



New Fish Species Studied for Aquaculture Potential by Aquaculture CRSP Researchers

by Dharendra Prasad Thakur, Asian Institute of Technology

Editor's note: This is the second article in a series discussing detailed aspects of biology of three fish species being studied for aquaculture potential.

Mahseer (*Tor putitora*)

The mahseer or golden mahseer (*Tor putitora*, Hamilton) is considered king of the Himalayan fishes. It is an important edible fish in the rivers and tributaries of Nepal (Shrestha, 1997). The mahseer's range extends throughout southern Asia, from Iran in the west to Thailand in the east, and from Sri Lanka in the south to the Himalayas in the north.

This species resembles a typical carp in structure and appearance. The body is semi-round and slightly flattened along the ventral surface from near the mouth opening to the anus, and there is sudden tapering of the body just after the anal region. Eyes are large, round, and situated more towards the dorsal surface. The nostrils are located near the eyes on either side of the mid-

dorsal line. The head is provided with two pairs of feelers—the rostral and maxillary barbells. The entire body, except the head and fin, is covered with large-sized cycloid scales and the fish, therefore, is called "large-scale barbel."

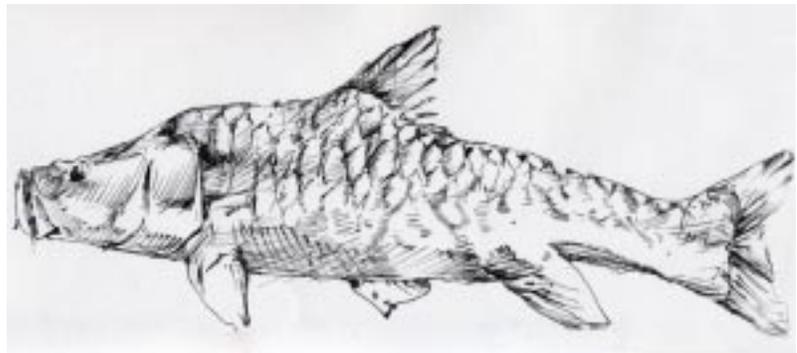
It is one of the largest species of the

Cyprinidae family, attaining a length up to 5 feet, and sometimes exceeding 70 pounds. In India, the mahseer affords the same kind of sport as salmon in the British Isles, and it rivals that fish in size, strength, and activity. Its flesh is likewise much esteemed.

The mahseer is oviparous and the sexes are separate. During spawning season males develop strong tubercles and hence are easily distinguished from the female ones. Its reproductive system consists of gonads, in which the germ cells are formed, and the

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BRODY LOWE



Tor is a diverse genus of the carp family, including *Tor musallah* illustrated here.

What's In a Name? Kenya Creates New Government Ministry

In August 2003, the Kenyan government announced the creation of a new ministry, called the Ministry of Livestock and Fisheries Development. According to Nancy Gitonga, Director of Fisheries and Aquaculture CRSP Principal Investigator, this is the first time in Kenya's history that a ministry has included

the word "fisheries." The new ministry evolved out of the original Fisheries Department within the Ministry of Tourism and Wildlife.

Heading the ministry is the Honorable Joseph Konzolo Munyao, Member of Parliament, assisted by Permanent Secretary Daniel Mule. The new Ministry was created through a split from the formerly gigantic Ministry of Agriculture and Livestock Development. The Kenyan government realized that the livestock and fisheries sub-

sectors could not reach their full potential under the Ministry of Agriculture and Livestock. A smaller ministry of fisheries and livestock would, therefore, facilitate better focus and resource allocations.

The new ministry was created in large part due to Gitonga's advocacy of aquaculture. She helped the government recognize the need to develop fisheries, especially in Exclusive Economic Zones, since they have great

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Kenya Fisheries Ministry

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potential to help alleviate poverty in rural Kenya. Inland aquaculture in particular promises to bring economic change to a large proportion of the rural population. In order to demonstrate recognition of the importance of fisheries by the current government, the president of the Republic of Kenya, Hon. Mwai Kibaki, agreed to be shown various marine fish species caught during a fishing competition, an event of the Agricultural Show of Kenya, which was held in the coastal town of Mombasa on 11 September 2003.

To the new ministry's staff, this is a great achievement since there will be more focus on the fisheries sector with regard to resource allocation and

donor funding. This positive step is bound to draw adequate attention that is likely to result in increased resource allocation to the sector. This move shows that aquaculture's capacity to enrich livelihoods in developing countries is being increasingly recognized by national governments. You can find more about the ministry on their website <<http://www.state-housekenya.go.ke/government/livestock.htm>>.

The Aquaculture CRSP is proud to have been a part of this exciting development. Indeed, Gitonga says, "The

DAVID NZIOKA



Dignitaries look at various marine fish species caught during a fishing competition in the coastal town of Mombasa. (Left to right: Lucy Kibaki, First Lady of Kenya, Hon. Mwai Kibaki, President of Kenya, Godfrey Monor, Assistant Director of Fisheries, and Nancy Gitonga, Director of Fisheries.)

[Aquaculture] CRSP has been a great contributor in bringing the sector to the forefront with regard to recognition."

