



## SEAFDEC/AQD Institutional Repository (SAIR)

Title	SEAFDEC/AQD highlights 2010.
Author(s)	
Citation	Aquaculture Department, Southeast Asian Fisheries Development Center. (2011). SEAFDEC/AQD highlights 2010. Tigbauan, Iloilo, Philippines: SEAFDEC, Aquaculture Department.
Issue Date	2011
URL	<a href="http://hdl.handle.net/10862/1610">http://hdl.handle.net/10862/1610</a>

This document is downloaded at: 2013-07-02 07:11:51 CST





# SEAFDEC/AQD Highlights 2010



Southeast Asian Fisheries Development Center  
**AQUACULTURE DEPARTMENT**  
[www.seafdec.org.ph](http://www.seafdec.org.ph)

## ON THE COVER

(L-R) Veterinary medicine students undergo on-the-job training on fish health; freshwater prawn *Macrobrachium rosenbergii*; stocking of seabass in a small reservoir in Dingle, Iloilo; spawning sandfish males; and a community in Guimaras learns post-harvest processing of milkfish



CM GENZOLA



MLC ARALAR



DD BALIAO



J ZARATE



## CONTENTS

SUMMARY OF ACCOMPLISHMENTS p3

R&D PROGRAMS p7

DEPARTMENTAL PROGRAMS

*Integrated mollusc: abalone, angelwing clam* p13

*Domesticating shrimp, mud crab* p16

*Marine fish* p20

*Seaweed strain improvement* p26

*Aquatic ecology* p28

*Small-holder freshwater aquaculture* p31

REGIONAL PROGRAMS

*Sustainable aquaculture* p34

*Food safety* p35

*Fish health* p35

*Resource enhancement* p37

SPECIAL PROJECTS p38

TECHNOLOGY EXTENSION

*AquaBusiness for entrepreneurs* p40

*For communities* p41

TRAINING & INFORMATION

*Training courses* p44

*Publications Videos AQD website* p46

*Library Databank FishWorld Visitors* p47

AQD SCIENCE PAPERS p48

STATEMENT ON SOURCES /  
APPLICATION OF FUNDS p 50

AQD community affairs p51

## AQD officers in 2010

*Chief* Dr. Joebert Toledo

*Deputy Chief* Dr. Teruo Azuma

*Head, RD* Dr. Evelyn Grace Ayson

*Head, TVDD* Dr. Ma. Rowena Eguia

*Head, TID* Mr. Renato Agbayani

*Head, AFD* Ms. Renee Valencia

*Head, BFS* Engr. Emiliano Aralar

*Head, DBS* Mr. Hanani Torrilla

*Head, IMS* Mr. Albert Gaitan

*Head, Manila Office* Ms. Grace Garcia

## Program leaders

*Mollusc* Ms. Milagros de la Peña

*Mudcrab & shrimp* Dr. Fe Dolores Estepa

*Marine fish* Dr. Relicardo Coloso

*Seaweeds* Ms. Ma. Rovilla Luhan

*Freshwater aquaculture* Dr. Ma. Rowena Eguia

*Aquatic ecology* Dr. Ma. Junemie Hazel Ramos

*Regional programs* Dr. Teruo Azuma

## Section heads

[RD]

*Breeding & seed production* Dr. Emilia Quintio

*Fish health* Dr. Celia Pitogo / Dr. Edgar Amar

*Nutrition & feed development* Dr. Mae Catacutan

*Farming systems & ecology* Dr. Ma. Junemie Hazel Ramos

*Socioeconomics* Dr. Nerissa Salayo

[TVDD]

*Demonstration & packaging* Ms. Jocelyn Ladja

*Technology verification* Mr. Rolando Gapasin

[TID]

*Training* Ms. Kaylin Corre

*Development communication* Ms. Milagros Castaños

*Library & data banking services* Ms. Luisa Pacino

[AFD]

*Engineering* Engr. Salvador Rex Tillo / Engr. Zaldy Suriaga

*Human resource management* Mr. Rene Cabalum / Ms. Renee Valencia

*Budget-cashiering* Mr. Juan Garin Jr.

*Accounting* Ms. Amelita Subosa

**RD**, Research Division; **TVDD**, Technology Verification & Demonstration Division; **TID**, Training & Information Division; **AFD**, Administration & Finance Division

**BFS**, Binangonan Freshwater Station; **DBS**, Dumangas Brackishwater Station; **IMS**, Igang Marine Station



# Summary of accomplishments 2010

SEAFDEC member-countries are all in agreement that **aquaculture** anchors the food security and poverty alleviation programs of their respective governments, with most of them focusing on rural aquaculture. With wild fish catch in seemingly irreversible decline, aquaculture has been supplying 40% of the world's food fish.

A good part of the research-and-development (R&D) needs of the aquaculture industry in Southeast Asia is being undertaken by SEAFDEC Aquaculture Department (AQD).

