

# Teaching a man to fish... or at least to raise them!



An account of my Borlaug ~Ruan Internship  
at the WorldFish Center in Abbassa, Egypt

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Borlaug ~Ruan International Intern Summer 2009

Front cover pictures (from top left to bottom right): Mr. Samir and I, standing in front of the great pyramid at Giza; trainees learning to properly weigh samples for proximate analysis of feeds; Mr. Ahmed Nasralla (foreground) and Dr. Waheed Elwan counting tilapia fry; Dr. Waheed Elwan explaining how to properly fillet a catfish; a trainee named Numa purchasing fruit from a local vendor in Abu Hammoud

**Table of Contents**

Acknowledgements ..... 1

Experiences in Egypt..... 2

Research Project Report: The Impact of Different Feeding Rates on improved Nile Tilapias (Oreochromis niloticus)..... 16

**Dedication**

**This report is gratefully dedicated to all who made me who I am today, to God, to my Family, and to my Friends.**



Pictures (from top-left to bottom-right): Nile Tilapia (*Oreochromis niloticus*) a member of the breeding program; a typical Egyptian breakfast; trainees celebrating a graduation Egyptian style; Dr. Mohammed Fatim showing trainees how to prepare slides for fish sex determination; a plate of freshly prepared freshly caught fish from the WorldFish Center ponds; trainees learning titration methods to test for water quality factors; reading a RFID tag for the genetic selection program, each fish has a unique ID numbers allowing for individual fish selection for breeding pairs; freshly prepared baladi bread, a staple Egyptian food eaten with almost every meal; workers sorting fish by size during the early morning harvest.

## **Acknowledgements**

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I want to thank my Physics teacher Michelle Jedlicka, and her dad Dr. Sam Feagley for encouraging me to write the paper for and attend the Youth Institute in Des Moines last October. I also want to thank them for encouraging me to apply for the internship, and for helping me with applications.

My parents and grandparents have always been supportive of whatever I have decided to do, and have encouraged me to do my best in whatever I do. I thank them both for helping me to apply for the internship and giving words of reassurance whenever they were needed.

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Finally, I want to thank the late Dr. Norman Borlaug who became one of my heroes in the past two years. His determination, tireless work ethic, willingness to serve others, and empathy for those less fortunate than him were traits that I hope to develop in myself in whatever profession I go into. Dr. Borlaug served as a living example that one man, no matter how humble his background, can make a difference in the world around himself. I am very fortunate to have had the opportunity to carry his name and legacy as a part of the internship program which was his idea. Thank you, Dr. Borlaug for your service, and for your example. May you rest forever in peace with the giver of life.

## Experiences in Egypt

Ever since I could remember I always knew that some way or another I would be involved in agriculture, considering that both my father and grandfather are professors and researchers in the field of crop science. My dad works on the development of high yielding, drought tolerant, pest and disease resistant varieties of sorghum which have been used throughout the world; my grandfather is a cereal chemist who works on improving the nutritional value of many different cereal crops, and how to best process those crops. Growing up I always enjoyed the times I got to help my dad work in the fields, help Grandpa at his lab, or help both my grandparents work cattle. When I was in the fourth grade I began raising poultry as a project for 4-H just as my dad had done twentyish years previous. For nine years my two younger brothers and I, raised over three thousand broilers and turkeys for shows and sale. As my age increased so did my number and variety of projects: I raised steers for my county livestock show and was a member of the FFA, which helped me to expand into the areas of agricultural mechanics and agriscience fair, during my last two years of high school. With my brothers and family I operated a small scale poultry harvesting operation for myself and those in the surrounding counties, and we processed approximately 1500 chickens and turkeys per year for the last three years. In my family agriculture is a major part of all our lives.

But in truth agriculture plays a major role in not only in my family's life but in the lives of every family across the world. There is a bumper sticker that my dad has in his office that says "If you eat you are involved with agriculture" and it is absolutely correct. Every person in this world needs food to live. From the time we are born until we die, every human is destined for a life time that requires agriculture. Hunger does not discriminate based on race, socioeconomic status, age, where a person lives, or employment; food is a necessity to all people, and therefore agriculture is a necessity for all people. If the necessity of food is one of the few great common things which bind all people and all nations together, then hunger anywhere in the world is a force of division in the world. Norman Borlaug said in his Nobel laureate lecture that "If you desire peace, cultivate justice, but at the same time cultivate the fields to produce more bread; otherwise there will be no peace". His words still ring true today as millions still go hungry each day and the consequences of this hunger are many of the wars seen in parts of the world today.

Near the end of my junior year of high school, early May of 2008, my physics teacher Michelle Jedlicka approached me with an opportunity that her dad, Sam Feagley, a professor at Texas A&M University, had shown her for high school students. It was called the World Food Prize Youth Institute and at first I was a little skeptical about going through with the entire process because it required me to write a three thousand word research paper. There were numerous reasons for my hesitance to actually go ahead and write the paper: I had just about finished everything at school and was tired of doing academic work; I had a myriad of other projects for 4-H, FFA, and other organization that had to be done around the same time the paper was due; I had very little time to write the paper before it was due for the Texas A&M Youth Agricultural Symposium which was held in early June 2008 and was the qualifying contest for the World Food Prize Youth Institute in Des Moines, Iowa. Despite these reasons not to write the paper I decided to give it a shot anyway.

Mrs. Jedlicka's presentation of the opportunity and my acceptance of the challenge started a series of events that have been the greatest opportunities of my life. I placed in the top



three at the state Symposium and was given the honor of representing A&M Consolidated High School, and Texas at the World Food Prize Youth Institute in Des Moines in October 2008. This experience was enlightening to me as I learned the many successes of the past and the hope for the future in the war on hunger throughout the world. The institute gave me a glimpse into the fight on hunger, helping me to realize that there is a great need for people to become educated on the situation. It also solidified my commitment to be a part of agriculture for the rest of my life, and influenced my decision to pursue dual degrees in Poultry Science and Agricultural Engineering at Texas A&M University.

During my time at the meeting I had the honor of meeting and visiting with many of the world's foremost authorities on hunger eradication in the world. As I listened to speeches by people whose names I knew from my textbooks, I realized four very important things. First, merely on the basis of human dignity, it is imperative that the world work to ensure that all people have food security. Second, achieving food security is an enormous task that requires eternal urgency and vigilance. Third, this challenge will soon be the responsibility of my generation; we will have to figure out how to feed a hungry world. Finally, if food security is not achieved, failure means death for literally millions if not billions of people, either by famine or by war over agricultural resources. These challenges can be overcome with great effort. The FFA creed begins "I believe in the future of agriculture", but more importantly it qualifies that belief as "born not of words but deeds". For agriculture to continue to meet rising global demand and to feed a hungry world, we must have more action, and continue the "struggle" of the "present agriculturalists."

