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Abalone culture - a new business opportunity

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Abalone is a marine gastropod (single shelled mollusk) that has a big foot muscle, inhabits rocky and coral reefs, and feeds mainly on seaweeds. There are about 100 species of abalone in the world but only 20 are of high commercial importance.

In the Philippines, the abalone species are *Haliotis asinina*, *H. varia*, *H. ovina*, and *H. glabra* but it is *H. asinina* which has high commercial value. Live abalones command a high price of P250-300 per kg (15-20 pieces; P55 = US\$1). Middlemen or processors blanch these to remove the shell and gut. The blanched meat is sold at P450-550 per kg. These semi-processed abalone are then frozen, dried or canned for export to many countries such as Hong Kong, Japan, Korea, Taiwan, Singapore, China, Australia, USA, Canada, Spain, Netherlands. In China, abalone is believed to have aphrodisiac and medicinal value, and canned abalone is a prized gift.

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The abalone Haliotis asinina (photos by J. Altamirano); netcage culture at AQD's Igang Marine Substation (rightmost, photo by R. Buendia). In floating net cages, it is easy to monitor, feed, and harvest abalone. Seaweeds that grow naturally on nets can serve as additional food



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ASEAN-SEAFDEC 5-YEAR PROGRAM
Integrated Regional Aquaculture Program

Inspiring aquaculture development in rural Cambodia

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Family of Khiev Sam, fish breeder, in front of their new house

Sam and Som

Mention Cambodia and most likely the horror of the 'killing fields' comes to mind. If you go to the province of Takeo and meet Khiev Sam and Som Hekk, most likely you will have a new "first thing that comes to mind" when you hear Cambodia mentioned. Not only that, unless you are a dyed-in-the-wool cynic, you will likely leave inspired and your faith in aquaculture for rural development strengthened. But that's going ahead of the story.

Takeo province was the first stop in Cambodia for the SEAFDEC/AQD Site Visitation Mission to get the Integrated Regional Aquaculture Program going as a component of the ASEAN-SEAFDEC Five-Year Special Program. Its capital town also called Takeo is located a little over 100 km southwest of Phnom Penh.

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Mangrove community structure survey

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Carles is one of the major sources of marine and aquacultured fish in Iloilo province, producing 80,300 mt in 2002. The municipality is located in the north-east tip of Panay Island (see map). The territorial waters of Carles take a large portion of the Visayan Sea and its coast has 1,539 hectares of fishponds.

The importance of mangroves in capture fisheries, aquaculture and the lives of coastal residents manifests in the activities of the *Northern Iloilo Mangrove Rehabilitation Program* mainly funded by the Japan Bank for International Cooperation (JBIC). This program is managed by the Sub-Project Site Management Office (SUSIMO) of the Department of Environment and Natural Resources (DENR) with the active participation of its beneficiary, the MACABATA-ARM Inc. (which stands for Manlot, Cabilao, Bancal, Tarong Association for the Rehabilitation of Mangroves Inc.), a people's organization registered with the Securities and Exchange Commission on January 2001 with 366 members. As per DENR-JBIC project agreement, the mangrove rehabilitation project covers 531 hectares that is now replanted with *Rhizophora mucronata*.

With this on-going rehabilitation and involvement of the local people, baseline information on the characteristics of the mangrove community and the people living in the coast need to be established - one of them is an assessment of the mangrove community structure of the project site. This information is useful for further studies, including valuation of resources, and the estimation of the costs and benefits from rehabilitation and conservation of mangroves. These studies comprise the SEAFDEC/AQD-JIRCAS socio-economics project on sustainable aquaculture systems.

The seven mangrove-fringed coastal barangays of Carles were chosen as study site. On April 2003, the authors of this article conducted a mangrove community structure survey (MCSS) in 13 selected sites in five mainland barangays and two island barangays in Carles (see map). The MCSS aims to qualitatively describe the species composition, community structure and plant biomass of mangrove forest.

Below is a photo-essay of field activities involved in MCSS following the methods of English et al. (1994).



Map of Carles, Panay Island

Highlights

- ✓ The 13 sample sites for the MCSS shown on the map on this page altogether listed 18 mangrove species dominated by *Avicennia marina*, locally called 'miapi'. Other major species are *Sonneratia alba*, *Ceriops decandra*, and *Bruguiera cylindrica* (table at right).
- ✓ *Rhizophora mucronata* (photos at right), the species being planted to rehabilitate mangroves in Carles, was only moderately found during the survey, as were *A. rumphiana* and *Camptostemon philippinensis*.
- ✓ Species locally known as dungon, bantigi, nilad/sagasa, piagaw and tawalis were least found during the survey.
- ✓ A site in Brgy Cabilao Grande recorded the highest species diversity with impressive 14 species sighted, including *Aegiceras floridum*, *Osbornia octodonta*, and *Pemphis acidula* that are rarely found in Panay.



1 General inspection of the study area to determine the location of representative sites, aside from references to maps. Thirteen sites were identified to represent the (a) seven barangays covered by the study area; (b) various environmental parameters such as low, mid and high intertidal zones; and (c) main forest types according to tree species.



2 Setting of corner markers for 10 m x 10 m quadrat that is a sample representative of each site.

Mangrove species identified during the mangrove community structure survey (MCSS) in Carles, Iloilo, April 2003

Local name (Ilonggo)	Scientific name
saging-saging	<i>Aegiceras floridum</i>
miapi	<i>Avicennia marina</i>
miapi	<i>Avicennia officinalis</i>
bungalon	<i>Avicennia rumphiana</i>
pototan	<i>Bruguiera cylindrica</i>
baras-baras	<i>Ceriops decandra</i>
gapas-gapas	<i>Camptostemon philippinensis</i>
tungog	<i>Ceriops tagai</i>
alipata	<i>Excoecaria agallocha</i>
dungon	<i>Heritiera littoralis</i>
tabao	<i>Lumnitzera racemosa</i>
tawalis	<i>Osbornia octodonta</i>
bantigi	<i>Pemphis acidula</i>
bakhaw-lalaki	<i>Rhizophora apiculata</i>
bakhaw-babae	<i>Rhizophora mucronata</i>
pagatpat	<i>Sonneratia alba</i>
nilad/sagasa	<i>Scyphiphora hydrophyllacea</i>
piagaw	<i>Xylocarpus mekongensis</i>

the mature trees are dying. This at least indicates the likelihood of replacements if at least a few seedlings survive.

- ✓ Other interesting sites include those which are characterized by a wide strip of mangroves like the intertidal area in Brgy Pantalan with big *S. alba* and *A. marina* trees; and naturally-growing *R. mucronata* trees and saplings (right, middle).

- ✓ The site at the mouth of a river, in tidal streams along fishpond dikes, in Brgy Tupaz is a 20 m-wide mangrove belt (right, bottom) that is also characterized by naturally growing *R. mucronata* trees and saplings.

- ✓ There are other mangrove species found in the survey area but not listed in the sample quadrats. These include *R. stylosa*, *Xylocarpus granatum*, and *Nypa fruticans* or nipa that is commonly used as roofing. Mangrove associate species that are locally called 'roma', 'dapdap', 'bancal' and 'talisay' are also often abundant in back mangal areas. They were not within the quadrats in the 13 sample sites. page 18



- ✓ Sites located between inlets and fishpond dikes recorded high species diversity, for example, the above mentioned site in Brgy Cabilao Grande and two other sites in Brgy Tupaz and in Brgy Manlot.
- ✓ The site in Brgy Tarong (right, top) is distinguished by the abundance of *A. marina* seedlings even though



3 Identification and counting of trees. Measuring the tree girth at 1.3 m height



4 Identification and counting of saplings.



5 Identification and counting of seedlings.



6 Recording of data on slate boards, which would be analyzed using established MCSS parameters.

SEAFDEC inputs to BIMP-EAGA fisheries meeting

SEAFDEC shared its technical expertise during the 7th Meeting of the Brunei Darussalam Indonesia Malaysia Philippines - East ASEAN Growth Area (BIMP-EAGA) Working Group on Fisheries Cooperation held 10-12 June at the Barcelo Asturias Hotel, Puerto Princesa City, Palawan.

The situationers on the current status of fisheries in the Southeast Asian Region came from SEAFDEC. That on aquaculture was presented by Dr. Rolando Platon, the SEAFDEC/AQD Chief. The situationer on Capture Fisheries was prepared by Dr. Mansor Mat Isa of SEAFDEC's department in Malaysia but was presented on his behalf by George Chong, Senior Fisheries Officer and Head of the Extension and Training Section of the Fisheries Department of Sarawak, Malaysia.

The AQD Chief's presentation also covered the Special 5-Year Program as well as the Regional Programs on Mangrove friendly shrimp culture and Fish diseases. The update on the Special 5-Year Program was relevant because the initial countries that were covered during the first part of the Site Visitation Survey on May 11 to 23, 2003 were Brunei Darussalam, Indonesia and Malaysia.

BIMP-EAGA was formed to foster stronger collaboration between the public and private sector, most especially trade, between the four countries, which share a common Malay heritage. The private sector, which is recognized as the main engine of growth, participates through the East Asia Business Council (EABC). Along this line the government sector works towards making it smooth and convenient for trade to proceed between the four countries.

The three-day meeting dwelt on common issues in fisheries and how each country can help each other. It began with an

assessment on actions taken on recommendations made during the 6th Meeting held in South Sulawesi, Indonesia on February 2 to 4, 1999. These included enhancing trade among small and medium enterprises, tariff harmonization on tuna, fisheries quarantine, proposed BIMP-EAGA home page and viable bilateral ventures. The 7th meeting affirmed the need to pursue these matters and brought out new specific issues.

In aquaculture, there was a specific request from Malaysia for closer cooperation with the Philippines in developing their own seaweed industry in terms of experts and consultants. The lack of fry especially of the high value species such as groupers was also highlighted. The issues brought up included the lack of private investments in marine fish hatchery, the need to further improve hatchery technology and the unabated smuggling of fry and fingerlings to Taiwan. The Malaysian delegates also expressed their desire to see Philippine deboned milkfish products in their supermarket shelves.

In marine fisheries as well as in fish processing the issues brought out include the lack of direct air and sea linkage between the BIMP countries, which hampers the flow of goods, and people. Also brought out is the need for harmonized quarantine procedures for fishery products. The recommendation included the complementation of rules and regulations on CIQS (Customs, Immigration, Quarantine and Surveillance) between the four countries including the adoption of a common form. The need to exchange expertise among the BIMP countries was brought out.

Simultaneous with the meeting was a mini-trade exhibit, which had four exhibitors. The Philippines as the host country has the most number of participants with 105 participants of which almost 50% were from the private sector. The Malaysians were not too far behind in terms of numbers with a total of 22 delegates from Sarawak and Sabah.

Partnership with LandBank

SEAFDEC/AQD has recently taken on a new partner, the LandBank of the Philippines, to expand its *Joint Mission for Accelerated Nationwide Technology Transfer Program* (JMANTTP) with the Bureau of Fisheries and Aquatic Resources. The LandBank came into the JMANTTP partnership because they already provide credit assistance to cooperatives. These cooperatives, as well as the new technology adoptors, can benefit from the technical assistance of AQD and BFAR. LandBank will also provide funds to pay part of the JMANTTP technology promotion activities or initiatives.

In related development, LandBank's Western Visayas Technology Promotion Center (TPC) hosted a 3-day national TPC assessment forum in early September in Iloilo. There were about 60 participants from LandBank units, TPC-member universities and institutions, including AQD. The participants had a tour of AQD's main station in Tigbauan and the Dumangas Brackishwater Station where JMANTTP is validating environment-friendly shrimp farming technology.

Welsh grad students conduct thesis at AQD

Two graduate students from the University of Wales, United Kingdom, are conducting their thesis at SEAFDEC/AQD in the Philippines under the supervision of AQD scientists Dr. Emilia Quintio and Dr. Veronica Alava.

Paloma Carillo de Albornoz, 27 and Andrew Teuma, 23 are pursuing Masters degrees on shellfish biology, fisheries and culture. Their studies at AQD started in June and will end October.

Paloma is studying the antagonistic behavior and strategies to reduce cannibalism in mud crab juveniles. Andrew works on the natural and artificial feeds for mud crab larvae. Their studies are both under the European Commission-funded project entitled "Culture and Management of *Scylla* species (EC-CAMS)" in which AQD, University of Wales, Can Tho University and Ghent University are the collaborating agencies.



AQD scientist honored for work in zoology

The National Academy of Science and Technology (NAST) of the Philippines declared Dr. Evelyn

Grace de Jesus-Ayson as a recipient of the 2003 Outstanding Young Scientist (OYS) Award in the field of zoology. Dr de Jesus-Ayson is a researcher with SEAFDEC/AQD's Nursery Section. She received a plaque and a cash prize of P30,000 during the awarding ceremony in July in Manila. Congratulations!

Mangrove-friendly aquaculture seminar-workshop

The regional seminar-workshop on *Mangrove-friendly shrimp culture* (MFSC) was held June 24-27 in Bangkok with representatives from SEAFDEC member-countries and institutions involved in the MFSC project attending.

It was convened to review the progress of activities of the project and to confirm the proposed activities for the extension of the project including the development of guidelines on the responsible use of mangroves for aquaculture in SEAFDEC member countries.

The participants from AQD included AQD Chief Dr Rolando Platon and 10 senior staff.

MFSC is a collaborative project of the ASEAN-SEAFDEC Fisheries Consultative Group which started in 1998. It is focused on mitigating the impacts of shrimp culture on mangroves, adopting three approaches - research, verification/pilot demonstration, and information dissemination.



AQD scientist receives IFS research grant

Dr. Wenresti Gallardo, a scientist at AQD's Farming Systems and Ecology Section,

was awarded a US\$10,000 research grant by the Sweden-based International Foundation for Science (IFS). The grant will fund Dr. Gallardo's study on "Development of release strategies for stock enhancement of the tropical abalone *Haliotis asinina*."

Dr. Gallardo and his team will determine the best abalone size, release season, habitat, and stocking density that would result in high survival, growth, and reproduction of released abalones. Results are expected to contribute to the development of stock enhancement strategies for the tropical abalone. The study will be conducted for three years, most likely, at Sagay Marine Reserve in Negros Occidental. The grant will supplement and support the work initiated by the AQD stock enhancement team.

In a letter to Dr. Gallardo, the Scientific Program Coordinator of IFS, Ingrid Leemans, wrote that the scientific advisers and experts considered the topic of his proposal very relevant, and if successful, could have an impact on re-population of this species of abalone.

IFS is an international research council supporting scientists below 40 years old from developing countries to conduct relevant and high quality research on the management of biological resources. Support is given for projects in areas such as agriculture, forestry, natural products, and aquatic resources, as well as for research on the sustainable utilization and conservation of natural ecosystems.



AQD wins best paper award in aquaculture

Dr. Anicia Hurtado, scientist at AQD's Farming Systems and Ecology Section, won the 16th Dr. Elvira O.

Tan Memorial Award given by the Philippine Council for Aquatic and Marine Research and Development (PCAMRD), the sectoral council of the Department of Science and Technology (DOST).

Dr Hurtado's paper titled "Deep-sea farming of *Kappaphycus* using the multiple raft, long line method" reaped the Best Published Paper in Aquaculture. The paper, co-authored by Renato Agbayani, is published in the journal *Botanica Marina*, volume 45 in 2003.

The awarding was held on July 18 in Pasay City during the Los Baños Science Community's celebration of the national science and technology week. PCAMRD is based in Los Baños, Laguna.

