end of that pond. As the water moved along under the aerators millions and millions of bacteria that were in the water and were being constantly mixed was working it on.

The downwind smell was horrific and probably accounted for a lot for the fowl cooked citrus odor that Tropicana is noted for.

On my tour of the plant I came up with an idea of putting the tilapia in cages and lining up the cages on cables or ropes stretched across the pond positioned between the aerators so that the so the water flowed within about 2 or 3 feet of each cage. But first I felt we should put a few cages of fish in the third pond in the series.

The concentration of solids going into the first pond was averaging 350 -400 parts per million in the first pond and by the time it entered the second pond the parts per million were down to 35 - 40 and by the time the water entered the third pond the parts per million were down to 3-5 and by the time it reached the last pond the parts per million were

down to 0.3-0.35 parts per million which was we were told was low enough to meet EPA emission standards to be dumped in the Manatee River.

I figured that by putting the caged tilapia in the third pond there would be very little risk to the fish and so I proposed to take the fish out of the ponds that I had on Highway 41 and count them 1,000 at a time into cages which Tropicana would supply the materials for and my crew would provide the labor to build. They, Tropicana, would supply enough new aerators so that we had at least 200 horsepower in each lake, and they would have enough power strung out to each pond to supply power to the aerators. Tropicana would also supply any equipment needed to move the fish around.

When I first took the tour I was shown a sight that I have not seen anywhere else but It impressed me a lot. Barry took me to the edge of the first treatment pond when we got there the water was a solid pink color and I asked him why, and he said it was from the Daphnia that were living in the water and were eating the solids or at least were feeding on the bacteria that were breaking down the citrus waste.

I stooped down to get a closer look and suddenly I saw the tiny pink animals swarming around in what appeared to be high schools on a diminutive basis. I threw in a small stone and it seemed to make a hole that spread and then closed back in on itself. I looked across the pond and was struck by the sheer enormity of the biomass which stretched as far as the eye could see shifting this way and that throughout the pond. For the tilapia this would be like manna from heaven.

Daphnia are a very valuable food for people who raise tropical fish. If you breed cichlids such as Angel fish, and you have something like Daphnia to feed the hatchlings you can get most of them up to a good size where they will survive and that makes all the difference in production.

Live food in general is generally very expensive to produce and when I saw the nearly two acres of solid daphnia I knew that the tilapia were going to do just fine in the pond.

I went back to the Director and made a proposal to him which we put in writing to make sure we both understood what we were expected to do and so he would have some documentation of our agreement.

We wrote the agreement up as a Joint Venture which said what Tropicana was agreeing to supply all of the cage making materials and ropes or cables needed to put the cages in the ponds.

Which included pay for the people making the cages, aerators, and an oxygen monitoring system with a loud alarm on it which would tell anyone with a half mile that there was a problem with the oxygen level if the oxygen level ever went down to a point where the fish were in danger. We both signed the agreement and then I sat down with his secretary and told her what needed to be ordered in the way of cage materials.

One agreement that I got from Barry was that he would take readings and record them for each day of the project and we would also weight a sample of the fish each week and put that together with his information so we would be able to analyze the growth of the fish as it related to the flow of solids and turn that information in to usable formulas that could be used to expand the growing of tilapia in other waste water plants where countless tons of valuable nutrients are being burned up each day.

Then when the fish were ready for Market we (Natural Systems) would be responsible for marketing the fish, although any help from Tropicana would be acceptable, and we would split the take 50/50 from the fish sold.

The project was beginning to have promise and then I had a birthday. It was the 4th of August and that was the day on which I was borne. Jan and I had a small celebration at our home in Palmetto and the next morning we were awakened by a phone call from Barry. He asked if we had looked at the fish within the last 24 hours and I said we had not. He said that I needed to come and take a look because they were all swimming upside down.

When I got to the waste water plant and looked at the cages the fish were not swimming at all, they were all dead and floating.

We asked Barry to run an oxygen check and the level came out at minus 1 PPM which I had never seen before. Then I begin to ask the obvious questions. Like when did they know something was wrong? The day before a guard had noticed that there was a funny odor. Why had they not called us since we had left instructions to be called if anything unusual happened? They said, " what would you have done" I answered we would have gotten our whole crew out of bed and come and moved the cages across the pond bank into the next pond where the water was still supportive and if the water in that pond had begun to bottom out we would have moved the cages over to the last pond and had Tropicana swing 4 or 5 aerators over into the pond or even all of them if necessary. But what we would not have done is stand around watching the fish die. It must have taken the better part of a day for the water to get bad enough to kill all of the fish.

It seems that some of the cleanup crew that worked in the juicing plant had found 3 large containers (50,000 pounds each) of spoiled citrus molasses and had decided to dump them into the drainage ditch which led to the retainer pond which led to the first waste water pond. Then Barry had been on a lunch break the day before and had been in an automobile accident and had not got to the retainer pond to turn off the valve that led to the wastewater pond and so when the spoiled molasses (all 150.000 gallons of it) hit the pond it turned the water into sugar water and the fish were essentially pickled in the waste water pond.

The saddest thing about this accident was that it never needed to occur. If the monitor had been installed (which we had in the contract that it would be installed) and it had sounded an alarm in response to the dropping of the oxygen level, the guard would have been notified and he would have seen that the instructions were to contact Natural Systems and to keep trying until he got someone. Natural Systems would have sent

people to the pond site and assessed the situation and have begun moving the cages and alerting Tropicana people to lend a hand and we would have had a good chance of saving most of the fish. Since we had a very large investment in the fish in the pond we would have done everything necessary to save them.

If the act of dumping large quantities of spoiled molasses into the drainage system was legal which I believe it was not, we as co-investors in the joint venture to raise tilapia would have been notified that there was a problem. It took nearly a day and a half for the molasses to turn the water quality so bad that it started sucking the life out of the fish with a negative oxygen reading and the alarm would have sounded early on the first day if the oxygen monitor had been mounted and connected to the monitor. The monitor could have even been set to dial our numbers until someone picked up to deliver a notice that there was a problem in process of developing.