I was also informed about the Borlaug~Ruan International Internship. I was not sure if spending the summer after my senior year in a foreign country removed from my friends and family was a good idea, but a few things motivated me to apply nevertheless. First, the experience of a the internship would allow me to learn firsthand about the challenges agriculture is facing in a developing country and to some extent learn how to take action. It would give me the valuable chance to stand on the shoulders of the "present agriculturalists" to learn from them. In the next generation, my generation, agriculture will have to feed more people than ever before; the world faces the challenge of feeding 10 billion people in the next fifty years. The only way that challenge can be met is for my generation, for me, to learn as much as we/I can from the present generation. An internship would give me the chance to participate and learn about ongoing research activities. Knowledge is always a major motivator to me; and finally, my grandfather, who I respect greatly, encouraged me to do so.

In the spring of 2009, on a Saturday morning, I was out running some errands for a project that I was working on with a friend and my mom called me and told me that she just opened the mail and that I had received an internship position. My first reaction was weird and I suppose the best way to describe it would be bittersweet, feelings of both extreme excitement and some small anxieties, crept into my mind about the internship. When I found out I would be interning at the WorldFish Center, I was excited to get the chance to learn about a field of agriculture that I had little to no experience in.

It seemed almost surreal when I first arrived in Egypt at 10:30 pm on June 6<sup>th</sup>; it did not seem possible that I was seven thousand miles away from home. I was dog-tired from my flights, and I was in a strange place where there were only a few people with whom I could actually communicate. When I got off the plane, my fellow passengers and I were shepherded on to a bus

to the terminal. When we arrived there, to me in my half conscious stupor, it seemed like pandemonium; there were people with surgical mask and gloves handing out with cards that requested your information for the ministry of health because of the H1N1 virus (commonly called Swine Flu) risk. The card would not have been a challenge to fill out but as I couldn't find my pen as I searched for it in my pockets. I then realized that I could not even ask people around me to borrow a pen. I finally managed to communicate my request to a person next to me by miming writing several times and I was able to fill out the card. I was then viewed by an infrared camera to test my temperature before being allowed to enter the terminal. My next challenge was finding the WorldFish staff members who were supposed to meet me before passport control. As I looked around I finally managed to find a man wearing a WorldFish ID badge and holding a sign with my name. I assumed that this was Mr. Samir who Ms. Fleming had told me I would meet at the airport, we shook hands, and he guided me through the lines of passport control and to the baggage carousel where I picked up my bags, and proceeded through customs out into the parking lot which took about 30 minutes. There I realized that the man who I thought was Mr. Samir was actually the driver. I was, in fact, just meeting Mr. Samir who would become my good friend throughout my time in Egypt. Mr. Samir and the driver helped me with my bags to the car and we all got in.

At this point I expected we would go straight to the center as it was nearly 11:45 already and I knew that the center was at least an hour away from Cairo; however, Mr. Samir explained that we would be going to the grocery store to pick up supplies for me. I thought this was strange, but upon my arrival in the grocery store, I realized that in Cairo it's never too late to go grocery shopping; to say the place was busy would be a dramatic understatement. Mr. Samir assisted me in choosing and purchasing some food for the week: bread, apples, chicken, minced beef, honey, cooking oil, some vegetables, cheese, milk, jam, rice, bottled water, Diet Coke, and eggs were all on the list. When we went to check out the bill was 360 Egyptian pounds, or around sixty dollars. As we walked out of the supermarket I noticed the suit shop next door, and Mr. Samir jokingly asked if I wanted to buy a new suit. We then went to the McDonalds next to the market, and Mr. Samir brought back chicken sandwiches for me, the driver, and himself, and after the driver finished his at about 1:20 am, we set out to Abbassa. As we drove I quickly became aware that the driving in Egypt was a little different than back in College Station. It was absolutely crazy to say the least. One thing stood out above all for me - the amount of honking. In College Station, horns are used rarely usually only in cases to tell another driver that they are in the wrong, and that the honking driver has the right of way. That night on our 1.5 hour drive to the center I heard more honking than I had heard in the previous year in Texas.

When we arrived at the center, which seemed much more isolated from other towns than I had expected, I noticed that the entire place was surrounded by a security fence and that there were armed security guards who watched the gate. When we arrived at the apartment, the driver and Mr. Samir helped me with the groceries into the apartment and showed me around the place. Mr. Samir gave me his phone number and told me to call if I had any questions, said that he would have someone call me the next day because he had a doctor's appointment, and then, after saying good-bye, left. It was at that moment that I realized how far away from home I really was, and how much I would miss my family for the next eight weeks. I then took a quick shower and fell asleep around 3:30 am. I was awakened at about 1:30 pm the next day by the phone ringing in the living room area of the apartment. I did not realize exactly who it was, but he said Mr. Samir had asked him to call to check on me.

The next day Mr. Samir woke me up with a knock on my door around 9:00 am. He said that he would show me around the facility and introduce me to the researchers and staff members at the center. The first person that we met with was Dr. Gamal El-Naggar who is the director of research at the center and who would help me develop my research project. He explained that for the first few weeks I would be observing the researchers and going around to all the departments to familiarize myself with the work of the center. Mr. Samir then took me around to all of the researchers and introduced me to them. I realized as I met each person that if I thought learning names in English was hard, then it was going almost impossible to remember people's names here in Egypt. Throughout my internship as I worked with people, I tried very hard to remember their names, but this was always difficult for me. After this quick tour, Mr. Samir showed me my office and gave me the key.

One of the more memorable things that happened in my first couple of weeks in Egypt was that the main line from the generator that gives power to the campus became faulty. On several occasions this caused the electricity to go out throughout the campus. As Murphy's Law predicts, these outages almost invariably happened after 4:30 pm when everyone who spoke English had already gone home for the day. These outages became a blessing in disguise. Although at the time they were annoying, I was forced to communicate with people who did not speak the same language as I did. This helped me considerably throughout my time in Egypt (I became pretty good at hand gestures). On the first of many occasions before they fixed the problem, I was watching a movie on my laptop and eating dinner (chicken and rice). During that afternoon and early evening the lights flickered every once in a while and I expected that this was simply the nature of electricity in Egypt, so I was not particularly worried about it. In early June, the sun sets around eight in Egypt, and it gets dark at around 8:30 or 8:45. Right around this time the power went completely out at the apartment and the center. This would not have bothered me that much except that I had food in the refrigerator that needed to be kept cool. First, I looked for the circuit breaker box in hopes that I could simply fix the problem myself; I eventually found one but to no avail. I then went around the campus looking for a worker or a security guard to ask to help fix the problem but could not locate one. I then called Mr. Samir in hopes that he could tell me who to ask. He told me that he would call the people to fix it at the center and told me he would have the security guards come pick me up and take me to a place with electricity.