The selection was based on the following criteria: contribution to industry and science; technical quality (methodology, results, and conclusion); and sustainability/environment.

16 international fellows

Sixteen fellows are participating in the two-month international training course on *Responsible aquaculture development* (RAD) starting September 16 at SEAFDEC/AQD in Iloilo. RAD is a Third Country Training Program (TCTP) funded by the Japan International Cooperation Agency (JICA).

The trainees came from Bangladesh, Cambodia, China, India, Indonesia, Kenya, Mozambique, Pakistan, Philippines, and Tanzania.

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Initial results on training need survey

From the attendees of AQD's anniversary celebration seminar dubbed "Business Opportunities in Aquaculture" (AquaBiz) held July 7 and 8 in Iloilo were 39 expressions of interest in undergoing training in aquaculture (total respondents = 48). About 40 would like to undergo training for purposes of business and employment credentials; 30 preferred training duration of less than two weeks. Of the 18 aquaculture technologies on the survey list, six significantly stand out. These are grow-out culture systems of shrimp and milkfish in ponds; seabass, grouper, snapper, and mud crab in pens or cages. Future training programs of AQD would address these needs.

A parallel three-month survey was also conducted at the AQD website, and results will be further consolidated. In the meantime, AMD's training head PL Torres Jr. would like to thank the respondents for the insights they have shared.

The opening ceremony was graced by JICA's Deputy Resident Representative, Mr. Hirohiko Takata, and the AQD Chief Dr. Rolando Platon.

RAD-TCTP has now trained 113 fisheries officers from ASEAN, South Asia, Africa and China in the past 9 years.

The goal of RAD TCTP is to provide participants with sufficient knowledge and skills so that they will be able to plan and implement sustainable aquaculture development projects in rural communities.

JIRCAS: hello and goodbye

Dr. Iknari Kiryu, a researcher from the Japan International Research Center for Agricultural Sciences (JIRCAS), has joined AQD beginning July 1 this year. His tour-of-duty is up to March 2006.

Dr. Kiryu, a fish pathology expert, is working on the development of control methods for factors suppressing sustainable production of aquaculture species. He is working with Dr. Leobert dela Peña and Dr. Erlinda Lacierda of Fish Health Section.

Before joining JIRCAS this year, Dr. Kiryu worked as a researcher at the National Research Institute of Aquaculture (NRIA) in Japan. He obtained his PhD in Fish Pathology at Tokyo University.

A warm welcome to AQD to Dr. Kiryu and his wife, Tamami!

Meanwhile, AQD bids JIRCAS senior researcher Yukio Maeno adieu as his term ends July 25. Dr. Maeno has been conducting his study at AQD since November 1, 2000. Also with Dr. Lacierda and Dr. dela Peña, Dr. Maeno worked on systems for sustainable production of aquatic animals in brackishwater mangrove areas. He is a Fish Physiology and Pathology expert.

Maeno was senior researcher at NRIA before working at JIRCAS. Fare well, Dr. Maeno!

Dr. Kiryu

Dr. Maeno



First IRAP on-site training conducted

With funding support from the Aquaculture Component of the SEAFDEC-ASEAN Special Five-Year Program, the first IRAP (Integrated Regional Aquaculture Program) on-site training was conducted from August 4 to 17 at the Bati Fish Seed Production and Research Station in Prey Veng Province, Cambodia.

Four small-scale fish farmers and three Department of Fisheries (DOF) Cambodia technicians attended the training that focused on the seed production and rearing of the Mekong catfish *Pangasius hypophthalmus*. The course organizer and lecturer, Ngan Heng, is also the Director of the Bati Station. He was assisted by Sujin Nukwan, Senior Fishery Biologist from DOF Thailand who served as a resource person. Serving as overall coordinator was Chin Da, Vice Chief of the Aquaculture Bureau of DOF Cambodia. Mr. Da is also the Technical Coordinator for Cambodia for the Supply of Good Quality Seeds component of the Special Five-Year Program.

The training course included lectures on the biology and breeding characteristics of *P. hypophthalmus*; general discussion on hormone calculation, identification of male and female, and priming injection; demonstration on collecting fish ova, sperm collection and preservation, stripping, and fertilization; larvae maintenance and releasing to nursery pond; pond preparation; feeding practices; and fish seed counting and harvesting.

It was obligatory to hold the training in August because the window on the proposed farmers' training on *Pangasius* breeding would end in September. Otherwise, the training would have to be postponed until April 2004, quite late for the timing of the activities in Cambodia under the Special Five-Year Program.

Bati Fish Seed Production and Research Station is located in Prey Veng Province about 70 km from Phnom Penh at the other side of Tonle Sap River. A river ferry system enables vehicles from Phnom Penh to drive all the way to Prey Veng. The station was established in 1988 with the assistance of the Partnership for Development of Kampuchea (PADEK), a non-governmental group. Until 1997 the station operated



Top to right: Trainees selecting the *Pangasius* broodfish from a Bati Station pond, checking broodfish for eggs, stripping the fish for artificial breeding, and trying their hands at incubating the eggs (Photos courtesy of VT Sulit)

under a PADEK funded program, after which the station operates under the Prey Veng provincial fisheries office. Since 2000 the station has been cooperating with the Mekong River Commission as part of its Aquaculture of Indigenous Mekong Fish Species (AIMS) project for the propagation of indigenous freshwater species.

In spite of its name the Bati station was established solely for fish propagation. Until 1997 it was capable only of propagating the silver barb (*Barbonymus gonionotus*). In 1998 the station succeeded in propagating the Mekong catfish when it

produced 12 fingerlings. Survival rate has since improved and the station can now routinely produce *Pangasius* fingerlings. It is now working on the propagation of a trey krum (*Osteochilus melanopleurus*), a local carp species, and the gourami (*Trichogaster pectoralis*) as part of MRC's AIMS project. Also in the pipeline is the propagation of the giant gouramy (*Osphronemus gouramy*) and a local bottom feeding carp species, *Puntiopilus falcifer*. As a sub-component of the World Bank assisted Agricultural Productivity Improvement Project (APEP) the station is also standardizing procedures for the propagation of a snakehead species, *Channa micropeltes*, with the aim of producing a manual for the species.

Way back in 2002, the Bati Station proposed to conduct a hands-on training on the propagation of *P. hypophthalmus*. The



three-week training scheduled to start in April would have involved four farmers from three provinces, two from Prey Veng, one from Takeo, and one from Svay Rieng, and three technicians from DOF Cambodia. However, funds for the purpose have not been released by the DOF Cambodia. Since the last chance to hold the training is the month of August, funding was sourced from the Special Five-Year Program's Aquaculture Component.

Although the culture of *Pangasius* is being promoted in the country, the DOF Cambodia has apparently not given consideration on the problem of feeding them. *Pangasius* is a voracious feeder, which accounts for its rapid growth. Promoting its culture could possibly result in farmers using up low-value and small fish, which could either grow to larger sizes or could

"Stock now pay later" in Jalajala

In order to popularize the SEAFDEC Strain (SSt) tilapia developed by the AQD Binangonan Freshwater Station (BFS), and in order to encourage more people to go into tilapia farming within Rizal province, the Aquaculture Based Countryside Development Enterprises Foundation Inc. (ABCDEF Inc.) in Punta, Jala-Jala, Rizal has launched a "Stock Now-Pay Later" plan for small scale fish fanners. Expected beneficiaries of the plan are agrarian reform beneficiaries in the area as well as Laguna de Bay fishers.

Although Jalajala is along the shore of Laguna de Bay and has large areas of irrigated ricefields there is surprisingly very little aquaculture activity. In order to encourage other townfolk into raising fish, three members of the Sangguniang Bayan of Jalajala, namely, Leopoldo Salgatar, Magusig Estrella, and Luzviminda Villaran offered to pilot the scheme to demonstrate



be directly consumed as food. The use of fish biomass as food will likely make it not economically viable to produce. Fortunately, as an omnivore, it can subsist on a wide range of feed and when cultured in earthen ponds can feed completely on vegetable materials such as agricultural byproducts. It is only when cultured in cages that some amount of fish is necessary.

The Bati Station Director also expressed keen interest in seed quality improvement through selective breeding of *Pangasius* and in the capability building of the station staff. In this regard, the DOF Cambodia would like to continue bringing a limited number of technicians and promising fish farmers on study tour to Thailand and also to bring technicians for hands-on training on tilapia and carp breeding and culture possibly to the Philippines. The same concern was also reiterated by the Chin Da in his initial report about the training at the Bati Station. Once the proposal is approved, AQD will be meeting more Cambodians before the end of this year, if not early 2004. -VT Sulit



Cooperating partners of the Stock Now Pay Later Plan hold a ceremonial bag of SSt tilapia fingerlings

its viability. Other future fish farmers have expressed interest but are still in the process of putting up their cages or digging their ponds to accommodate 10,000 fingerlings.

The program is the outcome of a meeting held at ABCDEF Inc. on August 19, which was attended by officers of the different local farmer cooperatives, members of the Sangguniang Bayan, and Municipal Agrarian Reform Officers (MARO) from the towns of Jala-Jala, and Teresa, Rizal. Under the plan small fish fanners within Rizal province has to have ponds or cages ready for stocking. These are visited by ABCDEF staff members and once determined to be suitable and ready for stocking each operator is allocated 10,000 size 22 SSt tilapia fingerlings. Each recipient is responsible for picking the fingerlings up from the ABCDEF Inc. hatchery in Punta, Rizal.

ABCDEF Inc. is a joint undertaking of the Meralco Foundation Inc. (MFI), and AQD. It was established as a vehicle for countryside development through aquaculture. Its main activity now is the operation of the former MFI tilapia hatchery as a multi-species freshwater hatchery using the technical expertise of BFS personnel. In addition to tilapia, it produces quality fingerlings of snakehead or mudfish, native *hito*, and bighead carp. The hatchery maintains a standing stock of about 1.5 million fry and fingerlings of various stages at any one time. - WG Yap

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Environment-friendly aquaculture: a repeat invitation

An AQD team conducted a seminar on *Environment-friendly aquaculture* in Cagayan de Oro City from July 22 to 23. The seminar was part of DOST Region 10's National Science and Technology Week (NSTW) celebration with the theme "Empowering SMEs (small and medium enterprises) through science and technology."

This is the second invitation from Regional Director Dr. Constancio Cañete for the AQD team, the first was for Tanguib City, also in Mindanao, last March.

There were 82 participants from the private sector, government agencies, local government units of Region 10 provinces, and academe. The topics discussed were health management in shrimp culture; culture of seaweeds; soil and water quality; feeds and feeding management; tilapia and milkfish culture; environment-friendly shrimp culture systems and shrimp culture methodology. Lectures and discussions were delivered in Cebuano and Hiligaynon. Most of the participants were interested in cage culture of milkfish.

Techno-caravan in Aurora

AQD participated in the lecture/demonstration organized by the Bureau of Fisheries and Aquatic Resources (BFAR) in Baler, Aurora on August 18. The activity was aimed at bringing the latest aquaculture technologies closer to fisherfolk, and was one of the highlights of Baler's town fiesta. There were about 60 fisherfolk participants from coastal barangays.

Resource persons from AQD spoke on hatchery and grow-out of mudcrab, grouper and tilapia; shrimp hatchery and environment-friendly schemes in intensive shrimp farming.

Training on livelihood opportunities

AQD held a two-week training course on livelihood opportunities in abalone, seaweeds (*Gracilaria* and *Kappaphycus*), and mud crab hatchery and culture. These commodities require low capital but have high income potential.

good friend and colleague



Dr. Roselyn Duremdez, former AQD scientist, dies in car mishap

"We have lost a dear friend and a valuable member of the fish health community," say colleagues of Roselyn Duremdez, 47, scientist and former head of the Fish Health Section at SEAFDEC/AQD, when news reached AQD that she died on July 31 in a vehicular accident in Kuwait. Duremdez was working as associate research

scientist at the Fisheries and Marine Environmental Department, Kuwait Institute for Scientific Research.

In honor of her contribution to the institute, the Marine and Fisheries Department of Kuwait is renaming the institute's fish pathology laboratory after her. The commemorative plaque appears as:

*Dr. Roselyn Duremdez Laboratory
Associate Research Scientist
19 July 1998-31 July 2003*

Duremdez joined AQD in June 1977 as Fishery Technician, eventually capping her AQD career as a Scientist by the time she resigned in January 1998. She had a number of scientific publications including "The bacterial flora of milkfish *Chanos chanos* eggs and larvae" in *Fish Pathology* in 1996. She had also co-authored extension manuals on fish disease management published by AQD.

Duremdez earned her BS Fisheries degree (Inland) from the Mindanao State University, Marawi City in 1976, and her masters in Fisheries at the University of the Philippines in the Visayas in 1982. She earned a Doctorate of Fisheries from Hokkaido University, Japan in 1993. She had also trained on fish pathology at the Oregon State University in the Pacific Northwest, USA, in 1985.

The AQD community offered a mass for the repose of her soul on August 8. She was interred in her hometown of Naawan, Misamis Oriental in northern Mindanao.

Eighteen participants attended the course which started on August 11 up to the 23rd. They were fisherfolk representatives from different regions of the country and staff members of the Fisheries and Aquatic Resources Management Council (FARMC).

AQD collaborated with the Bureau of Fisheries and Aquatic Resources (BFAR) and the National Program Management Center of FARMC in the conduct of the course. The latter requested the training.

Inspiring aqua ... from page 13

earlier During the second crop he used a local variety with a longer cropping period of more than five months. Consequently the fish had more time to grow although he had a lower rice yield. In addition to the silver barb and common carp fingerlings he related that he also released about 25 to 30 adult gouramy and that by the harvest time he was able to harvest some 2,000 pieces of marketable gouramy.

Som is also in a rain fed area. He has managed to sink a well but the amount of water he gets is only enough for his household needs. Som clearly is a hard working and clever fellow to get to where he is now. Asked whether he has a refrigerator to keep the hormones he uses to induce spawning he grinned and showed us a practical way to keep the hormones cool. He went to the pond and fished out a vial of hormone wrapped in waterproof plastic. He keeps them in the deepest part of the pond. Mr Sujin Nukuan from DOF Thailand remarked that he learned something new that he can even extend to Thai fish farmers.

Now if only we can have more Sams and more Soms not only in Cambodia but throughout Southeast Asia. ###



AQD Research Publications

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Bautista-Teruel MN, Eusebio PS, Welsh TP. 2003. Utilization of feed pea, *Pisum sativum*, meal as a protein source in practical diets for juvenile tiger shrimp, *Penaeus monodon*. *Aquaculture* 225 (1-4): 121-131

Abstract The potential of feed pea meal as an alternative protein source to soybean meal in practical diets for the juvenile tiger shrimp, *Penaeus monodon*, was assessed in several experiments. Six isonitrogenous diets were formulated to contain 40% protein. Protein from the feed pea meal replaced 0, 20, 40, 60, 80, and 100% of the protein from defatted soybean meal in the diets. These values were equivalent to 0, 5, 10, 15, 20, 25%, respectively, of the total protein in the diet. A negative control with no protein sources was added to the treatments. Twelve shrimp post-larvae with an average weight of 0.02 ± 0.01 g were randomly assigned in thirty-five 60-l oval tanks equipped with a flow-through seawater system. The shrimp were fed the formulated diets at a daily feeding rate of 20-25% body weight for 90 days in five replicate samples. No significant differences ($P > 0.05$) were observed in weight gain, feed intake, feed conversion ratio (FCR) and protein efficiency ratio (PER) of shrimp fed diets 0 up to the highest level of replacement. Weight gain of shrimp fed the negative control was, however, significantly lower ($P < 0.05$) compared to the rest of the treatments. Specific growth rates (SGR) of shrimp showed likewise no significant differences among treatments except for the negative control. Survival of shrimp for all treatments ranged between 75% and 100%. The apparent dry matter (ADMD) and protein (APD) digestibilities of the dry feed pea in *P. monodon* were high at 73.38 ± 4.98 and 92.74 ± 2.62 , respectively. Digestibility coefficients for dry matter and protein for the feed pea meal-based diets increased with increasing level of feed pea replacement. There were no significant differences in whole body composition (dry matter, protein, lipid, ash, fiber) of shrimp fed the various diets with feed pea replacement. Pellet water stability was similar for all diets even up to the highest level of replacement. The results have demonstrated that feed pea meal has a very good potential as a substitute protein source up to 100% of the protein from defatted soybean meal, which is equivalent to 25% of the total protein in the diet. An inclusion level of up to 42% in the juvenile shrimp *P. monodon* practical diet did not manifest any adverse effects on growth, feed intake, FCR, survival, body composition, and digestibility coefficients for dry matter and protein of the shrimp.

