AQUANEWS

Sustainable Aquaculture and Fisheries for a Secure Future

AquaFish Collaborative Research Support Program Newsletter

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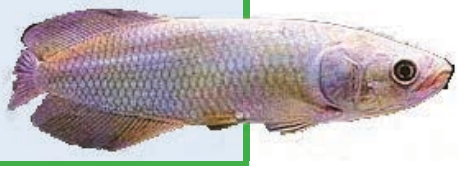
Development and diversification of indigenous species for aquaculture in Ghana

By Nelson Agbo, Steve Amisah, Emmanuel Frimpong, and Kwamena Quagrainie

There is a growing need to diversify species used in aquaculture as capture fisheries decline and demand for fish increases. Studies in different parts of the world continue to investigate the use of "non-traditional" species in aquaculture. In Ghana, as in many parts of sub-Saharan Africa, the tilapias and the clariid catfishes (*Clarias gariepinus* and *Heterobranchus* sps) have been the main focus of development efforts in aquaculture for subsistence and for purposes because of their well-understood biology and adaptability to culture environments. However, over the past several years there has been a clear trend among farmers towards diversification of species in Ghana, and the Purdue University-led AquaFish CRSP team in Africa has thrown its weight behind this effort.

Recent studies by Dr. Emmanuel Frimpong, an assistant professor at Virginia Polytechnic Institute and State University (Virginia Tech) and US Co-PI of the AquaFish CRSP Ghana Project and Drs. Nelson Agbo and Steve Amisah, CRSP researchers at Kwame Nkrumah University of Science and Technology (KNUST), Ghana, revealed that farmers were increasingly culturing a number of 'non-traditional' species. Some of the most common among these species are African bony-tongue *Heterotis niloticus*, the Claroteid catfish, *Chrysichthys nigrodigitatus*, and the African snakehead, *Parachanna obscura*, which are indigenous to the area and are among the most highly valued species in West African inland fisheries. These species are widely distributed in tropical rivers and freshwater lakes of Western and Central Africa. In Ghana, the Claroteid catfish forms about 40% of the catch from the Volta Lake alone. Both the African bony-tongue and the Claroteid catfish are omnivores, with a wide variety of food preferences. African snakehead, on the



Three species of interest pictured from top to bottom: Claroteid catfish Chrysichthys nigrodigitatus, *African snakehead* Parachanna obscura, *and the African bony-tongue* Heterotis niloticus.

Diversification of Species continued on page 12...

CRSP Biodiversity Symposium

THE EFFECTS OF SEMI-INTENSIVE AQUACULTURE ON BIODIVERSITY IN NEARSHORE AND INLAND WATERS

By Stephanie Ichien

AquaFish CRSP Director Hillary Egna and US Lead Project PI Jim Diana organized a Biodiversity Symposium as a way to discuss the primary impacts of semi-intensive aquaculture on biodiversity and to illustrate ways of mitigating its negative impacts on organisms and habitats. Sponsored by the CRSP, the symposium was hosted within the American Fisheries Society (AFS) 2011 Annual Meeting in Seattle, Washington and took place on 8 September 2011. A panel discussion, attended by the invited speakers on the morning of the symposium from preceded the formal session and provided the group with the context, structure, and intentions of the symposium. This panel discussion was a valuable time for the invited speakers to discuss their ideas about the future of aquaculture and the potential global impacts. The formal session took place that afternoon, where thirteen presentations were offered for all conference attendees, and staged the topic in a broarder arena.

The topics covered in the symposium were based on the environmental impacts of aquaculture as reported in Jim Diana's article in the January 2009 issue of Nature, "Aquaculture Production and Biodiversity Conservation." Eight primary impacts were the focus of the 13 talks given during the AFS session. Speakers included CRSP oparticipants and non-CRSP participants in order to provide a wide range of perspectives.

With the intention of reaching an audience beyond the aquaculture community, one of the outputs of the symposium will be a brief synoptic article in a large, well-circulated journal. Each of the speakers will also produce an individual manuscript of their presentation, which will be submitted for publication in a special section of an aquaculture journal.

For a full list of invited authors and their topics see page 13.

***The AquaFish CRSP Fifth Annual Report* is now availbale on the AquaFish website along with the *Feed the Future: Enhancing the Profitability of Small Aquaculture Operations in Ghana, Kenya, and Tanzania First Annual Report*.**

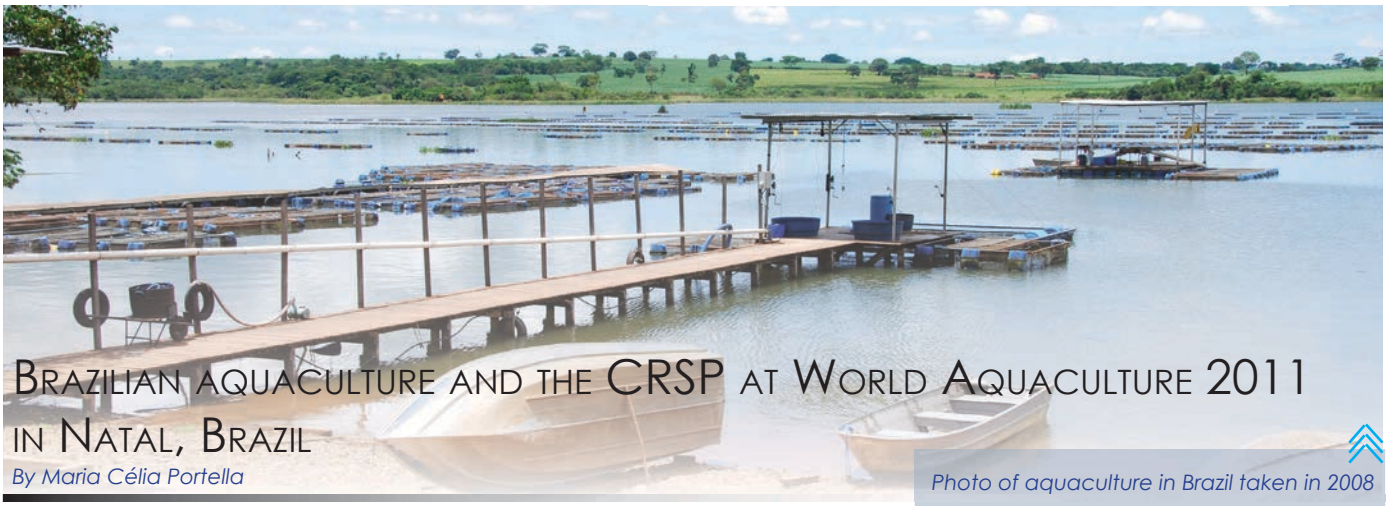
Goings-on in the Pond...

AquaFish CRSP Lead Host Country PI Dr. Charles Ngugi was recently appointed the Chief Technical Advisor to the Permanent Secretary of the Ministry of Fisheries Development in Kenya. In this new position, Dr. Ngugi will be responsible for coordinating all fisheries matters in the country and will be in charge of four directorates including the Kenya Marine and Fisheries Research Institute. With Kenya poised at a critical juncture in the development of their aquaculture and fisheries sector, Dr. Ngugi is well placed to provide quality information and good practical advice. We congratulate Dr. Ngugi on this great honor and wish him all the best in his new position.

Congratulations to Dr. Steve Amisah, AquaFish CRSP Host Country PI in Ghana, who was given the Honorary Award: Best Researcher in Science from Kwame Nkrumah University of Science and Technology, in Kumasi, Ghana. (see "Congratualtions" page 18 for more.)

Michelle Zamora Abella, AquaFish CRSP graduate student at Central Luzon State University (CLSU) in the Philippines, won the best thesis award in the M.S. category for her work titled, "Effect of Broodfish Potential Social Condition on Seed Production of Nile Tilapia (*Oreochromis niloticus L.*)." The award was presented on 14 April at the CLSU Tea Party and Recognition Program in honor of graduating students. Congratulations to Michelle!