The guard that came to the apartment spoke English as well as I spoke Arabic; so I showed him what was wrong and rode on the back of his motorcycle to the guard station which ended up being in the opposite direction that I had been looking. I sat down with the guards and they taught me several new words in Arabic. These are phonetic spellings as Arabic does not use the Latin alphabet but I found out that "Mea mea" means "good" and "mous" means mosquito. Communication between me and the guards consisted of many hand gestures combined with the word we were trying to communicate in our respective languages, in hopes that we could get our point across. I am sure that if people who spoke both English and Arabic were watching us that they would have thought we were crazy. But in reality, it is amazing that we could communicate, and the fact that we could communicate to some extent, regardless of the language barrier which divided us, showed me that the similarities which bind us together as humanity far outweigh the differences that divide us. Our ability to laugh together that night, despite the fact that I was in a strange place that I knew very little about, where the people spoke a language that I knew nothing of before my arrival showed me that all men have great similarities with each other.

Another memorable incident that happened during my second week in Abbassa was climbing through windows to get back to my apartment in the evenings. During the first week and the last week of my stay at the WorldFish Center, the wireless internet worked in the apartments. For some unbeknownst reason during the weeks in the middle, the Wi-Fi quit working in the apartment. In order to call home on Skype and check my emails at a time that would be convenient to my parents at home I would often go to my office at around six o'clock and stay till eight or nine before heading back over to the apartment. The first evening that I did this I got a little surprise. I locked my office door and proceeded to walk down the hallway to the exterior door. When I got to the door and pulled to open it I found that it was locked. I went back to another door and found that it too was also locked. The key that I had only unlocked the door to my office, and I did not have my cell phone so I seemed to be in a conundrum. After a little bit of thinking I guess I remembered the old adage "that when God shuts a door, he opens a window" and I began to look around. After going up and down the hall a few times, I realized that the windows right next to the door that I had been trying to get out of that could be unlocked. I opened one and successfully (and gracefully Ha!) hoisted myself over the ledge and outside. Before closing the window, I made sure that I could get back in if so needed. I told Mr. Samir about the problem the next Sunday, and he said he would tell the guards to check if I was in the office before locking the door. On several occasions I had to repeat my acrobatic feat to get out of the office when they forgot.

During the next couple of weeks I worked with several different people in a few different areas in order to familiarize myself with the center. One of the first researchers who I got to work with was Mr. Ahmed Nasralla, who quickly became a good friend to me. During my time in Egypt whenever I needed something Ahmed was always happy to help me. I learned how the center stocked the earthen grow out ponds with young tilapia fry for both research purposes and for commercial sales that provide the center with its operating budget. In order to estimate the amount of fry that were being moved one scoop of fry had to be counted each day before moving the fry. When I worked with the Texas A&M Corn Breeding Lab, we had to count corn kernels, and I thought that was tedious until I got to do this. Corn kernels do not move; fry are crazy, small, living, and have to be kept in water. Because of these minor details, they can be quite a challenge to count, and this process takes a significant amount of patience and a steady hand, to accomplish without stressing the fry. I eventually got the right strategy down of just getting a few in the scoop and moving them to the other container and continually adding to the running count in my head. During my internship I helped the workers on numerous occasions repeat this procedure with fry for a variety of proposes including my own project.

Another project that Ahmed introduced me to was the work being done to use rice paddies as environments for aquaculture. Rice is a staple food in many countries throughout Asia and is grown as a major crop in Egypt. In these same areas there is often a lack of protein in the diet and a need for subsistence rice farmers to have some source of income in order to ensure food security in hard times. The WorldFish Center is working to determine the best methods of using flooded rice paddies as environments for aquaculture in order to produce protein with minimal additional input costs to the farmer. Existing paddies could be easily modified by increasing levee height to allow the paddies water level to be increased after rice harvest to permit more room for the fish to reach a marketable weight.



In my next rotation, I had the pleasure to work with the tilapia genetics program. The WorldFish Center is developing fast growing, high end weight varieties of tilapia for aquaculture through its programs. The tilapias that have been developed through these programs have increased annual yields and allow farmers to produce more crops of fish per year. For five days, I worked with Dr. Mahmoud Rezk and Mr. Nabil Ibrahim, the scientists who manage the tilapia improvement program at the center. During this time, I learned a little about fish genetic research programs at the center. The program was in its fifth generation during the time I was at the center. To facilitate the breeding program, each fish is tagged with a microchip that is injected into the fish when it is a fingerling. The fish are then grown to a certain age and then weighed. From these weights the fish is given an expected breeding value, and then compared with its siblings and half-siblings. The best fish from each family are bred with the best fish from an unrelated family (at least past first cousins) to reduce inbreeding, increasing hybridization. The crosses are then evaluated on weight and other desirable characteristics and the process begins again. Each morning the workers Abdul, Osmond, and Mahmed took fish from grow-out tanks. The fish were scanned and Dr. Mahmoud or Mr. Nabil would look the fish up in their records and give instructions as to should be done with it. These instructions allowed me to learn a few Arabic words because they were often the same instructions with just a few words differing. With the help of my Egyptian colleagues I learned that “shemel” and “yemean” meant left and right respectively and I learned most of the numbers. During my time with the genetics program there was plenty of time to talk as we worked; my coworkers and I had many topics of conversation. I asked about Islam and why Mecca was so important to Muslims, and what Egyptians thought of Americans (this answer may have been biased by the fact that the US beat Egypt in the Confederation cup during this time); their questions to me were just as interesting. I enjoyed working with the genetics group because I learned so much about both fish and the culture of the people raising the fish.

While working with the genetics group Mr. Samir told me that there were trainees coming the next week from a variety of different countries in Africa, including several that spoke English. I was excited because this meant that there would be people to speak with after 4:30pm and that I would not have to cook all of my own meals since the cafeteria would be open. On the first day of the training, a Saturday, there was a demonstration on the methods used to spawn fish and how to artificially spawn catfish fry by Dr. Waheed Elwan, the hatchery manager. The next part of the training was learning about water quality analysis and how to test the hardness, the alkalinity, the nitrogen content, the dissolved O<sub>2</sub> Concentration, the phosphate content, and the amount of photosynthetic materials that are present in the water. These tests took me back to doing titrations in chemistry classes in high school, and I was able to assist Dr. Dia Kweey who would become my research supervisor, in teaching the trainees how to correctly use the equipment.