The truth is that the Director had not put enough of a priority on getting the oxygen meter and monitor on site and plugged in. I was told on several occasions that the monitor was sitting on a shelf in the supply room and was awaiting the maintenance crews installation of a pole and an electrical plug to run the monitor during most of the time. There was a built in battery that stayed charged when the power was on, but if the power went off an alarm would be triggered and the device would have begun the dialing sequence, so the monitor would let us know if there was a power interruption or an oxygen problem. Either way, if there was a problem we would have known about it if the monitor had been installed. The director, however was so confident that his team of people would detect a problem and respond to it that he never saw the need to have an automatic monitor in place.

Once the fish kill had occurred it was cover up time and all responses by Tropicana employees were geared to cover up the incident and to shift the blame over to us.

It took a work crew of Tropicana employees nearly 3 weeks to pull all of the dead tilapia out of the ponds and bury them.

Later I tried to approach the Director with a new proposal, but somehow he had decided I was to blame for the incident and would not discuss it with me.

I approached a local lawyer with the possibility of suing Tropicana for our loss in the joint venture based on their wrongful acts in dumping the molasses and in their neglect in not installing the monitoring system, but the Lawyer said that Tropicana was too big and that if any attorney sued them that they would be blacklisted and out of work in this area and since they represented a substantial portion of the employment that was a no for a lawyer.

So, again I had to just let it go, but I vowed that I would never again put my fish at risk in someone else's situation where I did not have control over all of the variables.

THE WORLD AQUACULTURE MEETING IN VENICE ITALY

The contract was pretty much completed and all of the breeders were at work on the various breeder farms in the 18 different states in Mexico and we were considering the possibility of bidding a new contract to the Departamento De Pesca to help them put in the growing ponds which it seems they had neglected to do before contracting for the breeder production centers.

We had successfully collected 100% of the money that Mexico had agreed to pay us for the contract and the Department of Fisheries had just issued us a Letter of Commendation for completing the terms of the contract ahead of schedule, and that they were very pleased with the results.

We had our own doubts about whether the Mexicans would be able to go from where we tried to leave them to a place where they were able to produce a substantial amount of product.

I was asked to return to Vera Cruz in Mexico a couple of years ago and while there I was treated to a number of slide shows and displays featuring the Red tilapia in many situations.

It seems that growing the Red tilapia has really caught on in Mexico and there are now 2,500 or more growers in various areas growing crops of red tilapia and marketing them. Total production of the Red tilapia in Mexico is estimated at being well over three hundred million pounds as of 1999. It seems that the main effect of the hatcheries was to supply growers with hybrids that they then bred with each other to produce their own gene lines and set up their own marketing systems for fingerlings and for marketing the finished fish. Most of the fish in Mexico are marketed whole and so the red color is very important to them.

Unfortunately the breeding programs never got under way to be able to supply the Mexican growers with a supply of improved breeders, however individual initiative means there are many suppliers of fingerlings and so the overall efforts have been successful.

The fact that there are virtually no hatcheries producing any tilapias with improvements in color helps to support my theories that the improvement in color needs to be pursued by developing individual gene lines and then crossing them to get multiple improvements in the same fish.

Anyway, it was not time to go to the World Aquaculture Convention and I decided that we would go in force and take with us the people who had played significant roles in the completion of the Mexican contract.

Getting ready to go to the Convention was in itself a very busy and pleasurable event. Much of the pleasure came from the satisfaction of having made a sizeable contract with the Mexican Government, having put together a crew in a few months to sell the project and having successfully delivered on our promises and to have done so in what

the Mexican Government felt was not only well ahead of schedule, but they were more than satisfied with the results.

One of the things we had done to create and deliver the contract was to produce a number of photo displays on the production of hybrids. These displays illustrated the different species we used to create the hybrids and took the clients step by step through the process of setting up breeders and growing the hybrids.

So, one of the things we wanted to do when we go to the conference was to give a slide show where our presentation was made. To get ready for the trip, we went to a travel agent who arranged for tickets for 8 of us. We decided that we were taking Jake and his wife as he had really put together a workable contract that made it possible to do business with the Mexican Government by making sure they were satisfied and got what they wanted.

Now all of the work, the effort, the perseverance and the belief we had in the workability of the tilapia as a fish that could change lives was beginning to pay off and it seemed as if people were finally giving us the chance to prove what we could do.

I was, to be sure, riding high and for the first time in my life I felt I had more money at my beck and call than I would need for a lifetime. When we went Christmas shopping that year, the sky was the limit and every one received a large Christmas bonus. I thought we had a sure winner and that things were going to continue to improve.

I had been doing a lot of research in the aquaculture literature, which we could get our hands on and had read about a company in England called Shearwater; that was promoting or selling the technology for the use of Liquid Oxygen in intensive systems to grow fish. The article that I read was about the use of pure oxygen in a trout growing facility in Sterling, Scotland and talked about how they had been able to triple the productivity of the growing system by utilizing oxygen storage units and I called them on the phone and spoke with their general Manager, who wanted to know if I would be at the show in Venice and I told him I would be there. He agreed to meet me there and talk with me about the possibility of our buying technology from them. So, we prepared for the trip to Venice. The people we took with us included Lynda and Jeff Milks who were at that time our best friends and who had been working with us or for us for the past five years.

Then we took Emily Deaver who had joined us just prior to the Mexico contract and had been referred by Tony Provenzano of Old Dominion University. I had met Tony at an Aquaculture convention in Atlanta Georgia about a year before and we had become instant friends, and I had talked to him frequently on the phone after that and I had asked him for the names of some people who would make good employees when we had gotten the indication that we were going to get the Mexico contract.

Tony had given me the names of Emily Deaver and Jim Michaels who were both at that time students at Old Dominion University and they too agreed to join us to be part of the Aquaculture Company that was to do the contract with Mexico.