In 2010, AQD implemented 98 studies in six departmental programs, four regional programs, and three special projects. AQD also continued to showcase and transfer its packaged technologies through 33 experiential training courses attended by 251 aquaculturists & fisheries officers from all over the world.

One of the highlights in 2010 is the new commodity undertaken by AQD ~ sandfish *Holothuria scabra* ~ both for profit and for bioremediation, and for which AQD built and inaugurated a hatchery in April. AQD also conducted a training course on sandfish hatchery & nursery for the first time.

AQD continued work on abalone, mudcrab, shrimps, marine fishes (grouper, sea bass, pompano, snapper, siganid, milkfish, seahorse), freshwater fishes (tilapia, freshwater prawn, bighead carp) and seaweeds. Thematic areas of study included aquatic ecology, promotion of sustainable aquaculture technology, food safety, capacity building in fish health and resource enhancement.

AQD kept its stakeholders informed of new research results, publishing 36 papers in peer-reviewed science journals, and sharing its program or study results in 18 forums conducted from China to Canada to France and some places in-between.



AQD Chief Dr. JD Toledo

Another highlight in 2010 was the recognition given by the Philippine Department of Science & Technology to an AQD scientist ~ Dr. Ma. Rowena Eguia ~ as having the best published paper in aquaculture & inland fisheries. We are very proud of this because it recognizes the quality of research work done by AQD. AQD has been a continuous recipient of the Dr. Elvira O. Tan Memorial Award for Fisheries Research since 1987.

AQD produced six farmer-friendly manuals & two books, posted updates in its website ([www.seafdec.org.ph](http://www.seafdec.org.ph)) which were seen by more than 48,000 stakeholders this year, and sent news to the mass media. The media was a good partner this year, helping AQD explain what research has done to improve the aquaculture industry.

AQD took on 15 new collaborating partners this year, including universities, entrepreneurs and local governments. Our long-time collaborating partner, the Government of Japan Trust Fund, which funds AQD's regional programs, was still on-board, along with ACIAR (Australian Center for International Agricultural Research), JIRCAS (Japan International Research Center for Agricultural Sciences), Collaborative Research Support Program (CRSP), and Petron Foundation Inc.

We also collaborated with the FAO (Food & Agriculture Organization) which, through its Aquaculture Service, requested AQD to organize and host a workshop on on-farm feeding management. This was held in Manila in September.

As another decade begins, the SEAFDEC family convened a series of regional technical consultations (RTCs) in Southeast Asia to work out the needs of governments and their people for sustainable fisheries & aquaculture. The new SEAFDEC workplan will cover 2012 to 2020. For aquaculture, the RTC was held in March in Bangkok.

What the RTC outcomes essentially mean for AQD R&D is a shift from commodity-based approach to a thematic approach, focusing on five thematic areas:

- (1) meeting socioeconomic challenges in aquaculture
- (2) quality seed for sustainable aquaculture
- (3) healthy and wholesome aquaculture
- (4) maintaining environmental integrity through responsible aquaculture
- (5) adapting to climate change

We look forward to the new workplan to better provide profitable, environment-friendly and equitable technologies to our stakeholders.

Lastly, we thank our partners, especially AQD's host country, the Philippines, for their trust and support.

A handwritten signature in black ink, appearing to read 'Joebert Toledo'.

**Joebert Toledo**, D. Agri.  
Chief  
SEAFDEC / AQD



AQD Chief with collaborators WorldFish, University of Tehran, entrepreneur Mr. Zaldy Nava, and GAIA Singapore during agreement signing

## New agreements with AQD

*Worldfish Center (Penang, Malaysia):* Agreement on research collaboration (Jul 2010 - Jul 2015)

*North Carolina State University (USA):* Collaborative Research Support Program (CRSP) in aquaculture and fisheries (Apr 2010 - Sept 2014)

*University of Tehran (Tehran, Iran):* Collaboration in instruction, research, and training and extension programs (starting Oct 2010)

*GAIA Mariculture Pte. Ltd. (Singapore):* Exchange training in aquaculture (Sept 2010 - Sept 2015)

*Bureau of Fisheries and Aquatic Resources - Philippines (BFAR):* Expansion of the Multi-Species Hatchery Facility of BFAR in Region 4B in Sta. Lucia, Puerto Princesa City, Palawan (starting Jul 2010)

*Municipal Government of Binangonan (Philippines):* Aquatic resource and conservation and management awareness program (Mar 2010 - Mar 2015)

*Municipality of Narra, Palawan (Philippines):* Community-Based Fishery Research and Development Center for brackishwater/freshwater fish culture and management and development of Mariculture Park/Zone (Nov 2010 - Nov 2013)

*Banate Bay Resource Management Council (Philippines):* Banate Bay Coastal Resource Management Plan (starting Jan 2010)

*Mindanao State University (Philippines):* Collaboration in instruction, research, training and extension programs in fisheries, aquatic and related sciences (Dec 2010 - Dec 2015)

*Surigao del Norte College of Agriculture and Technology (Philippines):* Strengthening of capabilities of faculty and students with emphasis on abalone culture and technology (Dec 2010 - Dec 2015)