The AquaFish CRSP Management Team has developed a set of brochures that outline programmatic impacts by region. The three brochures, covering work in Asia, Africa, and Latin America, are now available on the AquaFish CRSP website. aquafishcrsp.oregonstate.edu/publications.php



Brazilian aquaculture and the CRSP at World Aquaculture 2011 in Natal, Brazil

By Maria Célia Portella

Photo of aquaculture in Brazil taken in 2008 during the AquaFish CRSP HCPI Exchange project. Photo by Jim Bowman

The beautifully situated city of Natal, the capital of Rio Grande do Norte State, Brazil, was the scene of World Aquaculture 2011. Surrounded by impressive dunes and a light blue sea, the Natal Convention Center welcomed more than 4300 participants, representing about 90 countries from around the world. This year, World Aquaculture 2011 was hosted by the World Aquaculture Society (WAS) and the WAS-Latin American and Caribbean Chapter (LACC), and was held along with the 8th International Shrimp Farming Symposium (FENACAM). The latter event takes place every year in Brazil, and is sponsored by the Brazilian Association of Shrimp Producers (ABCC). In addition to more than 50 technical sessions, about 1000 posters were displayed and over 300 exhibitors exposed their latest products, equipment, and innovations in aquaculture at the Trade Show.

In the opening ceremony, the Brazilian Minister of Fisheries and Aquaculture, Ideli Salvati, explained the goals of the Ministry's program for exploring the multiple and varied natural resources found in the country for aquaculture production, and the policies for developing them in Brazil. For many years, Brazil was referred to as "a land of promise," a big, democratic, and stable country, rich in natural resources with fair economic development. It is not different in the aquaculture sector. The favorable climate, warm temperatures (year-round in most areas of the country), abundant water resources (about 5 million ha of flooded lands suitable for cage fish farming and 8,500 km of coastline), huge diversity of native fish species, inexpensive labor, and plentiful grain production, have made aquaculture in Brazil a promising activity.

In the last decade, we have observed fast development of aquaculture in Brazil, growing from an artisanal and disorganized activity to a professional guided industry, producing valuable protein sources and employing many people. The outlook for the Brazilian economy is positive today, and with the fisheries sector upgraded to the status of Ministry of Fisheries and Aquaculture, great efforts have been made to regulate stakeholders and to structure the aquaculture production chain, thereby solidifying Brazil's huge potential as a world seafood supplier. The development of regional technology and know-how is supported by the scientific knowledge generated by many universities and research institutions. Universities in all regions offer undergraduate and graduate courses in Aquaculture, in addition to more than 90 courses that are offered on other related topics all over the country. This results in the generation of new experts every year. The opportunities and challenges in Brazilian aquaculture are clearer now; the results can already be seen in the increase of production of native (pacu, tambaqui, and surubins) and exotic (tilapia, carp, and shrimps) species.

During World Aquaculture 2011, the technical sessions covered the most relevant topics of innovative aquaculture systems and management. The most attended sessions, like the Tilapia Session, offered translation from English to Portuguese. In this specific session, the room was completely filled with scientists, students, entrepreneurs, and stakeholders who all provided very interesting discussions following each presentation. During this

Brazil continued on page 6...

Development of More Sustainable Prawn Aquaculture in Thailand

By James S. Diana

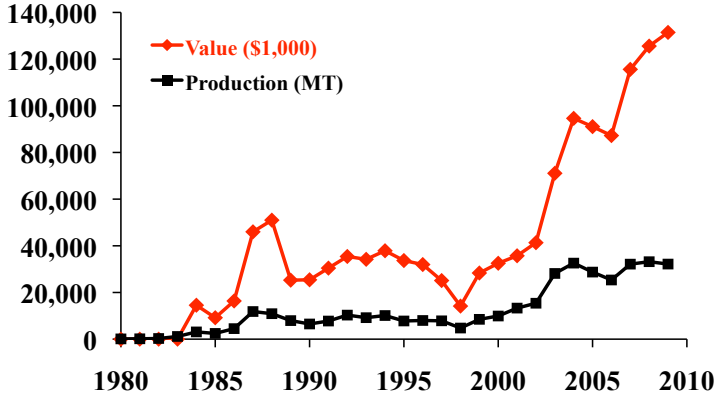
It is well known that aquaculture plays a major role in the production of food for both export and local markets. The case of the giant river prawn *Macrobrachium rosenbergii* is interesting in Southeast Asia, particularly Thailand. Prawns are very popular food items in this region and, as such, contribute largely to the local economy. In 2008, the total production of prawns in Thailand was approximately 32,000 metric tons, worth about $131 million. The production of prawns has maintained itself at around 30,000 tons since 2003, while the value has increased dramatically – almost doubling during that same time period (Figure 1). Clearly, the quality of the crop and the value per pound has increased over that time period. Prawns grown in Thailand are entirely marketed locally, with no export reported. As such, for several reasons they are not necessarily stong market forces driving more sustainable production nor are they good candidates for certification. First, Thais already understand and value aquaculture. Second, local consumption eliminates organizations, such as importers from Europe or America, having any say in the standards for growing prawns. And third, local consumers in Thailand are more concerned about price than environmental performance.

In 2005, the University of Michigan CRSP project conducted surveys of prawn farming in Thailand, with the intent of understanding the environmental impact (Schwantes et al. 2009). The end results showed that prawn farming was lucrative for farmers, but there were major concerns about eutrophication of water sources, overuse of feed, and other environmental impacts symptomatic of an over-intensity of prawn production. As a follow-up to that evaluation, in August 2011 Yuan Derun and I conducted a workshop as part of a current AquaFish CRSP project, intended to convince prawn farmers to undertake more sustainable production practices. We brought together a group of managers and farmers and planned to review the status of prawn farming and educate them on how to minimize the environmental impacts from farming practices. We thought we could teach farmers new methods, but we were definitely mistaken.

As the workshop progressed, we were surprised to find that prawn farming had changed dramatically since the 2005 survey. The typical prawn farmer had significantly reduced stocking density, tended to use no water exchange systems for production, and reduced total yield while achieving a higher standard product from the grow-out systems. As a result, the concerns about eutrophication and overfeeding had largely disappeared over the six-year period. Farmers began following the Thailand GAP (good aquaculture practices) standards for Thai shrimp. The shrimp GAP includes ten requirements that are either major (must be adhered to), minor (requires 70% compliance), or recommended (requires 60% compliance). These include major categories of: farm location, farm management, use of drugs, effluent and sediment management, energy use, farm sanitation, harvest and post-harvest handling, labor and welfare, social and environmental responsibilities, and record keeping. While the system is voluntary, GAP standards have been adopted by a large number of shrimp farmers in an effort to improve the sustainability of their operations. In the absence of specific prawn standards, prawn farmers have adopted these practices.

To our surprise, prawn farmers in Thailand had willingly changed their practices to a very substantial degree. In 2005, 96% of all farmers practiced intensive monoculture. While we were unable to conduct a similar survey with statistical methodology in the 2011 workshop, reports at the workshop indicated that 80% of farmers today practiced polyculture instead. The common polyculture was with *Macrobrachium* (about 6 individuals per square meter) and white shrimp *Litopenaeus vannamei* (about 12 per square meter) in

Figure 1: Prawn production and value in Thailand from 1980 to 2010.



Prawn Aquaculture continued on page 5...

...Prawn Aquaculture continued from page 4

freshwater. This is in comparison with the monoculture of prawns, which was done at about 40 individuals per square meter; so effectively, the overall density had decreased by at least one-half. Similarly, in 2005, feeds were often handmade and were of low quality with many fine particles, while in polyculture, commercial feeds were used, which are controlled more regularly. Feeding rates are now evaluated using feeding trays. Water exchange in 2005 was about 60% per pond per week, while currently water is exchanged at a much lower rate and most of that water is retained. These changes have occurred in part because the GAP standards for shrimp are being applied to prawns and in part because of a move by the Thai Department of Fisheries to help farmers become more environmentally aware, as well as more profitable.