Both Emily and Jim turned out to be very loyal and very good employees who both put all of their effort into everything we asked them to do.

Another person who had joined us during that first year was David Port who served as a facilitator for the project. Then there was Peter who spoke fluent Spanish and was married to a Honduran girl and who did all of the translation of our manuals into Spanish.

When it came down to who we would take with us we had to leave enough people here in Palmetto to keep the Company running and take care of any business that came up. So we got tickets for Me, Jan, Emily, Jake, Jake's wife, Dave, Lynda and Jeff. We agreed to pay the Air Fare for everyone and the cost of the Hotels and expenses and everyone agreed to pay for any extras above and beyond that. I went to the Island Bank and drew out \$20,000 in Money Orders to use for any expenses we encountered on the trip and then I found out that I would have to sign each and every one and so I found a place to sit and began signing. After several hours of this I had a sore hand but I got all of them done. Altogether there were around 600 because of all of the \$20.00 We flew out of Miami. We went to Frankfurt then to Venice, where we landed and then were presented with our choice of water taxis, which would take us to downtown Venice via the Water Highway.

We flew on American and since we had booked all of our Mexico freight on American, they upgraded our tickets to First Class when we got on board. This served to make our in flight experience much more comfortable what with the liquid tranquilizers that they served for free in First Class.

The upgrade somehow made it to the other two legs of the trip and by the time we reached Venice Jan and the other girls were well tranquilized and so when we boarded the Water Taxis they were ready for bed and so we went straight to the Hotels that we had had booked for us by our travel agent. Each hotel it seemed was like a Victorian castle that had been converted to a more or less modern accommodation. The ceilings were at least 14 feet and the windows were very tall and narrow openings that allowed for tremendous views and the decorations in the room and the furniture was Lewis the 14th . The beds were large overstuffed pillows of comfort that you sank into when you laid down. Luxury was part and parcel of the rooms, and literally oozed from every portion of the room and even the bathroom fixtures were large apparently gold plated or solid and the bathtub was a very large one that allowed two people ample room for joint ventures in cleaning.

When we walked into the hotel after the semi adventurous Taxi boat ride it was like we were walking a very luxurious past. The only thing missing was the period costumes or dress and to some extent the dress of the people in the hotel provided some of that.

I got the feeling that these accommodations had been built a long time ago by people who not only knew what pleased the rich and powerful but also what would last for a very long time.

One could envision the Royalty that the rooms were built to please and accommodate and who sailed into Venice on glorious ships to spend time amid these beautiful frills of existence.

Since we did not want to miss any of the events going on at the Aquaculture Show I called the desk to arrange for an early wakeup call and I got a guy who spoke acceptable English and told him that we would like to be awakened at seven. He said that we would be called on time and so I hung up. I leaned over and told Jan that I had made arrangements to be awakened at seven, but the bed and the airline liquid tranquilizers had worked their magic and she was already asleep. So, I took a deep breath and sank slowly into the bed quilts and the next thing I heard was Jan laughing and laughing.

She said, "Mike, you have to hear the wake up call to understand. So, as she would not tell me what had amused her so much and so I forgot it, as we made ready to go to The World Aquaculture Society Meetings.

In a way, we were arriving at the meeting of the aquaculturist of the world and it felt good to be viewed as the creator of the red tilapia, the new fish sensation of the world.

Somehow I had the naive idea that having sold the project to Mexico and having delivered everything ahead of schedule that we would be somehow recognized for our development of the red tilapia and that this work would lead to more recognition and more success for tilapia and for my Company.

In other words it was like a dream come true, NO! It was a dream come true and I was right in the middle of it, really enjoying the attention I thought I was getting. I had developed several new strains of tilapia from amongst the pure gene line strains available to me.

I had developed a way to advertise the availability of hybrids from those strains and I had successfully sold a project to a major buyer and had delivered what we sold in record time and had collected all of the money.

So, I now had money to start projects and order new devices or equipment and here I was, at the hub of the aquaculture universe.

So, while I was here, I intended to look at everything going on and make key decisions that I felt would help to change the world, as we knew.

One of the companies that I had seen would be at the conference was called Shearwater. I had read an article about how they had installed a new type of growing technology on a trout farm in Scotland and how the production of the farm had been increased as a result of the new technology.

Technology was something I considered as palpable at that point in time, and I felt we could buy technology from others and put it to use on our farm and so I was very eager to meet with the Shearwater group and anyone else I could meet that could demon-

strate new technology that I could possibly purchase while I was there at the Aquaculture show.

Jan also had been reading some of the aquaculture literature, which we were receiving and had already made arrangements for me to meet with a guy from Shearwater and so again serendipity appeared to be making its appearance in our lives.

When Jan and I had time to discuss our meeting with the Shearwater people I found that Jan had brought out of the meeting, a brochure that explained what Shearwater could do for customers and so we decided that we would contact them to make a contract to buy from them technology for growing tilapia using pure oxygen, when we arrived back at home.

As we made our way from exhibit to exhibit and from talk to talk, we had brief periods during which we had opportunities to catch meals in the Venetian restaurants. Suddenly our attention began to focus on the extremely good quality of the food and we found ourselves living as much for the experience of the next meal as for the new information we were getting from the conference.

Each new restaurant seemed to have its own masterpiece recipes, and everything we put in our mouths was so incredible that we would eat a bite or two and pass some on to the person next to us.

Jan, as we have discussed before was and is very picky about what she would eat, and yet she found herself eating such things as liver pate and squid or octopus and almost any of the pastas, none of which she would touch in any of the restaurants she had experienced in Florida.

Each meal blended into the previous and the next meal as one continuous esoteric experience. The deserts were the exquisite lacy trim on the fabric of our culinary experience.

The true thousand layer cakes that were created in the Venetian restaurants really demonstrated the true skill and artistry of the Venetian chefs.