*Rizal National Science High School (Philippines):* Research capacity- building for science students and educators (Mar 2010 - Mar 2015)

*PETRON Foundation Inc and Taytay Sa Kauswagan Inc (Philippines):* Sustainable community and enterprise development program for Guimaras fisherfolk under the "Pilot project on milkfish cage culture as livelihood option for affected Guimaras fisherfolk" (starting Feb 2010)

*Lunsad Multi-purpose Cooperative of Binangonan, Rizal:* Technical assistance in lake-based freshwater prawn culture (starting Dec 2010)

*Mega Fishing Corporation (Philippines):* Technical assistance for the Tawi-tawi high-value multi-species hatchery (starting Jan 2010)

*Zaldy Nava of Nueva Valencia, Guimaras (Philippines):* Marine fish culture at the Igang Mariculture Park (Feb 2010 - Feb 2012)

*Juancito Jastillano of Dumangas, Iloilo (Philippines):* Assessment of mudcrab population and fisheries (May 2010 - May 2013)

## AQD shares results with the world's science community in these meetings:

**9th Practical Course: Aquaculture Feed Extrusion, Nutrition & Feed Formulation** (25-26 January; Ho Chi Minh City, Vietnam) organized by Novus Aqua

**Global Soy in Aquaculture Strategic Planning Meeting** (26-28 February; San Diego, California, USA) organized by United Soybean Board

**World Aquaculture Society 2010** (01-05 March; San Diego, California, USA) organized by World Aquaculture Society

**Abalone and Sea Cucumber Workshop** (14-16 April; Semporna, Sabah, Malaysia) organized by World Wildlife Foundation-Malaysia

**14th International Symposium on Fish Nutrition and Feeding** (31 May-04 June; Qingdao, China) organized by International Symposium on Fish Nutrition and Feeding

**International Institute of Fisheries Economics and Trade Conference** (12-16 July; Montpellier, France) organized by International Institute of Fisheries Economics and Trade

**2010 Soy in Aquaculture Stakeholders Strategic Planning Meeting** (29 August - 03 September; Campbell River, British Columbia, Canada) organized by United Soybean Board

**6th International Symposium on Aquatic Animal Health** (05-09 September; Tampa, Florida, USA) organized by International Symposium on Aquatic Animal Health

**FAO Global Conference on Aquaculture** (21-25 September; Phuket, Thailand) organized by Food and Agriculture Organization

**NACA 21st Governing Council Meeting and Global Conference** (22-26 September; Phuket, Thailand) organized by NACA

**2010 AquaFISH-CRSP Project Impact Assessment Workshop**

(3-11 October; Seattle, USA) organized by AquaFISH-CRSP

**2010 Forum on Fishery Science and Technology** (10-12 October; Wuxi, China) organized by Chinese Academy of Fishery Sciences

**1st International Conference on Managing Ecosystem Health of Tropical Seas** (19-21 October; Kuala Lumpur, Malaysia) organized by UNESCO, Ministry of Higher Education-Malaysia, Malaysian Fisheries Society, among others

**2nd International Congress on Aquatic Animal Health Management and Diseases** (26-27 October; Tehran, Iran) organized by Veterinary Council and IR Iran

**NACA Regional Advisory Group Meeting** (7-12 November; Bangkok, Thailand) organized by NACA

**13th International Conference on Shellfish Restoration** (17-20 November; Charleston, South Carolina, USA) organized by South Carolina Sea Grant Consortium

**Meeting on Chemical Use in Aquaculture** (25-27 November; Kuala Lumpur, Malaysia)

**JIRCAS Workshop on Sustainable Stock Management and Aquaculture Technology Suitable for Southeast Asia** (6-12 December; Tsukuba, Japan) organized by JIRCAS





## AQD's award winners

AQD scientist Dr. Ma. Rowena Eguia received the prestigious **2010 Dr. Elvira O. Tan Memorial Award** for her paper *Genetic changes during mass selection for growth in Nile tilapia, *Oreochromis niloticus* assessed by micro-satellites*. The paper was recognized as the *Best published paper in aquaculture and inland fisheries*. Her co-authors are Dr. Minoru Ikeda, Dr. Zubaida Basiao and Dr. Nobuhiko Taniguchi. The award was given

by the Philippine Department of Science & Technology on 27 July at Los Baños, Laguna.

In addition, AQD's senior technical assistant **Ms. Dianne Hope Tormon** was awarded the *Best scientific paper* for her work *Identifying women's roles in sustainable aquaculture livelihood development: experiences from the oil spill crisis in Guimaras Strait in the Philippines*. The award was given by the National Network of Women in Fisheries in the Philippines during their 5th national conference in Cagayan de Oro City in September. Her co-authors are Dr. Nerissa Salayo and Mr. Renato Agbayani.