CRSP Student Receives Scholarship from Mexican National Council

by Mary Ann G. Abiado, The Ohio State University

Ohio State graduate student Gustavo Rodriguez was recently awarded a two-year scholarship from Mexico's National Council for Science and Technology (CONACYT). Worth \$80,000, the scholarship covers Rodriguez's stipend, tuition, fees, and health insurance. The main thrust of CONACYT's 2002-2006 program is to increase food

production research in Mexico. CONACYT desires to strengthen the expertise of Mexican scholars in aquaculture, agriculture, livestock production, agrobiotechnology, and phylogenetic resources.

In Mexico, environmental concerns with the widespread use of a synthetic steroid hormone, 17 α -methyltestosterone (MT), for sex reversal of fish has led the government to search for alternative means of changing gender in tilapia for aquaculture production. Investigators are looking into phytochemical usage, devising quantitative means of measuring MT degradation, residues in fish tissues, and possible derivatives in water.

Hence, Rodriguez's doctoral research, "Fate of MT in Tilapia Juveniles and Sex Reversal," fits perfectly with CONACYT's program. Funded by the Aquaculture CRSP, Rodriguez is now working on the project, "Use of Phytochemicals as an Environmentally Friendly Method to Sex Reverse Nile Tilapia."

In January 2002, Rodriguez started his graduate studies in

aquaculture in the School of Natural Resources under the supervision of Dr. Konrad Dabrowski.

As a graduate research associate, Rodriguez worked on the CRSP project "Studies on Fate of Methyltestosterone and its Metabolites in Tilapia and on the Use of Phytochemicals as an Alternative Method to Produce a Monosex Population of Tilapia." Results of this study were given in two oral presentations at the Aquamar Internacional conference held in Cancun, Mexico, 3-7 September 2002, and in February 2003 on a poster presentation at the Aquaculture America Conference in Louisville, Kentucky.

Two further papers will be presented in March 2004 at the annual Aquaculture America Conference in Honolulu, Hawaii. Being a member of the World Aquaculture Society (WAS) and the US Chapter of WAS, and of the Mexican Student Association at Ohio State, Rodriguez intends to compete for travel grants so he can participate in the 2004 meeting.

Rodriguez will be returning to work in Mexico once he completes his Ph.D. in 2005. He aspires to a university professorship and to have the opportunity to train Mexican students in the hope of improving freshwater fish production in Mexico.



Graduate student Gustavo Rodriguez samples tilapia reared in the tropical fish facility that he designed and built in Kottman Hall at The Ohio State University.

MARY ANN ABIADO

International Training Courses in Aquaculture and Nutrition of Prominent Amazon Species

by William N. Camargo, Southern Illinois University at Carbondale

The Third International Aquaculture Training Course with Prominent Amazonian Species and the First International Tropical Fish Nutrition Course was held at the Instituto de Investigaciones



W. CAMARGO

Practical work for the participants of the Third International Aquaculture Training course with Prominent Amazonian Species.

intended to initiate small but productive aquaculture ventures. The long-term aim is to aid in facilitating food security and additional income to farmers and indigenous communities of the Amazon region. To advocate sustainable production, various native Amazonian plant products, such as fruits, foliage, and agriculture by-products, were promoted as sources of food for plant-eating fishes. 



W. CAMARGO

Mobilization of some participants of the Third International Aquaculture Training course with Prominent Amazonian Species to initiate part of the practical work in the Ucayali Naval Base.

de la Amazonia Peruana (IIAP) Ucayali facility in Pucallpa, Peru, from 18 to 22 August, 2003. The Aquaculture CRSP and Southern Illinois University at Carbondale jointly sponsored both training courses. Sixty-four participants from six South American countries—Bolivia, Brazil, Colombia, Ecuador, Peru, and Venezuela—attended. This was the third of a proposed series of training courses to offer basic tools



W. CAMARGO

Participants of the Third International Aquaculture Training course with Prominent Amazonian Species and the First International Tropical Fish Nutrition Course.

On-Farm Trial Participants Share Successes

By Remedios Bolivar, Central Luzon State University

The final meeting of tilapia farmer-collaborators involved in the Aquaculture CRSP-funded on-farm trials of tilapia feeding strategies was held at the Central Luzon State University's Freshwater Aquaculture Center on 25 August 2003.

The participants discussed project accomplishments to date, particularly regarding the final feeding strategy trials. These trials examined moderation in feeding, notably a scheduled feeding on alternate days.

The author, Host-Country Principal Investigator for the Philippines, presented results of the trial. US Principal Investigator, Chris Brown of Florida International University, provided technical guidance

throughout the experiment.

The meeting was attended by 13 farmer-collaborators, five project staff, and four undergraduate students. The meeting started at 10:00am and ended at 1:00pm with a lunch gathering by all the participants.

A discussion and exchange of experiences by farmers ended the meeting. Each participating farmer in the farm trial received a copy of the technical report on alternate day feeding strategies. 



CLSU STUDENT

Participants of the tilapia farmer-collaborators meeting at the Freshwater Aquaculture Center, Central Luzon State University.