On the next day of the training we learned proper fertilization methods that increase the growth of natural foods in the ponds which are essential for fish growth. I assisted the trainees in setting up a catfish predation trial which tested the effect of tilapia density on the rate of predation by catfish. That evening, the trainee’s leader invited me to come along with them to Abu Hammoud to walk around the city. I traversed the city with several of the trainees and purchased, with the help of a trainee named Numa who spoke Arabic, some fresh apricots and an assortment of sweets from a bakery.

The next day I helped the trainees clean out the tanks from the feeding trial that they had started during their previous visit to the center. The fish had to be counted and weighed to determine the effect of the different treatments on the fish. This took nearly 3 hours to do all 12 tanks. That afternoon Dr. Mohamed Yahia, of the fish nutrition department, taught us how to do proximate analysis of protein, fiber, ash, fat, and carbohydrates. These procedures are very important because they allow the researchers at the center to determine the nutritional value of feeds used. That day I also learned that nearly all tilapia aquaculture is done with mono-sex male phenotype individuals which are produced by feeding the young fry feed which has methyl-testosterone impregnated into it. There are several advantages of mono-sex culture: First, the male tilapia grows faster and larger than the female tilapia. Second, since tilapia are prolific breeders and are able to spawn after only three months, having them in a mono-sex culture ensures that the fish do not use energy for reproduction instead of growth. Additionally, if tilapia breed in the pond, it will become overcrowded resulting in numerous non-marketable sized tilapia that are of no use to a farmer. Because of these reasons, it is now accepted practice to use hormones to cause sex reversal within the first month following spawning. Dr. Mohamed Fathi also showed how to determine the sex of small fry under the microscope. This allows farmers to estimate the effectiveness of the hormone treatment on the fish.

During the following days I learned how to remove the pituitary gland from the catfish in order to get the hormone necessary to induce milt (egg) production in females. Inducing many females to milt at approximately the same time ensures that enough fry of a certain age are produced to stock the tanks. A good side effect of learning to remove the gland (though not for the fish) was that Dr. Waheed showed us how to fillet a catfish quickly and easily, and I had catfish for dinner that night, which was delicious.

More than just learning about fish anatomy and husbandry in the training, I was learning about the cultures of my fellow trainees who were from many different African countries, which were all facing food security problems. I wish that I would have had more time to get to know all of the trainees, but the time that I had with them was invaluable. On several occasions, we traveled to the town of Zagzig in the evenings. Zagzig is located about thirty-five minutes away from the center and is the capitol of the province of Sharika. We would meander around the city, stopping at any place which interested us; Egyptian ice cream shops, sweet's shops, and fruit stands were frequented. One evening the center threw a small party celebrating the graduation of one of the trainee's brothers from college, and I saw that Egyptian hospitality was very similar to the southern hospitality that I was used to in Texas. Throughout my time in Egypt there were several more trainings that were held at the center; however, the trainings were all presented in Arabic so I was unable to actually take part in them.

In several cases there were some trainees who could speak English, and I was able to have good interesting conversations with them. One of them, who I met on the second to last Monday of my internship, named Reda, said that one of his goals in life was to come to study in America. He asked a variety of questions about America and said that he had been learning English for the past two years and working on a master's degree in hopes of coming to America to do research. During our conversation, his frustration with some of the problems with researching in Egypt has presented him with became apparent. He told me that one of the worst things about doing research in Egypt was that his salary as a researcher with a nearly a master's degree was much less than he could make working at a tourist resort taking orders on a

computer. This greatly surprised and shocked me. His view was that this was the reason that many young people want to leave Egypt to do research in other countries. This showed me that non-governmental organizations ought to invest more heavily in research programs in developing countries to encourage people to become more educated in these countries. Without this investment, there is little reason for a young person to become educated if he or she can make as much money without the degree.

One other department that I got to observe at the center that was very interesting to me because of my goal to eventually become a veterinarian was the fish health department, where I worked with Dr. Mohammed Fatim who is the center's local vet. Throughout my time at the center whenever there was something to be done in the health lab, Dr. Fatim would let me know so that I could help. Working with Dr. Fatim, I learned how to take blood from a fish, do fish dissection and look for evidence of disease in and on the fish under the microscope. Some of the most interesting work done at the center is conducted on the use of immuno-stimulants to increase fish immune system response to diseases. These immuno-stimulants must be well tested to check if they cause a cost efficient increase in the weight or the mortality rate of the fish. If significant increases are not seen then the farmers will not use these products.

One of the most interesting things that I participated in while at the WorldFish center was harvesting mature tilapia early one morning. The fish are removed from the ponds with large seining nets after most of the water is pumped out. After the fish are removed they are sorted by size and (if necessary) species, loaded into boxes, weighed, and shipped to market. This process requires a tremendous amount of human labor, and in developed countries, it has been replaced by machinery; however, in developing countries labor is cheaper than investing in the required machinery so it is still used almost exclusively.

After the first few weeks of observing the research that was being conducted at the center, Dr. Gamal and I sat down to talk about what my project would be. Since I had been working with the genetics group for much of the time that I was at the center, and I had enjoyed learning about their programs I wanted to do something to help them. The more important thing to me, however, was that my work would be helpful to the center. Dr. Gamal said that a trial between a commercial variety of tilapia, which is in common use, and the improved variety that is being developed by the center would be useful to the program. He said that it would be useful to compare the two varieties at several different feeding rates or different densities. After some discussion and a little research on my part, we decided to compare based using three feeding rates of forty-five percent, thirty-five percent, and twenty-five percent. I would do three replications of the experiment to provide plenty of data to compare and ensure results were accurate. Dr. Gamal also informed me that Dr. Dina Kweey would be my direct supervisor for my research and that I would be able to use the aquariums in the one of the wet labs. The experiment seemed essentially pretty simple, and I had done similar projects with chickens for FFA projects in high school, so I expected it would go pretty well. As I found out quickly, fish are not chickens.