Borlongan IG, Eusebio PS, Welsh T. 2003. Potential of feed pea (*Pisum sativum*) meal as a protein source in practical diets for milkfish (*Chanos chanos* Forsskal). *Aquaculture* 225 (1-4): 89-98

Abstract. A 12-week feeding trial was conducted to evaluate the use of feed pea meal as a dietary protein source for juvenile milkfish. Six isonitrogenous (30% crude protein) and isocaloric (16.5 kJ/g) practical diets were formulated. The control diet contained fish meal, soybean meal, meat and bone meal and copra meal as principal protein sources. Feed pea meal was progressively substituted at 0, 5, 10, 15, 20, 25 and 30% of total protein. A leading commercial milkfish feed was also tested as an addi-

tional control. The experimental diets were fed to triplicate groups of milkfish fingerlings (mean initial weight of 0.42 ± 0.01 g) at 10% body weight/day. Growth performance (expressed as percentage of weight gain and SGR), survival, feed conversion ratio (FCR) and protein efficiency ratio (PER) of milkfish fed diets with up to 10% substitution of the dietary protein with feed pea meal were not significantly different ($P > 0.05$) compared to fish fed the control diet. Replacement with feed pea meal at 15% and higher levels led to milkfish fed these diets showing a significantly lower growth response compared to fish fed with the control without any feed pea meal. Nevertheless, it was observed that milkfish fed diets with up to 20% of total dietary protein substitution with feed pea meal showed better growth rates and feed conversion ratios than the commercial feed control. Whole body composition (crude protein, crude fat, crude fiber, nitrogen-free extracts and ash content) of milkfish fed the various test diets was not significantly different. Apparent digestibility coefficients of feed pea meal and experimental diets in milkfish were also determined. Results indicate that feed pea meal is an acceptable protein source and can replace up to 20% of the total dietary protein in milkfish diets.

Coloso RM, King K, Fletcher JW, Hendrix MA, Subramanyam M, Weis P, Ferraris RP. 2003. Phosphorus utilization in rainbow trout (*Oncorhynchus mykiss*) fed practical diets and its consequences on effluent phosphorus levels. *Aquaculture* 220 (1-4): 801-820

Abstract. Excessive dietary phosphorous (P) concentrations in effluents from aquaculture present a major environmental problem. We therefore studied the effect of dietary P and vitamin D₃ on P utilization by rainbow trout-fed practical diets and on P concentrations in the soluble, particulate and settleable components of the effluent from fish tanks. Rainbow trout (average weight: 78 g, initial biomass: 13 kg in 0.7 m³ tanks) were fed for 11 weeks, practical diets that varied in total P, available P, and vitamin D₃ concentrations. Soluble, particulate (10-200 µm) and settleable (>200 µm) P in the effluent were sampled every 0.5-6 h for 1-3 days in the third and eleventh weeks of the experiment. Trout in all diets more than doubled their weight after 11 weeks. Increasing the concentrations of available dietary P from 0.24% to 0.88% modestly enhanced growth rate. Feed conversion ratio (FCR) and biomass gain per gram P consumed decreased as dietary P concentrations increased. Carcass P, daily P gain, and plasma P concentrations were lower in fish fed with low P diets. Soluble P concentrations in the effluent peaked immediately after and again 4-6 h after feeding, and is a linear function of available dietary P. No soluble P would be produced during consumption of diets containing less than $0.22 \pm 0.02\%$ available P. Above this dietary concentration, soluble P would be excreted at 6.9 ± 0.4 mg/day/kg for each 0.1% increase in available dietary P. Particulate P concentrations in the effluent were independent of dietary P concentrations. Settleable, presumably fecal P concentrations tended to increase with dietary P concentrations. In trout fed with low P (0.24% available P, 0.6% total P) diets, 60% of total dietary P were re-

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tained by the fish and the remaining 40% were excreted in the effluent as settleable P (20-30%) and particulate or soluble P (10-20%). In trout fed with high P (0.59-0.88% available P; 0.9-1.2% total P) diets, 30-55% of total dietary P was retained by fish, and the remaining 15-25% appeared in the effluent as settleable P, 20-55% as soluble P, and 5-10% as particulate P. Vitamin D₃ did not affect fish growth nor effluent P levels. Physico-chemical management of aquaculture effluents should consider the effect of diets on partitioning of effluent P, the peaks of soluble P concentration following feeding, and the contributions of particulate P to total P in the effluent. Increasing our understanding of how dietary P is utilized and is subsequently partitioned in the effluent can contribute significantly towards alleviating this important environmental and industry problem.

Coniza EB, Catacutan MR, Tan-Fermin JD. 2003. Growth and yield of asian catfish *Clarias macrocephalus* (Gunther) fed different grow-out diets. *Israeli Journal of Aquaculture-Bamidgeh* 55 (1): 53-60

Abstract. Juveniles of the Asian catfish *Clarias macrocephalus* (3.6±0.17 g; 78.0±0.09 mm) were fed one of four diets: a laboratory-formulated diet of 18.9% (Diet 1) or 34.2% (Diet 2) protein, a commercial feed pellet of 28.9% protein (Diet 3) or a diet of 80% blanched chicken entrails and 20% rice bran (31.7% protein; Diet 4). After 120 days of culture, catfish fed Diet 2 grew significantly better ($p<0.05$) than the other groups, reaching 108.9 g and 232.8 mm (daily weight gain 0.88 g; specific growth rate 2.9%), with a condition factor of 0.86 and production of 18.2 kg per 25 m² pen. Feed conversion with Diets 2 and 3 (2.5 and 2.3, respectively) was better than with Diets 1 and 4 (3.4 and 5.0). Survival (68-81%) did not differ significantly among treatments ($p>0.05$). Catfish fed Diet 2 had the highest apparent lipid retention (131.7%). The protein efficiency ratio was lowest (1.3) in Diet 2, but did not differ significantly from Diets 1 and 3. Catfish fed Diet 4 were fatty and had a lower crude protein content. Results suggest that *C. macrocephalus* fed 34.2% crude protein have a significantly higher weight and total yield. Further, a taste test showed that odor, flavor and appearance did not differ amongst the diets.

de los Reyes AA Jr. 2001. Recirculating aquaculture systems: experiences, concepts, designs, p 65-81. In: Tansinsin LG, Halos PM, Joson LM, Sonido EP, Anglo PG, Rabago LM, Sevilla FB III, dela Pena FT (eds). *Harnessing Science and Technology to Meet Global Challenge - Proceedings of the World Conference on Science and Technology*. Philippine Association for the Advancement of Science, Manila

Abstract In a general sense, recirculating aquaculture systems are designed to approximate the fundamental aspects of natural systems in order to support aquatic life. They may involve tank, pond, and other culture systems where water is reused. In fish culture, the waste load mainly results from excreta and wasted feed, which obviously cause water quality deterioration if unchecked. System management requires major attention to water quality, mainly dissolved oxygen, total ammonia nitrogen, nitrite, biochemical oxygen demand, and suspended solids. The processes required and options for water treatment in recirculating systems have been clearly recognized. Among the critical processes are gas exchange (aeration and degasification), solids removal, and biological filtration or biofiltration. Solids removal is a solid-liquid separation process, and may involve gravity separation, filtration (screen, granular media, porous media), and flotation for fine organics and other solids (foam fractionation, protein skimming, froth flotation, and air stripping are other terms used.)

Biofiltration involves the use of living organisms to treat the water. In tank recirculating systems, it refers primarily to nitrification, which is the conversion of toxic ammonia and intermediate from nitrite to relatively harmless nitrate. In pond systems and integrated systems, biofiltration also includes the utilization of aquatic plants and animals other than the culture species. Other treatment processes include pH and alkalinity control, denitrification, and ultraviolet (UV) sterilization. Heaters and/or chillers may be provided for temperature control. While the processes and equipment are provided for specific purposes, they are complementary, and a complex interrelationship exists in recirculating systems. System designs, components, and sizing criteria vary widely, and are mainly provided to comply with specific production needs. Recirculating systems for fish production are generally meant to be intensive. The paramount objective is to design reliable and cost-effective systems.

Emata AC, Borlongan IG. 2003. A practical broodstock diet for the mangrove red snapper, *Lutjanus argentimaculatus*. *Aquaculture* 225 (1-4): 83-88

Abstract A practical broodstock diet (39% protein, 8.6% lipid) was formulated for the mangrove red snapper as part of a project to ensure consistent production of good quality eggs and larvae through broodstock nutrition. Reproductive performance of mangrove red snapper broodstock fed practical diet ($n = 14$ females) was enhanced in comparison to those fed raw fish ($n = 12$ females). Broodstock fed practical diet had total egg production of 82.34 million from 68 spawns for two spawning seasons while broodstock fed raw fish produced 77.64 million eggs from 66 spawns. Mean percent of egg viability, hatching rates and percent of normal larvae did not vary between the two groups. However, broodstock fed the practical diet had higher mean cumulative survival rate of eggs to normal larvae (40.4%) than that of broodstock fed raw fish (35.2%). Also, survival activity index (4.08) of broodstock fed practical diet was higher than that of broodstock fed raw fish (2.97). The results clearly indicate the improvement of reproductive performance of mangrove red snapper fed practical diet. Further studies should focus on the specific nutrients that can ensure consistent production of high quality eggs and larvae of the mangrove red snapper to support its aquaculture.

Gallardo WG, Buen SMA. 2003. Evaluation of mucus, *Navicula*, and mixed diatoms as larval settlement inducers for the tropical abalone *Haliotis asinina*. *Aquaculture* 221 (1-4): 357-364

Abstract Different biological films reportedly effective in larval settlement of other abalone species were tested on the tropical abalone *Haliotis asinina* to determine the most effective settlement inducers for the species. Larval attachment was significantly higher on mucus, *Navicula*, *Navicula* + mucus, and mixed diatoms + mucus than on mixed diatoms and the blank control. Metamorphosis was significantly higher on *Navicula*, *Navicula* + mucus. These results indicate the important contribution of mucus in larval settlement and the effectiveness of *Navicula* as a single species over mixed diatoms in larval settlement of the tropical abalone *H. asinina*.

Hurtado AQ. 2002. Seaweed research at SEAFDEC Aquaculture Department, p 65-68. In: Hurtado AQ, Luhan MRJ (eds). *Seaweed Industry Association of the Philippines*, Cebu City, Philippines

Abstract. Seaweed research at the Aquaculture Department of SEAFDEC focuses mainly on 2 genera of agarophytes (*Gracilaria* and *Gracilariopsis*) and carageenophytes (*Eucheuma* and *Kappaphycus*). From

1988-1998, research works were mainly on *Gracilaria* and *Gracilariopsis* along these areas: (1) refinement of culture technique, (2) basic biology, production ecology, and crop management, (3) product utilization, (4) screening and characterization of natural products, and (5) economics of farming systems. Four years ago, the Seaweed Production Program of the Department re-focused its thrust on Advanced Aquaculture Technologies (Biotechnology) to include also *Eucheuma* and *Kappaphycus* in answer to the needs of the industry.

Research studies (using biotechnology techniques) are in the following areas: (1) protoplast isolation and callus formation, (2) tissue culture and mutagenesis, (3) hatchery production of 'new variants', (4) outplanting of regenerants (young plants), (5) nursery production, (6) molecular analysis of 'new variants', (7) colloid characterization, and (8) biofiltration and bioremediation. The above-mentioned research areas are conducted to: (1) develop improved strains of the economically important seaweeds, *Kappaphycus*, *Eucheuma*, *Gracilaria*, and *Gracilariopsis* that will exhibit increased growth rate, improved carageenan or agar quality, and wider tolerance to temperature and salinity fluctuations; (2) verify the performance of improved strains in selected areas under controlled and natural management procedures; and (3) assess the performance of the selected seaweeds as biofilter in nutrient-enriched and polluted environments.

Hurtado AQ, Cheney DP. 2003. Propagule production of *Eucheuma denticulatum* (Burman) Collins et Harvey by tissue culture. *Botanica Marina* 46 (4): 338-341

Abstract Plants of *Eucheuma denticulatum* collected from Danajon Reef, Bohol, the Philippines were used to produce tissue cultures for the purpose of generating new strains. The plants were sectioned and grown in media encouraging callus growth. New shoots were produced after 3 months of *in vitro* culture. After another 3 months of laboratory growth, 5 plants were outplanted in the field. After 4 months growth at approximately 0.50 m depth, five plants grew to biomasses that ranged from 354.9 to 1055.9 g wet weight. They demonstrated growth rates that ranged from 5.8 to 7.2% day⁻¹. The growth rates of the plants produced through tissue culture in this study suggest that such plants can grow at rates as good as, if not better than, those of seedlings produced by the traditional method in the commercial cultivation of *E. denticulatum*.

Reyes OS, Fermin AC. 2003. Terrestrial leaf meals or freshwater aquatic fern as potential feed ingredients for farmed abalone *Haliotis asinina* (Linnaeus 1758). *Aquaculture Research* 34 (8): 593-599

Abstract Three terrestrial leaf meals, *Carica papaya*, *Leucaena leucocephala*, *Moringa oleifera* and a freshwater aquatic fern, *Azolla pinnata* were evaluated as potential ingredients for farmed abalone diet. All diets were formulated to contain 27% crude protein, 13% of which was contributed by the various leaf meals. Fresh seaweed *Gracilariopsis bailinae* served as the control feed. Juvenile *Haliotis asinina* (mean body weight = 13.4 ± 1.6 g, mean shell length = 38.8 ± 1.4 mm) were fed the diets at 2-39% of the body weight day⁻¹. Seaweed was given at 30% of body weight day⁻¹. After 120 days of feeding, abalone fed *M. oleifera*, *A. pinnata*-based diets, and fresh *G. bailinae* had significantly higher ($P < 0.01$) specific growth rates (SGR%) than abalone fed the *L. leucocephala*-based diet. Abalone fed the *M. oleifera*-based diet had a better growth rate in terms of shell length ($P < 0.05$) compared with those fed the *L. leucocephala*-based diet but not with those in other treatments. Furthermore, protein productive value (PPV) of *H. asinina* was significantly higher when fed the *M. oleifera*-based diet compared with all other treatments ($P < 0.002$). Survival was generally high (80-100%) with no significant differences

among treatments. Abalone fed the *M. oleifera*-based diet showed significantly higher carcass protein (70% dry weight) and lipid (5%) than the other treatments. *Moringa oleifera* leaf meal and freshwater aquatic fern (*A. pinnata*) are promising alternative feed ingredients for practical diet for farmed abalone as these are locally available year-round in the Philippines.