Mahseer

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gonadal ducts, through which the germ cells leave the body.

The mahseer is generally found in cold, well-oxygenated rivers, with rocky gravel beds. However, during winter months the fish moves into warmer waters due to its migratory habits. Mahseer live and grow to maturity in larger rivers and migrate to headwater creeks to spawn from June to September. As soon as spawning is over, they move downstream to feeding areas of larger rivers where they grow older and larger every year and continue to spawn.

The months from August to September are the breeding periods for mahseer in the Himalayas. In these months, water flow, temperature, pH, and dissolved oxygen are favorable for breeding. Mahseer produce 45,800 to 75,500 eggs. A fertilized egg measures

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Small-scale Aquaculture Enterprises for the People

By Khalid Salie, University of Stellenbosch

The Division of Aquaculture of the University of Stellenbosch, in collaboration with the Department of Agriculture and a local NGO, conceptualized small-scale fish farming in valley lakes as a means of creating livelihood opportunities in rural and peri-urban areas. Valley lakes are used for summer irrigation of high value crops in the winter rainfall areas of the Western Cape Province of South Africa.



KHALID SALIE

Nstikelelo Nlenzama feeding his rainbow trout at the Unlimited Olive Peoples' Trust Farming Project.

In 1995 the pilot project was launched in the rural town of De Doorns in the Hex River Valley, approximately 150 km northeast of Cape Town. De Doorns was specifically chosen, as it typifies socio-economic conditions prevalent in most rural towns. Rural towns are characterized by high unemployment, poor nutritional status, and lack of enterprise development. The pilot project started in partnership with the commercial farm owner, farm manager, and the farm worker.

An intensive rotational farming model has been proposed with tilapia (*Oreochromis mossambicus*) during the summer months and rainbow trout (*Oncorhynchus mykiss*) during the winter months. This tilapia species is indigenous to South Africa and the rainbow trout, given its history in the country, is considered to be a naturalized species. Fish are reared in cages from fingerlings to marketable sizes. Fingerlings are supplied via the university and other private hatcheries. The motivation for choosing tilapia as

a candidate species was that it should be destined for sales amongst the local communities (farm gate sales). Trout is considered a higher value commodity and is mainly farmed for the processing markets. Thus, tilapia production is for the improvement of nutritional status of the populace and trout production to complement household income. Trout harvests are contracted to local processors.

The program goals are:

- To develop micro-enterprises for rural and peri-urban communities;
- To foster participation in the aquaculture industry in South Africa;
- To provide additional household income;
- To provide an affordable alternative protein source, available on a regular basis;
- To improve nutritional status of the rural populace; and
- To foster job creation, especially for seasonally or unemployed women.

From 1995 until 2003, nine trout farming projects were implemented. Each project can produce between 4–10 tons per production cycle. Three projects failed to continue due to transfer of farm ownership, vandalism and theft, and water quality concerns.

To ensure greater sustainability of emerging projects, sites are carefully selected and detailed evaluations are done on security, farm owner attitudes, and water quality



KHALID SALIE



Farmers harvesting rainbow trout.

considerations, as well as the secondary users of water in the catchment. A lot of time is further allocated to training on business management principles.

Although tilapia farming has been proposed for summer production in the same cage system, commercialization has not yet been realized. The tilapia industry in South Africa is still in the R&D phase; the manipulation of precocious breeding, the advantages of all-male production, feed development, and related areas are being researched. The tilapia situation stems from the fact that farmers utilize only 60% of the capacity and profitability of the rotational farming system.

A major breakthrough in small-scale aquaculture development has been the initiation of a co-operative. The Hands-On Fish Farmers' Co-operation Ltd. has been structured for the small-scale farmers, in a response to the call of the farmers for greater representation. The co-op has a mandate to address issues such as ensuring the sustainability of markets, sourcing alternative markets, and exploring the advantages of collective buying of fingerlings and feeds. The co-op should also serve as the focal point for accessing financing and providing training. Marketing agreements have already been reached between Hands-on and local processors of trout.

Broader application of the program is currently under investigation; including small earthen ponds for koi, catfish and tilapia farming, and tunnel farming for ornamental fish. These systems are considered marginal or

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Aquaculture in the Peruvian Amazon: A Case Study of Microenterprise

Salvador Tello, Instituto de Investigaciones de la Amazonía Peruana

The Instituto de Investigaciones de la Amazonía Peruana (IIAP) and BIOFOR-USAID conducted a research project titled "Cultivation of Native Fish: A Sustainable Development Option for the Area of Influence of the National Park Abiseo River." Nineteen farmers with 39 fishponds in a 10-hectare area participated in this study.

Three fish species were used: gamitana (*Colossoma macropomum*), boquichico (*Prochilodus nigricans*), and the hybrid pacotana (*paco x gamitana*). The rearing system included single and polycultivation for each species. The fish were fed a pelleted diet formulated with local feedstuffs and prepar-

ROGER HARRIS



IIAP employee Cherry Yahuarcany captures an adult tambaqui (*Colossoma macropomum*) from an experimental fishpond at IIAP near Iquitos, Peru.

ed by the farmers.