In the new aquaculture system, most farmers rely on freshwater culture of white shrimp at low density for their basic income, and then culture prawns at even lower densities to supplement their income because of prawn's high market value. As a result, farmer's overall production has stabilized over the past six years, while the value of their crop has increased dramatically, and the environmental impact of their growing system has decreased dramatically. Assuming the reports presented at our workshop reflect what is actually happening throughout the industry, this is a win-win situation, with prawn culture remaining more profitable, while improving its environmental performance. Perhaps the most interesting aspect of this impact was the rapidity of this change; in about six years the industry has changed dramatically from one dominated by intensive monoculture to one using more semi-intensive polyculture. Both systems are very profitable, but the current system appears to be more so because of the lower impact of diseases and the high value of large prawns, which grow more rapidly in the lower density culture systems.

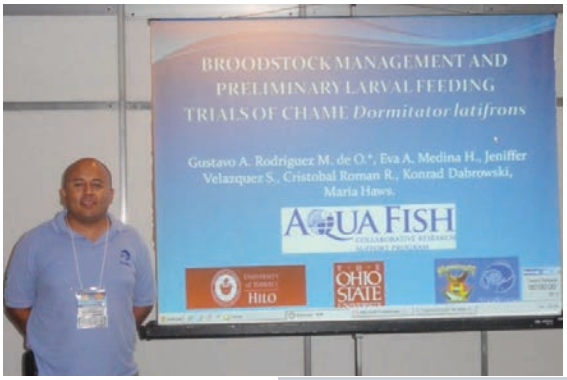
Workshop participants pose for a photo. Photo Courtesy of Jim Diana

The results of the workshop were surprising. Yuan Derun coordinated the workshop, inviting 14 farmers and 17 researchers or government managers of aquaculture systems. Because the workshop was located in Bangkok, most farmers were from Suphanburi or Ratchaburi, two provinces near Bangkok. However, their views almost certainly reflect those of the industry, as those two provinces are the major producers of prawns in Thailand.

Overall, the workshop was a success in many ways. From the AquaFish CRSP perspective, major changes in prawn culture have occurred in Thailand as a result of increasing scrutiny for environmental performance. The aquaculture programs continue to be profitable – probably even more profitable than before – but at the same time, much more environmentally sustainable. Intensive efforts by the Thai Department of Fisheries various research groups including NACA (Network of Aquaculture Centers in Asia-Pacific) and the AquaFish CRSP, along with the results of our previous study, led this movement toward more sustainable production. More than anything, this change demonstrates the importance of sustainability to aquaculturists in Thailand and bodes well for the future of aquaculture in that region.

To our friends and colleagues in Thailand who are suffering from the worst floods of over a century: Our hearts go out to you for a speedy recovery.

...Brazil continued from page 3



AquaFish CRSP participants attended WAS'11 and were active throughout the conference. On the far left Pamila Ramotar; in the middle, Gustavo Rodriguez; and on the right Claude Boyd. Photos by Maria C. Portella

session, Pamila Ramotar, CRSP HC PI from Guyana, gave a talk on behalf of CRSP US PI Kevin Fitzsimmons entitled "Global Overview of Tilapia Production and Markets." Pamila also presented a poster regarding "Seventy five years of tilapia culture in Indonesia."

Several other CRSP participants attended the meeting and gave oral and poster presentations, further contributing to the extension of the scientific knowledge generated by their projects. Claude Boyd of Auburn University reviewed the efforts to reduce the waste load of aquaculture facilities. Konrad Dabrowski, attending from The Ohio State University, reviewed progress in understanding the thiamine (vitamin B1) function in fish, and discussed the new results on the replacement of plant protein with algae for growth enhancement of tilapia. Gustavo Rodriguez (CRSP HC Co-PI, Mexico) gave two oral presentations. One was directly related to his currently funded AquaFish CRSP investigation on "Reproductive broodstock management and preliminary larval feeding trials of chame *Dormitator latifrons*", and the the other presentation described respiratory rates of the spotted rose snapper *Lutjanus guttatus* during larval development. Maria C. Portella presented on the "Effect of methyl-testosterone on muscle development of three different tilapia strains," "Free amino acids in pacu eggs and larvae" as well as on "Production of microencapsulated diets containing probiotics for pacu larvae." David Bengtson from University of Rhode Island, presented the work on "Replacement of fish meal with soybean meal and soy protein concentrate in diets for summer flounder," and Michal Wojno, Dabrowski's student from Ohio State University, addressed the question "Why the dietary free amino acids are excreted in fish."

Maria Portella, AquaFish CRSP representative at WAS'11 standing with two of the AquaFish CRSP posters prepared by the Management Team. Photo courtesy of Maria Portela

Representing the AquaFish CRSP at WAS'11 in Brazil, Maria C. Portella displayed and presented three posters prepared by the CRSP Management Team. One poster (Ichien et al.) was entitled "Supporting the development of sustainable aquaculture and fisheries through capacity building and gender integration" and explained the objectives of AquaFish CRSP to build and strengthen capacity in developing countries through training and outreach activities. Short- and long-term trainings were discussed, as well as gender integration efforts. The two other posters (by Ichien & Egna) were related to (1) "Developing and improving the culture of indigenous species," emphasizing the AquaFish CRSP efforts to stimulate indigenous species production development in Cambodia, Ghana, Mexico, Nepal, Nicaragua, and Vietnam, and (2) "Investigating the relationships between rural

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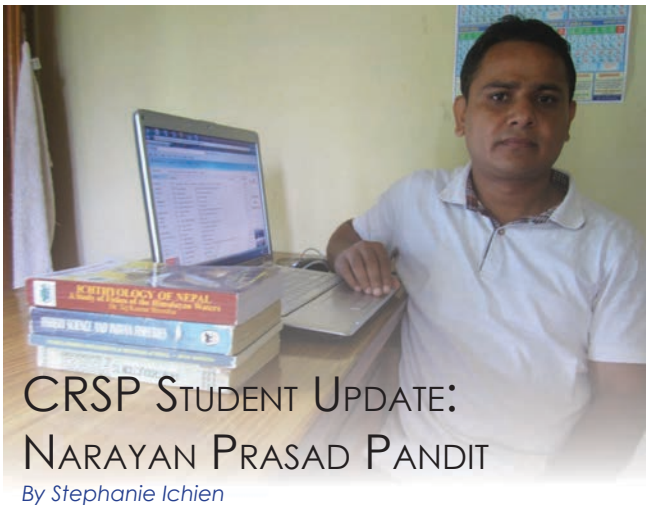

CRSP Student Update: Narayan Prasad Pandit

By Stephanie Ichien

Winner of the 2011 SOU-CRSP Yang Yi Young Scientist Travel Award, Narayan Prasad Pandit has been involved with the CRSP since 2002 and has had many accomplishments in that time. Currently, Pandit is an Assistant Professor of Aquaculture at the Institute of Agriculture and Animal Sciences (IAAS) under Tribhuvan University, Nepal and is on a path to start his PhD in 2012. This will come after a BS in Agriculture and two master's degrees. Pandit's first master's was in Aquaculture from IAAS on an Aquaculture CRSP (ACRSP) project entitled "Polyculture of grass carp and Nile Tilapia with napier grass as the sole nutrient input in the subtropical climate of Nepal," working under the guidance of his major professor, Dr. Madhav Shrestha, CRSP HC Co-PI. Following the completion of his first graduate degree with CRSP support, Pandit remained involved with the CRSP on two projects focused on cage-cum-pond aquaculture systems in Nepal before his second master's in 2008. This degree was in fisheries science from the University of the Ryukus in Okinawa, Japan, on the "Effect of high temperature on reproductive physiology of Nile tilapia."