## Mass media

To reach its general public stakeholders, AQD wrote press releases that explain its R&D efforts and recent research results. Most notable among the press coverage in 2010 in Philippine media were:

- "New methods could control fish disease" in **BusinessWorld**, 28 January issue
- "Bighead carp: most affordable fish for the masses" in **Agriculture Magazine**, August issue
- "Research helps bangus industry grow" (at left) in **Manila Bulletin**, 2 September issue
- "SEAFDEC Aquaculture Dep't's founding day celebrated" in **Agriculture Magazine**, October issue

In addition, AQD news appeared **30** more times in print media and **80** times in various websites.



**SEA CATCHERS FROM MALIBU** — The Southeast Asian Fisheries Development Center (SEAFDEC) based in Tigbauan, Iloilo, has developed an innovative fishery and aquaculture extension program that aims to improve the livelihoods of small-scale fishers and aquaculturists. The program focuses on providing technical assistance and training to fishers and aquaculturists. The program also provides access to credit and other services. The program is a joint effort of SEAFDEC and the Philippine Council for Aquatic Marine Research and Development and University of the Philippines Visayas. The program is currently being implemented in Malibu, Iloilo. Photo shows Dr. Rowena Eguia, SEAFDEC scientist, and the local fishers of the SEAFDEC hatchery.

MANILA BULLETIN  
 Agriculture Thursday, September 2, 2010 B-5  
 Volume 130 No. 183

**LARVAL REARING TANK FOR BANGUS** — The Southeast Asian Fisheries Development Center (SEAFDEC) pioneered the artificial propagation of milkfish as far back as 1976, and collaborated with the Bureau of Fisheries and Aquatic Resources (BFAR) in extending hatchery technology in the country. Photo shows a larval rearing tank at SEAFDEC's main station in Tigbauan, Iloilo. Because of research, the bangus industry has been able to grow significantly.

### Research helps bangus industry grow

**TIGBAUAN, Iloilo** — Thanks to research, the milkfish or bangus industry has grown significantly and is now a dollar earner for the country.

According to the Bureau of Fisheries and Aquatic Resources (BFAR) and the Food and Agriculture Organization (FAO), milkfish production in the Philippines reached P300,000 metric tons in 2007. Although the exported volume was only one percent of production, this brought in P24 million for the country. Exported milkfish went to the United States, Canada, United Kingdom, Australia, Japan, Korea and Hong Kong.

The 2007 milkfish production in the country was more than double that of ten years earlier as the industry grew at 7 percent a year. This growth is attributed by industry watchers to a number of factors. First is the shift back to milkfish farming by tiger shrimp farmers. Second is the adoption and proliferation of sea cages. And the third is the development of new aquaculture technologies, in particular the availability of hatchery-reared fry and the availability of formulated feeds.

In technology development, the Iloilo-based research center SEAFDEC or the Southeast Asian Fisheries Development Center pioneered the artificial propagation of milkfish as far back as 1976, and collaborated with BFAR in extending hatchery technology to the country. SEAFDEC has also studied the basic biology and physiology of milkfish. These studies have been the prelude to establishing nutrient or feed requirements, stocking densities in sea cages, maintaining fish health, even in engineering the design of milkfish egg collectors, among others.

SEAFDEC is a treaty organization that serves 11 member countries (ASEAN + Japan), and the Philippines, the host country of SEAFDEC Aquaculture Department (AQD). It is usually the first testing ground of its technologies and the Filipinos are the first to benefit. Only three countries are farming milkfish — the Philippines, Taiwan and Indonesia. However, Malaysia and Thailand are expressing their interest.

Milkfish hatchery technology did not immediately take off. There were still a lot of fry caught in the wild in the '80s and the fish farmers themselves were doubtful of hatchery-reared fry because of deformities. This was "cured" by researchers by adding vitamin C to fish diet. Still, SEAFDEC, BFAR and other institutions like PCAMRD (the Philippine Council for Aquatic Marine Research and Development) and University of the Philippines Visayas persevered, knowing that wild catches of most commercially important fishes have been historically declining because of pollution and over-exploitation.

The experts firmly believe that aquaculture can bridge the demand and supply gap. Thus, by 1984, AQD began conducting its annual training course in marine fish hatchery, and also initiated an adopt-a-milkfish-hatchery scheme for the private

sector. It built an integrated fish seedstock and hatchery demonstration complex in 1986 in Tigbauan, Iloilo to give trainers hands-on experience and to disperse fry to the private sector. It was also able to formulate an effective diet for milkfish larvae by 1990 and for broodstock by 1997.

"We are often asked what the impact of R&D is, especially research from SEAFDEC," noted Dr. Joebert Toledo, chief of SEAFDEC/AQD. "Without research, there would be no milkfish hatchery, no seedstock, no levels, and no ways of controlling the spread of fish diseases, in aquaculture. The bottom line is to see the benefit of milkfish that the country is producing. If this comes from aquaculture and not from municipal or commercial fisheries, then it comes mostly from research. And if it comes from research, then it comes mostly from SEAFDEC, too."