After six months of study, a feed conversion ratio of 1 to 2 was obtained. The daily growth during the study

ranged from 1.5 to 2.5 g, which was observed in 75% of the population. The average body weight after six months was 450 g, and the annual yield obtained ranged from 4 to 10 mt per ha. The annual profitability of the operation varied from 55 to 139% and the net actual value ranged from \$700 to \$1500. These results indicate that a farmer can obtain a significant margin of profit after recovering the initial investment in infrastructure, equipment, operative costs, and a monthly interest of 1%. In addition, these results demonstrate that these native species have great potential to be raised in captivity in the Peruvian Amazon.

This experience is allowing IIAP to successfully promote the rearing of native Amazonian species as a productive option for farmers in this region of Peru, which has suffered terrorism and drug trafficking over the last 20 years. 🐟

Meet a Tilapia Farming Husband and Wife Team

By Remedios Bolivar, Central Luzon State University

Ray and Mercy Limos started with a 6.6 hectare rice farm in Barangay Santo Rosario in the Philippines. In 1998 when the Aquaculture CRSP Philippines project staff visited them as potential collaborators, they were operating only two backyard fishponds—the rest of the farm was devoted to rice production. Today, the couple have about 1.6 ha converted to tilapia ponds with 5 ha retained for rice farming. They now have three ponds, each with an area of 3000 m² and another three ponds of 500 m² each.

Based on their estimated profit from

tilapia culture, the couple earns an estimated \$2,000 per year from each of their large tilapia ponds. With the proceeds, they were able to put up a "nipa" hut (a traditional thatched dwelling) in their backyard, buy a rice thresher, pay for the schooling of their young children, and purchase some household appliances.

During the fish harvest, they call in middlemen, wholesalers, and retailers to buy their tilapia. A portion of the fish harvest is always kept for family consumption, and sometimes tilapia are given as payment to a half dozen or so laborers for their harvesting efforts.

The price of the fish depends upon the size at harvest. The bigger the fish, the higher the selling price. The couple is able to harvest tilapia twice a year.

The Limos' realize that tilapia farming is helping the economy of the country. To be successful in a tilapia venture, they emphasize the need for sound management and financial stability.

Problems that Ray and Mercy have encountered include poaching (although a rare occurrence in their case), lack of water, and difficulty in draining the ponds due to higher elevation. The latter problem they solve by siphoning the water out.

The Limos' do not intend to increase the land area devoted to tilapia farming because this area is manageable for them to operate. Nevertheless, they are delighted with the benefits that aquaculture has brought to their lives. 🐟

South Africa Microenterprise

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undesirable for trout farming.

The Division's first collaboration with the Aquaculture CRSP was in

2002 on the "Reaction of Liming Materials in Pond Bottom Soils." Another collaboration has been approved for 2003–2004 under which the "Influence of Daily Feed Allowance on Pond Water and Effluent Quality" will be investigated. Both these projects

will unveil invaluable information for future site selection and pond quality evaluation. This type of collaboration will provide the impetus required to broaden the application of small-scale fish aquaculture projects in South Africa. 🐟



Graduate Student Profile: George Owiti Osure

By Ian Courter

George Owiti Osure was born and raised in Yala, Western Kenya. Living near Lake Victoria, Osure developed a childhood interest in fish, as they were an important part of his diet. Osure's early fondness of fish inspired him to want to know more.

In 1992 Osure enrolled at Moi University, Kenya, and began studying fisheries. Four years later he graduated with a bachelor's degree in Fisheries and began working for the Kenya Department of Fisheries, in the Ministry of Livestock and Fisheries Development Division (recently renamed the Ministry of Fisheries and Livestock, see story p. 2).

In addition to his own ambition, while at Moi University, Osure was inspired to study aquaculture by Mucai Muchiri, B.C.C. Wangila, and in particular Charles Ngugi, all instructors at Moi.

Osure continued to work for the Department until 2002, when he was offered Aquaculture CRSP funding by Principal Investigator Ron Phelps to study the "Evaluation of reproductive efficiencies, growth performance, and genetic variability of strains of Nile

tilapia" at the Department of Fisheries and Allied Aquaculture, Auburn University, Alabama. His study objectives were to compare the reproductive efficiencies, growth performance, and microsatellite variability of Egypt, Ivory Coast, Sagana, and Lake Victoria Nile tilapia (*Oreochromis niloticus*) strains.

Osure concedes that the most difficult yet most exciting aspect of his research was the analysis of genetic variability of the four strains of tilapia using microsatellites, or molecular markers. During his research, Osure relied on the technical expertise of Ron Phelps, Leonard Lovshin, and John Zhanjiang Liu.

According to Osure, Kenya is an excellent place to develop aquaculture. He emphasizes the abundance of



George Osure

water and land resources as well as the high demand for fresh fish in local markets. Osure believes that expanding aquaculture would benefit Kenya socially and environmentally through macro- and micro-economic development, reducing fishing pressure on wild stocks, and providing a much needed protein source. Osure also feels that aquaculture is the only way of sustaining production levels that satisfy the expanding global demand for seafood.