When you look at Venice, surrounded by water and observe the pace of life one wonders if perhaps that the artistry of the chefs may have been nurtured by the periods of time between visits by ships and that they had become great at what they do by having so much time to spend working on it.

When we left Venice we went to a section that was on dry land and took the train from there to Rome. Our hope was that we would be able to see part of Italy by going on the train but as it turned out most of the distance was through tunnels and so we got to see very little.

When we got to Rome we toured the Roman ruins and went to the Vatican, and to the Coliseum. Each trip was mind-blowing in terms of the information that was made avail-

able. For instance there we were told that there were over one million paintings on display at the Vatican, but when we counted them we came up with only a little over 900,000. Possibly the rest were in restoration.

Rome did however give me reason to become more humble when viewing the sheer totality of human effort recorded in the paintings at the Vatican and the truly monumental feats recorded in the Coliseum. From the construction complete fighting ships, to the outfitting of these ships with real soldiers and filling of the Coliseum with 30 feet of water to enact actual war games where men rowed the ships into each other and killed each other at the whim of Roman Emperors.

NEW TECHNOLOGY APPLIED TO THE TILAPIA

When I got back to Palmetto the first thing I busied myself with was contacting Shearwater and asking them to give us a bid on coming to Palmetto and helping us. I wanted them to help us build a system that would use pure oxygen to grow tilapia.

One of the main points of discussion was the fact that almost nothing was known about how pure oxygen should or could be used to grow tilapia.

All of Shearwaters experience and therefore expertise was in the production of various marine species and cold water species such as turbot and trout and so when it came to tilapia they simply had very little information at that time.

In order to get their help we had to write our contract as a joint venture contract where they would participate with us to put together a system designed to grow tilapia (a warm water fish) using the technology garnered from building systems to grow cold-water fish.

The differences at first glance seem to be not that different because of the fact that the amount of oxygen needed to grow a pound of fish is basically the same. The rate at which the oxygen needs to be made available however changes as the temperature rises so that if you have a biomass of 100,000 pounds of trout growing at 55 degrees f. it is possible to get a weight gain of perhaps one half of one percent per day under really good growing conditions which would mean a gain of 500 pounds of fish per day from the 100 thousand pounds of trout. To get the fish to eat enough feed to grow 500 pounds would require the addition of 1,500 pounds of feed for the trout to eat and about the same poundage of oxygen would need to be dissolved and delivered to the fish. The trout would use most of the oxygen to digest and process the feed and bacteria to break down the excreted and undigested feed would use the rest.

If we outfitted some growing tanks to have 100,000 pounds of tilapia growing in them at 85 degrees these tilapia could grow at the average rate of 3% per day which would require six times more oxygen to be dissolved in the water and available to the tilapia in order for the fish to gain weight at the rate of 3% per day. This was the technology that we wanted. How do you create a system that will dissolve and make available to the tilapia enough oxygen to support their growth at 3% average weight gain per day?

We made a contract that included paying for one of their technicians coming to Palmetto and participating in the construction of a facility, which they would help to design.

The facility would be capable of dissolving pure oxygen in water at a rate capable of supplying to growing tilapia stocked at 4 pounds per cubic foot enough oxygen to support this growth and provide for bio-reduction of the waste.

We decided to build four tanks that held ten cubic meters of water and three rows of tanks that held one cubic meter of water. Each of the tanks had an inlet for water that would allow enough water into the tank to change the water in each of the tanks approximately 10 times a day.

The amount of money it took to pay for the design assistance and layout of the farm along with the design of the water system and the pure oxygen dissolving system was a total of \$100,000.00 and I had to make a down payment of \$60,000 just to get the technician over to our farm in Palmetto. We then had to pay for his transportation to and from England and his housing while he was there.

In addition to the cost of the technology we had to pay for the materials that it took to put the whole system together.

We purchased and installed two steel buildings which were each built on our site. One was 120 feet by 60 feet and the other was 90 feet by 60 feet. We built our tanks out of sections of material ordinarily used to build feed tanks. We built three rows of tanks from six foot ring sections that were bolted together, and then the plumbing was put together and dug in so the drain pipes all emptied into group drains that took the water out of the building and into a series of ponds we used to filter the water.

The technician told me that if we painted these tanks that that would help to protect them against corrosion and make them last ten to twenty years.

The Six foot diameter tanks when the concrete was poured and they were filled they to 42 inches they each held approximately one cubic meter of water.

This was important for understanding the dynamics of the growth in the tilapia that were grown in them. Since all of the oxygen came into each tank dissolved in the water, the amount of water flowing into and out of each tank determined the amount of oxygen available for growth.

Each row of tanks was painted a different color and there were seven tanks in each row for a total of 21. The First row were blue, the second was red and the third was orange. They were set up so that each experiment that was run could be run with an experimental group and two control groups.

My thoughts were that since we had virtually no data about the growth of tilapia at different temperatures and different levels of oxygen and since we could control the amount of oxygen going into each tank so as to be the same in each of the three tanks in which we could put the test fish for a growth test this would allow us the ability to gather a great deal of need to know data over a relatively short period of time.

For instance if we wanted to determine how long it took for 100 fingerling weighing a gram each to reach 100 grams at a given oxygen level we could set the level of water going into each of three tanks so that the total O₂ reading was always at a certain level such as 4 PPM OR 8 PPM OR 12 PPM and find out if there was a difference in the rate of growth of tilapia that had the same genetic origin and that were all the same sex.

I felt that this was all needed information that was of course not available from Shearwater. In fact Shearwater did not seem to have any information as to whether there were

any beneficial affects of high levels of oxygen at different stages of growth in either trout, turbot or Salmon.

Most of the available information seemed to be focused on keeping an adequate amount of oxygen available to the fish in a given space and how the different techniques of adding it contributed to the overall goal of sustaining whatever growth was achieved.

So, our setup was designed to generate a lot of information and we set about generating it as quickly as possible after the system was finished.