On the day before the project was going to start I was introduced to Ibrahim who is one of the workers at the center. Dr. Dia informed me that Ibrahim was the one who took care of the lab that I would be working in. Dr. Dia said he would help me prepare the lab for the fish and help me with tasks as needed throughout my experiment. Preparing eighteen aquariums inside the wet lab for fish placement was hard sweaty work. I managed to find ten aquariums that were

the same size and supplemented those with eight that were of different sizes. After cleaning the aquariums with soap and water we filled them to the correct heights of water ensuring that all tanks contained the same volume of water so fish density would be the same. After a while Ibrahim noticed that the water was leaking out of several of the tanks, so we had to find suitable replacements, which luckily, were easily found.

The next day, I looked forward to getting to really start my experiment and put fish in the aquariums. On this day, I learned why so many mistakes between countries speaking different languages are made: miscommunication. I went to Dr. Waheed who Dr. Dia had said would be able to get the two varieties of fish that I needed from the fry hatching/rearing tanks on that day. I told him how many fish I needed, that I needed the two different types, and that they should be similar in size and even though his English was not very good he told me that he could get me them in about an hour because he had to do some other work. I came back in about an hour and they were not ready to net the fish yet, and then again in another hour, and they were still not ready. At this point I was becoming mildly frustrated with the fact that I needed to get the fish, and I thought they knew what I needed but that they were not helping me to get the fish I needed. I went and asked Dr. Dia to come out to the tanks to ensure that they knew what I needed. He accompanied me out to the tanks and spoke with Dr. Waheed for a minute in Arabic. He then told me that there had been a miscommunication between Dr. Waheed and me. He remedied the situation and told me I would get the fish soon. The next thing that I had to communicate to the workers helping me was that I needed approximately three thousand of each variety that were the same size. This was easier said (ha! Not in Arabic for me) than done because that morning while he was still under the impression that I just needed one type of fish Dr. Waheed had removed nearly all of the smallest fry from the commercial tank. After much seining, and grading, we managed to get enough of the smallest fry to use from the commercial tank. Getting the fry from the improved variety was much simpler because there were an over abundance of young fry.

After obtaining the fry from the nursery tanks I took them into the wet lab, where the prepared aquariums were set up and labeled. Dr. Dia told me that the best way to ensure that all the tanks had similar densities was to count out a sample of three hundred fry from each variety, weigh that sample and use that weight of fish for each tank. Weighing fish, especially small fry, is difficult because stress must be kept to an absolute minimum because they are fragile, not to mention that they have to be weighed in water. After a few spills Ibrahim and I managed to place fish into all of the tanks. The next morning Dr. Dia and were happy to observe that there were only a few fish that had perished the night before. Dr. Dia said that we would begin feeding the treatment ration next day, and just give each group a small amount of feed that day to allow the fish a chance to adapt to the new environment. Each day thereafter feed I weighed the feed each morning, and the fish were fed three times a day. Twice a week I sampled the water and checked the ammonia level, the nitrite levels, the dissolved oxygen levels, and the pH to check the water quality in each tank. Every few days Ibrahim and I siphoned the wastes from the tanks to keep the water quality constant. Each week Ibrahim and I would remove all the fish from the tanks and weigh them so that the amount of feed could be adjusted based on the amount of biomass weight in the tank that week.

For the first week the trial went extremely well, the fish grew well and all of the improved variety fish increased in weight, though there were some losses in the commercial variety tanks. The next week, however, the stress from the first week's weighing may have

contributed to some fish mortality during the week and there were substantial losses seen in nearly all tanks during the second week. I went and talked to Dr. Dia and Dr. Rezk about these losses and both said that they were normal. Dr. Rezk told me that when he was getting his Ph.D. at Auburn University the professors there told the graduate students that they measured the students' progress based upon how many fish they lost; if they were not losing fish they were not learning. So he advised to not worry about the losses, and to keep the project going.

On Sunday of my last week in Egypt, Ibrahim and I removed, weighed, and counted all the fish in the aquariums that were left. I was really disappointed that the mortality rate was as high as 97% in some of the tanks, and the causes behind this mortality rate are still unknown to me. The result turned out to be non-significant in all factors measured, which was disappointing, but I learned a great amount from the experience.

One of the most interesting things I got to do in Egypt was to learn about Egyptian culture firsthand by going shopping and traveling around the country with my excellent guide Mr. Samir. At least once a week, Mr. Samir would arrange a driver to take me to Zagazig, the capitol of the Governate of Sharkia (comparable to a state in the US), where he lived and which was about thirty-five minutes away from the center. There, I would go with Mr. Samir to the stores to purchase food and supplies for the week. On the first of many of these trips I met Mohammed who owns the grocery store that I frequented throughout my internship for everything but vegetables and fruits. In Egypt the customers are very loyal to one particular store for particular products, so Mr. Samir knew Mohammed as a good friend. This bond of friendship between customers and the owners is important in Egypt because prices depend on a system of haggling. The price that is offered to a customer depends on both how good of a haggler a person is and who that person knows in the store. At Mr. Mohammed's store each week I would purchase a variety of items such as: chicken, fish, shrimp, beef hamburger patties, flat bread, frozen peas and carrots, chocolate, juice, cheese, cookies, water, dish soap, laundry detergent, beans, canned pineapple, Tang (mango and orange flavored), butter, eggs, spaghetti, tomato sauce, and spices. After going to Mr. Mohammed's store we would go on to the fruit vegetable stand that was around the corner. There, each week I purchased an assortment of fresh fruits and vegetables including peaches, apples, plums, mangos, pears, tomatoes, parsley, garlic, basil, dill, eggplant, cucumber, onions, grapes, and cherries. One of things that I quickly noticed in Egypt was that prices on almost all items, especially food items, were very low compared to their costs in the United States. The cost of fresh tomatoes is a good example: in the US vine ripened fresh tomatoes cost at a minimum 99 cents a pound, at the stand where I purchased them in Egypt each week they cost me about 5 pounds (or around a dollar) per kilogram, which is more than double the amount of a pound.

Some of the most poignant moments during my internship occurred when I was shopping or walking around in Zagazig, or the other Egyptian villages that I visited. On several occasions, beggars approached me or my companions for money or food. In Egyptian culture begging is highly looked down upon, so often the beggars are the handicapped, or children who are unable to survive in any other manner. On one occasion that I will be able to recall for my entire life, there was a man sitting on the curb in front of a store that I had entered and his legs curved severely inward making it difficult for him to walk, he was hunched over with rags on for clothes. To my shame, I was so afraid of losing the people who I was with (this was one of my first trips to Zagazig) that I did not have enough time to give the man money. His image has

stuck with me and for a few days after that trip I thought about him quite a bit. His face will always resonate with me; it inspires me to continue to work hard so that one day I might be able to make a difference for people like that man.