Osure successfully defended his thesis in September—and received the Best M.S. Student Award to boot. This is an annual award given by Auburn's Department of Fisheries and Allied Aquaculture in memory of the Department's founder H.S. Swingle.

On returning to Kenya, Osure will resume working as a fisheries officer at the Kenya Department of Fisheries until he can secure funding for a Ph.D. project. In the future he hopes to become a professor, perhaps to inspire others like himself to continue following their interests and achieving their goals.

In his spare time, Osure enjoys sharing his faith with others in addition to playing table tennis and soccer. He also spends considerable time reading fisheries literature to stay abreast of recent developments in fisheries science. 

Mahseer

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2.18 to 2.87 mm. They grow well in highly mineralized water with high specific conductance and nearly neutral pH.

They are long-lived, slow growing, and feed on insects and fish fry of other species. Mahseers feed mainly on drifting aquatic and terrestrial insects. As they grow, they become increasingly piscivorous. In the creeks, mahseers feed on fish and shrimps.

Male fish mature when two years old and about 200 mm total length. The female matures at 300 mm total length after about three years (Shrestha, 1994).

This versatile fish is ranges from just above sea level to 2,000 meters above.

In 1987, the Mekong River in southeast Asia was restocked with Indian mahseer to provide food for local communities. However, pond culture of mahseer was not successful due primarily to the slow growth of the fish in captivity. Islam (2002) concluded that the fish is not suitable for monoculture due to extremely high FCR (5–7).

However, water temperature remained high (over 28°C) throughout their experimental trial, which might have caused slow growth of the fish, and thus there remains the possibility of the species performing better in lower water temperatures.

Threats that mahseer natural stock is facing include dams, deforestation, soil erosion, and illegal fishing. Hence, development of an efficient cage culture system can

help maintain fish species diversity in the region and also a constant supply of this highly esteemed fish to the consumer.

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Fish Culture at the Pucallpa Navy Base in the Peruvian Amazon

by William N. Camargo, Christopher C. Kohler, and Susan T. Kohler, Southern Illinois University at Carbondale; Mariano Rebaza Alfaro, Carmela Rebaza Alfaro, and Sonia Deza Taboada, Instituto de Investigaciones de la Amazonía Peruana, Pucallpa; and Eliana Villafana Salinas and Carlos Alvarez Janampa, Marina de Guerra Ucayali, Pucallpa

Since May 2001, the Institute for the Investigation of the Peruvian Amazon (IIAP), with the assistance of two part-time Ucayali navy biologists, Eliana Villafana Salinas and Carlos Alvarez Janampa, has been leading an applied aquaculture training program at the Ucayali Naval Base in Pucallpa, Peru. Through this program, fish culture of the most prominent and highly accepted fish species: gamitana (*Colossoma macropomum*), paco (*Piaractus brachypomus*), and paiche (*Arapaima gigas*) is being promoted in the Peruvian Amazon region to increase the supply of fish and to reduce overfishing of wild populations. According to Ministry of Fisheries statistics, these species together now represent only 0.7 to 2.0% of the total landings in the

region. In the 1970s gamitana landings were listed singly because of the large volume captured; nowadays it appears under the label "others," or species captured that are less than 1% of the total catch (Fernando Alcantara, personal communication).

Our program seeks to train navy personnel, particularly those from the Amazon region, in techniques used to culture native aquatic species. In addition to making the naval base more self-sustaining with respect to food supply, it is anticipated that when these personnel conclude their tours of duty they will have the experience to successfully initiate



The Ucayali Naval Base aquaculture ponds near the city of Pucallpa, Peru.

MARINA DE GUERRA

reactivation involved the rehabilitation of the ponds since they were not used much, or at all, after they were constructed. Thus, IIAP rehabilitated the ponds in 2001 and hired part-time biologists. The training program, which is entirely voluntary, takes place over three months out of a two-year tour of volunteer military service.

IIAP (Pucallpa) Aquaculture Production Director Mariano Rebaza Alfaro is responsible, together with his two colleagues, Carmela Rebaza Alfaro and Sonia Deza Taboada, for the theoretical and practical training of the navy personnel at the IIAPs Pucallpa research station. The two part-time biologists are in charge of the daily reinforcement of the concepts learned through IIAPs three-month technical training program. To date, approximately 20 navy personnel have matriculated in the joint IIAP-navy program—so far, all that have enrolled have graduated.

The species cultured at the Ucayali Naval Base are paco, gamitana, and paiche, the latter used for fingerling production. Other species include acarahuasu (*Astronotus ocellatus*) and pacotana, a hybrid of male paco and female gamitana. While paco, gamitana, and paiche are highly accepted among both rural and urban inhabitants, acarahuasu, commonly known as oscar, is less accepted as food fish by city dwellers. The pacotana hybrid species is still under research and is very promising for cultivation in enclosed environments because of their larvae's low-temperature resistance and very rapid growth.

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Ucayali Navy biologist Eliana Villafana of the Ucayali Naval Base aquaculture station.

W. CAMARGO



Left to right: Mariano Rebaza Alfaro, IIAP Aquaculture Production Director, holding a paco, President Edwin Vazquez López, Ucayali Regional President, holding a gamitana, and Carlos Alvarez Janampa, holding some acarahuasu at the Ucayali Navy Base.