Actually the purpose of being able to control the exact amount of oxygen being made available to a given number of tilapia of a particular strain, species or hybrid and the amount and quality of feed provided and oxygen provided to support whatever growth could occur. We had the ability to determine within certain parameters what extra oxygen did to influence the growth of the fish being tested over that of others being held at normal levels.

When we had deposited \$60,000 in Shearwater's bank, and the technician was notified, the technician opened his small notebook and began to teach us about how oxygen is dissolved in water and what could be done to improve on the methods currently being used by 99% of fish farmers in the world.

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Once each individual test was set up it was possible for various individuals to keep track of what was going on. We simply had to make up a sheet for each tank and put it on a clipboard and whoever was assigned that duty for the day would have to perform the task required to fill out the sheet. Each sheet had the number and source of the fish placed in the tank such as 100 T. hornorum, sex- male, average weight 10 grams, length 10 centimeters, time and date of placement, amount of feed fed each day, amount in that feeding, number of dead fish if any, number of fish remaining in test, amount of high oxygen water flowing out of the intake pipe, the oxygen reading coming in to the tank (taken by placing the oxygen probe in the flow out of the pipe) and the oxygen reading on the bottom of the tank. A new sheet was filled out each day for each of the tanks set up with fish.

The clipboard was hung on the railing of each tank and a new sheet was added each day and the sheets were picked up and the numbers placed on a master sheet for that tank each week and entered into a program that we had made up for us that ran on our Macintosh.

One of the other things I had done when I got access to the money from the Mexico Contract was to buy about 12 Macintosh computers and place them at various points or offices on the fish farm. I then set up a network-to-network all of them into a sort of internal web and instructed each person to enter data from their individual computer. I then found a boy genius that said he could write a program that could receive all of this data and assemble a picture of what was happening in each tank and on the farm as a whole and set it to run on any of the computers. Once this was set up and running I had the hardware and the software program that could help me to access the network through a Macintosh located anywhere where there was a phone and determine what was happening. All of this took about 8 or ten months to set up and to get it running.

OXYGEN and WATER the OLD WAY

To get pure oxygen to dissolve in water there is a fundamental process. In this process the gas is broken into bubbles of a given size using a sparger or other means to break the gas up in to small bubbles.

Contact the oxygen makes with the water that we are trying to dissolve the oxygen into then determines how much of the oxygen is dissolved.

The actual number of molecules of oxygen that leave the bubbles and find places within the waters molecular space to become temporary residents determine the percentage of oxygen used up in the process. The number that can leave the bubbles and not be replaced by oxygen leaving the water to jump back into the bubble is determined by the amount of oxygen already dissolved.

That portion of a bubble that is not oxygen also tends to dissolve, in proportion, at about the same rate as does the oxygen. so if the bubble is 70% nitrogen, 2% rare gases, and 8% carbon dioxide we will find about the same ratio dissolved in the water of these other gases.

This is important to understand because both nitrogen and carbon dioxide have other effects on the fish, some of which may be undesirable. When nitrogen for example is dissolved above the level said to saturate water then it tends to come out of solution and cause bends in the fish as well as other problems.

When this happens in nature it generally happens where waterfalls allow large quantities of water to fall over the edge of rocks and "fall" for a large distance and fall onto rocks and when the water hits the rocks there is a lot of bouncing and a lot of disturbance in the water so that the water is thoroughly mixed at high pressure (from the fall) and therefore the mixture of nitrogen and oxygen in the air where the water is falling is say 80% nitrogen and 20% oxygen provides a continuous flow of water supersaturated with both nitrogen and oxygen.

This continuous flow of supersaturated water allows a fish that is taking in oxygen "gases" through its gills to pull in both nitrogen and oxygen as dissolved gases, at higher than normal levels (normal being saturated.)

This supersaturated condition of the water allows the gases to diffuse through the membranes in the gills (as part of the water) the oxygen is captured in the blood stream by hemoglobin which tends to only absorb the oxygen, thus releasing the nitrogen as a gas which forms tiny bubbles wherever the blood is flowing. Much of this is in the tiny gill capillaries which then burst destroying part of the ability to absorb more oxygen from the water.

Since this is virtually everywhere in the system (including the brain, the capillaries in the gills, and nerve centers,) wherever bubbles can form that can cause trouble they do form and often this leads to the death of the fish or other organism exposed to water directly under a waterfall. This is the reason why it is called Fall's disease.

The dissolution of oxygen in water is a very complicated process. What has to happen is that enough of the air has to be exposed to the water by either separation of the water into small pieces or drops or the oxygen needs to be divided up into very small bubbles which are then allowed to rise in the water column brushing by many of the areas of water where molecules of the gas can be separated off and thereby occupy the spaces within the water matrix that accommodate the gas molecules.

The process of breaking the water tension when the water is broken into small droplets requires energy as does the forcing of air into pipes and through small holes that release it into the water. Either process requires a lot of energy when air is used. To break water up into small droplets and fling it into the air where it absorbs oxygen from the air takes about 1 horsepower per hour for each 340 grams of oxygen dissolved. A very similar amount is dissolved when air is bubbled into water so that it takes approximately one horsepower for each 340 grams of oxygen dissolved by a blower blowing air into water.

Water molecules are always in motion as demonstrated by Brownian motion and the warmer the water the faster the motion is. This constant internal vibration creates a situation where the water is always kicking out a few gas molecules due to this vibration, most of which is done at whatever gas water interface exist.

Gas molecules that stay in the water volume, once they are dissolved are said to be dissolved and molecules that tend to be kicked out are part of the super saturated gases that have been temporarily dissolved above and beyond what the water has places for and can hold on to at that particular temperature and pressure.

If we are throwing water into the air and we have a PPM of 3 that means we have 3 grams of oxygen in each cubic meter of water and we can add easily at around 70 degrees f. or above about 3 additional grams per hour using an aerator. That means we will have to create air to water interface in approximately 113.5 cubic meters of water for the water to absorb the 3 grams of oxygen per cubic meter. This means that our aerator will have to move 1,000 pounds of water to add each gram of oxygen to the water.