According to the FAO, 96.24 percent of the milkfish produced in the Philippines in 2007 came from aquaculture. BFAR could not report milkfish catch from municipal or commercial fishing as this was negligible.

"If there are milkfish farms and milkfish hatcheries, there must be technical people manning these

businesses. Technical training comes from research centers. I think SEAFDEC does it best because it developed the breeding and hatchery technology, and conducted the fish nutrient requirement and fish health studies," Dr. Toledo said, noting that about 121 papers on milkfish were already published by SEAFDEC in peer-reviewed science journals, with the first paper appearing in 1978 and the latest in June 2010.

"The results described in these science papers are used in our training courses, in our farmer-friendly extension manuals, and in our demonstration and field verification projects," he said. "This is why SEAFDEC can proudly say that its aquaculture technologies are science-based."

Most recently, four barangays in Nueva Valencia, Guimaras, that were affected by the 2006 oil spill took home their profits from a SEAFDEC-Petrowest Foundation project on milkfish sea cage culture project. Women in two barangays in Tigbauan, Iloilo were also trained on milkfish postlarval and marketing, an activity that was part of a SEAFDEC collaborative project with North Carolina State University and funded by the AQUAFISH Collaborative Research Support Program.

**FISH FEED** — The SEAFDEC scientists have developed appropriate feed formulations for the different life stages of bangus which are manufactured at the Center's feed mill.

**MILKFISH SEACAGE** — The proliferation of sea cages for the production of bangus has contributed immensely to the increase in bangus output in the Philippines. The sea cage technology is now used in mariculture parks that the government is promoting. Photo shows a milkfish sea cage at the mariculture park in SEAFDEC's Iqang Marine Station in Guimaras.



## Regional technical consultation on sustainable aquaculture (RTC-A)

AQD convened the RTC-A in Bangkok, Thailand from 17-19 March to work out the priority issues and R&D areas that would go into the SEAFDEC workplan on aquaculture for 2012-2020.

SEAFDEC member countries, as well as AQD, made status reports and assessments of their progress from 2002 to 2009 in these four thematic areas: (1) meeting social and economic challenges; (2) better seeds for sustainable aquatic food production; (3) healthy and wholesome aquaculture; and (4) protecting the environment and climate change.

Overall, the RTC-A recommended a back-to-basics approach by shifting more focus to integrated polyculture systems, rural aquaculture and small-holder food production systems.

The countries all agreed that food security issues are very complex and unique to each country, and that aquaculture still plays an important part in national government plans on poverty alleviation.

## Strategic planning workshop

After the RTC-A, AQD held its annual *In-house planning and review* on 28-30 September specifically to harmonize its own 2009-2012 strategic plans with those of the RTC thematic areas. This was held at AQD's Tigbauan Main Station in Iloilo.

AQD senior staff determined major gaps in current aquaculture technologies, suggested priority R&D areas, made action plans and identified potential collaborators. Knowledge gaps became the basis for the new proposals made by AQD researchers for 2011.

## Drafting plans-of-action for 2012-2020

AQD inputted the RTC-A and strategic planning workshop results into the draft of the document titled *ASEAN-SEAFDEC resolution and plans-of-action*. This was done during the 20-21 December meeting convened by the SEAFDEC Secretariat in Samut Prakan, Thailand to consolidate the outcomes of the RTC series and/or surveys on international fisheries-related issues.

The final draft will later be presented at the *ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security Towards 2020* that will be held in June 2011 in Bangkok.



## FAO workshop on feeds

AQD organized and hosted for the Aquaculture Service of the Food and Agriculture Organization (FAO) a workshop on "On-farm feeding & feed management." With 62 participants, this was held in Manila from 13 to 15 September.

The workshop noted that, generally, the use of high quality feeds does not necessarily mean high returns for fish farmers. It is on-farm feeding protocols, like skip-feeding, that can significantly reduce costs. Both issues highlight the need for better extension and dissemination of new feeding strategies.

Participants to the *Regional technical consultation on sustainable aquaculture* held 17-19 March 2010 in Bangkok, Thailand