W. CAMARGO

subsistence levels of aquaculture production or to find employment as technicians in the region's growing fish culture industry.

The Ucayali Naval Base is located on the outskirts of the city of Pucallpa, Peru. The base has a total of seven hectares of ponds (3 ponds of 0.1 ha, 2 ponds of 0.35 ha, 3 ponds of 0.5 ha, and a reservoir of 4.3 ha) constructed in 1994 by the National Fund for Fisheries Development (FONDEPES) and reactivated in 2001. The

The CLSU-Aquaculture CRSP Project Funds Four Undergraduate Students

By Remedios Bolivar, Central Luzon State University

The Aquaculture CRSPs program at the College of Fisheries, Central Luzon State University, has been supporting fisheries students with undergraduate student assistantships after rendering 30-hour per month work service. Over the past four years, the CRSP has supported nine undergraduate students from CLSU.

This school year, four students are being funded under the CRSPs Eleventh Work Plan. They are Ronaldo Bernardino, Mark Joseph Rafael, Oliver Reclamado, and Nova Marie Pesebre. All four underwent their one-month off-campus training from April to May 2003.

Bernardino and Pesebre were assigned to the Bureau of Fisheries and Aquatic Resources, Northern Luzon Fisheries Outreach Station in Cagayan, Philippines. Bernardino worked on the growth performance of mud crab

(*Squilla serrata*), while Pesebre worked on the culture of a seaweed (*Gracilaria firma*). Rafael and Reclamado went to Central Visayas at FYD International, Inc., a company that is trying to revive the Philippine shrimp industry by integrating tilapia into shrimp ponds to develop a green water system. Rafael will look into the reduction of disease problems in the tilapia-shrimp system, while Reclamado will

investigate aspects of tilapia-shrimp polyculture.

All four students are now writing their field practice reports under the supervision of the author, Host Country Principal Investigator in the Philippines. As part of their work service, the students are helping the project in the implementation of its research activities. 🐟



REMEDIOS BOLIVAR

Undergraduate students jointly funded under the Aquaculture CRSP-CLSU On-Farm Trial project attend the Farmer-Collaborators Meeting held at the FAC Conference Room on 25 August 2003 (Left to right: Ronaldo Bernardino, Oliver Reclamado, Nova Pesebre, and Mark Joseph Rafael).

Peruvian Aquaculture

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In a 10-month period, the Ucayali navy program successfully produced up to 8,000 kg ha⁻¹ of fish in semi-intensive culture conditions. These were large fingerlings. In May 2001, June 2002, and August 2003 harvested fingerlings weighed in at 15 g, 50 g, and 12 g, respectively. The diet comprised 28% crude protein supplemented with several local fruits, such as camu-camu, starfruit, pijuayo, and others. The fingerlings were donated by IIAP and Southern Illinois University Carbondale under Aquaculture CRSP sponsorship or, in the case of gamitana, purchased from the Instituto de Investigaciones Tropicales y de Altura (IVITA) in Pucallpa.

Following the success of the joint project, a similar program is underway at the Loreto Naval Base under the direction of FONDEPES in Iquitos,

Peru. The fish produced by the Ucayali Naval Base are either consumed at the base or sold (October through April) in San Martín, Aguaytía,

Tingo María, Alto Huallaga, and as far away as in Lima. The profits are reinvested into the aquaculture enterprise. 🐟



W. CAMARGO

Fish donated by IIAP and SIUC under Aquaculture CRSP sponsorship being used to stock a pond by volunteer navy personnel in the Ucayali Naval Base.

Notice of Publication

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

CRSP RESEARCH REPORT 03-195

ULTRASOUND ENHANCED IMMERSION PROTOCOLS FOR MASCULINIZATION OF NILE TILAPIA, *OREOCHROMIS NILOTICUS*

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Androgen immersion protocols have been unsuccessful in consistently producing all-male tilapia at a high enough ratio for them to be commercially viable. This study explored the use of ultrasound to improve on the results of previous immersion studies. Variables tested include two hormones (trenbolone acetate-TBA and 17 α -methyl-dihydrotestosterone-MDHT) at two concentrations (100 and 250 mg/L) and with or without ultrasound (cavitation level). All hormone treatments with ultrasound and non-ultrasound resulted in significantly higher masculinization than the appropriate controls ($P < 0.05$). Among pairs of treatments of the same hormone at the same dose, all ultrasound treatments resulted in significantly higher number of males compared with non-ultrasound treatments with the exception of MDHT 250 mg/L ($P < 0.05$). Comparing across all ultrasound treatments, TBA 250 mg/L with ultrasound had higher masculinization than all the other ultrasound treatments ($P < 0.05$). Comparing across all non-ultrasound treatments, TBA 250 mg/L had higher ($P < 0.05$) masculinization than MDHT 100 mg/L and TBA 100 mg/L with non-ultrasound. Two of the three replicates of TBA 250 mg/L ultrasound treatment resulted in 100% males and the highest mean percentage (98%) of males. This study thus demonstrated the potential of a short-term immersion protocol using ultrasound to more predictably produce all-male, commercially viable tilapia seed.