After finishing his second master's degree in 2010, Pandit transferred into a permanent position, his current job, with IAAS and is again involved with CRSP. Working on the AquaFish project "Incorporation of tilapia (*Oreochromis niloticus*) and sahar (*Tor putitora*) into the existing carp polycutlure systems of Nepal" with Dr. Shrestha, Pandit remains a key AquaFish CRSP collaborator in Nepal and a rising leader in Nepali aquaculture research. With no aquaculture PhD program available in Nepal, he will head overseas to obtain his doctorate, but plans to return to continue advancing aquaculture research in Nepal and inspiring the next generation of researchers through his accomplishments and his teaching.

To read more about Pandit's involvement with the former ACRSP, he was featured in a Graduate Student Profile during his first master's program in the Summer 2003 issue of Aquanews, available on the AquaFish CRSP website at: aquafishcrsp.oregonstate.edu/Documents/aquanews_pdf/summer03.pdf.

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aquaculture development and biodiversity," highlighting the global partnership to develop sustainable solutions in aquaculture and fisheries and focusing on three topics: mitigating environmental impacts, sustainable feed technology, and indigenous species culture development.

On a final note regarding CRSP participants at World Aquaculture 2011 in Natal, during the meeting the new Board of Directors of the Latin American and Caribbean Chapter of the World Aquaculture Society for the 2011-12 term was inaugurated. It was constituted as follows: Maria C. Portella (President), Patricia Moraes Valenti (Secretary), Carlos A. Alvarez Gonzalez (Treasurer), and Maria Jose R. Paiva and Paulo Carneiro (Directors). Contributing to the strengthening of aquaculture in LAC region and the establishment of linkages and communication between the countries of Central and South America are the highest priorities and challenges for these new office members.

Finally, the participants could also appreciate the delicious local cuisine and fine culture of Natal. A festival with a seafood-based menu with shrimp and tilapia was held at the Convention Center, and shows featuring regional singers took place during the lunch breaks. These events offered the participants the warmth and special attention with which the Brazilians receive their guests.

Graduate Student Profile: Naim Sidrotun

By Stephanie Ichien

Aquaculture—shrimp culture in particular—is one of the main livelihoods in Indonesia, where Naim Sidrotun is from. However, shrimp disease has been and remains a recurring problem for farmers, which is where Naim hopes to change things. Shrimp diseases have been her focus for over five years, and she is now working on a PhD to minimize shrimp disease through shrimp-tilapia-seaweed polyculture with her major professor, Dr. Kevin Fitzsimmons, at the University of Arizona (UA). With support from AquaFish CRSP, Naim is taking full advantage of the opportunities and the resources available to her in the US and is on track to complete her PhD by December 2012.

Naim is from the town of Bandung, West Java, in Indonesia, where she grew up the seventh child of eleven. Her interests took her down several paths and have led her to find her passion as a researcher. In 2002, Naim completed her undergraduate studies in biology at Bandung Institute of Technology in Indonesia. Three years later in 2005, Naim finished her first MS in marine biology and aquaculture at the University of Queensland, Australia. Most recently, in 2010, she finished the first of her three degrees from UA: her second MS in environmental science.

Naim first got involved with her work at UA when she met Dr. Fitzsimmons at an AquaFish CRSP workshop in Banda Aceh, Indonesia. Already deeply interested in shrimp diseases and their mitigation, Naim was pleased to learn of Dr. Fitzsimmons' expertise in shrimp-tilapia polyculture and its application to minimizing shrimp disease. Issues with disease in Indonesian aquaculture have been a limiting factor in the industry. Resources for dealing with disease in Indonesia are scarce and there are few experts in the field, but Naim hopes that she will be able to change this. She is now well into her PhD research, with the preliminary studies done. Moving forward, Naim will conduct bioassay tests in the lab and plans to scale up to ponds in order to determine the best stocking densities for the shrimp, tilapia, and seaweed to optimally share space.

Through her work with AquaFish, Naim has continued to be involved with workshops and trainings, providing her the opportunity to teach others and to connect with the CRSP community around the world. In July 2011, Naim and Dr. Fitzsimmons conducted a training on nutrition and seaweed handling in Jakarta, where 21 people were involved. Ultimately Naim would like to teach at a university. She wants to establish an aquatic disease reference lab in Indonesia where she can continue to share her expertise and expand the aquaculture knowledge base in her country. Further, she has a specific desire to empower women through science.

In 2009 Naim was one of the recipients of the L'Oreal-UNESCO "For Women in Science" award in Indonesia and represented her country in a similar competition at the international level. A 2010 article in the Jakarta Post further highlights some of Naim's accomplishments: www.thejakartapost.com/news/2010/08/02/sidrotun-naim-becoming-a-shrimp-pathologist.html

Master Training for CRSP Participants at Auburn University

By Stephanie Ichien, Chelsea Stephen, and Jim Bowman

By providing jobs and wages, commercial aquaculture can help alleviate poverty, especially for those in rural areas where employment opportunities are limited. In these areas it has become clear that human resource capacity is a key to sustained advancement of the aquaculture sector. However, in many countries there are not enough qualified trainers, i.e., aquaculture specialists with the necessary knowledge and experience to provide reliably high quality information.

With awareness of this need for skilled trainers and quality trainings, particularly in Africa, the AquaFish CRSP Auburn University project is conducting an investigation called "Training Trainers for Long Term and Sustained Impact of Pond Aquaculture in Africa." The goal is to provide a master training program to a select team of highly qualified current aquaculture trainers from Kenya, Tanzania, Uganda, and Ghana, and prepare them to hold trainings and provide technical assistance in their home countries. Eight candidates, two from each of the four countries, were nominated and vetted by the training coordinators and the AquaFish CRSP Director, Hillary Egna. The eight participants took part in an Auburn University Master Trainer course, held 26 July-26 August 2011, in Alabama. Through this month-long field training, the participants were exposed to a variety of experiences in pond aquaculture, recirculating systems, partitioned aquaculture

Participants getting valuable field experience at the experiment station north of Auburn University in Alabama. Photo courtesy of Karen Veverica

systems, fish transport and handling, feed management and feed trials, pond fertilization, water quality monitoring, aeration technology, fish harvesting, and marketing. The hands-on field training further provided the participants the necessary skills to begin developing their own training events, ultimately providing opportunities and a valuable resource for new or aspiring fish farmers in their own countries. The trainees also took part in a distance-learning program, the "Certification of Aquaculture Professionals" (CAP) program, which consists of 10 web-based modules that provide a foundation for professionals in the aquaculture industry. Auburn University's Karen Veverica coordinated of the training.

The training doesn't end at Auburn, however. The eight participants are now gearing up to hold two one-week training sessions for current and new-entry farmers in each of their home countries. The new Master Trainers will be guided in these in-country trainings by experienced CRSP collaborators, including Auburn's Karen Veverica and long-time CRSP researchers Charles Ngugi and Yuan Derun. The benefits of the combined CAPs and Master Trainer programs are already being felt by the participants. "I am already using the information to advise farmers and two students from Makerere University working as interns with our organization," says Ben Kiddu, coordinator of the Walimi Fish Farmers Cooperative Society (Uganda) and Master Trainer participant. "I am so grateful for the opportunity offered to me and the rest of the group that traveled to Auburn for the Master Trainer Course. I have learned a lot and made many new friends."

AquaFish CRSP Workshops in Guyana

By Kevin Fitzsimmons

Guyana, in South America, has some of the best protected rainforests in the world as well as enormous quantities of pristine freshwaters, little industry, a relatively small population, and a long coastline. The northern watersheds drain to the coastal areas to the east and west of the capital, Georgetown, and into the Caribbean, while its southern watersheds are part of the Amazon Basin. Our AquaFish CRSP work in Guyana is split between the two areas. The road to the west of Georgetown does not extend very far into Region 3 (Figure 1), but the east road extends all the way to the border with Surinam. In this eastern area, Regions 4 and 5, we have worked with a number of individual farmers rearing tilapia and pacu and with one women's cooperative rearing tilapia and hassar, a local armored catfish. The farms are all arrayed along the coastal highway and use their fish primarily for direct consumption and local sales, as well as for some sales to the major population center of Georgetown.