# Research-and-development programs

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
<b>DEPARTMENTAL PROGRAMS</b>					
<b>Integrated mollusc</b>					
1 Experimental hybridization between Philippine native abalone species; <i>Haliotis asinina</i> , <i>H. glabra</i> , <i>H. ovina</i> , <i>H. varia</i> , <i>H. planata</i> ; and triploid induction <i>H. asinina</i>	MR de la Peña	85%	531 370		
2 Optimization of culture conditions of the marine thraustochytrid strain <i>Schizochytrium</i> sp. LEY7	G Ludevese	20%	439 788		
3 Cultivation of <i>Cocconeis</i> sp. for settlement, growth and survival of post-larval abalone <i>Haliotis asinina</i>	MR de la Peña	45%	196 925		
4 Refinement of hatchery techniques for the donkey's ear abalone <i>Haliotis asinina</i> : improvement of fecundity and seed quality of wild breeders; standardization of transport techniques of larvae and juveniles; selective breeding; and bacterial diversity and algal community structure in biofilms of settlement plates for larvae	MR de la Peña / LD de la Peña	60%	528 901		
5 Stock enhancement of the abalone <i>Haliotis asinina</i> in San Joaquin	JP Altamirano	8%	194 945		
6 Development of recirculating system for the intermediate nursery rearing and broodstock maintenance of the donkey's ear abalone <i>Haliotis asinina</i>	TRC Mallare	45%	174 200		
7 Development and evaluation of microparticulate diet for feeding post-larval abalone <i>Haliotis asinina</i> Linne on the onset of larval settlement and metamorphosis: protein / energy levels	MB Teruel	15%	275 249		
8 Development of maturation diet for tropical donkey's ear abalone <i>Haliotis asinina</i> Linne: effect of dietary protein/energy levels on abalone reproduction	MB Teruel	15%	518 598		
9 Fisheries and seed production of the angelwing clam <i>Pholas orientalis</i> Gmelin 1790 for the rehabilitation of depleted wild stock	MJHL Ramos	80%	111 523		Government of Japan Trust Fund (GOJ-TF) for 2007-2009 activities
10 Culture of the tropical abalone <i>Haliotis asinina</i> Linne 1758, in plastic trays at three different sites; and growth of the tropical abalone <i>Haliotis asinina</i> and sandfish <i>Holothuria scabra</i> in black fabricated trays	VC Encena II	80%	823 512		
11 Large-scale production of donkey's ear abalone <i>Haliotis asinina</i> juveniles	NC Bayona	90%	685 438		



STUDY TITLE	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
<b>Mud crab / shrimp</b>					
12 Domestication of the indigenous white shrimp species <i>Penaeus merguensis</i> / <i>P. indicus</i>	FDP Estepa	35%	364 613		
13 Refinement of feeding and water management strategies in larval rearing of mud crab	ET Quinitio	25%	734 367		
14 Effects of dietary tryptophan on the antagonistic behavior of mud crab <i>Scylla serrata</i>	JLQ Laranja Jr	70%	675 147		
15 Development of practical feed for the grow-out culture of mud crab <i>Scylla serrata</i> Forskal	MR Catacutan	97%	400 871		
16 Culture of marine annelid <i>Perinereis</i> sp. and its use as substitute for fishmeal, shrimp meal and squid meal in shrimp feeds	VR Alava	50%	398 520		
17 Comparative performance of wild and pond-sourced <i>P. monodon</i> broodstock fed natural and artificial diets	MB Teruel	99%	129 999		Kagoshima University (Japan) for 2007-2009 activities
18 Polyculture of <i>Penaeus monodon</i> with <i>Siganus guttatus</i> in a biosecure environment-friendly culture pond system	NV Golez	35%	1 038 717		
19 Fattening of mud crabs in mangrove using individual bamboo pens and fed with trash fish or mussels	NG Opiña	90%	196 463		
20 Production of mud crab ( <i>Scylla serrata</i> ) with milkfish ( <i>Chanos chanos</i> ) and siganid ( <i>Siganus guttatus</i> ) in brackishwater ponds	RPCB Ragus	50%	420 229		
21 Nursery production of mud crab <i>Scylla serrata</i> in brackishwater ponds	JLQ Laranja Jr	100%	650 910		
<b>Marine fish</b>					
22 Development of assay utilizing IGF-II mRNA expression as marker for egg quality in grouper and siganid	JB Gonzaga	40%	129 950		
23 Growth, survival and nutritional composition of grouper fry fed formulated diet	OS Reyes	50%		393 110	Novus International
24 Refinement of seed production techniques for high value marine fish species such as grouper, red snapper, seabass and pompano	OS Reyes	80%	1 774 639		
25 Optimization of seed production of milkfish through feeding fortified diets: effects on eggs and fry quality	OS Reyes	80%	1 089 190		
26 Digestibility and effective level of meat and bone meal in formulated diet for milkfish <i>Chanos chanos</i> Forsskal grown in fresh and seawater	MR Catacutan	50%		552 000	Fats and Protein Research Foundation and National Renderers Association
27 Formulated diets for seahorse	MR Catacutan	22%	163 458		
28 Effect of dietary vitamin C on reproduction, egg and larval quality and immune responses of grouper <i>Epinephelus fuscoguttatus</i>	VR Alava	50%	356 400		
29 Use of soybean meal and soy protein concentrate as alternatives to fish meal in practical feeds for milkfish <i>Chanos chanos</i>	RM Coloso	75%		1 732 224	United Soybean Board (USA)
30 White cowpea meal as alternative source of protein for grouper <i>Epinephelus coioides</i>	PS Eusebio	86%	193 000		
31 Improvement of the nutritional value of locally available feed resources for practical aquatic feeds by submerged fermentation and solid substrate fermentation using milkfish gut bacteria and/or selected fungi	RM Coloso	65%	397 850		