This abstract is excerpted from the original paper, which was published in the *Journal of the World Aquaculture Society*, 34(2):210–216.

Graduate's Corner

The Aquaculture CRSP congratulates Nguyen Thanh Long on the successful defense of his M.S. thesis at the Asian Institute of Technology, Thailand, in August. CRSP Principal Investigator Yang Yi served as his major professor. Long is presently a Lecturer and Researcher at the Department of Fishing and Fisheries Resource Management, College of Aquaculture and Fisheries, Can Tho University. In 1985 he received his Bachelor of Science in Fishing Technology from Can Tho University, and went on to participate in several important programs involving the development of aquaculture in Vietnam. We wish him every success in his future endeavors.

STOCKING RATIOS OF HYBRID CATFISH (*CLARIAS MACROCEPHALUS* X *C. GARIEPINUS*) AND NILE TILAPIA (*OREOCHROMIS NILOTICUS*) IN AN INTENSIVE POLYCULTURE

(Abstract of Nguyen Thanh Long's M.S. thesis)

An experiment on intensive polyculture of hybrid catfish and Nile tilapia was conducted in fifteen 5-m² outdoor cement tanks at the Asian Institute of Technology for 91 days, to determine the appropriate stocking ratio of Nile tilapia (*Oreochromis niloticus*) to hybrid catfish (*Clarias macrocephalus* x *C. gariepinus*) and effects of different stocking ratios on the growth of both Nile tilapia and hybrid catfish, water quality, nutrient utilization efficiency and economic returns. There were seven stocking ratios (treatments) of Nile tilapia to hybrid catfish. Hybrid catfish fingerlings of 25–26 g size were stocked at 100 fish per tank (20 fish/m²), while Nile tilapia fingerlings of 20–23 g size were stocked at 0, 5, 10, 15, 20, 25 and 30 fish per tank (0, 1, 2, 3, 4, 5 and 6 fish/m²), giving stocking ratios of Nile tilapia to hybrid catfish as 0:100, 5:100, 10:100, 15:100, 20:100, 25:100, and 30:100, respectively. The control (0:100) had three replicates, while other treatments had two replicates each. No fertilizers were applied to the tanks. Floating pelleted feed (30% crude protein) was given twice daily at 0830 and 1530 h 6 days per week. Feed rations were calculated based only on hybrid catfish biomass estimated by biweekly fish sampling and observed survival rate. Feeding rates of 5% and 3% body weight per day were used for hybrid catfish smaller than 100 g and larger than 100 g, respectively. All tanks were aerated by airstones throughout the experimental period. The addition of Nile tilapia into hybrid catfish tanks did not cause any significant effects on survival, growth and yields of hybrid catfish ($P > 0.05$). Survival of Nile tilapia was not significantly different in the polyculture treatments ($P > 0.05$). With increasing stocking ratios of Nile tilapia to hybrid catfish, mean tilapia weights at harvest decreased linearly, while both net and gross tilapia yields increased linearly ($P < 0.01$). FCRs based on either hybrid catfish alone or combined hybrid catfish and Nile tilapia were not

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Graduate's Corner (cont.)

Congratulations are also in order for Melinda C. Clarke, who successfully defended her M.S. thesis in August at The University of Michigan. CRSP Principal Investigator Jim Diana served as her major professor. We wish her every success in the future.

SHRIMP AQUACULTURE BROWNFIELDS: SOCIAL, ENVIRONMENTAL AND ECONOMIC ISSUES DETERMINING REHABILITATION OPTIONS

(Abstract of Melinda M. Clarke's M.S. thesis)

Intensive shrimp culture in Thailand has fueled the country's economic development, but has left areas of abandoned and degraded ponds. Thailand is dependent on agriculture, but has exhausted availability of cultivable land, making it necessary to rehabilitate abandoned land. This study examined the scale of shrimp pond abandonment as well as related environmental, economic and social issues.

Data were collected using semi-structured questionnaires in Chanthaburi, Chachoengsao and Samut Sakhon provinces in Thailand. Shrimp farmers, head villagers and other stakeholders were interviewed about social development of villages throughout the shrimp boom, local employment preferences, and how local people viewed land abandonment. All interviewed groups were asked common sets of questions about these issues. Data generated from these questions were analyzed comparing frequency distributions using a chi square test to determine if responses differed from a random distribution. Field observations of alternative uses for failed shrimp farms were used to understand viability of conversion options.

The study documented a number of conversion options and measured significant areas of abandoned and converted land. At the time of the study 26% of the area of land surveyed was still active in shrimp culture, 55% had been converted to other uses, and 14% had been abandoned. Respondents indicated that villages had developed in positive ways in the decade during which shrimp culture proliferated. They indicated improved environment, employment, government representation, health, and opportunity for children. They did not recognize land abandonment as a community-wide problem. A preference for on-farm income generation and land ownership over wage labor was demonstrated. Preference for type of on farm employment varied by study site as did demonstrated conversion options. Although the conversion pattern after failed shrimp culture was expected to be linear, the observed pattern demonstrated a cycle of repeated conversion and return to shrimp culture.