In Regions 4 and 5 we have worked with most of the individual farmers including those growing tilapia, pacu, and shrimp, a feed mill producing fish feed, and one tilapia hatchery. The tilapia farmers are using both Mozambique tilapia imported years ago and improved selections of Nile tilapia donated by Swansea University in Wales with support from the British Department for International Development (DFID). The two shrimp farmers we work with use extensive methods of non-fed, tidal impoundments. On our last visit we collected shrimp samples for eventual species identification and gross health exam. We have suggested that the farmers consider growing tilapia in cages in their ponds to increase revenues, increase growth and survival of the shrimp, and diversify their sales (in time and product).

Figure 1: Map of Guyana, ten regions.

Region 1	Barima-Waini
Region 2	Pomeroon-Supenaam
Region 3	Essequibo Islands-West Demerara
Region 4	Demerara-Mahaica
Region 5	Mahaica-Berbice
Region 6	East Berbice Corentyne
Region 7	Cuyuni-Mazaruni
Region 8	Potaro-Siparuni
Region 9	Upper Takutu-Upper Essequibo
Region 10	Upper Demerara-Berbice

The Trafalgar Union Women's Cooperative operates one of the largest farms in Region 5. This cooperative of 16 women have pooled their resources and been provided with a low cost lease on 12.5 hectares of federal land. The farm now includes 10 ponds, with four more under construction. We have conducted three workshops for the group. One workshop was held at the National Aquaculture Center at Mon Repos, one at the Maharaja Feed Mill, and a third at the Trafalgar Union Farm. The workshops included basics of aquaculture and tilapia biology, basic fish nutrition, feed formulations, feed manufacturing, and on-farm feed handling and distribution.

Our second area of interest is in the Rupununi Basin in the southern portion of Guyana (Region 9). The Rupununi is a part of the Amazon watershed that seasonally floods large areas of savanna. The indigenous populations of the Rupununi are commonly referred to as AmerIndians. These native people have a very different culture and lifestyle compared to the coastal populations,

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...Guyana Workshops continued from page 10

Office and feed storage at the Trafalgar Union Model Farm. Coop leader, Ms. Shenella Lewis and several sons and nephews who have been hired to work at the farm. Photo courtesy of Kevin Fitzsimmons

which are composed of the descendants of black slaves and East Indian indentured workers. There is only one unpaved road across the Rupununi Basin and no electrical or phone systems. The people are essentially subsistence farmers utilizing solar panels or diesel generators for household electrical power. As there are no phone, radio or television signals, internet connections through satellite dishes provide the only communication with the outside, aside from irregular mail service when the dirt road is passable.

Our focus in the southern watersheds has been to study, develop, describe, and demonstrate a simple integrated farming system utilizing native fishes and vegetable crops grown in the area. We organized our workshops and visits with the Fisheries Office staff in Georgetown before flying by small plane to the airstrip at Annai. We held our first workshops to describe the system to the community members and to gather their input and suggestions as to how to improve the concept. We also visited several ponds that had been built in the area. None of the ponds could be drained. None were fenced to keep out caiman or other fish eaters. Several of the ponds were more than three meters deep. The attempts at stocking had failed, and any attempts to harvest by net were unsuccessful.

Therefore we recommended a simple small pond system coupled with production of local vegetables. With the lack of reliable electricity we incorporated a solar panel for the pump used for irrigation periods. For the demonstration pond and garden, a solar panel was purchased in Georgetown along with a battery, a controller, and a direct current pump. We took the materials as our checked baggage and flew to Annai with a change of clothes in hand.

After the prior workshop and discussions with the local association of farmers, we decided to put a demonstration farm at the Rock View Lodge. The Lodge is situated between the airstrip and the dirt highway crossing the Rupununi Savanah. The regional primary and secondary schools are on either side of the Lodge and virtually all the school children cross the property twice a day going to or returning from school. With the open and sharing nature of the society, it is normal for everyone to stop and see anything that is new when "passing by." Everyone agreed this would be the best location. The proprietor, Colin Edwards, has started the rcommended pond construction and planted the garden. He has the solar panel and battery apparatus ready to install when the fish are stocked. The current plan is to stock with pacu fingerlings. The pacu are native to the area and fingerlings are available from a hatchery across the border in Brazil. Delivery is only possible in the dry season, but plans have been developed for stocking in September 2011.

The participants of the AquaFish CRSP workshop in Annai at the Bina Hill Community center pose for a picture. Photo courtesy of Kevin Fitzsimmons

...Diversification of Species continued from page 1

other hand, is a voracious predator. In captivity, remarkable growth of these species have been reported, with mean body weight of the African bony-tongue reaching up to 4 kg in 12 months.

"Production of these species in captivity is necessary because environmental degradation and overfishing have reduced their populations," says Steve Amisah, associate professor at KNUST and the Host Country PI of the AquaFish CRSP Project in Ghana.

When farmers were asked in a survey why they were eager to culture these species, their most frequent response was that these species are in high demand and fetch higher prices in local markets than tilapia. Thus, the farmers are motivated by the market potential of these species.

AquaFish CRSP graduate students, Ethel Tettey (left) and Peter Akpaglo (right), working in Ghana, preparing feed for indigenous species. Photo by Nelson Agbo

Before initiation of the AquaFish study, technical information on the culture of these species in Ghana was scanty, including knowledge of their ecology and biology, especially their dietary requirements under culture conditions. To consider the species for development, it is important to verify their life-history, trophic level, and other ecological traits that could be exploited for commercial seed production and fast grow-out in ponds and cages. Documentation of such information will provide the basis for further studies on the species for development in Ghana. The study, therefore, was designed to gather information from literature, fish farmers, vendors, and fishers, and to conduct experiments to determine the nutritional requirements of the African bony-tongue, the Claroteid catfish, and the African snakehead.

Over the past two years, Aquafish CRSP investigations at KNUST, in collaboration with Virginia Tech, have documented information on several aspects of the culture and nutritional requirements for the three indigenous fishes. They have determined the dietary protein requirements for juvenile African bony-tongue and the Claroteid catfish as 30-35% and 35-40% respectively. These findings were the result of several feed trials conducted to compare the effects of varying crude protein (CP) levels ranging from 25% to 45% using fish meal/soybean meal as protein sources in a ratio of 2:1 in practical diets. The Claroteid catfish were reared in tanks and African bony-tongue were reared in hapas.

An AquaFish CRSP workshop held in July 2011 in Ghana on the culture of the new indigenous species received overwhelming attendance by over 100 farmers– an indication that farmers' interest in the production of these species remains high. Farmers enthusiastically participated in an open forum to share their experiences with the culture of indigenous species. During the workshop, considerable and very useful anecdotal information was gathered, including interesting comments like "when Claroteid catfish is overfed it becomes very fatty and dies" and "African snakeheads do not need to be fed; they just eat mud and grow very big," referring to the snakeheads ability to subsist on natural production in extensive ponds. Farmers were so intrigued by the preliminary findings that some started requesting the experimental diets to feed their fish.

Our studies are still in the preliminary stages and additional work is on-going for these species. Future work at KNUST will continue looking at nutritional requirements and developing strategies for the establishment of sustainable production systems, marketing schemes, and profitability plans for the culture of these species.