We can see that the cost of dissolving oxygen is complicate by many factors but the most expensive is the cost of energy to lift 1,000 pounds of water and propel it in such a way as to break it up into small droplets just to add one gram of oxygen to it.

The fact that it takes 1 Horsepower motor to run a blower that dissolves almost the same amount of oxygen in water (with a 3 PPM oxygen reading,) so it is costing virtually the same amount of energy whether we lift the water and break it into pieces or break the air into small bubbles by pushing it into tubes and spargers.

The major cost difference between a motor with blades that throws water and a motor that pumps air is in the maintenance of our equipment to keep it working with high efficiency. If all we have to do is keep our motor serviced and running and wipe off any encrustments that begin to form on the blades of the machinery then the cost are relatively

low but if we have to remove air stones frequently and clean them with caustic chemicals or replace them altogether, the cost can be much higher.

Now we see that dissolving oxygen in water is really a lot of labor if we have to pay for it which is why most aquaculture has depended on natural means of creation of the water movement that puts oxygen into water.

Oxygen levels in water need to be taken into account when aeration is considered. Oxygen levels that are already near the saturation level are relatively more expensive from the point of view of how much water needs to be moved to achieve saturation. If the oxygen level is say at 5 PPM then we can only add easily one part per million and so to add the one or two parts per million in each cubic meter we will have to move 2,000 or 3,000 pounds of water to add the one or two parts per million.

Therefore to add oxygen to a system it is easier if you are making sure that something is taking it out at more or less the same rate that you are putting it in. The best way to do this is to have a biomass that can use or take out the amount you are putting in as you put it in.

If oxygen is being removed by a biomass that is in the tank such as a bunch of fish then the oxygen addition process will maintain more efficiency in terms of the amount of energy being used to dissolve the oxygen being put in. So to remove 4 grams of oxygen you need to have a biomass that can absorb the 4 grams.

Fish can eat an average of from 1.5%-15% of their body weight each day in high quality food and to eat that amount of feed they need to have the same amount of dissolved oxygen available. In other words the amount of food eaten is equal to the amount of oxygen available. We seldom get in trouble if we use this number and strive to achieve putting in at least this much oxygen.

A balance needs to be reached where the amount of oxygen being added per hour is equal to the amount being removed.

For most of the history of farming trout, which is only about 150 years the only means for adding oxygen was the use of gravity.

In most cases this was done on a trout farm by diverting running water from a mountain stream into one or more narrow raceways and letting it travel for about 50 meters or 50 yards and then dropping the water out the end and letting it splash into another raceway that went another 50 yards or so and to repeat this about four times. Once the water became contaminated with trout waste and uneaten feed it was allowed to go back to the downhill stream.

The narrow raceway, say 3 to 6 feet insured that a fairly large quantity of water say one cubic meter per minute carrying about 7 PPM of oxygen would go into the beginning of the raceway, the trout would be feed enough feed to cause about 3 PPM to be subtracted by the time the water reached the end of the raceway.

The flow into the race way is generally about 100 liters per second so that if the race-way is two meters wide and 50 meters long it will refill once every 20 minutes, bringing 2 to 3 grams of oxygen to the fish every minute. this allows the trout farmer to add around 200 to 300 grams of feed to the race way every 20 minutes without killing his fish.

Up to one cubic meter with 50 pounds of fish or 20 kilograms of fish per cubic meter can be supported by the addition of oxygen using air as the source of oxygen.

The oxygen being added to the system is being added by the use of gravity, which adds approximately one gram per 1,000 pounds of water that goes through the system. Cold water at 45 degrees f. generally picks up slightly more oxygen in the fall from one tank to the next tank because oxygen is more soluble at the lower temperatures.

Many kinds of contraptions have been tried to make the water pick up more oxygen either as it moves through the raceway or when it spills out and falls into the receiving end of a raceway, but each method still relies on gravity for the energy and some devices cause a small fraction more of oxygen to be captured than others.

Many people in the trout production field have worked out the length, depth and width of the raceways. It has been determined that the amount of oxygen, 2.2-3.0 grams of oxygen per drop per cubic meter of water, is considered adequate for trout production.

OXYGEN AND WATER SOME IMPROVEMENTS?

New technology came to the aquaculture industry when people tried to use non moving bodies of water to grow more pounds of fish than could be grown using natural methods of dissolving oxygen.

The first sort of improvements that came to aquaculture was back when farmers just had ponds and noticed that when they threw food or fertilizer in the ponds that they could get slightly higher yields of fish and at the same time they learned that they could kill them very easily if they threw in too much food.

If one travels back in history and looks at the history of various cultures we find the stirring the water to be a common practice among Asian farmers who often invented various devices that allowed a man or multiple men to move water through specially constructed ditches to flood rice patties or other areas where aquatic plants were being grown for food.

This movement of the water which allowed small quantities to be lifted up over barriers that then kept the water from flowing back to where it came from and channeled it to where it was needed allowed the water to first drip and then flow thus exposing a large surface area to the air where it was able to pick up oxygen which it then carried to where it was going. The methods all required an immense amount of energy all of which was supplied by the activities of humans.

In fact, it may just have been crazy Americans, with cheap fuel, as the industrial revolution became established in America. This revolution may have allowed the first farmer who invented the process of beating oxygen into water using an engine that was fueled by fossil fuel to drive a spinning device that was able to throw large quantities of water into the air and thus "quickly improve or increase the amount of oxygen dissolved in the water"

Just imagine a pond with a large quantity of catfish that has just been fed when a cloud layer moves over the farm and blocks the photosynthesis that provides the large amounts of oxygen needed to eat the food being supplied by the farmer.

As long as the sun shines the manufacture of oxygen by green plants and algae continues and the amount of oxygen that can be supplied by photosynthesis is truly astounding.