Santiago CB, Gonzal AC, Ricci M, Harpaz S. 2003. Response of bighead carp *Aristichthys nobilis* and Asian catfish *Clarias macrocephalus* larvae to free-living nematode *Panagrellus redivivus* as alternative feed. *Journal of Applied Ichthyology* 19 (4): 239-243

Abstract The use of *Panagrellus redivivus* as live feed for bighead carp and Asian catfish larvae was tested. In experiment 1, carp larvae were given *Artemia nauplii* (control) or *Panagrellus* twice daily for 21 days. A third treatment consisted of unfed larvae. The same three treatments were used in experiment 2 plus another with a commercial entomopathogenic nematode (EPN). Bighead carp larvae given *Panagrellus* in experiment 1 had much lower growth and survival than those fed *Artemia* nauplii. This could be due to low nematode density (5-30 mL⁻¹ water) during feeding. The unfed larvae had 100% mortality by days 11-13. In experiment 2, growth and survival of carp larvae given *Artemia* nauplii (5-10 mL⁻¹) and *Panagrellus* (50 mL⁻¹) did not differ significantly ($P > 0.05$). All unfed larvae had died by day 13, while larvae fed EPN were all dead by day 8. Two experiments on Asian catfish were likewise conducted. In experiment 1, the catfish larvae were fed *Tubifex (ad libitum)*, *Panagrellus* (50-100 mL⁻¹ per feeding) or *Artemia* (5 nauplii mL⁻¹ per feeding) three times daily for 14 days. In experiment 2, larvae were fed *Artemia* alone (10 nauplii mL⁻¹ per feeding), *Panagrellus* alone (100 mL⁻¹ per feeding), or their combination with a 38% protein dry diet twice daily. For both experiments, catfish larvae fed *Panagrellus* had significantly lower growth and survival than those fed *Tubifex* or *Artemia*. The combination of *Panagrellus* and dry diet created little improvement in the growth and survival of catfish larvae.

Siar SV. 2003. Knowledge, gender, and resources in small-scale fishing: The case of Honda Bay, Palawan, Philippines. *Environmental Management* 31 (5): 569-580

Abstract The coastal zone is a place of intense activity where resources, users, and resource use practices interact. This case study of small-scale fisheries in Honda Bay, Palawan, Philippines shows that resources, space, and gender are intertwined. The study was conducted between June 1997 and July 1998. The data were gathered using free listing, pile sort, ranking, resource mapping, and key informant interviews. The results showed that women's knowledge about fishery resources and their fishing activities are associated with the intertidal zone whereas men's knowledge is associated with coral reefs. In classifying fishery resources, appearance is the main consideration for women whereas a combination of appearance, habitat, and type of fishing gear is the consideration used by men. Market price is very important because of its dependence on the demand of the export market as well as the local market. Women dominate the buying of fishery products. Many women market their husband's catch, process fish, or gather shells and sea cucumber for sale. Among the fishing households, type of fishing gear provides an indication of socioeconomic standing. This paper concludes that access to resources is shaped by gender and age. The differences in resource knowledge possessed by men and women lead to differential access to fishery resources. In addition, the differences in socioeconomic status also influence resource ac-



The present hatchery of Sam already much improved

Indeed in Cambodia the provinces are always named after their respective capital town or city.

The Department of Fisheries (DOF) of Cambodia scheduled 8 July 2003 for us to visit and talk with two fish farmers in Takeo. We were first taken to the village of Tropang Trach to visit Mr. Khiev Sam in his farm. Cambodians would normally call him by his first name, Khiev, but lets call him Sam. From Tropang Trach we were taken to Tropang Kabas to meet Mr. Som Hekk. This time lets adhere to what is conventional in Cambodia and call him by his first name Som.

Sam and Som. They are easier to recall and besides we were assured by Mr. Hav Viseth, the Acting Chief of the Aquaculture Division who was with us that it is alright to use either the first or the last name.

From porter to fish breeder

Sam is 42 years old, married and has one son and three daughters with the eldest, a girl, only in her teens and the youngest, a spunky 5 or 6 years old. The son is the second in the family. To augment his meager income from his 6,000 square meter rice field and raise his growing family he had to carry heavy loads in the river port along Tonle Sap (or Mekong) River in Phnom Penh. In other words Sam was a porter - until 1997 that is.

By what chance or what fate we failed to ask, but Sam took time off from his heavy work to attend a training session on aquaculture conducted by the DOF in

Takeo Province in 1997. He immediately deepened a portion of his ricefield and stock them with a mixed bag of fingerlings from the DOF consisting of tilapia, silver barb and common carp. The harvest must have been

good because the next year he stocked the pond with fingerlings again. In 1999 he also got fry from the government hatchery and nursed them to fingerling size and sold them. Again the results must have been even better because the next year he dug a hole in the ground, well, actually a very small pond, and used it to spawn common carp.

He actually earned enough from his seed production venture to purchase a used wooden house for 5 million Riels in year 2000. The whole structure was moved into his home lot by rolling it on logs along the highway with the help of neighbors and friends. With a secure roof over his family he also decided to improve his hatchery facilities by constructing an above ground tank using a plastic sheet draped inside a bamboo frame. This time in addition to common carp he started to breed the silver barb as well. His buyers were his fellow-farmers in the district.

The Provincial Fisheries Office had been monitoring his progress and providing technical advice through weekly visits and by the DOF Central Office in Phnom Penh through monthly visits. His seriousness and his progress therefore did not escape their attention. In 2002 the DOF financed the construction of concrete tanks for spawning and for larval rearing as well as for storing water. The Chief of the Aquaculture Division explained that this is much cheaper and

more effective than if the DOF were to construct and operate its own hatchery in the area. Not only that, Sam was also chosen to be one of the farmers to participate in a study tour on small-scale seed production and fish farming in northeast Thailand from 14 to 18 October 2002 under the Aquatic and Aquaculture Resources Management (AARM) of the Asian Institute of Technology (AIT).

The year 2002 was indeed a good year for Sam, he produced a total of 210,000 fingerlings. Depending on the species and the size they sell at a price range of 30 to 50 Riel each. Assuming an average of selling price of 40 Riel, Sam must have grossed some 8,400,000 Riels in 2002. At the present exchange rate of 4,000 Riel to the dollar he earned the equivalent of US\$2,100. And this does not include the income he got from selling grown fish for eating as well as the rice harvest from what's left of his rice field. He worked the hatchery and farm himself assisted by his wife so did not incur labor expenses. His major expenses include the hormone he used to induce spawning and gasoline for his small pump, which runs intermittently to fill up his concrete storage tanks using water from the pond.

He has bought some pre-cast concrete posts. He wants to replace the wooden posts propping up his house with the longer and sturdier materials so he can have a full head room beneath his house. This will be useful when other farmers come to visit and if the DOF would like to conduct training in his farm.

Sam scooping out some silver barb fingerlings from the hapa nets





Som Hakk and wife (left) and their hatchery system (right) equipped with oxygen tank for fingerling packing and transport

Rainfed fishpond

Sam's story is remarkable enough by itself. What makes it amazing is that Sam's fishpond and hatchery is actually rainfed. That's right. He relies on the rain for his water supply. He is far from a river. The area is not irrigated and he does not have a well. At the time of our visit he already has fingerlings ready to sell. The neighboring farms are not yet buying - like Sam they are waiting for the rain to fall so their fields are still dry. Three of Sam's four ponds are dry and empty.

He has concentrated all the water in one single pond where he is also keeping his fingerlings in hapa nets as well as his brood fish. He has run out of hapa nets so he is forced to keep the last batch of fingerlings in the concrete tank. To keep them alive he is flowing water through them from the concrete storage tank. The storage tank is filled by pumping water from the pond. Overflow water from the holding tank goes back to the earthen pond. The monsoon season has started and it should have already rained but Sam is still waiting.

During the training session in 1997, Sam was all ears. The handouts were useless. Neither could he have taken notes. You see Sam cannot read and write. But he sure can raise fish!

From taxi driver to fish breeder

At 48, Som is older than Sam by 6 years. He also appears to have had better means than Sam. His rice land measured 1.2 ha. He used to own and drive a taxi for a living not only around Takeo but also to Phnom Penh and any point in Cambodia that his passengers may wish to go. Then as with all mechanical contraption his taxi began to fall apart and his income could no longer finance the maintenance. In a last ditch effort, he pawned his rice land to finance his taxi operation leaving only the lot where his house stood. But to no avail he still lost his taxi business.

Like Sam he also participated in the fish culture training in 1997. He put up a rudimentary hatchery in his homelot and started to breed common carp. With the earnings from his fingerling sales he was able to slowly recover the land that he pawned so that in 2002, he had recovered all of his 1.2 hectares. His breeding tank and water storage tank facilities are identical to those of Sam's and were also provided by the DOF. He was with Sam in the AIT-AARM sponsored study tour to north-east Thailand.

There are various certificates hanging on the outside wall of his house facing his hatchery including the AIT Certificate for

the study tour. One indicates that he also participated in the Season-long Training in Rice Production from 1 August to 15 December 1999. Another says he has successfully completed Vocational Training for the Alleviation of Poverty sponsored by UNDP and ILO. Another certificate was completely in Khmer.

In 2002 he produced a total of 300,000 fingerlings consisting of common carp and silver barb. Som left 3,000 square meter as riceland. From this area he was able to harvest some 540 kg of paddy plus 250 kg of fish on October 2002 after less than four months. From October 2002 to March 2003, he harvested some 480 of paddy and 300 kg of fish. In other words just from the fingerlings alone Som must have earned some 12 million Riels in 2002 - which is equivalent to a cool US\$3,000.00 — very much higher than he would ever receive from the government for a year of service said the DOF Aquaculture Division Chief.

The difference in the rice yield and fish yield between the two crops he explained is due to the fact that during the first crop he used a high yielding variety (HYV) from IRRI. The fish harvest was lower because the growing season for fish was less than 4 months since the HYV can be harvested

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Som stocked this riceplot with fish (silver barb, common carp and gouramy) in canal dug next to the dike. At far left is Som's newly improved house from the sales of fish fingerlings and cultured fish in ponds and riceplot





AROUND THE WORLD

CDs and books

Fish Base: an information tool for fisheries and aquatic conservation

Fish Base is a global database of more than 27,800 species that can generate customized information, including more than a hundred report types.

It is also a handy *Networking* tool for information exchange, and to contribute data, as well as an *Analytical* tool for data-poor situations (stock assessment, ecosystem analyses, aquaculture). And lastly, it is a *Learning and Training* tool (on-line courses, species identification, workshop presentations).

This was explained by Mr. Boris Fabres, officer-in-charge of the Philippine Office of the WorldFish Center based in Malaysia. Fabres is a native of Trinidad and Tobago in the Caribbean. He has a BS degree in Psychology from McGill University in Montreal, Canada and a masters degree in statistics from Florida State University in Tallahassee, USA.

Fabres further cited an example of Fish Base use. For instance, users can be informed that there are 18 species with adverse ecological impacts, 13 have been introduced globally, and 12 have been introduced in the Philippines. "Fish Base reminds researchers to be careful in the introduction of a particular species," Fabres said. "They can check countries where the species has been introduced and learn from experiences there."

It is practical to use Fish Base to fill in information gaps and because scientific lit-

erature is difficult to access. Subscription to many published journals is increasingly expensive.

Fish Base also carries updates of research, technology, and ecological or socio-economic impacts of fisheries. It is available in both CD and the web and Fish Base 2003 will be available in CD and DVD this month. Check it out: <http://www.fishbase.org/>

Fish quality for the European fishery sector

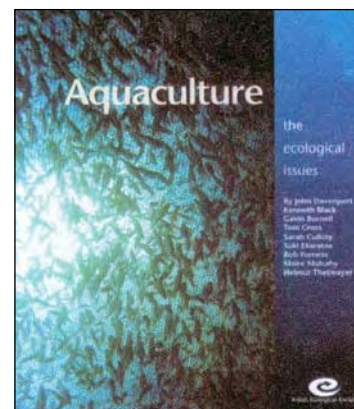
Recently a new publication titled "Quality of fish from catch to consumer: labelling, monitoring and traceability" by IB Luten, J Oehlenschäger and G Olafsdottir, became available at Wageningen Academic Publishers [ISBN 9076998140].

In this book, for the first time, scientists from various disciplines and all partners in the fishery chain address the important issues of quality labelling, monitoring and traceability of fish.

The complexity of the European fishery sector, the attitudes and progress of implementing traceability schemes from catch to consumer are covered. New tools for measuring the quality of the catch and the experience with quality grading of landed fish are described.

An overview on consumer research on fish in Europe is also included. There are papers covering consumer's responses to fresh fish, the evaluation of a promotion campaign for seafood consumption and consumer's opinions towards farmed fish, health and food safety.

The book is 456 pages, in hardcover, and costs EUR 85. The full table of contents can be downloaded from www.WageningenAcademic.com/fish. Or contact: Ms Dineke van den Biezenbos, Sales, Wageningen Academic Publishers Postbus 2206700 AE Wageningen, The Netherlands, tel. +(0) 317 476514. fax +(0) 317 453417. e-mail: biezenbos@wageningenacademic.com



Aquaculture- the ecological issues

Aquaculture may provide a crucial part of the world's food supply, but there are key ecological issues that question its sustainability, says a team from the British Ecological Society. These issues are:

Wild resource harvesting. Aquaculture is not yet a closed-cycle system and thus relies on wild resource, for seed and broodstock and for fishmeal diets. Seed collection often involves damaging by-catch; the capture of a single tiger prawn postlarva can involve destruction of 1,400 planktonic animals of similar size. And six tons of wild-caught fish are needed to raise one ton of cultured fish.

Physical change to the habitat. Considerable damage has been done to coastal ecosystems, particularly coastal mangroves, with the development of pond aquaculture, particularly for penaeid prawns. As well as clear cutting mangroves, pond culture has resulted in soil salination and irreversible soil acidification and sulphuration. The damage to coastal wetlands has caused significant declines in coastal fisheries, and has indirectly resulted in the destruction of coral reefs because of smothering following coastal erosion. Artificial structures used in aquaculture have affected local ecosystems, and large-scale bivalve farms have altered local food webs.

Effect of aquaculture wastes on ecological systems. The culture of aquatic herbivores usually creates little waste, how-

ever, intensive culture of carnivorous fish or prawns risks organic pollution from uneaten food and faeces. Cage culture effects on the sea bed are localized, and are quickly reversed by fallowing. As for harmful algal blooms, these have been associated with intensive aquaculture but causal links have not been established. Antibiotic resistance has been found in wild species near fish farms, while sea lice densities in the wild may be locally increased by intensive (salmonid) culture.

Diseases and parasites. In some situations, the movement of fish and shellfish stocks have resulted in the spread of diseases in the wild, and the indiscriminate release of antibiotics in farm wastes can result in the emergence of resistant bacteria, or the alteration of the bacterial flora in the environment. However, the aquaculture industry is now regulated at both national and international levels with regards to handling and introducing exotic species (through the strict protocols of the International Council for the Exploration of the Seas, ICES) and to the risk of spreading aquatic animal diseases (through the health guarantees required of trading partners by the Office International des Epizooties, OIE).

Genetic effects on wild fish and invertebrates of accidentally or deliberately introduced cultured organisms. Desirable qualities in farmed animals differ from those needed by wild animals. Captive breeding and rearing usually leads to reduced levels of genetic variability and differences in genetic composition compared to wild progenitors. [Where the effective number of parents is two (1:1 male to female ratio), 25% of existing genetic variability is lost in each generation.]