The July workshop held by the CRSP team in Ghana caught the attention of journalist Kofi Adu Domfeh, who published a story called "Fish farmers recount prospects of aquaculture for job creation." The article appeared in several online publications, and included an interview with CRSP US Co-PI Dr. Emmanuel Frimpong. The article at africanews.com can be found here: http://bit.ly/p6SJgK

Some of the Biodiversity Symposium participants met at the AFS reception before the symposium got underway. Pictured here from left to right: Konrad Dabrowski, Marc Verdegem, Barb Diana, Maria Portella, Jim Diana, and Stephanie Ichien. Photo Courtesy of Barb Diana

On the day of the CRSP Biodiversity Symposium, invited speakers and organizers posed for a group picture after the panel discussion. In front: Marc Verdegem and Hillary Egna. Standing from left to right: Bob Pomeroy, Claude Boyd, Mark Peterson, Felipe Cabello (front), Jim Diana, Thierry Chopin, Todd Slack, Ling Cao, Maria Portella, Konrad Dabrowski, and Wilfrido Contreras-Sanchez. Photo By Stephanie Ichien

Topics and Presentations in the CRSP Biodiversity Symposium (...continued from page 2)

The Effects of Semi-Intensive Aquaculture On Biodiversity In Nearshore and Inland Waters: An Overview
James Diana, TheUniversity of Michigan

Integrated Multi-Trophic Aquaculture (IMTA): Biodiversifying fed fish aquaculture with extractive seaweed and invertebrate aquaculture to provide both biomitigative services and diversified seafood production
Thierry Chopin, University of New Brunswick

Aquaculture Effluents and Eutrophication
Claude Boyd, Auburn University

Transboundary and Emerging Diseases of Freshwater Farmed, Ornamental and Wild Fish
Melba G. Bondad-Reantaso, Food and Agriculture Organization of the United Nations

Applying Environmental Footprint Concept for Biodiversity Conservation In Semi-Intensive Aquaculture
Ling Cao, The University of Michigan

Environmental Performance
Marc Verdegem, Wageningen University

Antimicrobial Use In Aquaculture, Microbial Diversity and Antimicrobial Resistance
Felipe Cabello, New York Medical College

Primary Questions of Nutritional Physiology That Would Combine the Whole Life Cycle In Culture of South American Pseudoplatystoma Destined for Conservation and Industrial Purposes
Konrad Dabrowski, The Ohio State University

Social and Economic Impacts of Semi-Intensive Aquaculture on Biodiversity
Robert Pomeroy, University of Connecticut-Avery Point

Aquaculture for the Conservation of Native Fish Species In Southeastern Mexico
Wilfrido Contreras-Sanchez, Universidad Juárez Autónoma de Tabasco

Understanding the Basic Biology and Ecology of Invasive Nile Tilapia: The Role It Plays In Sustainable Aquatic Biodiversity
Mark S. Peterson, University of Southern Mississippi

Tilapia and Aquaculture: a Review of Management Concerns
William T. Slack, U.S. Army Engineer Research and Development Center, Mississippi

To view the submitted abstracts and the presentations given at AFS during this symposium, please see the AquaFish CRSP website: aquafishcrsp.oregonstate.edu/biodiversity.php

AquaFish CRSP at FtF Forum and CRSP Council Meeting

By Stephanie Ichien

The AquaFish CRSP Director, Dr. Hillary Egna represented AquaFish in the international development arena. From Washington DC to Kampala, Uganda, Dr. Egna has kept aquaculture and fisheries research in the discussion, as new research strategies are developing and budgets continually change.

In June 2011, Hillary Egna was invited to travel to Washington DC to participate in the "Feed the Future Research Forum: Engaging the Research Community," where more than 300 members of the global agriculture research community gathered to refine the Obama Administration's hunger and food security initiative, Feed the Future (FtF). The Association of Public and Land-grant Universities (APLU) organized the forum in collaboration with the Board for International Food and Agriculture Development (BIFAD), the US Agency for International Development (USAID), and the US Department of Agriculture (USDA). Also present at the forum were representatives from the National Science Foundation (NSF), the National Institutes of Health (NIH), the US Geological Service (USGS), and the National Oceanographic and Atmospheric Agency (NOAA). The three-day event was aimed to further develop the research strategies outlined in the FtF initiative through invited presentations and breakout sessions. The result of this forum will be critical in framing future workplans and funding allocations for any research conducted under FtF. The DC FtF meeting followed the FtF research strategymeeting held at Purdue University in January 2011, in which Hillary Egna aslo participated.

About a month later, Dr. Egna traveled to Uganda for both the CRSP Council meeting and AquaFish CRSP site visits. Nine of the eleven existing CRSPs have projects in Uganda—the greatest number of CRSPs represented in a single country— and is a "priority" focus country under the FtF initiative. With ten CRSP directors present, this was an opportunity to discuss program status, progress, and challenges within the CRSP framework. Further, the meetings provided the opportunity to share information with representatives from USAID and the Bureau of Food Security's Office of Agriculture Research and Technology.

The trip also provided a valuable opportunity for site visits, as Uganda is a recent addition to the AquaFish CRSP research portfolio and a prime site for continuing research. As part of the CRSP Council activities, the group toured Makerere University in Kampala and visited sites from a few of the CRSPs, including one of the AquaFish CRSP experimental ponds. Beyond the CRSP Council activities, Dr. Egna took some time to visit some of the other aquaculture facilities in the area and connect with AquaFish CRSP researchers in Uganda.

All photos from AquaFish CRSP Director Hillary Egna's trip to Uganda in June 2011. Photos by and courtesy of Hillary Egna

Notices of Publication

Notices of Publication announce recently published work carried out under AquaFish CRSP sponsorship. To receive a full copy of a report, please contact the author(s) directly.

ROLE OF AQUACULTURE POND SEDIMENTS IN SEQUESTRATION OF ANNUAL GLOBAL CARBON EMISSIONS (10-269)

Claude E. Boyd [a]*, C. Wesley Wood [b], Philip L. Chaney [c], and Julio F. Queiroz [d]

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[b] Department of Agronomy and Soils, Auburn University, Auburn, AL 36849, USA
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Efforts to quantify carbon sequestration in inland water bodies have focused on inland seas, natural lakes, and large river impoundments (Mulholland and Elwood, 1982; Dean and Gorham, 1998). A recent study in Iowa (Downing et al., 2008) suggested that small, agriculturally-eutrophic impoundments bury carbon at an average rate of 2122 gm^{-2} yr^{-1} five times higher than in large, river impoundments, 30 times more than in small, natural lakes, and over 400 times greater than in inland seas and large natural lakes (Mulholland and Elwood, 1982; Dean and Gorham, 1998). The combined water surface area of small impoundments in farming areas was estimated at 21,000 km^2 in the United States and 77,000 km^2 globally (Smith et al., 2002; Downing et al., 2006), and these impoundments may bury more carbon than the world's oceans (Downing et al., 2008).

The area of agriculturally-eutrophic impoundments used for estimating carbon sequestration (Downing et al., 2008) did not include aquaculture ponds. According to statistical data on aquaculture production maintained by the Food and Agriculture Organization (FAO) of the United Nations, there are 110,830 km^2 of aquaculture ponds worldwide (Verdegem and Bosma, 2009). Aquaculture ponds also may be important in global, carbon sequestration.

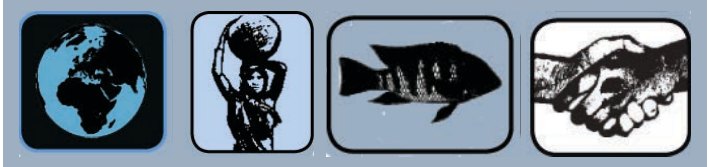
Aquaculture ponds do not have large external sediment loads typical of river reservoirs or small, watershed ponds in agricultural or other rural areas (Boyd, 1995). However, earthwork of aquaculture ponds is eroded by rain, waves, and water currents generated by mechanical aerators, activities of culture species, and harvesting operations. Manure, grass, and other agricultural wastes traditionally have been applied to ponds as organic fertilizer to increase aquatic animal production, but high-quality, pelleted feeds are rapidly replacing fertilizers as a means of achieving greater production (Boyd and Tucker, 1998). Fertilizers and feeds contain inorganic nutrients that stimulate organic carbon production by phytoplankton photosynthesis in ponds (Boyd and Tucker, 1998).