Algae suspended in the water column can add as much as 10 grams to 20 grams and more to each cubic meter of water in a period of eight or ten hours. This oxygen is supplied as carbon dioxide is removed and turned into carbohydrates by the cells in the algae or other plant life.

The process of photosynthesis is complex but essentially the visible energy from the sun supplies the energy for chlorophyll to undo the bonds between carbon and the two oxygen molecules bonded to it in each carbon di-oxide molecule.

The carbon is then hydrated (becomes a part of the carbohydrates) and the oxygen is then kicked out of the cell where it is immediately dissolved and becomes a part of the water oxygen complex.

The carbohydrates manufactured by the cells in the water that contain chlorophyll become potential food for a vast array of organisms and the oxygen released into the water as dissolved oxygen becomes an essential requirement for any fish or other organism feeding in the water to metabolize (break down and supply energy from) food being eaten.

But, photosynthesis is suddenly interrupted by the thick layer of clouds and does not begin again for 3 or 4 days since the clouds are remaining over the site for the next four days.

The photosynthesis has pumped oxygen into the water so that a reading with an Oxygen meter reveals that the level of oxygen in the water is 16 PPM when the clouds first moved over the pond.

Subsequent readings reveal that the O₂ level several hours after the clouds move in is down to 14 PPM and a couple of hours later it is down to 12 PPM...

It does not take a genius to predict what is going to happen when the Oxygen level on the second or third day drops below 4 PPM and the large crop of catfish which has been growing like crazy for several weeks before the cloudy blackout will soon be faced with a crisis. This crisis can only occur if the catfish have had the extra oxygen to overgrow the potential oxygen supply available in the pond. Organisms which have evolved under the conditions that are prevalent in a pond, and survive, tend to pass the attributes that allowed them to survive on to their descendents. So, if low oxygen conditions tend to occur in a pond we would expect that critters that have been found in the pond for years would be able to survive those conditions again if they occur.

The occurrence of low oxygen conditions then should not be a problem if the critter is capable of adapting to those conditions unless the conditions happen in such a way as to be a surprise. For a pond to have a surplus of food and oxygen simultaneously for a period of time is not a very frequent occurrence, but where the farmer is able to provide extra nutrients when conditions are good and then conditions turn suddenly as they do in the case of a cloud cover, then the farmer has basically extended the ability of the catfish to grow beyond their capability to survive a sudden low oxygen, but, if the farmer now has the ability to drive a tractor to the edge of a pond and hook up to a device that throws the water into the air and creates an unnatural flow of oxygen at a time when the level of oxygen is dropping below that where the catfish can survive, then he can in fact create the ability to grow more fish per acre or per hectare than other farmers who have not yet figured this out. The degree to which the farmer becomes familiar with the natural fluctuations and unnatural fluctuations of oxygen and with how he can add oxygen at the right time to keep his fish alive then becomes a learned technological skill. This skill has made the fortunes of many catfish farmers in the United States.

I once heard a manager of a catfish farm describe the process of feeding catfish in a pond and adding oxygen as being like maintaining balance on a rolling log in a pond. If you did not move the right way at the right time you would fall in and until you could stop feeding the catfish and harvest them you would have to maintain your balance or lose the fish.

Keeping the log moving was feeding the fish and maintaining your balance was supplying the extra oxygen. Balance was easy if you did not feed the fish, but without production of a minimum amount of fish which can only be accomplished by feeding then the economics of the growing system would spin you off into the water which would just be another way of losing.

Catfish farmers that do not feed do not get growth and without growth they lose.

So, you could say that the game of feeding fish in ponds is driven by survival in a competitive climate and involves the use of all of the factors that create growth and minimize losses of fish. You can also say that without the use of a very cheap energy source to throw the water that the catfish farmers would not have been able to afford the game.

Anyone who has not ever stayed up all night every night for a week or so, checking oxygen levels in various catfish ponds to see which ones reach the level where turning on the aerators driven by tractors or by any other power source, will do some good, wondering whether you will have a lot of dead fish the next day really does not know the meaning of living on the edge.

Tilapia as a genus of fish allow the farmers a lot more time to muster the water beaters because they can stand oxygen levels down below 1 PPM with no apparent risk due to oxygen whereas catfish cannot go below 3 PPM without a lot of risk.

But I move too quickly to the next subject when the subject I am discussing is about the ways that oxygen can be introduced and dissolved into water. The American Catfish Farmer has brought the ability to introduce oxygen into water using brute force or a lot of energy and has created the production of around 500 million pounds of catfish in ponds that would only have been able to produce around 100 million without the introduction of oxygen using power.

So mechanical aeration now has credibility because it has worked to grow a lot of fish in areas which could not otherwise support their growth.

What Shearwater seems to have brought to the aquaculture industry is in the use of pure oxygen combined with a system that allows for a long contact time so that a high percentage of the pure oxygen could be dissolved. This provided a lower cost method of dissolving the pure oxygen that could offset the higher cost of obtaining the pure oxygen.

Pure oxygen is obtained by a number of methods, some of which split oxygen from water molecules and obtain pure hydrogen and pure oxygen which can then be pressur-

ized and used to dissolve the oxygen in water and possibly use the hydrogen to move the water through the system.

Another method is the cooling of air in chambers where the gases will become liquids and can be separated as they condense due to the extreme cold as each gas has different temperatures at which they liquefy so each of them can be liquefied in a portion of the separation chamber that is set for the temperature for that gas.

Still another method that is becoming more popular is the use of separators that pressurize air in a chamber that contains clinoptolite, which is a mineral that has the ability to adsorb nitrogen when nitrogen is compressed next to it. When the pressure is then used to draw off the gas in the chamber that is not adsorbed by the clinoptolite, which results in a stream of gas that is around 95% oxygen instead of 20%, which is the normal level in air.

Now what Shearwater taught us was that by using pure oxygen we could devise a method to dissolve very high percentages of the gas so that the cost of the oxygen can be very low providing that we are buying oxygen at a low price.