On weekends during my internship when he was not too busy with other work, Mr. Samir arranged trips to different parts of Egypt so that I could learn about Egyptian culture and see the sights. We first visited was Ismailia, one of three cities next to the Suez Canal. We took a car ferry over the canal to the Sinai Peninsula and while waiting on the ferry we watched a full container cargo ship navigate the canal. The transformation from the relatively green area of Ismailia to the desert sands of Sinai was incredible. Sinai was completely desert sands, and it surprised me that people even tried to farm at all in this area, but as we drove I saw several farms that Mr. Samir said were irrigated by the channels from a river. On that trip we also went to an abandoned Israeli military command base, which was used during one of the many wars between the two countries. To this day, there is still a tremendous amount of conflict between the neighboring countries. From the high point on the military base, the entire Suez Canal could be surveyed. The region around Ismailia is also famous for its watermelons during June and July and so Mr. Samir purchased some to take back to the center and to his family; they were delicious.

The next weekend Mr. Samir and I traveled to Cairo and to Giza to see the Pyramids and to see the famous mosques in Cairo. We went to the Pyramids in the morning, and I climbed down into the Queen's Pyramid and stood in the burial chamber. The fact that the Ancient Egyptians were able to build the Pyramids with no modern machinery was even more incredible to me after seeing firsthand the blocks used to construct them; most of the blocks stood about as high as my shoulders, were longer than I was tall, and were about as wide as a car. That afternoon Mr. Samir took me on a tour of Cairo and showed me many of the famous mosques. The next week we traveled to Egyptian Aquaculture Center, which is a non-governmental organization and working commercial fish farm owned and run by Dr. Ismail A. Radwan, a native Egyptian and Auburn University graduate, who built the business from scratch. After the farm became well established, Dr. Radwan began offering training courses for aquaculture students and farmers to give them hands on experience in the best methods to increase aquaculture yields. His operation was impressive, and he gave me a full personal tour of the facilities, explaining as we walked the challenges of using intensive aquaculture practices in Egypt and in all lesser developed countries such as the lack of working capital for investment and the problems with infrastructure development. He said that oftentimes governments in these countries especially do not act in the best interest of agriculture for numerous reasons whether explicitly or implicitly and that this really hurts the farmers in these areas. His insights into both aquaculture and general agriculture in lesser developed countries we both found interesting and informative.

Our next trip was to the ancient city of Alexandria located on the north coast of Egypt. There I got to swim in the Mediterranean Sea for a while. After the beach we traveled through the city to the Montazah Palace and Gardens which was a resort for the Kings of Egypt until the monarchy was overthrown in 1952. The gardens were most notable because they had the most trees of anywhere that I traveled in Egypt. We continued our travels to the site of the old lighthouse of Alexandria, where the Citadel of Qaitbay was built as a defensive fort in the dark ages. The view from the fort was fantastic, and I enjoyed learning about its history. After the fort



we traveled to the modern library of Alexandria which was erected in the same place as the ancient library that burned down thousands of years ago. The library is one of the largest in the world and contains books in many different languages. It was very interesting to see the diversity of people from all over the world that came to the library and the museums which are a part of its complex. The final long trip that Mr. Samir and I took together was to Sharm El-sheikh, which is located on the southern tip of the Sinai Peninsula by the Red Sea. During my time in Sharm I went out on a boat to snorkel the coral reefs which are found in the Red Sea and are among the most beautiful in the world. It was a new experience for me and one that I will never forget.

The culture of Egypt was very welcoming to me. It seemed that Texas hospitality and Egyptian hospitality have much in common. All the people I meet throughout my travels in Egypt were courteous and kind. One of the major differences that became readily apparent to me was that people often did not express their opinions as readily as we do here in the states. Dr. Rezk informed me about this early in my internship and from what I could discern, most of the Egyptian people disliked former President Bush's decisions, especially his policies regarding the Middle East. In general these people also supported President Obama. Often when people found out that I was from America, the first thing that they would say was "Obama, Obama!" essentially questioning whether I supported him or not. Because of the language barrier, it was difficult to explain that despite my recognition that Bush was not a perfect president, that because of my conservative beliefs on many issues, I do not support many of President Obama's policies.

One of the things I enjoyed most about Egypt was the variety of different foods which are a part of the Egyptian diet. In Egypt the mealtimes are not very rigid, but most people eat breakfast at 7:30 or 8:00 and then take a large lunch late in the afternoon around 3:00 or 4:00 pm at the earliest, and dinner is later in the evening. This system of dining took some getting used to for my American stomach. During the times when trainees were at the center I would usually join them for breakfast and lunch in the cafeteria. Breakfast each morning usually consisted of flat bread called *baladi* in Arabic (essentially a pita bread; the literal translation means "local bread"), *falafel* which is made from crushed fava beans and spices and then fried, some cheese, a small piece of kofta (sort of like sausage), jam, cream cheese, or olives. Lunch each afternoon consisted of many items salad, a noodle soup, a vegetable soup usually poured over rice, and chicken and beef cooked in a variety of ways. For desert there was fresh fruit and a bottle of "Coka" as they call it. On one special occasion the chef for the cafeteria prepared the tilapia harvested that morning for the lunch for everyone. One of the more traditional Egyptian dishes is called *koshari* it is a rice and noodle mixture that different sauces are added to enhance the flavor.

Throughout our travels we stopped at many different restaurants and food stands to take our meals. On most trips, we bought breakfast from a street vendor when we started early in the morning on a trip. Usually it consisted of two pieces *baladi* bread, one stuffed with *falafel* and cabbage with some sort of sauce, and another filled with bean paste like a bean burrito. Mr. Samir knew from his previous experiences with interns where the best local food was, and during every trip, I got to sample the local cuisine. I would let Mr. Samir order for me in these situation because he knew what to get. On my first trip to Zagazig, Mr. Samir took me to Momo's which he terms, "an Egyptian McDonalds." The food was definitely a grade above your standard American fast food joint. They have a variety of hot Egyptian sandwiches for sale, served on

long bread, and I had the beef sandwich (there was more to the name but it was in Arabic). The beef came off a long roast that was slow cooked rotisserie style and cut off right on to the sandwich. The total cost for the sandwich (which was huge), some fries, and a 12 oz - I mean 355 mL- diet Pepsi was around \$3.50 which is about 20 Egyptian pounds. In Ismailia, we ate at a seafood restaurant that Mr. Samir knew was good even though he disliked seafood himself. At most sit down restaurants in Egypt they bring out appetizer salads, called *mezze*, at this restaurant which was my first experience with this tradition there were 7 different small plates with a variety of cold salads from cold pasta to fava beans. We then had a seafood soup, which had a whole crab, shrimp, mussels, and other seafood in it. The soup's tasted delicious, but I felt like I breaking some unwritten rule (that my mom would get mad at me for) using my hands to eat soup because you had to open the crab and the shrimp but it is apparently normal in Egypt. Then when I was almost full they brought out the main course of roasted mullet with a tomato paste on it and many herbs, along with shrimp in rice.