Coarse, soil particles suspended by internal erosion settle near edges of ponds while smaller particles tend to settle in deeper areas (Boyd,1995). Organic matter from dead plankton, organic fertilizers, uneaten feed, and excrement of culture species settles on pond bottoms and gradually mixes with soil particles. Aquaculture management favors microbial decomposition of organic matter. For example, organic matter inputs usually have a narrow carbon: nitrogen ratio, ponds with acidic, bottom soils are limed, and mechanical aeration avoids oxygen-depletion at the sediment-water interface (Boyd and Tucker, 1998). Much recently-settled organic detritus is discharged when ponds are drained for harvest (Ayub et al., 1993). After draining, pond bottoms usually are dried to enhance soil aeration and accelerate decomposition of labile organic matter (Boyd, 1995). Nevertheless, a layer of sediment with an organic carbon concentration higher than that of the original pond bottom soil and with a characteristic profile of well-defined strata or horizons develops (Munsiri et al., 1995).

This abstract is excerpted from the original paper, which was in **Environmental Pollution** 158 (2010): 2537-2540

NOPs Continued on page 16...

All past and present Notices of Publication can be found on the AquaFish CRSP website at: aquafishcrsp.oregonstate.edu/publications.php



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DEVELOPMENT OF DIGESTIVE ENZYMES IN LARVAE OF MAYAN CICHLID CICHLASOMA UROPHTHALMUS (11-270)

G. López-Ramírez, C. A. Cuenca-Soria, C. A. Alvarez-González, D. Tovar-Ramírez, J. L. Ortiz-Galindo, N. Perales-García, G. Márquez-Couturier, L. Arias-Rodríguez, J. R. Indy, W. M. Contreras-Sánchez, and E. Gisbert F. J. Moyano

The development of digestive enzymes during the early ontogeny of the Mayan cichlid (*Cichlasoma urophthalmus*) was studied using biochemical and electrophoretic techniques. From yolk absorption (6 days after hatching: dah), larvae were fed *Artemia* nauplii until 15 dah, afterward they were fed with commercial microparticulated trout food (45% protein and 16% lipids) from 16 to 60 dah. Several samples were collected including yolk-sac larvae (considered as day 1 after hatching) and specimens up to 60 dah. Most digestive enzymes were present from yolk absorption (5–6 dah), except for the specific acid proteases activity (pepsinlike), which increase rapidly from 8 dah up to 20 dah. Three alkaline proteases isoforms (24.0, 24.8, 84.5 kDa) were detected at 8 dah using SDS–PAGE zymogram, corresponding to trypsin, chymotrypsin and probably leucine aminopeptidase enzymes, and only one isoform was detected (relative electromobility, Rf = 0.54) for acid proteases (pepsin- like) from 3 dah onwards using PAGE zymogram. We concluded that *C. urophthamus* is a precocious fish with a great capacity to digest all kinds of food items, including artificial diets provided from 13 dah.

This abstract was excerpted from the original paper, which was published in **Fish Physiology and Biochemistry** (2011) 37:197-208.

EFFECTS OF *MICROCYSTIS AERUGINOSA* ON LIFE HISTORY OF WATER FLEA *DAPHNIA MAGNA* (11-271)

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Cyanobacterial blooms in eutrophic freshwater systems are a worldwide problem, creating adverse effects for many aquatic organisms by producing toxic microcystins and deteriorating water quality. In this study, microcystins (MCs) in *Microcystis aeruginosa*, and *Daphnia magna* exposed to *M. aeruginosa*, were analyzed by HPLC-MS, and the effects of *M. aeruginosa* on *D. magna* were investigated. When *D. magna* was exposed to *M. aeruginosa* for more than 2 h, Microcystin-LR (MC-LR) was detected. When exposed to 1.5 x 10^6, 3 x 10^6, 0.75 x 10^7, and 1.5 x 10^7 cell/mL of *M. aeruginosa* for 96 h, average survival of *D. magna* for treatments were 23.33%, 33.33%, 13.33%, 16.67%, respectively, which were significantly lower than the average 100% survival in the control group ($P < 0.05$). The adverse effects of *M. aeruginosa* on body length, time for the first brood, brood numbers, gross fecundity, lifespan, and population growth of *D. magna* were density-dependent. These results suggest that the occurrence of *M. aeruginosa* blooms could strongly inhibit the population growth of *D. magna* through depression of survival, individual growth and gross fecundity. In the most serious situations, *M. aeruginosa* blooms could undermine the food web by eliminating filter-feeding zooplankton, which would destroy the ecological balance of aquaculture water bodies.

This abstract was excerpted from the original paper, which was published in the **Chinese Journal of Oceanology and Limnology** (2011), 29 (4): 892-897.

PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF NILE TILAPIA (OREOCHROMIS NILOTICUS) EXPOSED TO AQUEOUS EXTRACTS OF NEEM (AZADIRACHTA INDICA) (11-272)

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In this study, the physiological and biochemical response of Nile tilapia (*Oreochromis niloticus*) after 96 and 24 h exposure to aqueous extracts of neem (*Azadirachta indica*) in extract concentrations ranging from 0 to 32,000 mg/l was evaluated. After 96 h and 24 h exposure, the LC_{50} of neem extract was estimated at 3,200 and 6,800 mg/l, respectively. Plasma cortisol increased beyond pre-treatment levels at neem extract concentrations above 2,000 mg/l over 96 h and above 4,000 mg/l over 24 h. Blood glucose increased at neem extract concentrations above 1,000 and 5,000 mg/l at 24

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and 96 h, respectively. Neem extract concentraton had little effect on serum sodium and plasma chloride. Hematocrit was higher than the control at neem concentrations above 1,000 mg/l in the 96 h exposure and above 2,000 mg/l in the 24 h exposure. Plasma ammonia increased significantly at neem extract concentrations above 2,000 mg/l for both the 96h and 24h tests. Immediately after beginning treatment, cortisol levels increased significantly at neem extract concentrations above 2,000 mg/l in the 96 h test and 4,000 mg/l in the 24 h toxicity test. Exposure to neem extract interfered with the antioxidant defense system of the fish by reducing liver catalase activity. Even though extracts of neem are less toxic at low concentrations, concentrations exceeding 3,200 mg/l influence physiological and biochemical disturbances in fish.

This abstract was excerpted from the original paper, which was published in the **Journal of Applied Aquaculture** (2011), 23 (2): 177-186.

LIFE CYCLE ASSESSMENT OF CHINESE SHRIMP FARMING SYSTEMS TARGETED FOR EXPORT AND DOMESTIC SALES (11-273)

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We conducted surveys of six hatcheries and 18 farms for data inputs to complete a cradle-to-farm-gate life cycle assessment (LCA) to evaluate the environmental performance for intensive (for export markets in Chicago) and semi-intensive (for domestic markets in Shanghai) shrimp farming systems in Hainan Province, China. The relative contribution to overall environmental performance of processing and distribution to final markets were also evaluated from a cradle-to-destination-port perspective. Environmental impact categories included global warming, acidification, eutrophication, cumulative energy use, and biotic resource use. Our results indicated that intensive farming had significantly higher environmental impacts per unit production than semi-intensive farming in all impact categories. The grow-out stage contributed between 96.4% and 99.6% of the cradle-to-farm-gate impacts. These impacts were mainly caused by feed production, electricity use, and farm-level effluents. By averaging over intensive (15%) and semi-intensive (85%) farming systems, 1 metric ton (t) live-weight of shrimp production in China required 38.3±4.3 GJ of energy, as well as 40.4±1.7 t of net primary productivity, and generated 23.1±2.6 kg of SO_2 equiv, 36.9 ± 4.3 kg of PO_4 equiv, and 3.1 ±0.4 t of CO_2 equiv. Processing made a higher contribution to cradle-to-destination- port impacts than distribution of processed shrimp from farm gate to final markets in both supply chains. In 2008, the estimated total electricity consumption, energy consumption, and greenhouse gas emissions from Chinese white-leg shrimp production would be 1.1 billion kW-h, 49 million GJ, and 4 million metric tons, respectively. Improvements suggested for Chinese shrimp aquaculture include changes in feed composition, farm management, electricity-generating sources, and effluent treatment before discharge. Our results can be used to optimize market-oriented shrimp supply chains and promote more sustainable shrimp production and consumption.