The use of pure oxygen (95% will do) and a good dissolving system like the oxygen stack offered as technology by Shearwater opened the door for us to be able to develop the ability to grow about many times the weight of fish that can be grown using air as the source of oxygen.

Their technology got us there by showing us how to entrain O₂ bubbles in a stream of water that is moving down at the rate of 2.3 meters per second so that a quarter inch size bubble that is headed upward is doing so in a stream that is moving down at the same speed or a slightly higher speed.

We even built a window in the large 16 inch PVC pipe that we constructed the first stacks out of. We had a four inch entry at the top of a six foot tall pipe which had a 16 inch reduction fitting that went to a four inch inlet pipe and then to an incoming four inch pipe which came from the high volume low pressure pump in our waste water treatment pond.

The four inch pipe brought the water into the 16 inch pipe and the oxygen was injected at the place where the four inch pipe came into the 16 inch pipe and so the speed of the water downward was just enough faster than it needed to be to make the quarter inch bubbles move gradually down even though the bubble was rising at the rate of 2.3 meters inside of the stream of water going down.

The Plexiglas windows were set into the top of each of the 16-inch stacks and with adequate light we could see the bubbles as they bounced around in the window. They would swirl around and dance around and gradually move down in the window to be replaced by others being brought down against the current.

If they did not move gradually down and instead moved upward then we would open a valve located at the bottom of the stack which allowed more water to go through the tube and therefore increased the speed downward, so the bubbles again move gradually down bouncing all of the way.

The system that we built was designed by Shearwater with my guidance in terms of what we wanted to be able to do with the system. It had four oxygen dissolving stacks, which were located outside of the building inside of a small shed. The water was pumped from a pond, which was last in a series of six small outdoor ponds designed to clean up the water before being re-circulated through the system again.

Six hundred gallons a minute of water was pumped by a 10 horsepower high volume low pressure water pump through a twelve inch pipe that pumped into a manifold that broke the flow down into four inch pipes before they went into each of the four 16 inch stacks.

When properly tuned, using the window on each tube and the valve located at the bottom of each stack delivered water with about 16,5 Parts Per Million. Again, the tuning was done by opening the valve on the outflow of each stack so that the speed inside each stack was very close to the 2.3 meters per second required to keep the oxygen bubbles moving gradually down from the top of each stack to the bottom of each stack before being caught in the outflow pipes which led to the building.

In the building there were the red, blue and yellow rows, each row consisting of 7 tanks in each row, each of which was one cubic meter.

So the water flowing at 700 gallons a minute containing 14.5 grams of oxygen per cubic meter constituted 33 cubic feet of water in a cubic meter which is just over 250 gallons of water the actual amount of oxygen moving through the system is approximately 35 grams per minute which on a 24 hour period is just over 50 thousand grams or fifty kilograms a day.

This fifty kilograms then needed to be divided into each one of the 21 one cubic meter tanks and each one of the four ten cubic meter tanks. This was done by opening each of the valves on the entry pipes into each tank, so that a specific number of liters per minute were going into each tank. To do this we had to take a container that held about four liters and a watch and open each valve until the flow equaled the desired flow for that tank.

Earlier in this chapter we discussed how many times a day we could empty the tanks and refill them with water flow of a given amount and we concluded that we could fill a one cubic meter tank (1,000 liters) with 6 liters of flow once each 2.7 hours. This would require a flow of 162 liters per minute to replace the water in each of 27 tanks every 2.7 hours. The four 10 cubic meter tanks would require a flow of 60 liters per minute per tank to be emptied and refilled once each 2.7 hours.

Since our output from our oxygen saturator was 2,200 liters per minute then we would only be using up 222 liters out of our 2,200 liters per minute of available high oxygen flow. But since that is the flow rate at the beginning of each experiment and we might have to increase the amount of oxygen by a factor of ten by the time we concluded each experiment we felt we were covered as long as we did not reach the end needs for oxygen in all of the tanks at the same time which would require 4,020 liters per minute to supply enough water to refill each tank every fifteen minutes.

So, on completion of the construction of the facility we had adsorbed all of what Shearwater had chosen to share with us for a fee of \$100,000 and we could now move on to learn from where what they had taught us left us and move on into the future.

I immediately drew up a plan for running experiments with the various tilapias that I had at that time. The experiments were designed to see how fast each gene line and hybrid of each gene line could grow when fed the best-feed possible and allowed sufficient oxygen in a controlled temperature environment where the water was kept clean.

THE FRUITS OF A LABOR OF LOVE

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Each sheet had the number and source of the fish placed in the tank such as 100 T. hornorum, sex-male, average weight 10 grams, length 10 centimeters, time and date of placement, amount of feed fed each day, amount in that feeding, number of dead fish if any, number of fish remaining in test, amount of high oxygen water flowing out of the intake pipe. The oxygen reading coming in to the tank (taken by placing the oxygen probe in the flow out of the pipe) and the oxygen reading on the bottom of the tank and the difference was recorded. A new sheet was filled out each day for each of the tanks set up with fish.

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Once this was set up and running I had the hardware and the software program that could help me to access the network through a Macintosh with a modem located anywhere where there was a phone and determine what was happening. All of this took about 8 or ten months to set up and to get it running.

Then to set up experimental conditions that would provide information that could be analyzed the people left at the farm had to do exactly what the experiment called for in each tank. And they had to record everything starting with the size and source of the fingerlings, the amount of water being measured into each tank and the oxygen level and level of anything else in the tank.

Essentially every tank had the same source of oxygenated water which had the same Ph, temperature, Co2 level and every other factor since all of the 31 tanks drained into the same outdoor pond and was mixed constantly.

When we started up the building we had plans to empty out each of the six settling ponds about every six months to pump out any accumulation of bottom detritus and head off any degradation in water quality that this might have caused.

Barry from Shearwater had assured us that this would be necessary, as they had to do that with their filtration ponds in England and Scotland that were used to grow turbot and trout.