STUDY TITLE	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
32 Assessment of the potential of mysid shrimps (Crustacea: Mysidacea) as live food in marine fish culture: nutritional evaluation of the mysid shrimps	PS Eusebio	90%	133 000		
33 Characterization of innate immune response of <i>Epinephelus coioides</i> to <i>Vibrio</i> sp. (JD2)	EC Amar	45%	300 000		
34 Intensive production of red tilapia hybrid ( <i>O. mossambicus-hornorum</i> hybrid x <i>O. niloticus</i> ) in polyculture with siganid ( <i>Siganus guttatus</i> ) in brackishwater ponds	RM Coloso	40%	710 554		
35 Verification of pompano ( <i>Trachinotus blochii</i> ) SEAFDEC grow-out diets in cages in pond	EB Coniza	40%	430 283		
36 Nursery cage culture of grouper and seabass in brackishwater ponds: use of an in-pond sorter cage, determination of optimum stocking density and appropriate feeding frequency to mitigate cannibalism	RSJ Gapasin	30%	648 562		
37 Use of phased diets (starter, grower and finisher) for grouper ( <i>Epinephelus fuscoguttatus</i> ) cultured in floating net cages	RM Coloso	90%	477 690		
38 Refinement of intensive grow-out culture of sea bass ( <i>Lates calcarifer</i> ) in brackish water ponds using SEAFDEC formulated diets with higher energy level	RM Coloso	80%	605 130		
39 Refinement and dissemination of intensive grow-out technique for the polyculture of milkfish <i>Chanos chanos</i> , white shrimp <i>Penaeus indicus</i> and crab <i>Scylla</i> spp.	NV Golez	100%	509 199		
40 Netcage culture of sea bass <i>Lates calcarifer</i> (Bloch) in freshwater farm reservoir using SEAFDEC formulated diet and commercial feed	DD Baliao	90%	326 028		
41 Verification of rabbitfish ( <i>Siganus guttatus</i> ) SEAFDEC grow-out diets in cages in ponds	EB Coniza	100%	118 042		
42 Semi-intensive production of siganid <i>Siganus guttatus</i> fingerlings in ponds using artificial diets	JM Ladja	95%	340 272		
43 Demonstration and semi-intensive production of rabbitfish ( <i>Siganus guttatus</i> ) and snapper ( <i>Lutjanus argentimaculatus</i> ) in pond using SEAFDEC grow-out diets	EB Coniza	40%	448 041		
44 Fingerling production of high value marine fishes <i>Lates calcarifer</i> and <i>Lutjanus argentimaculatus</i>	JM Ladja	50%	533 092		
45 Nursery culture of pompano ( <i>Trachinotus blochii</i> Lacepede) in floating net cages	AG Gaitan	40%	97 583		
46 Pompano ( <i>Trachinotus blochii</i> Lacepede) grow-out culture in floating net cages	AG Gaitan	100%	809 878		
<b>Seaweed strain improvement</b>					
47 Development of molecular genetic markers for <i>Kappaphycus</i>	MMD Peñaranda	35%	372 025		
48 Evaluation of <i>Kappaphycus alvarezii</i> as bioremediator in intensive shrimp culture	HS Marcial	10%	321 953		
49 Studies on the bioremediation capacity of seaweed <i>Gracilaria heteroclada</i> and <i>Caulerpa racemosa</i> : microscale experiment	HS Marcial	15%	319 053		
50 Seed production of <i>Kappaphycus</i> : hybrids	MRJ Luhan	40%	1 123 712		
51 Screening of antimicrobial activities of crude extracts from Philippine seaweeds	MMD Peñaranda	35%	307 025		