This abstract was excerpted from the original paper, which was published in **Environmental Science & Technology** (2011), 45 (15): 6531-6538.

Polyculture of Sahar (*Tor putitora*) with mixed-sex Nile tilapia (11-274)

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Sahar (*Tor putitora*) is an economically important indigenous fish in Nepal, with major efforts to conserve and propagate the species. It is a predator and may function to control recruitment by naturally produced Nile tilapia (*Oreochromis niloticus*) in ponds. Sahar (*Tor putitora*) were cultured with Nile tilapia (*Oreochromis niloticus*) to evaluate control of tilapia recruitment in aquaculture ponds. Two experiments were conducted to assess the effects of the sahar to tilapia stocking ratio on the recruitment and growth of mixed-sex Nile tilapia. The first experiment was conducted in 100 m^2 earthen ponds at the Institute of Agriculture and Animal Science, Chitwan, Nepal to determine these effects. The second experiment was conducted on farm at Kathar, Chitwan, Nepal to verify the results in working ponds. The on-station experiment had four treatments with three replicates each: tilapia monoculture (T1), 1:16 sahar to tilapia ratio (T2), 1:8 sahar to tilapia ratio (T3), and 1:4 sahar to tilapia ratio (T4). Tilapia were stocked

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Upcoming Meetings and Events...

The AquaFish CRSP promotes workshops and meetings designed to facilitate increased knowledge and communication in aquaculture. Meetings and workshops coming up include...

Third International Symposium On Cage Aquaculture in Asia (CAA3)
16-19 November 2011
Kuala Lumpur, Malaysia
www.asianfisheriessociety.org/caa3/

WAFICOS Annual Fish Farmers' Symposium and Trade Show
11-13 January 2012
Uganda

Aquaculture America 2012: Bringing Players to the Table
29 February- 2 March 2012
Las Vegas, Nevada USA
www.was.org/WasMeetings/meetings/Default.aspx?code=AA2012

Australasian Aquaculture 2012
1-4 May 2012
Melbourne, Victoria, Australia
www.was.org/AA12/Default.aspx

IIFET 2012 Biennial Conference
16-20 July 2012
The University of Dar es Salaam
Dar es Salaam, Tanzania
http://oregonstate.edu/dept/IIFET/

The Ninth International Conference on Recirculating Aquaculture
24-26 August 2012
Roanoke, Virginia
http://www.recircaqua.com/icra.html

Aqua 2012: Global Aquaculture Securing Our Future
1-5 September 2012
Prague, Czech Republic
www.was.org/WasMeetings/meetings/Default.aspx?code=Aqua2012

For more meeting and employment opportunities visit our Education & Employment Opportunities network database online, EdOpNet, at aquafishcrsp.oregonstate.edu/edop.php

PONDERINGS...

"End of the Line"
By Bryan Walsh
Excerpted from the full story in *Time* Magazine
July 18, 2011

Humans have been raising some fish in farms for almost as long as we've been fishing, beginning with Chinese fishponds 4,000 years ago. But it's only in the past 50 years that aquaculture has become a true industry. Global aquacultural production increased from less than 1 million tons in 1950 to 52.5 million tons in 2008, and over the past few decades, aquaculture has grown faster than any other form of food production. Today about half the seafood consumed around the world comes from farms, and with the projected rise in global seafood consumption, that proportion will surely increase. Without aquaculture, the pressure to overfish the oceans would be even greater. "It's no longer a question about whether aquaculture is something we should or shouldn't embrace," says Ned Daly, senior projects adviser at the Seafood Choices Alliance. "It's here. The question is how we'll do it."

Walsh, Byran. "End of the Line". *Time* 18 July, 2011: Vol. 178 No.3

Read more: http://www.time.com/time/health/article/0,8599,2081796,00.html#ixzz1TG048oNq

Congratulations!

In addition to receiving the Honorary Award for Best Researcher in Science, Dr. Amisah was also recently promoted to the rank of Associate Professor at Kwame Nkrumah University of Science and Technology (KNUST) in Kumasi, Ghana. Congratulatoins to Associate Professor, Dr. Steve Amisah!

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at 2 fish m^{-2} (average size 11.3 g), and sahar were stocked at treatment densities (15.2 g average size) in each pond. The ponds were fertilized weekly using diammonium phosphate (DAP) and urea at the rate of 0.1 g P^{2} d^{-1} and 0.4 g N m^{-2} d^{-1} respectively. Tilapia were fed with a locally made pelleted feed (27% crude protein), at the rate of 2% body weight every other day after attaining a size of 100 g. Results showed significantly increased average harvest size ($P < 0.05$) for treatment 2, when sahar were stocked with tilapia compared to the tilapia monoculture. The number of recruits significantly decreased ($P > 0.05$) when sahar were stocked, and recruit numbers were inversely proportional to stocking density of sahar. Stocking of sahar reduced tilapia recruitment in a mixed-sex Nile tilapia pond culture system and produced better tilapia growth and production. Stocking at a 1:16 sahar to tilapia ratio gave the best overall performance.

The on-farm experiment was composed of three treatments with three replicates each: tilapia monoculture (T1), 1:33 sahar to tilapia ratio (T2), and 1:16 sahar to tilapia ratio (T3). Ponds were fertilized every two weeks with DAP and urea at the same rate as on-station experiment, but there was no feeding. On-farm results showed significantly higher tilapia growth with a 1:33 stocking ratio of sahar to tilapia compared to tilapia monoculture. As with the on-station experiment, the number of recruits decreased with increasing stocking density of sahar. Lower sahar stocking provided higher growth and production of stocked tilapia, though there were fewer recruits at these levels. There might have some growth depression of tilapia at higher sahar stocking densities. Stocking sahar to Nile tilapia at 1:33 showed better overall performance than monoculture but not the 1:16 treatment in terms of Nile tilapia growth, production, growth of sahar and gross income.

This abstract was excerpted from the original paper, which was published in **Aquaculture** (2011) 319: 284-289.

THE DANGERS OF MICROCYSTINS IN AQUATIC SYSTEMS AND PROGRESS OF RESEARCH INTO THEIR DETECTION AND ELIMINATION (11-275)

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Microcystins (MC) are secondary metabolites of toxic cyanobacteria. The algae and metabolites often combine to cause strong discoloration of the water, accumulation at the surface in discrete scums and sometimes emit a strong odor (Figure 1, Figure 2A, Cai et al. 1997, Liang et al. 2001, Zurawell et al. 2005). MC belong to a family of extremely toxic compounds and are a health hazard to aquatic animals and even humans (Ding et al. 1998, 1999, Falconer 1991, Hernandez et al., 2000, Lawton et al. 1994). Researchers have identified blooms of cyanobacteria from eutrophic freshwater bodies in many parts of the world, and their occurrence can create a major water quality problem. For example, massive fish kills occasionally have been related to severe cyanobacterial blooms. Chromic damages, such as development of liver tumors may arise from long-term exposure to low concentrations of MC (Chen et al. 2006, Ding et al. 1998, 1999, Ibelings and Chorus 2007, Lankoff et al. 2004, Li et al. 2007, Shen et al. 2003, Smith and Haney 2006, Zimba et al. 2006).

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PARTING SHOT

Estero Aserradores, Nicaragua, is a site where two AquaFish CRSP investigations took place in collaboration with the University of Hawai'i at Hilo. The work involves developing strategies for co-management and bivalve sanitation for black cockles. Specifically targeting women, who comprise approximately 80% of the stakeholders, the AquaFish CRSP team has involved over 90 participants in their workshops. Photo By Nelvia Hernandez

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