With escapes inevitable in cage culture, even a 1% escape rate transfers huge quantities of genetic material to the environment. In Ireland and Norway, escaped farmed salmon have damaged wild salmon populations. Escaped farmed salmon are hybridizing more easily with other species than do wild fish.

Thus, stock enhancement and/or sea

ranching exercises must use only native or near native individuals as broodstock.

Interactions with wild life. Cultured species have been introduced to several ecosystems where they have out-competed native species. In the Philippines, the tilapia *Oreochromis mossambicus* have displaced the endemic *Mictichthys luzonensis* which has been brought close to extinction.

Aquaculture often attracts wildlife (like birds and seals) that benefits from extra available food, but these pose problems for fish farmers who sometimes respond by destructive persecution, creating conflict with conservationists.

Sustainability. Many past and existing practices are incompatible with ecological sustainability. Is the use of ecological footprint as a tool to determine sustainability the answer? (The concept is at an early stage of development; but generally, high technology, high input aquaculture has a considerably larger footprint than extensive artisanal aquaculture.) Are herbivorous species the answer? Does advanced technology provide solutions? What is the role of regulation in sustainability? When can integrated resource management be developed at a global level?

Read more of this 89-page book by John Davenport, Kenneth Black, Gavin Burnell, Tom Cross, Sarah Culloy, Suki Ekaratne, Bob Furness, Maire Mulcahy, Helmut Thetmeyer Email: info@britishecologicalsociety.org/

This integrated land-based polyculture system is a model for minimizing the environmental impact of mariculture, even without water recirculation. A commercial farm in Mikmoret, Israel combines culture of seaweed (*Ulva*, *Gracilaria*), the herbivorous gastropod abalone (*Haliotis*) which feeds upon the seaweed, and pellet-fed sea bream and penaeid prawns, whose particulate effluent supports mullet (*Mugil*) and sea cucumbers, while the dissolved nutrients are delivered to the seaweed culture units.

This system can deliver innocuous effluent to the sea, but require considerable sophistication of control and monitoring systems as well as much biological information and careful modelling to permit design of tank sizes and biomass of each species contained therein. They also require appreciable areas of land, with consequent impacts upon terrestrial ecosystems [fr Davenport et al. 2003. *Aquaculture the ecological issues*. British Ecological Society. p 80-81]



Integrated mariculture

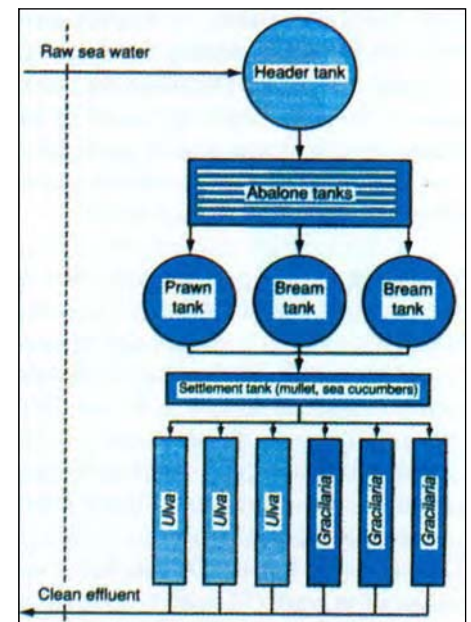
Dr Amir Neori who heads the Department of Algae, Water Quality and Bio-filters in Israel's National Center

for Mariculture at Eilat describes an integrated land-based mariculture system they have developed.

Dr Neori said the system is practical, non-polluting, and involves nutrient recycling. Water from fish (sea bream) tanks recirculates through biofilters of seaweed (*Ulva lactuca*, *Gracilaria conferta*), which remove most of the ammonia from water, and then on to the macroalgivores (abalone *Haliotis hannai* and sea urchins).

A few commercial farms in Israel has adopted the model on one hectare areas

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with a few modifications. The financial return from the low-value seaweed biomass can be raised by using it to feed the more valuable abalone. And, in integrating the culture of three organisms - abalone, fish and seaweed - it can no longer be said that mariculture is like having a pigsty on water because of organic loading.

Indonesia

Grouper culture takes off

Grouper culture has taken off in Indonesia after the Gondol Research Institute of Mariculture (GRIM) of the Ministry of Fisheries and Marine Affairs in Bali succeeded in converting their grouper research to a commercially viable technology. This started when the Institute succeeded in breeding the humpback grouper, *Cromileptes altiveles* sometime in the late 1990s under the JICA-assisted Multi-Species Hatchery Project (1994 to 2001). With so much extra grouper eggs available which could not be accommodated in the Institute's larval rearing tanks, some of the many milkfish hatcheries dotting the Singaraja coastline gave it a try. The pioneering hatcheries, it should be noted, are owned by Institute personnel who took it upon themselves to practice what they preach and invested in backyard scale hatcheries.

A survey conducted by Shogo Kawahara, JICA expert and Suko Ismi of GRIM shows that in 1999 there were five hatcheries engaged in grouper seed production. After doubling in number in 2000 the number increased sharply to 123 in 2001. Apparently many dropped out and the number fell to 68 in 2002. Bah has the largest number with 55 with the 12 others found in the provinces of East Java (7) and Lampung (6). Most of the hatcheries are classified as small (52) with 7 classified as medium and 9 large. Small means hatcheries with less than 5 people, medium 5 to 10, and large, more than 10 people.

Starting with only 186,100 fingerlings produced in 1999, this has increased to more than 3.3 million in 2002. The largest number consisted of tiger grouper,

*Clockwise: Counting and sorting of grouper fingerlings, grouper farm in Bali, and hatchery produced fingerlings of the humpback grouper *Cromileptes altiveles* (photos courtesy of WG Yap)*



Epinephelus fuscoguttatus (2,656,000), followed by humpbacks, *C. altiveles* (667,800) and the orange spotted grouper, *E. coiodes* (2,200). In 1999 production of the brown spotted grouper (*E. chlorostigma*) was also reported from Lampung but was no longer reported in the years following. Value of the grouper fingerlings produced in 2002 is estimated at 14.216 billion Indonesian rupiah (US\$1 = INR8,300).

Indonesia has had grouper cage culture using wild caught fingerlings since the late 1980s but this was confined to the Riau island group off Sumatra, within a short distance from Singapore. Later this expanded to Lampung province. After a pilot project launched by GRIM in Bali, many commercial cages are now found off the Singaraja coast. Periodically a boat comes in from Hongkong to purchase the fish and bring them back live.

Initially there was not much demand for the humpback grouper fingerlings because of its slow growth rate. It takes 18 months for a 10 cm fingerling to attain the 500 g size required by the Hongkong market. But the high price it fetches (reportedly \$3 5 per kg live ex-farm) has encouraged many cage operators to grow the species as well. What makes it more convenient is the ready availability of a formulated diet from a commercial feed mill using a diet formulated by the Gondol Institute. Grouper farmers now rely totally on the pellets for their growing operation. — WG YAP

Thailand

A seawater irrigation facility

The Seawater Irrigation System for Shrimp Culture at Kung Krabaen Bay, Chantaburi Province, Thailand is part of the Kung Krabaen Bay Royal Development Study Center, one of the centers established by His Majesty the King Bhumibol Adulyadej of Thailand. This was constructed through the efforts of the Department of Fisheries in response to allegations that "shrimp farming causes water pollution" and to demonstrate "techniques of producing shrimp in great quantities without creating pollution."

The Center is a three hour travel from Bangkok by bus. Located in the Thamai District, it was established in 1981 and has a shoreline area covering 640 ha of Kung Krabaen Bay and about 5,120 ha of agriculture and fishery farms.

The major activities of the Center include: (1) reallocation of 116.5 ha of deteriorated mangrove area and paddy field for

coastal aquaculture; (2) shrimp culture extension incorporating environmental conservation; (3) mangrove forest conservation; (4) mangrove reforestation; (5) seagrass conservation and management; (6) oyster seed bed development; (7) oyster hanging culture in outlet canal; (8) marine aquatic species seed production; (9) artificial reef; (10) shrimp sludge fertilizer; (11) sustainable agriculture extension; (12) standard of living development and environmental impact management; (13) seawater irrigation for shrimp culture; and (14) geographic information system for coastal zone management.

It took almost three years (from November 1996 to May 1999) for the Seawater Irrigation System for Shrimp Culture to be completed. A form of salt-water management system, the irrigation facility is aimed at ensuring good water quality for shrimp culture, just as freshwater irrigation system is for rice paddy. The system also serves as treatment canal for wastewater from shrimp ponds before this is released to the sea.

The facility has seawater high pressure HPDE conduits (1 m dia) buried under the

sand some 350 meters offshore. The conduits bring seawater to the water pumping station onshore. The water pumping station can store water of up to 4.7 million cubic meters and can drain water through eight 200 HP pumps, each of which has a drainage capacity of 1.25 cu m of water/sec. The water is then drained through 2 HPDE conduits of 1 m diameter into the shrimp ponds.

Before the construction of the seawater irrigation system, shrimp ponds around the Kung Krabaen Bay made use of water from natural canals and the water discharged from ponds flowed back to the Bay through the same canals. The practice had caused deterioration of the water in the Bay and caused problems to the shrimp ponds that drew water from the Bay.

In order to solve the problem, the concept of seawater irrigation system was developed. With the seawater irrigation facility, shrimp ponds now draw water from only one source and water discharged from ponds is being treated using biological and physical procedures before this is finally released to the Bay. – VT SULIT

France

Meet a researcher on phycopathology



This is Dr Bernard Kloareg, Directeur de Recherche, Université Pierre and Marie Curie in Paris, France. His research interests are marine plants and biomolecules, and he is looking

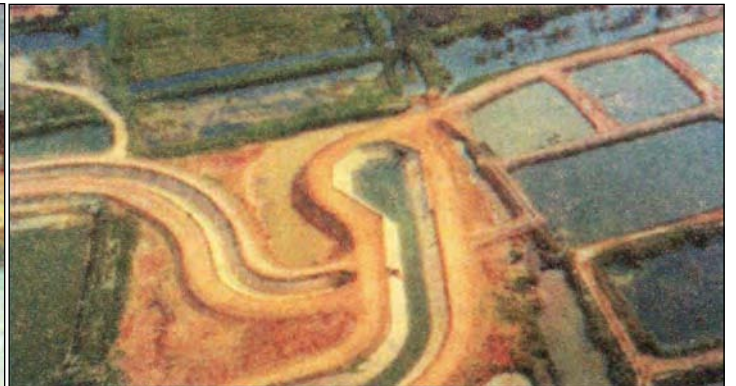
forward to collaborate with SEAFDEC/AQD in its seaweeds project.

Dr Kloareg was trained in agronomy, biochemistry and genetics. He was first interested in the structure and functions of plant cell walls, using marine macroalgae as experimental systems; this led Mm to develop techniques for protoplast, cell and tissue cultures of marine algae, including the purification and cloning of bacterial polysaccharides.

He is collaborating with a research group which addresses aspects of basic

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Seawater released (below, left) to main canal for the shrimp ponds (right)



Visitors crossing the mangroves via a hanging bridge; the regal entrance to the Kung Krabaen Royal Development Study Center

[Photos courtesy of VT Sulit]

plant biology such as the origin and evolution of plastids and mitochondria, again, using marine algae as models. In addition, the group has initiated a project on the genetic structure of kelp populations in the English channel, a topic that bridges knowledge in genetics with oceanography.

Dr Kloareg is also the head of a joint laboratory in St. Malo, France, where he is able to pursue the development and use of oligosaccharides as an alternative approach to disease control in both marine and agricultural crops. Dr Kloareg considers phycopathology a new science in mariculture.

Philippines

Novel fish products from Lake Buluan

Ever heard of *Paksiw na Bangus* in cans? No? How about *Tilapia Escabeche*, *Spicy Tilapia*, *Sweet and Sour Tilapia*, and *Tilapia in Oil* all conveniently canned and ready to eat? If you are not into canned stuff how about *Tilapia Chorizo*, *Bangus Chorizo*, *Tilapia Chicharon* and *Bangus Chicharon*? All these products and more were on display at the booth of the EGM Agri Food Industries (EGMAFI) of Buluan, Maguindanao during the recently concluded 7th Meeting of the BIMP-EAGA Working Group on Fisheries Cooperation held in Puerto Princesa City. The other EGMAFI products displayed were *Tilapia Fillet*, *Bangus Fillet*, *Tilapia Belly*, *Bangus*

Belly, *Bangus Chicharon*, *Bangus Tocino* and *Tilapia Tocino*. Samples for tasting laid out at the booth were crowd drawers.

The fresh fish used for the products were all grown in the fertile waters of Lake Buluan without any artificial fertilizers, chemicals, pesticides and antibiotics enabling the company to promote the processed fish as "Organic Products for a Healthier You!" Furthermore all the products are Halal certified. This means the products have been prepared in adherence to approved Islamic standards and can be sold in all Muslim countries.

That this is so is not surprising since the founder of the company is a Maguindanao who also happens to be the mayor of the municipality of Buluan. Mayor Esmael Mangudadatu is a young and amiable entrepreneur who is fondly called Mayor "Toto" by his constituency. According to the company brochure, EGMAFI is obliged and committed to produce all kinds of Halal products. The company was established in 1990 in Barangay Maslabing, Maguindanao in the Autonomous Region of Muslim Mindanao (ARMM). Its primary concern initially was the raising of bangus and tilapia in cages and pens in Lake Buluan. It is only recently that it branched out into processing to widen its market. According to Bureau of Fisheries and Aquatic Resources (BFAR) Region XII Director Sani Macabalang, EGMAFI set up its processing plant in General Santos City with technical assistance from BEAR. - WG YAP

mangrove survey ... from page 3

- ✓ These findings, which indicate modest yet declining diversity of mangroves in Carles, reinforce the need for their protection and management. This is not only in view of the importance of mangroves as habitat for fish and shellfish juveniles that replenish the stocks for capture fisheries and aquaculture (a major livelihood for many coastal communities), but also for the fact that Carles is one of the few remaining areas in Panay where rare mangrove species could still be found.

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ACKNOWLEDGEMENTS

The authors thank Dr. Jurgenne Primavera, Mr Cesar Andrada, MACABATA-ARM Inc members, Mr. Antonio Latoza Jr, and all SUSIMO-DENR staff in Carles for the insightful conversations about mangroves; Mr Edgardo Ledesma for the map; and the Japan International Research Center for Agricultural Sciences (JIRCAS) for financial support.

AQD publications ... from page 11

cess. The socialization of children into fishing reinforces the gender division of labor and space in the coastal zone.