In Cairo we stopped at Abou Sharka where Mr. Samir ordered us lamb shish-kabob, and kofta which resemble meatballs but with a different flavor. The kofta's salty and herby, flavors reminded me of Italian sausage slightly, and it was delicious. Kofta quickly became one of my favorite Egyptian food items. On the way back from Alexandria, we stopped at a restaurant to eat lunch, and as always Mr. Samir ordered for me after telling me that this particular place was famous for its Moloukhiya soup. Moloukhiya is a leafy green plant native to Egypt; the soup is prepared by finely chopping the leaves and stems of the young green shoots drying them and then adding them to chicken broth with spices. This creates a very viscous vibrantly green soup that is an excellent complement to rice or meat. As always at a sit down restaurant we were served *mezze* and some delicious sauces for dipping *baladi* in, following that course we were served a vegetable soup. Then they brought rice, and stuffed grape leaves, and the Moloukhiya soup which was delicious. I expected that this would be the main course of the lunch but then they brought out a plate with a small rice stuffed bird (quail, or partridge maybe), surrounded by kofta, meat pieces, all on a bed of herbs piled high. The kofta and the meat's salty taste went well with the *baladi*, and the bird was delicious. I was overfull and there was still a great amount of food left, so I had delicious meals for the next two days.

At the end of my eight week stay in the land of the Pyramids, I felt a mixture of emotions. At first I hoped that I had lived up to the expectations of my hosts and proven to be a good ambassador for my country. This fear that I had somehow failed in this regard was quickly assuaged when Dr. Gamal spoke at the going away party that they had for me on the Thursday before I left. He apologized that there were often times throughout my internship that there were not many people around the center to work with me because of scheduling. He applauded my independence in my work and said that it was good that I was able to be independent because of the schedules that summer. Following that emotion I was sad that I was leaving especially since it is extremely unlikely that I will be going back to Egypt anytime soon, and therefore it is unlikely that I will get to meet any of my Egyptian friends for a long time. At the same time however, I was very glad to be going home after so long.

Looking back Egypt was an experience that has impacted my view of the world tremendously. Because I was able to live and work day to day with people from an extremely different culture, I am better able to understand the difficulties in international research and cultures clashing. I also better comprehend problems facing people in developing countries, and

the mindset of the world's poor and food insecure. Most importantly I learned that hard work, perseverance, and an attitude of openness to new ideas and constructive criticism are the most important factors when doing any research. Learning these things has given me greater perspective on agriculture, and the problems facing people outside the United States. This more enlightened view of the world will help me in whatever I do.



Pictures (from top left to bottom right): View of Red Sea from hotel window in Sharm El-sheikh; climbing back out of the Queen's pyramid at Giza; roadside watermelon stands dot the countryside in many parts of northern Egypt; a container ship passing through the Suez canal; Dr. Ismail A. Radwan, a native Egyptian and Auburn University graduate, who owns runs the Egyptian Aquaculture Center walking through one of his intensive culture farm ponds; weighing fry for my research trial; Mr. Samir enjoying some traditional Egyptian food at a Cairo restaurant; the Qaitbay Citadel in Alexandria, built in the 15<sup>th</sup> century on the exact site of the light house of Alexandria it served as an important defensive stronghold for Egypt; touching the top of a Pyramid.

# **The Impact of Different Feeding Rates on improved Nile Tilapias (*Oreochromis niloticus*)**

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## **Introduction**

As food security issues arise throughout the world due to increased demand and costs to farmers and ranchers aquaculture will have a prominent role alongside other high quality sources of protein in ensuring food security. The growth of aquaculture in the past 50 years has been tremendous from 1 million tonnes in the early 1950s, production in 2006 was reported to have risen to 51.7 million tonnes (FAO, 2009). In 2006, fish provided 15 percent of the average per capita animal protein intake for almost 3 billion people (FAO 84 3-4). Aquaculture in the Near East and North Africa has increased rapidly since 1995 at an average growth rate of 21.7 % per year from 1994 -2003 (Poynton, 2006). The most common species for aquaculture in the Near East and North Africa is *Oreochromis niloticus* commonly known as the Nile tilapia. Production of *O. niloticus* was 201, 973 tonnes in 2003 and has been growing steadily as the amount of aquaculture has increased in the region (Poynton, 2006). Despite these favorable growth rates in this region tilapia, contributes only a small amount of the animal protein consumed in the area (Poynton, 2006).

To increase productivity of tilapia aquaculture and thereby increase available protein sources, the WorldFish Center Genetics program has developed an improved variety of tilapia over the past 7 years. This improved Tilapia has been selected for rapid growth and high final weight. Replicated tests have confirmed that the improved varieties perform approximately fourteen percent better than commonly used commercial aquaculture strains after three generations of breeding (Rezk Et al.). The program continues, and it is now in the eighth generation. While selection has been effective, the specific trait or reason for this improvement has yet to be determined. There are several hypotheses, but the most likely is that these improved fish are able to consume and utilize feed at an increased rate and more efficiently than the other variety. The objective of this research was to determine the difference of reaction to different feeding rates by the two varieties of Tilapia thereby determining whether or not feed intake and utilization are affected by the differences in genetics between the two varieties.