Results suggested that agencies wishing to address pond abandonment must work to understand how abandoned land is perceived at the local level. Research into alternative uses for those ponds should be focused on those activities that are most congruous with local perception and preference to enhance likelihood of adoption and dissemination of practices.

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Long Abstract

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significantly different among all treatments ($P > 0.05$). Combined net yields were not significantly different among all treatments ($P > 0.05$), however, combined gross yields increased linearly with increasing stocking ratios of Nile tilapia to hybrid catfish ($P < 0.05$). To produce 1 kg of live hybrid catfish and Nile tilapia generated 18-22 g nitrogen (N) and 3 g phosphorus (P) as metabolic waste. Approximately 34-40 % of total nitrogen and 52-55% of total phosphorus input from the feed were released in the tanks. There were no significant differences in nitrogen utilization efficiency among the catfish monoculture and polyculture of hybrid catfish and Nile tilapia ($P > 0.05$), however, phosphorus utilization efficiency was significantly lower in the mono-culture than in the polyculture ($P < 0.05$). The addition of Nile tilapia into hybrid tanks did not improve water quality. Water quality fluctuated largely among experimental tanks and deteriorated towards the end of the culture period in all treatments. Compared to hybrid catfish monoculture, the ratio of added return to added cost was highest in the polyculture at 10:100 ratio of Nile tilapia to hybrid catfish, intermediate at 5:100 ratio, and lowest at higher ratios (15-30:100). This study has demonstrated that the intensive polyculture of hybrid catfish with Nile tilapia is feasible and that the appropriate ratios of Nile tilapia to hybrid catfish are 5-10:100.

Upcoming Conferences

Date	Topic/Title	Event Location	Contact Information
October 29–31, 2003	Fish Africa 2003	Cape Town, South Africa	Heighway Events, Telephone House, 69-77 Paul Street, London EC2A 4LQ, UK; Phone: 44-0-20-7017-4529; Fax: 44-0-20-7017-4537; Email: sue.hill@informa.com; Website: <www.heighwayevents.com>
November 9–15, 2003	Expo Pesca	Lima, Peru	Thais Corporation SAC; Quilla 139, 2 Piso, Monterrico, Lima 33, Peru; Fax: 551-436-3318; Email: thais@amauta.rcp.net.pe; Website: <www.thaiscorp.com>
November 9–15, 2003	Genetics in Aquaculture VIII	Puerto Varas, Chile	Roberto Neira, Universidad de Chile; Fax: 56-2-541-3380; Email: genaqua@uchile.cl
November 13–14, 2003	East-West Fisheries Conference	Tallinn, Estonia	Heighway Conferences, Agra Europe, 80 Calverley Road, Tunbridge Wells, Kent TN1 2UN, UK; Phone: 44-0-1892-511-807; Email: conferences@heighway.com; Website: <www.heighway.com>
December 2–3, 2003	Aquaculture Asia-Pacific	Sydney, Australia	David Monaghan; Agra Europe Ltd, 80 Calverley Road, Tunbridge Wells TN1 2UN, UK; Phone: 44-0-1892-533-813; Fax: 44-0-1892-544-895; Email: david.monaghan@informa.com
December 3–5, 2003	Aquaculture Australia	Sydney, Australia	Heighway Events, Telephone House, 69-77 Paul Street, London EC2A 4LQ, UK; Phone: 44-0-20-7017-4529; Fax: 44-0-20-7017-4537; Email: sue.hill@informa.com; Website: <www.heighwayevents.com>
February 26–28, 2004	Asian Fisheries 2004	Bangkok, Thailand	Baird Publications, 135 Sturt Street, Southbank, Melbourne 3006, Australia; Website: <www.baird.com.au>
March 1–5, 2004	Aquaculture 2004	Honolulu, Hawaii	Conference Manager; 2423 Fallbrook Place, Escondido, CA 92027, USA; Phone: 760-432-4270; Fax: 760-432-4275; Email: worldaqua@aol.com; Website: <www.was.org>
March 22–27, 2004	AquaSur 2004	Puerto Montt, Chile	Sue Hill, Heighway Events, Telephone House, 69-77 Paul Street, London EC2A 4LQ, UK; Phone: 44-0-20-7017-4529; Fax: 44-0-20-7017-4537; Email: ariela.cesana@heighway.com; Website: <www.heighway.com>
May 19–21, 2004	Aquaculture International 2004	Glasgow, Scotland	Heighway Events, Telephone House, 69-77 Paul Street, London EC2A 4LQ, UK; Phone: 44-0-20-7017-4529; Fax: 44-0-20-7017-4537; Email: sue.hill@informa.com; Website: <www.heighway.com>
October 20–23, 2004	Aquaculture Europe 2004 “Biotechnologies for Quality”	Barcelona, Spain	EAS-Aquaculture Europe 2004, Slijkensesteenweg 4, B-8400 Oostende, Belgium; Phone: 32-59-323859; Fax: 32-59-321005; Email: ae2004@aquaculture.cc; Website: <www.easonline.org>

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