Sumagaysay-Chavoso NS. 2003. Nitrogen and phosphorus digestibility and excretion of different-sized groups of milkfish (*Chanos chanos* Forsskal) fed formulated and natural food-based diets. *Aquaculture Research* 34 (5): 407-418

Abstract. This study determined the digestibility of nitrogen and phosphorus, and the excretion rate of different-sized groups of milkfish fed a commercial diet, a SEAFDEC formulated diet or lab-lab (natural food-based diet). Fish

(31.2-263.0 g) were stocked in 12 units of 300-L fibreglass tanks filled with aerated seawater. The postprandial total ammonia-nitrogen (TAN) and phosphate (PO₄-P) excretion of fish were estimated from changes in TAN and PO₄-P concentrations in water for 24 h. Digestibility was determined from the nitrogen, phosphorus and Cr₂O₃ content of the diets, and pooled faeces after the fish had been fed diets marked with chromic oxide. TAN excretion rate (mg TAN kg⁻¹ fish day⁻¹) was significantly lowest (P<0.05) in medium to very big fish fed the lab-lab diet (60.8-124.4) and highest in small and medium fish fed the SEAFDEC diet (333.3-331.6) and small fish fed the commercial diet (280.1). Regardless of size, fish fed lab-lab excreted (mg

PO₄-P kg⁻¹ fish day⁻¹) significantly lower PO₄-P (36.2) but did not differ with fish fed the commercial diet (64.8). Excretion rates decreased exponentially as fish weight increased but positively increased with feed ration. Excretion pattern of milkfish revealed two peaks: the first peak occurred 6 h after feeding and the second peak at 18 h for TAN and 21 h for PO₄-P, coinciding with the start of the daylight hours. TAN and PO₄-P excretion accounted for 20.5-34.6% of total N consumed and 18.7-42.6% of P consumed respectively. Approximately 27.9-42.5% of N consumed and 47.2-58.5% of P consumed were lost as faeces. Total nutrient losses were lower using the lab-lab diet (0.31 g N and 0.14 g P kg⁻¹ fish) compared with the formulated diets (0.47-0.48 g N and 0.17-0.19 g P kg⁻¹ fish); the losses decreased per kg of fish as fish size increased. Results suggest that the diet and size of fish influence wastage of N and P to the environment with greater losses in small fish and when artificial diets are used. Such measurements will provide valuable information for the preparation of N and P budgets for milkfish in grow-out systems. ###

Environment-friendly shrimp grow-out technology

Based on techno-demonstration runs, investment required for a hectare of shrimp pond is from P400,000 to 800,000. For culture to be profitable, two croppings should produce about 4,700 kg per ha per crop.

Return on investment is 80% after two crops

The Philippines is one of the pioneers in farming the giant tiger shrimp *Penaeus monodon*; the first culture can be traced back to 1960. Like the industry in other countries, it underwent boom-and-bust. In 1996, shrimp production had stabilized somewhat, but then declined again due to disease outbreaks caused by self-generated pollution. This decline went on until 1999. After that, production gradually increased from 34,627 tons to 42,390 tons in 2001.

The ideal solution for the tiger shrimp industry is to reduce or even completely eliminate self-generated pollution without drastically reducing stocking density. Schemes towards this end have been tested and verified by SEAFDEC/AQD.

Environment-friendly schemes of shrimp farming have the following features: head reservoir to supply quality water, tail reservoir to serve as a treatment pond, filter box to reduce unwanted aquatic animals, long-arm paddle-wheel to aerate and circulate pond water, the use of sludge collectors and substrates like nets to enhance attachment of natural food.

Moreover, crop rotation is practised in about two croppings; salinity reduction is employed through addition of freshwater at the head reservoir; and biomanipulators like tilapia and milkfish are stocked at tail reservoir and sludge collectors to inhibit growth of luminous bacteria. It is also necessary to use high quality feeds for efficient growth rate, and probiotics to eliminate toxic gases and prevent growth of pathogenic bacteria.

Shrimp culture has an expected survival rate of 60 to 98% at stocking densities between 5 to 60 postlarvae per m². Body weight of about 30 to 40 g could be attained after 90 to 150 days of culture.

In 2000, BFAR and AQD collaborated for a nationwide extension of the improved shrimp technology, dubbed the *Joint Mission for Accelerated Nationwide Technology Transfer Program* (JMANTTP). Since then, verification runs on shrimp culture using environment-friendly protocols were conducted. Through JMANTTP, AQD can respond to the requests of the private sectors for on-farm technology demonstration.



Technology presenter and contact person

Dan Baliao is the head of AQD's Technology Verification and Extension Section (TVES), and Administration/Finance Division.

Baliao graduated from the University of the Philippines in the Visayas, College of Fisheries with a masters degree in Fisheries major in Aquaculture in 1978. His bachelor's degree in Biological Science was also earned at the same university.

Baliao authored several aquaculture extension manuals which were the results of the TVES verification studies. These manuals include: net cage culture of tilapia in dams and small farm reservoirs, grouper culture in brackishwater ponds, pen culture of mud crab in mangroves, grouper culture in floating net cages, milkfish ponds culture, and mud crab production in brackishwater ponds. *Email:* dbaliao@aqd.seafdec.org.ph

AQD's technology presentors on mudcrab, milkfish, seaweed, and mangrove red snapper thank Dr. Nerissa Salayo for the economic analyses.

Mud crab hatchery and nursery operations

Total investment cost for hatchery is P1.9 million. Return on investment after a year is 38%, payback period is 2 years.
Total investment cost for nursery is P155,000. ROI after a year is 106%, payback is 10 months

Farming of mud crab *Scylla* species has been practiced in the Philippines for decades, but it has received more attention recently due to the decline of the tiger shrimp industry. Mud crab has been identified as an alternative export and cash crop because of its high demand in many countries, profitability, environment-friendly culture system, and ease of transport.

Mud crab production in coastal areas in 1996 is 363 metric tons (mt), but decreased to 51 mt in 2000. However, production in brackishwater pond increased from 2,440 mt in 1996 to 4,495 mt in 2000. This decrease in production in coastal areas could be due to the collection of juveniles for stocking grow-out ponds and mangrove pens.

The expanding market for mud crab is the cause of intensified collection of wild juveniles. To counter the threat to wild population and ensure the sustainability of mud crab farming, there is a need to produce juveniles in hatcheries.

Hatchery-reared juveniles have growth performance similar to the wild. The advantages of using the former include uniformity in size; certainty of identification, especially in smaller juveniles; availability throughout the year; and absence of predators and other undesirable species.

Mature female with dark orange ovaries obtained from either brackishwater pond or mangrove could be held in tanks until the eggs are spawned or released and attached to the flap. Berried female (with eggs) may also be held in a tank until eggs hatch.

Egg hatches to zoea 9-14 days after spawning. Zoea passes through five stages (zoea 1 to 5), after which it becomes megalopa. The megalopa molts once and assumes a crab-like appearance. The small crab molts several times until full maturity.

Broodstock are fed mussel, marine worm, fish, or squid with or without artificial diets. A water depth of 30-40 cm is maintained. About 80% of the water is changed daily. Water temperature and salinity are maintained at 26-29°C and 30-34 ppt.

Zoea eats rotifers (*Brachionus*). Rotifers eat a wide variety of microalgae but *Nannochlorum* (formerly identified as *Chlorella*) is commonly used in hatchery because it is easy to culture. The



Mud crab megalopa obtained 16-18 days after the first larval stage (zoea) PHOTO COURTESY OF E. QUINTIO

production of natural food has to be synchronized with the hatchery operation so that food will be available as soon as eggs hatch. In addition to *Brachionus*, zoea is fed *Artemia* nauplii.

Megalopa is also fed *Artemia* nauplii. Small crab is fed minced trash fish, mussel, small shrimp (*Acetes*), or bivalves twice daily to satiation. The amount and size of feeds are adjusted based on the consumption and size of crab.

The rearing water is replaced at 30% daily starting day 3 and up to 80% as larvae grow longer. At the crab stage, about 30% of the water is replaced daily during the first five days, and every two days thereafter.

Stocking density of megalopa in tank is two individuals per liter. Black nets and cut PVC pipes are distributed as shelters when megalopa becomes crab instar.

In net-cage culture, megalopa is stocked at 50-70 individuals per m². About 50% of the water is replaced weekly. Megalopa are fed *Artemia* during the first two days. Food is then changed to minced fish and mussel. Nets and seaweeds can be used as shelters.

After harvest, crab juveniles can be transported even without water. Transport is preferably early in the morning or late afternoon.



Technology presenter and contact person

Emilia Qunitio is a Scientist at SEAFDEC/AQD. She joined AQD soon after obtaining her BS degree from the University of the Philippines in Diliman. From the same university, she finished her MS Fisheries in 1980. In 1995, she obtained her Doctorate in Fisheries Science from Hokkaido University, Japan.

Dr. Qunitio has been working on the various aspects of culture of mud crabs *Scylla serrata*, *S. olivacea*, and *S. tranquebarica*. Email: etqunit@aqd.seafdec.org.ph

Mud crab grow-out in ponds and pens

Monoculture, or polyculture with milkfish, requires investment of about P119,500 for a half-hectare brackishwater pond.

In monoculture, return on investment (ROI) is 46% after two croppings; thus, payback period is 2 years. In polyculture, ROI is 52%; payback, 2 years. In pen culture, investment required for 0.4 ha is P51,000.

ROI after two croppings is 60%; payback, 1.5 years

Small-scale farming of mud crab has been progressing rapidly because of its promising profitability. Thus, with the increasing market demand, commercial-scale production could be a lucrative industry. The three species of mud crab that are commonly cultured in the Philippines are *Scylla serrata*, *S. olivacea*, and *tranquebarica*. They can be distinguished from each other based on characteristics of frontal spine and cheliped, color and marking, ecology, and distribution. Mud crab is commonly called "alimango" in the Philippines.

Mud crab juveniles (10 to 40 g) are caught in marshlands and estuarine areas. Juveniles are available throughout the year, peaking during the months of May to September in the Philippines. In addition, there are also juveniles produced in the hatchery that are available for mud crab farming.

Mud crab can be cultured in mangrove pen, and can be mono- or polycultured with milkfish in brackishwater pond. About 5,000 to 10,000 juveniles can be stocked in a pond or pen. Salinity could be from 10 to 30 ppt. Stocking may be done in early morning or late afternoon, but preferably at night when the temperature is cool. Juveniles are fed with trash fish, and there is limited quantity of commercial feed already available. There could be at least two croppings per year. Culture period is about 150 days until mud crab reaches marketable size that is at least 200 g. Survival is from 50 to 80%.

Mud crab has high value in the market, but low volume can only be sold. Thus, selective harvesting is practical. In partial harvesting in pond, mud crab is caught using baited traps or hand lines with scoop nets, or caught using scoop net by allowing fat crabs to swim along the currents during re-stocking of water to a partially drained pond. In total harvesting, pond is drained and mud crab is collected manually or by hand.

In a pen, partial harvesting is done on the third month of culture. Mud crab is caught manually or by hand during low tide, and/or trapped with baits. Total harvest is done on the fifth month of culture.

Technology presenter and contact person

Dan Baliao (see page 19)



Crab juveniles can be transported with moist newspaper inside paperbox-lined styrofoam (top); one of the berried females held in a tank at AQD (above)



From top left: culture in mangrove pens, brackishwater ponds, and harvest scenes

Milkfish grow-out culture in ponds

Total investment cost in 1 ha pond is P27,000 for extensive straight-run, P44,000 for modular, P184,000 for semi-intensive, and P256,000 for intensive. Return on investment (ROI) in extensive straight-run after a year is 51%, thus payback period is 1.5 years. ROI in modular after a year is 102%, payback is 10 months. ROI in intensive after a year is 4%, payback is 4 years. In semi-intensive, there is still no ROI after a year



Considering the seasonal pattern in fish prices, it appears that extensive and modular systems are profitable even if harvest would fall during periods with low selling price of fish.

Modular, and also intensive, systems are profitable when harvest occurs at times of high selling price

Milkfish farming, practiced in Southeast Asia for over 500 years, is regarded as the backbone of Philippine aquaculture.

In 2000, about 45% of global milkfish production came from the Philippines, mostly from brackishwater ponds. About 42% came from Indonesia, also from brackishwater ponds; 12% from Taiwan, mostly from freshwater pond; and 1% from countries that include Guam, Micronesia, and Singapore.

In 2001, about 49% of the Philippines' aquaculture production (excluding seaweeds) was milkfish cultured from brackishwater ponds; about 2% was from marine pens and cages, and less than 1% from freshwater pen. The remaining 48% of the country's production includes shrimp and tilapia.

Milkfish production has three major culture systems: extensive, semi-intensive, and intensive. Common milkfish culture in brackishwater pond is classified into extensive straight-run, extensive modular, semi-intensive, and intensive.

In extensive, stocking density is low; thus fish depends on natural food for their nutrition. Stocking density for straight run is from 2,000 to 3,000 fish per ha in 2 to 50 ha ponds. There could be one to three croppings per year with the yield from 700 to 1,500 kg per

ha per year. Stocking density for modular is 3,000 fish per ha in 1 to 10 ha ponds. There could be six to eight croppings per year with the yield from 2,000 to 3,000 kg per ha per year.

In intensive culture, stocking density is high; thus fish depends largely on artificial feed and very little natural food. Stocking density is more than 20,000 fish per ha in 0.1 to 1 ha pond. There could be two to three croppings per year with the yield from 4,000 to 12,000 kg per ha per year

In semi-intensive culture, fish depends on both natural and artificial feed. Stocking density is from 8,000 to 12,000 fish per ha in 1 to 5 ha ponds. There could be two to three croppings per year with the yield from 2,000 to 4,000 kg per ha per year

Milkfish is stocked in extensive and semi-intensive ponds after about 40 days of pond preparation and growing of natural food. Preparation includes pest and predator control, drying, liming, and organic and inorganic fertilization.

In a modular system, pond preparation should not exceed 30 days to synchronize with the rearing period in other ponds. Pond drying could be shortened to 12 days and it is not necessary to apply lime on the second to the sixth cropping.

Stocking of milkfish should be done in early morning. It is also recommended that salinity and temperature levels in transport bags should be close to those of the pond before fish are released.

Milkfish is a daytime feeder; it feeds frequently. In semi-intensive ponds, milkfish is fed one month after stocking when biomass is 300 to 400 kg per ha, or when natural food is inadequate. In intensive ponds, milkfish is fed immediately after stocking to supply nutrients needed by fish at higher density and biomass.

Maximum production and feed ration were already determined in order to prevent water pollution in pond. In semi-intensive pond with no aeration, maximum biomass of milkfish should be about 0.8 to 1.3 tons per ha and feed ration should not be more than 50 kg per ha per day. In intensive ponds, estimated maximum biomass should not be more than 5 tons per ha and feed ration should not exceed 100 kg per ha per day.

Based on the nutritional requirement and water quality, feeding rate for milkfish is 4% of biomass when weight is below 150 g, 3% when weight is from 150 to 200 g, and 2% when weight is 300g. However, feeding rate should be adjusted so as not to exceed the maximum feed ration.

Milkfish is harvested after three to four months.



Technology presenter and contact person

Neila Sumagaysay-Chavoso is a scientist working on milkfish culture, pond dynamics and ecology, and environmental impacts of feeding at SEAFDEC/AQD. She finished her Masters of Science in Fisheries at the

University of the Philippines in the Visayas in 1988. This year she obtained her PhD in Marine Science from the University of the Philippines in Diliman. Email: nss@aqd.seafdec.org.ph

Farming the seaweed *Kappaphycus*

Total investment required for a module with five 500 m² multiple raft is about P54,000; for a module with ten 250 m² hanging long-line it is about P48,800. Return on investment after a year for multiple raft is 91%, thus payback period is nearly 11 months. ROI after a year for hanging long-line is 453%, payback is almost 3 months



Village women select seedlings of *Kappaphycus* for transplanting (top) at this site in Iloilo

Seaweed fanning is the top foreign exchange earner for the Philippines. *Kappaphycus*, the red seaweed locally known as 'guso' or 'tambalang' constitutes 80% of the Philippines seaweed export. In 2001, the Philippines is the third major seaweed producer in the world, after China and Korea. Japan ranked fourth.

Kappaphycus is sold in fresh and dried forms; however, dried seaweed has a greater demand though fresh seaweed is highly priced in restaurants. The three main seaweed products marketed are agar, alginate, and carrageenan. Carrageenan is used in meat preparation and processing, dairy products and desserts, beverages and juices, cosmetics and personal care products, petfood, air freshener gels, sauces and salad dressings, bread, noodles, and pasta.