## **Materials and Methodology**

Eighteen tanks were prepared to allow for three replications of three different feeding rates in experiment. These tanks all had the same initial conditions (water temperature, pH, dissolved O<sub>2</sub> concentration, etc) and the tank conditions were held constant throughout the experiment. The temperature, pH, dissolved O<sub>2</sub>, ammonia, and nitrite levels were tested twice weekly to maintain water quality unless there. These water quality tests were always conducted prior to siphoning any excess feed and fish wastes and tank cleaning to ensure that the levels were within acceptable limits at the times when the tanks were dirtiest. The volume of the tanks was 0.075 cubic meter and Tilapia fry were randomly assigned to tanks at a density of 4000 fry/ cubic meter or 300 fry per tank. Due to the fact that the fry were all of approximately equal size the number of fry placed into each tank was determined by weighing a sample of 300 fry from each variety and using that weight of fry for all tanks of that variety. The weight of 300 improved and commercial variety tilapia fry were 6 grams and 5 grams respectively. Three different feeding rate schedules were used: an average feeding rate (35%), a below average feeding rate (25%),

and a higher than average feeding rate (45%). The amount of feed fed per day was computed as a percentage of the biomass of the fish in the tank. The amount of biomass was found by removing the fish from the tanks from every 7 days and weighing them. The feeding rates and experimental design are summarized in Table 1. For the first two days from the beginning of the experiment the fish were not fed and dead fish were removed and replaced as needed. After this period, the treatments began and dead fish were removed during regular tank cleaning by siphon. The daily feed allotment for each tank was split into three equal amounts, and the fish were fed three times daily. After 26 days, the fry were removed from the tanks, weighed, and counted again to find an average final weight. The average growth per day and the total growth of the fry were compared using a general linear model ANOVA and Duncans multiple range test, between treatments, and the varieties using statistical software at an appropriate significance level.

**Table 1: Experimental design and starting conditions**

Trial #	Variety	Treatment	Feeding Rate % of BM	Starting # of fry	Density of fry (fry/m <sup>3</sup> )	Starting Weight of Fry (g)	Average Start Weight (g)
1	Improved	Low	25%	300	4000	6	0.020
2	Commercial	Low	25%	300	4000	5	0.017
3	Improved	Average	35%	300	4000	6	0.020
4	Improved	Average	35%	300	4000	6	0.020
5	Improved	Average	35%	300	4000	6	0.020
6	Improved	High	45%	300	4000	6	0.020
7	Commercial	Average	35%	300	4000	5	0.017
8	Improved	Low	25%	300	4000	6	0.020
9	Improved	High	45%	300	4000	6	0.020
10	Improved	Low	25%	300	4000	6	0.020
11	Improved	High	45%	300	4000	6	0.020
12	Commercial	High	45%	300	4000	5	0.017
13	Commercial	Average	35%	300	4000	5	0.017
14	Commercial	High	45%	300	4000	5	0.017
15	Commercial	Low	25%	300	4000	5	0.017
16	Commercial	Low	25%	300	4000	5	0.017
17	Commercial	High	45%	300	4000	5	0.017
18	Commercial	Average	35%	300	4000	5	0.017

## Results

No statistically significant differences were found at any levels based on any treatments or based on variety (Table 2). Tables 3 and 4 give the means with standard deviations for the commercial variety and improved variety respectively.

**Table 2: The results from trials**

Trial #	Finish # of Fry	Total Finish Weight (g)	Average Finish Weight (g)	Average Growth (g)	Growth Rate (g/day)	Mortality rate
1	21	3.93	0.18714	0.167	0.00727	93.00%
2	89	11.28	0.12674	0.110	0.00479	70.33%
3	45	8.82	0.19600	0.176	0.00765	85.00%
4	46	10.42	0.22652	0.207	0.00898	84.67%
5	48	8.84	0.18417	0.164	0.00714	84.00%
6	36	6.62	0.18389	0.164	0.00713	88.00%
7	52	7.26	0.13962	0.123	0.00535	82.67%
8	16	2.84	0.17750	0.158	0.00685	94.67%
9	54	12.85	0.23796	0.218	0.00948	82.00%
10	23	4.74	0.20609	0.186	0.00809	92.33%
11	19	3.83	0.20158	0.182	0.00789	93.67%
12	13	2.97	0.22846	0.212	0.00921	95.67%
13	41	7.79	0.19000	0.173	0.00754	86.33%
14	22	5.8	0.26364	0.247	0.01074	92.67%
15	11	2.01	0.18273	0.166	0.00722	96.33%
16	8	0.928	0.11600	0.099	0.00432	97.33%
17	36	5.63	0.15639	0.140	0.00607	88.00%
18	35	4.64	0.13257	0.116	0.00504	88.33%

**Table 3: Commercial Variety Means and Standard Deviations by treatments**

	Treatment	Average Final Weight	Average Growth	Average growth rate	Mortality rate
Means	Low	0.1418233	0.125	0.0054433	0.8799967
	Average	0.1540633	0.1373333	0.0059767	0.8577767
	High	0.2161633	0.1996667	0.0086733	0.9211133
Standard Deviations	Low	0.0358309	0.0359305	0.0015565	0.1530795
	Average	0.0313211	0.0310859	0.0013627	0.0287353
	High	0.0546722	0.0545558	0.0023808	0.0386359



**Table 4: Improved Variety Means and Standard Deviations by treatments**

	Treatment	Average Final Weight	Average Growth	Average growth rate	Mortality rate
Means	Low	0.1902433	0.1703333	0.0074033	0.9333333
	Average	0.20223	0.1823333	0.0079233	0.8455567
	High	0.20781	0.188	0.0081667	0.87889
Standard Deviations	Low	0.0145454	0.0142945	0.000630661	0.0120217
	Average	0.0218516	0.0221886	0.000949965	0.0050921
	High	0.0275681	0.0274955	0.0011992	0.0583429

## Conclusions

Since there were no statistical differences found with any measured variables either there are no significant differences between the two varieties or errors were made during the course of the research. Based upon the fact that Rezk et Al (2009) showed that there were significant differences between the two types of fish, the latter conclusion seems most likely. It is also possible that since the trial was conducted for such a short period of time the fry did not have enough time to grow to make the differences between the two varieties and the three trials more significant. If the trial duration was extended to 6 months or longer, the effect of the treatment would be more significant than with the short time period. These results could have come about because of the high mortality rates among the fry in all of the experimental units. This mortality may have been the result of the relative inexperience of the researcher when handling the fry, and from stress during weighing. In addition although the ammonia and nitrite levels were normal when checked, it is possible that during the course of the experiment these levels became toxic and caused the demise of the fry.

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The State of World Fisheries and Aquaculture [in] 2008. 2009. FAO Fisheries and Aquaculture Department. Food and Agriculture Organization of the United Nations. Rome.



Pictures (from top left to bottom right): View from a window in the Qaitbay Citadel in Alexandria, looking out onto the Mediterranean sea, on the horizon the other parts of Alex (as the locals call it) are visible; view of the Red Sea in the evening twilight; cleaning tanks by siphon for my research project; Mr. Samir and his wife, look at the fry rearing pens at the Egyptian Aqua Culture Center; standing in front of the Mediterranean sea; the Cairo skyline from the Giza Plateau; Mr. Ahmed Nasralla and workers capturing fry from the nursery to move out to the large earthen grow-out ponds.