In *Kappaphycus* farming, optimum salinity is 30 to 31 ppt, temperature 29 to 31°C, water depth of at least 4 m, and water movement of 20 to 40 m/min. The culture site should be free from freshwater run-off, and should have clear and clean water. The site should be free from agricultural, industrial, and domestic pollutions.

Culture techniques commonly used include multiple raft long-line, and hanging long-line. In multiple raft, several bamboo poles that are arranged in parallel design are connected to one another with flat binders to which the seedlings are tied. In hanging long-line, floaters are used to hold the cultivation ropes in place, and sand bags wrapped with nets are used as anchors. Appropriate use of culture technique based on culture site, seedling variety, and season is very important.

There are many varieties of *Kappaphycus* for farming. It is very important to use best quality seedlings that are brittle and young, free from epiphytes (undesirable seaweeds), and thallus whitening. Optimum stocking density is 0.5 to 1.0 kg per m². Periodic visits, about three to four times a week, are necessary to re-tie loose cultivation ropes and seedlings, to remove epiphytes, and to remove deposited silt and sediments. *Kappaphycus* is harvested after 45 to 60 days of culture.

Technology presenter and contact person

Anicia Hurtado is a Senior Scientist at AQD (see also page 5, this issue). She joined AQD's Farming Systems Section in May 1988. She holds several degrees: BSc Pre-Medicine (1970) and BSc Biological Sciences (1971) from the University of the East; MA Biology Education from De La Salle University (1980); and M Agriculture (1985) and Doctorate of Agriculture (1988) from Kyoto University. A Monbusho scholarship from the Government of Japan funded her studies at Kyoto.

Hurtado has been the leader of AQD's Seaweeds Project since 1988, and she has conducted several studies on the biology, ecology, fanning, and colloid characteristics of the red algae *Gracilaria*, *Kappaphycus* and *Eucheuma*. She recently finished a six-month biotechnology course on seaweeds (tissue culture, mutagenesis, cell-cell fusion) at Northeastern University in Boston, USA. She is now involved in seaweed biotechnology research, primarily on *Kappaphycus* and *Eucheuma*. She is also actively involved in AQD's coastal resources management program.

Hurtado has published several scientific papers in International and local journals, an extension manual on *Kappaphycus* farming, and a monograph, *Seaweeds of Panay*. <hurtado@aqd.seafdec.org.ph>

Aquaculture of the mangrove red snapper

Total investment cost in snapper culture in brackishwater pens is P117,000. Return on investment after a year is 153%, and payback period is 7 months

Mangrove red snapper, *Lutjanus argentimaculatus*, is an important marketable species throughout the Indo-Pacific region, but it is never found in large quantities. It is an excellent food fish, and a good aquaculture species because it doesn't get rancid easily when frozen. It commands a good export price with no limit on body size. It is sold in Hong Kong's live fish markets. In the Philippines, it can be found all over the country but is more known in Negros and Iloilo areas.

Mangrove red snapper is a euryhaline species; it can tolerate freshwater, brackishwater, and marine water. Juvenile and young adult are found in mangrove estuaries and in the lower reaches of freshwater streams. An adult is often found in groups around coral reefs. It migrates offshore to deeper reef areas, sometimes penetrating to depths in excess of 100 m. It feeds mostly on fishes and crustaceans, mainly at night. Juvenile is hardy, readily accepts pellets, and grows fast. There were no reported damaging diseases yet.

Fry from the hatcheries is longer and heavier compared to fry collected from the wild. Hatchery-produced fry is about 3.4 cm in



There is an emerging local industry of snapper culture in Panay Island



The mangrove red snapper Lutjanus argentimaculatus

length, and 0.64 g in weight. On the other hand, wild fry is about 2cm in length, and 0.15g in weight. Each fry costs about P5. Hatcheries in the Philippines include SEAFDEC/AQD, and Alcantara Group of Companies, particularly the Fish Hatchery Inc. However, AQD is producing fry only for research purposes.

Modular culture is the common system in snapper production. Stocking density is 4,000 fry per cropping. Fry from the wild or hatchery is cultured in nursery cages for three months. On the fourth month, fry are transferred to grow-out pens for four months. Thus, a culture period of seven months. However, on the fifth month of culture, another batch of fry can be stocked in the vacant nursery cages for three months. This second batch will be transferred to the grow-out pens after harvest of the first batch.

There could be two croppings per year. Feeding rate is about 5% of body weight. Light should be provided at night in cages and pens to attract zooplanktons, the live food of snapper. Survival rate is about 95%. Production could be about 3,800 kg per year. Snapper costs about P130 per kg.

Technology presenter and contact person

Arnil Emata is a Scientist and the head of SEAFDEC/AQD's Breeding Section. He obtained his PhD in Fish Physiology from the Louisiana State University in 1990. He graduated with Masters of Science in Zoology from the same university in 1983. Dr.

Emata has been working on the breeding of the mangrove red snapper at AQD.

Email: acemata@aqd.seafdec.org.ph



Business opportunities in aquaculture, Part 2 of 2 will cover:

- Grouper culture and seabass farming
 - Marine fish hatchery
 - Tilapia cage culture and hatchery-nursery operations
 - Bighead carp culture
 - Catfish seed production and grow-out ventures
 - Seahorses - an emerging fish species for aquaculture
- Read it here, in our December 2003 issue!**

**Abalone- new business ...
from page 1**

Abalone Juveniles are fed an artificial diet at the hatchery (photos courtesy of W Gallardo)



Locally, abalone dishes are served in some seafood specialty restaurants and commands a high price of PhP 120-150 per serving which consists of only one abalone cut into thin slices. The abalone shell also used for ornamental shellcrafts which are sold locally and abroad.

SEAFDEC Aquaculture Department (SEAFDEC/AQD) started its research on abalone in 1994 with the objective of developing technologies for hatchery and grow-out culture in order to provide continuous supply of abalone in case the wild populations are over-harvested due to unregulated gathering. As a result of almost 10 years of research, technologies for hatchery and grow-out culture have been developed but continuing research are still being undertaken to further improve and refine the technologies for adoption by the industry.

Based on SEAFDEC/AQD experience on breeding and culture of the abalone *Haliotis asinina*, the major activities and duration of breeding and culture are:

1. Broodstock conditioning (1-2 months)
2. Spawning, egg collection, larval rearing and stocking
3. Primary nursery rearing (2-3 months) - diatom feeding
4. Secondary nursery rearing (1-2 months) - seaweed feeding
5. Grow-out culture (9-12 months)

Abalone hatchery production

Hatchery production is outlined as follows:

Broodstock management

- Flow-through seawater supply
- Continuous feeding of seaweeds
- Dark environment
- Temperature: 27-29°C
- Salinity: 32-35 ppt
- 50-100 spawners per ton at a ratio of 1 male to 4 females

Spawning and egg collection

- Well-conditioned broodstock can naturally spawn every other week, at midnight to early morning
- Water sample from tank bottom is taken every morning (6-7 AM) to check any spawning

Larval rearing, stocking, and settlement

- Eggs or trocophores are collected from spawning tanks and stocked in incubation tanks
- Veliger larvae that swim up are collected by siphoning into buckets and stocked (100-250 larvae per liter) into larval settlement tanks with diatom-filmed corrugated plastic sheets; static water condition but with mild aeration
- Larvae settle on the diatom plates within 3-4 days and water flow may be started on day 4 or 5.
- Larval settlement is a major problem in hatchery production because this depends on the availability of coralline algae and diatom species on the settlement plates.

Primary nursery

- After one week in indoor tanks, corrugated plastic plates with settled post-larvae are transferred to outdoor tanks for better growth of diatoms which post-larvae and juveniles feed on for 2-3 months until they reach 1 cm shell length
- Outdoor tanks should have transparent roof (to allow maximum sunlight penetration but prevent rain which could lower salinity), flow-through seawater and continuous aeration.

Secondary nursery

- Juveniles more than 1 cm shell length are harvested from the diatom plates and fed seaweeds (*Gracilaria*) in trays or cages in indoor tanks with flow-through seawater and continuous aeration. To save on pumping costs, primary and secondary nursery may be carried out in the sea without strong waves and siltation.
- For sea ranching or stock enhancement purposes, juveniles are fed artificial diet for 3-4 weeks to produce the bluish-green shell band which will serve as marker of hatchery-produced abalones
- Juveniles with shell length of 1.5 cm or more can be used for grow-out culture.

➤ next page

business opportunities in aquaculture, part 1 of 2

Below are details of the hatchery economics:

Assumptions and givens

Total no. of spawners in 4 tanks (160 females: 40 males)	200
No. of females spawning every other week	80
No. of eggs spawned per female	100,000
Percent survival from eggs to larvae	5-7
Total no. of larvae every other week	500,000
No. rearing runs per year (excl. rainy months)	20
No. of rearing days to reach 1.5 cm juveniles	120-150
No. of juveniles produced per year	80,000
Project duration (years)	15

Investment items and operating costs (in pesos)

<i>Investment items</i>	386,450
Spawning tanks (4 units, 600-liter capacity, fiberglass)	
Incubation tanks (2 units, 250-liter capacity, plexiglass)	
Larval settlement tanks (2 units, 1-ton capacity, oval fiberglass)	
Primary nursery rearing tanks (2 units, 12-ton capacity, concrete)	
Secondary nursery rearing tanks (2 units, 6-ton capacity, concrete)	
Reservoir (30 tons, with sand-filter)	
Pump (5.5 Hp), Blower (1 Hp), Generator set	
Piping system, trays and cages	
Filter bags, plankton nets, pails, basins, etc.	
<i>Variable cost per run</i>	3,517
<i>Fixed cost per run</i>	6,705

Incomes and economic indicators

Revenue per rearing run (3,600 pcs at P5 per pc)	P 18,000
Income/run	7,778
Income/year	155,568
Return on investment (%)	40
Payback period (year)	2
Break-even price (PhP) per 1.5 cm juvenile	2.84
Break-even production (pcs.)	2,044
Net present value at 12% interest (PhP)	513,343
Internal rate of return (%)	37
Discounted benefit-cost ratio	2.5

Grow-out culture

The grow-out culture of abalone can be land or sea-based. Land-based cultures are in tanks, raceways or on-shore ponds. Sea-based cultures are in cages, pens, barrels, enclosed pile of rocks, inter-tidal ponds or by sea ranching.

Each type of culture method has its advantages and disadvantages. The land-based culture method allows greater control over the culture process and it simplifies animal maintenance (i.e. no need for diving), but it requires large initial investment in land, facilities and equipment, and involves high pumping and operation costs. On the other hand, the sea-based culture method generally requires lower capital investment and capital costs but allows little control over environmental conditions (e.g. typhoons, strong waves). The choice of culture method to use would therefore depend on budget, technology and site suitability.



Stocking abalone juveniles in the PVC pipes used for transport (top); checking for net damage and abalone mortality (photos courtesy of W Gallardo)

Suitable sites for abalone culture:

For land and sea-based culture

- Far from rivers or freshwaters sources
- Clean, clear, high salinity (32-35 ppt) seawater
- Rocky or sandy bottom (not muddy)
- Availability of the seaweed *Gracilaria* ("gulaman dagat") and abalone juveniles. These are the two major factors that determine the feasibility of abalone culture.

For sea-based culture

- Good water circulation
- Protection from typhoons and poaching
- Water depth; at least 2 m at lowest tide (for floating net cage culture)

Recommended conservation measures for abalone

Abalone (*Haliotis asinina*) locally known as "lapas", "sobra-sobra", or "kapinan" is a marine gastropod with very high commercial value. It commands a high price of P250-300/kg (live) or P450/kg (blanched, without shell) and is served as a specialty in some seafood restaurants in the country but is mostly exported to many countries in frozen, dried or canned form. Due to its high commercial value, wild stocks are over-exploited to near depletion as there are no existing laws specifically for abalone. To prevent the depletion of wild stocks, the following conservation measures are recommended:

(1) Minimum size of abalone to be collected from the wild should be 5 cm shell length. Based on a research finding (Capinpin et al., 1998, Aquaculture vol. 166, pp. 141-150), wild abalone (*Haliotis asinina*) attains sexual maturity at 3.5 cm shell length. By collect-

ing only those bigger than 5 cm shell length, the abalone is allowed to spawn at least three times before being collected from the wild. The offsprings produced are expected to sustain the fishery.

- (2) Marine sanctuaries or protected areas where there are natural populations of abalone should be established and implemented by local government units. There is a need to maintain breeding populations which will provide juveniles even to areas outside the marine sanctuary.
- (3) Corals should not be destroyed in the process of collecting abalones. Corals take years to grow and they serve as abalone habitat and shelter from predators. Fishermen should use spatulas or hooks designed for abalone gathering, instead of destroying the corals.
- (4) In depleted or almost depleted areas which are still suitable for abalone, stock enhancement or the release of hatchery-produced seeds may be carried out to rehabilitate the population

but the release site should be protected. The establishment and operation of a hatchery would be necessary for this.

These conservation measures should be implemented as soon as possible or the abalone fishery will collapse like the multi-million peso sea urchin fishery in the early 1990s [Juinio-Meñez et al., 1998, Canadian Special Publication on Fisheries and Aquatic Sciences vol. 125, pp 393-399]. There is now a very big demand for abalone in Korea and China and if measures are not undertaken, our abalone resources will be depleted. Seed production and grow-out culture techniques have been developed and being refined by SEAFDEC/AQD for adoption by the government and private sectors.

(Sgd) *Wenresti G. Gallardo, PhD*
Program Leader for Stock Enhancement
(Noted) *Clarissa L. Marte, PhD*
Head, Research Division
SEAFDEC/AQD

SEAFDEC/AQD has tried abalone culture in tanks and sea cages. The culture trials have shown technical feasibility but economic viability may be poor because of high capital investment and long culture duration (10-12 months). In consideration of economics, SEAFDEC/AQD is recommending the modular system of abalone culture in floating cages.

The modular system is based on the principle of increasing space for increasing size of abalone to maximize abalone growth. Every three months, the stocks are halved and transferred to twice the number of cages, or a ratio of 1:2:4. Depending on the capital available, an operator may have only one module consisting of 7 columns and 7 rows of net cages or seven modules which is in a ratio of 1:2:4. After each transfer, a new batch of juveniles is also stocked, thus, nine months after stocking the first batch of 1.5-2.0 cm juveniles, harvests will be every 3 months. To optimize use of a full-time laborer, a 7-module set-up is recommended for each farm operator.

The projected economics of this modular system of abalone culture in floating cages is shown below:

Assumptions and givens

Abalone size: initial 1.5-2 cm, 1.3 g (P5/pc); final: 5.5 cm, 50 g (P275/kg, 20 pcs/kg)
Culture period: 9 months
Number of crops per year: 3-4
Survival rate: 90%
Feed: seaweed *Gracilaria* ("gulaman dagat")
Feed conversion ratio, FCR: 12-13
Project duration: 4 years

Investment items and operating costs (in pesos):

	1 module	7 modules
<i>Investment items</i>	29,378	205,646
Bamboo frame (10x10m), floats and anchors	10,000	
Mother or barrier net (9x9m)	3,000	
Net cages (1x1x1.3m), 49 units	12,250	
PVC pipes for abalone transport and shelter	3,528	
Pails and containers	600	
<i>Variable cost</i>	32,880	230,160
<i>Fixed cost</i>	10,079	70,533

A new enterprise owned by Mr Vincent Encena II is now adopting this modular system of abalone culture in floating cages.

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abalone ... from previous page

Incomes and economic indicators:	1 module	7 modules
Revenue/crop (190 kg/module at 275/kg)	52,178	365,246
Total production cost (P)	42,960	300,720
Net income/crop (P)	9,218	64,526
Net income/year (P)	27,654	193,578
Return on capital outlay (%)		94
Payback period (months)		10
Break-even price (P)		226
Break-even production (kg/module)		156
Net present value at 12% interest (P)		58,685
Internal rate of return (%)		86
Benefit-cost ratio		3.2

Prospects

Abalone culture is expected to grow and expand in the Philippines because:

- Wild populations could be over-harvested, if gathering is not regulated (see box, page 27).
- There is a high demand in the world market, with a 40% gap between supply and demand.
- Small tropical abalones like *Haliotis asinina* are preferred by the biggest market (Chinese).
- Tropical abalones have faster growth and reproduction than temperate species.
- Technology for hatchery and grow-out culture is available and economically feasible.
- The Philippines has plenty of sites suitable for abalone culture.

There are still some constraints to both hatchery and grow-out culture, however, with SEAFDEC/AQD's continuing research, these problems in abalone culture could be solved.

About the authors

Dr. Wenresti Gallardo (see also page 5) is the abalone project leader and a Scientist at AQD's Farming Systems and Ecology Section of SEAFDEC/AQD. He obtained his BS in Fisheries and Master of Aquaculture from the University of the Philippines, and his MS in Fisheries and PhD in Marine Science from Nagasaki University, Japan.



Dr. Nerissa D. Salayo is an economist and an Associate Scientist at AQD's Socio-Economics Section. She obtained her BS in Agricultural Economics from the University of the Philippines at Los Baños, MS in Fisheries Economics from Universiti Pertanian Malaysia, and PhD Economics from Griffith University, Australia.

Drs. Gallardo and Salayo thank Shelah Mae Buen for the technical assistance.

NEW!

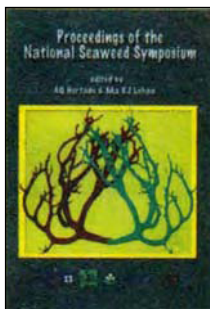


Research Output of the Fisheries Sector Program (FSP) Vol 1 Articles published in scientific journals. The volume contains 34 papers on coastal resources management and rehabilitation, aquaculture, and utilization of aquatic products. These are studies funded by FSP, a landmark national initiative which addresses issues in the fisheries sector. FSP's research agenda was coordinated by the Bureau of Agricultural Research. This report was compiled with the assistance of SEAFDEC/AQD. Email rd@bar.gov.ph



Report of the Seminar-Workshop on Integrated Regional Aquaculture Program (IRAP) is now available from the SEAFDEC Secretariat (www.seafdec.org). It may also be requested from SEAFDEC/AQD, email aqdchief@aqd.seafdec.org.ph/

IRAP is part of the aquaculture component of the ASEAN-SEAFDEC Special 5-year program on the contribution of sustainable fisheries to food security in the ASEAN region.



The **Proceedings of the National Seaweed Symposium** is published by the Seaweed Industry Association of the Philippines (SIAP). The 109-page book is edited by SEAFDEC/AQD researchers Dr. AQ Hurtado and Ms. Ma. RJ Luhan.

It contains industry cluster situationers; global overview including developments in Chile; and programs of LandBank, Quedancor, Department of Trade and Industry, Department of Agriculture, Department of Science and Technology, University of the Philippines, and SEAFDEC/AQD,

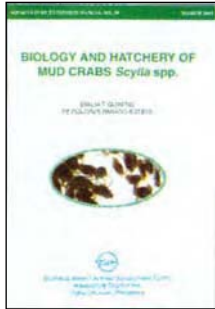
The proceedings is available from SIAP Rm 203 Jose R. Martinez Jr. Bldg, Osmeña Boulevard, 600 Cebu City, Philippines. Tel. (63-32) 253 7433, Fax (63-32) 254 8780. Email siap@digitelone.com



Diwata ng Dagat (or enchantress of the sea) is the official newsletter of the University of the Philippines College of Fisheries Alumni Association, first issued July 2003. It contains articles on the fisheries programs of UPV and newsbriefs on aquaculture. To be on the mailing list, contact upv_cfos@yahoo.com/Telefax (63-33) 315 8143. Alumni are also enjoined to attend a general homecoming in July 2004 (date to be announced later) in Iloilo.

Books, websites, training courses EXTENSION MATERIALS

NEW!



Mud crab hatchery technology

SEAFDEC/AQD has released its newest extension manual entitled "Biology and hatchery of mud crabs *Scylla* spp." All of 42 pages with colored photos and step-by-step methods, it is written by researchers Dr Emilia Quintino and Dr. Fe Dolores Parado-Estepa. The contents include biology of *Scylla*, hatchery and nursery operations, common problems and solutions, economics, and a list of references.

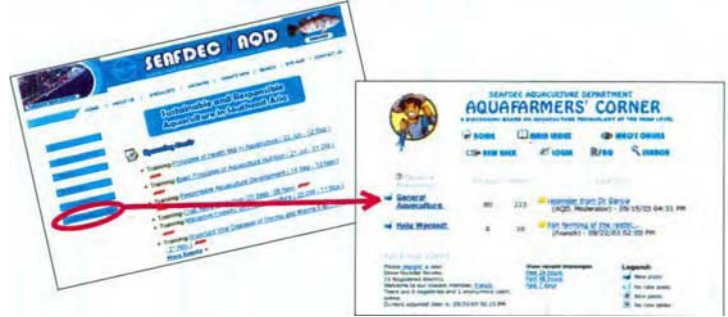
The book launching ceremony was held July 8 at Barcelo Sarabia Manor in Iloilo City during AQD's anniversary seminar on business opportunities.

The hatchery protocol developed at SEAFDEC/AQD is described in this manual. Although studies on mudcrab started in 1977, these were not given priority until 20 years later, in 1997, when the Australian Centre for International Agricultural Research (ACIAR) collaborated with AQD to develop seed production techniques. By 1999, AQD offered the first on-the-job training to hatchery technicians and in 2001 with ACIAR's sponsorship, the first course was successfully held. To date, three training courses have been offered by AQD to both local and international participants. The mud crab hatchery technology was also disseminated in the Philippines through the Fisheries Technology Caravan organized by the Bureau of Fisheries and Aquatic Resources and AQD. Hatchery-reared crab juveniles have been grown in ponds in the Visayas and Mindanao.

For a copy of the manual, contact sales @aqd.seafdec.org.ph/

Progress report

"2002 Highlights" reports SEAFDEC/AQD's accomplishments for the year 2002. AQD programs have been aligned along four areas - managing broodstock and improving seed quality, developing responsible and sustainable aquaculture techniques, screening new species for aquaculture, and developing strategies for stock enhancement. It is noted that AQD lends a big hand in at least three regional programs (implemented in Southeast Asia). These include mangrove-friendly shrimp culture technology, aquaculture disease management, and integrated regional aquaculture program (ASEAN-SEAFDEC); third-country training program and research on advanced aquaculture technologies (or biotechnology).



Website for fishfarmers learning new technologies

<http://www.seafdec.org.ph>

Check out SEAFDEC/AQD's discussion board - *Aquafarmers' Corner*. This is your site for exchanging and sharing ideas and issues to further aquaculture development in the region. Our vast pool of experts, through *Aquafarmers' Corner*, hopes to answer your queries on aquaculture technology at the farm level. We would like to hear about your experiences too, so that we may build on it. Come, visit us!

Website for networking with fish health professionals in Southeast Asia and elsewhere

<http://afs-fhs.seafdec.org.ph>

Home of Fish Health Section of the Asian Fisheries Society or APS which has membership of about 3,000 fisheries professionals from 75 countries and territories. AFS-Fish Health Section's secretariat is presently hosted by AQD.

Some of SEAFDEC/AQD numbers are new!

SEAFDEC/AQD trunkline, connecting all offices

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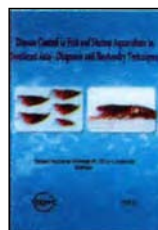
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SEAFDEC websites on the internet

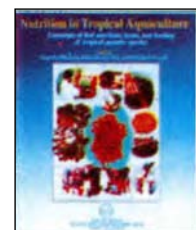
www.seafdec.org; www.seafdec.org.ph

www.mangroveweb.net

www.agrolink.moa.my/dof/seafdec



Disease Control in Fish and Shrimp Aquaculture in SEA - Diagnosis and Husbandry Techniques, 215 pages, edited by Yasuo Inui and Erlinda Cruz-Lacierda. Email eclacier@aqd.seafdec.org.ph or fax (63-33) 5118709, 3351008.



Nutrition in Tropical Aquaculture is edited by SEAFDEC/AQD scientists Dr. Oseni Millamena, Dr. Relicardo Coloso, and Dr. Felicitas Pascual. <sales@aqd.seafdec.org.ph>

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() Manual #28	Mudcrab <i>Scylla</i> Production in Brackishwater ponds, 1999	2
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Mr. Daniel Ochuodho of Kenya is one of the 16 trainees invited by AQD and JICA to take part in the Third Country Training Program (TCTP). He works for his country's Fisheries and Marine Institute. His co-trainees in RAD-TCTP are from Bangladesh, Cambodia, China, India, Indonesia, Mozambique, Pakistan, Philippines, and Tanzania.



Basic Principles of Aquaculture Nutrition - Online, *ongoing* July 21-Oct 31

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Management of Sustainable Aquafarming Systems, *completed* May 7-June 5

Crab Seed Production, *completed* Apr 23-May 22

For further information, please contact

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The 94-page fully illustrated, full color book entitled "**Husbandry and health management of grouper**" is now available in Vietnamese. Request book copy from:



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The official English version original and the translations in five other languages - Bahasa, Thai, Mandarin, Filipino -- are still available. Contact Dr Erlinda Cruz-Lacierda at eclacier@aqd.seafdec.org.ph or fax (63-33) 5118709, 3351008

The Southeast Asian Fisheries Development Center (**SEAFDEC**) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in Southeast Asia. Its Member Countries are Japan, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, the Socialist Republic of Viet Nam, Union of Myanmar, and Indonesia.

Four departments were established in the Member Countries; one of them, the Aquaculture Department (**AQD**) located in the Philippines, pursues aquaculture research and development

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Contributions

We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs and line drawings must be camera-ready, glossy B&W prints or colored slides. The newsletter editor reserves the right to edit contributed articles for brevity and style.

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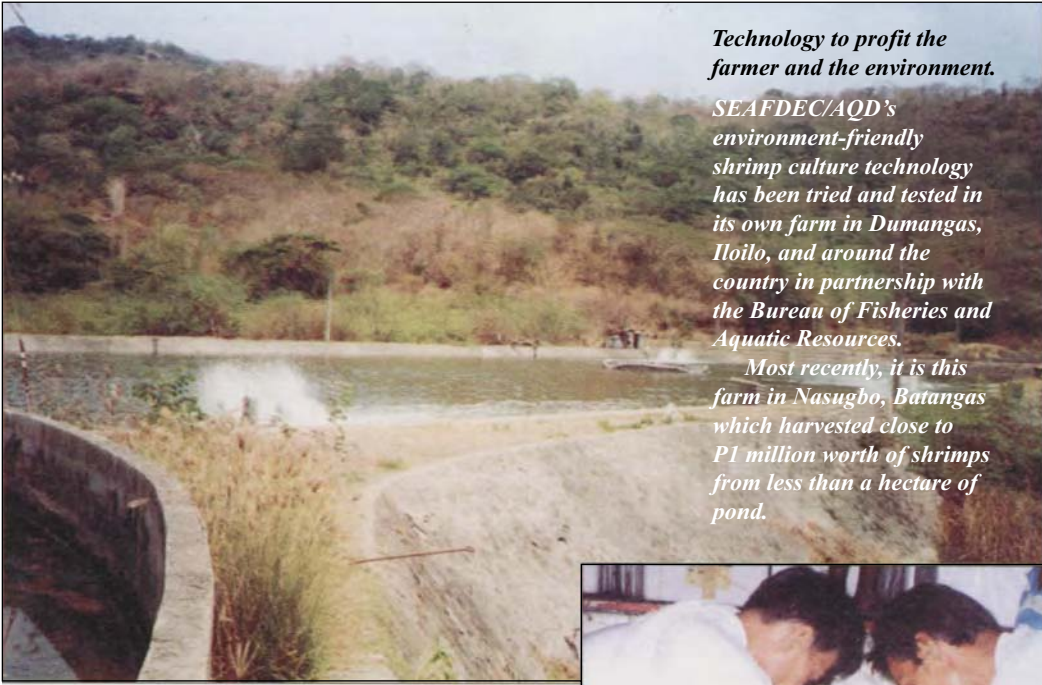
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Technology to profit the farmer and the environment.

SEAFDEC/AQD's environment-friendly shrimp culture technology has been tried and tested in its own farm in Dumangas, Iloilo, and around the country in partnership with the Bureau of Fisheries and Aquatic Resources.

Most recently, it is this farm in Nasugbo, Batangas which harvested close to P1 million worth of shrimps from less than a hectare of pond.

AQD celebrates three decades of R&D

SEAFDEC/AQD is well-known for its technical expertise on aquaculture in Southeast Asia, and in the Philippines, it is a major source of technology for fishfarming entrepreneurs. AQD's impact can not be doubted because the aquaculture sector now accounts for the country's 1.34 million tons of fish, or about 40% of total fish production. As an export industry, the tiger shrimp sector alone is worth P30 billion and directly employs 180,000 people.



SEAFDEC/AQD celebrated its 30th year this July with a roadshow seminar of the most recent technologies it has developed. There are 15 of these technologies to date with varying levels of business risk — culture and/or hatchery of tiger shrimp, mudcrab, milkfish, grouper, seabass, tilapia, mangrove red snapper, bighead carp, catfish, seaweed, seahorses, abalone. [Seven of these are summarized on page 19 onwards, the rest to follow next issue.] AQD, however, assures entrepreneurs of their technical viability and of its technical support.

In addition to the technology seminar, AQD launched its newest extension manual on the *Biology and hatchery of mud crabs* *Scylla spp.* that was written by Dr. Emilia Qunitio and Dr. Fe Dolores Parado-Estepa (page 29). The yearly Dean Domiciano K. Villaluz (the first AQD Chief) Memorial Lecture was held, with Dr. Anicia Hurtado, a senior scientist at AQD, as lecturer on *Seaweed research and industry sectors - partners toward globalization*. AQD's environment education center, Fish World, invited schoolchildren to an *Aquaculture week* where there were contests on painting, photojournalism, seafood dish, and aquarium set-ups; and quizzes on ecology and aquaculture, and nutrition and aquaculture. To continue a yearly tradition, AQD gave recognition to 14 employees who have worked for the department for 20 years.

In the past seven years when AQD was under the helm of the present AQD Chief Dr. Rolando Platon, it has expanded its facilities to include the *Dumangas Brackishwater Station* in northern Iloilo where trials on environment-friendly shrimp culture were first made and are continually done; the *Integrated Fish Broodstock and Hatchery Demonstration Complex* which is meant as a showcase for AQD's fish breeding and hatchery technologies; *Fish World*; and the *Laboratory for Advanced Aquaculture Technologies* which conducts research on biotechnology for future applications.

AQD's "product" is aquaculture technology which it has continuously sought to improve to better use scarce resources and minimize environmental impact. With the support of the Philippine government and its collaborating partners, AQD hopes to continue its work on technology generation, verification, demonstration and techno-transfer.