STUDY TITLE	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
<b>Aquatic ecology</b>					
52 Determination of optimal conditions for growth and survival of sandfish juveniles for culture	JP Altamirano	15%	414 222		
53 Co-culture of sandfish <i>Holothuria scabra</i> and black tiger prawn <i>Penaeus monodon</i> in the mangroves	MJHL Ramos	100%		434 980	Japan International Research Cooperation Agency (JIRCAS)
54 <i>Anodontia philippiana</i> and <i>Holothuria scabra</i> as bioremediators in an intensive cage culture system	MJHL Ramos	40%	264 492		
55 Identification of fish species suitable for polyculture with sea cucumber	J Zarate	40%	156 000	371 800	Australian Center for International Agricultural Research (ACIAR)
56 Biodiversity in the brackishwater ponds and the adjoining mangroves, rivers, and shores in Dumangas, Iloilo: species composition and volume of the pond by-catch in relation to natural seeding and farm management practices	TU Bagarinao	90%	30 000		
57 Social acceptability of aquaculture as livelihood option for fishers affected by oil spill in four coastal barangays in Nueva Valencia, Guimaras	ET Aldon	50%	70 175		
<b>Small-holder freshwater aquaculture</b>					
58 Selective breeding for enhanced traits in saline-tolerant tilapias ( <i>Oreochromis</i> spp). I. Growth, survival and fillet yield of Mozambique tilapia, commercial tilapia hybrids and saline-adapted Nile tilapia in brackishwater conditions	MRR Eguia	60%	466 455		
59 Reproductive biology of the silver perch <i>Leiopotherapon plumbeus</i> (Teleostei: Terapontidae) from selected freshwater habitats in Luzon	LMB Garcia	95%	325 000		
60 Larval rearing of the silver perch <i>Leiopotherapon plumbeus</i> (Kner, 1864) under laboratory conditions	FA Aya	5%	194 735		
61 Partial replacement of fish meal with cowpea meal in diets for postlarvae and juvenile giant freshwater <i>Macrobrachium rosenbergii</i> (de Man 1879)	FA Aya	5%	219 957		
62 Production characteristics of the giant freshwater prawn <i>Macrobrachium rosenbergii</i> cultured in cages using different grow-out management strategies	MLC Aralar	35%	134 606		
63 Carrying capacity, decision support tools for freshwater systems in Australia and the Philippines	MLC Aralar	3%		1 225 126	ACIAR
64 Supportive breeding and restocking of indigenous freshwater fishes in selected Philippine inland water systems. I. Cage farming of the silver therapon, <i>Leiopotherapon plumbeus</i> in Laguna de bay	MA Laron	90%	118 214		
65 Identification and control of freshwater and marine fungi affecting <i>Macrobrachium</i> spp., broodstock and larvae	CL Pitogo / D Catedral	30%	20 000		
66 Netcage culture of tilapia and freshwater prawn in freshwater dam/reservoir using SEAFDEC and commercial feed	DD Baliao	35%	258 091		
67 Grow-out culture of Asian catfish <i>Clarias macrocephalus</i> (Gunther) in net cages in Laguna de Bay, Philippines	AD Evangelista	65%	131 500		



STUDY TITLE	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
68 Freshwater aquaculture seedstock production in Laguna de Bay I. Advance bighead carp fingerlings production in a small fishpen	EV Aralar	75%	499 486		
69 Mass production of freshwater prawn post-larvae using green water system	MA Laron	90%	360 823		
70 Mass production of <i>Tilapia nilotica</i> and red tilapia	DM Reyes Jr	75%	567 366		

## REGIONAL PROGRAMS

### Promotion of sustainable and region-oriented aquaculture practices

71 Selective breeding of mud crab <i>Scylla serrata</i>	ET Qunitio	15%	299 585	282 000	GOJ-TF
72 Selective breeding of <i>Penaeus monodon</i>	FDP Estepa	15%	93 609	282 000	GOJ-TF
73 Genetic improvement in the giant freshwater prawn <i>Macrobrachium rosenbergii</i> . I. Development of effective broodstock management schemes for improved growth and reproductive performance	MRR Eguia	80%	266 850	282 000	GOJ-TF
74 Reproductive biology of pompano and other potential species for aquaculture	FL Pedroso	20%	373 740	282 000	GOJ-TF
75 Survey of availability and quality assessment of feed resources	MR Catacutan	15%		282 000	GOJ-TF
76 Development of low-pollution diets for giant freshwater prawn broodstock	FA Aya	2%		235 000	GOJ-TF
77 Mass production of <i>Kappaphycus</i> from spores	MRJ Luhan	15%		282 000	GOJ-TF GOJ-TF / RESCOPAR (Wageningen University)
78 Establishment of management technology for disease tolerance and sustainable aquaculture environment	EA Tendencia	10%		604 392	
79 Socioeconomic assessment and impact analysis of transfer and adoption of sustainable aquaculture technologies	DB Baticados	20%	468 388	188 000	GOJ-TF

### Food safety of aquaculture products in Southeast Asia

80 Surveillance of chemical contaminants in aquaculture products and feeds	MR Catacutan	15%		329 000	GOJ-TF
81 Withdrawal period of antibiotics in milkfish <i>Chanos chanos</i> and some freshwater fish species cultured in the tropics	MT Arnaiz	92%		521 700	GOJ-TF

### Accelerating awareness and capacity-building in fish health management in Southeast Asia

82 Establishment of immunization regimen for the prevention of viral nervous necrosis (VNN) in high-value marine broodfish	RV Pakingking Jr	40%		282 000	GOJ-TF
83 Establishment of novel prophylactic and therapeutic methods for the prevention of viral infections in commercially important maricultured fish	RV Pakingking Jr	15%		282 000	GOJ-TF
84 Evaluation of carriers for practical delivery of vaccines to shrimp, <i>Penaeus monodon</i> and other crustaceans	EC Amar	20%		282 000	GOJ-TF
85 Parasitic and shell diseases of abalone ( <i>Haliotis asinina</i> ) in the Philippines	GE Pagador	20%		164 500	GOJ-TF
86 Surveillance of parasite fauna of economically important freshwater fish in some Southeast Asian countries	GE Pagador	9%		150 400	GOJ-TF
87 Molecular diagnosis and prevention of viruses in economically important fish and shrimp; and susceptibility of different shrimp species to white spot syndrome virus (WSSV)	LD de la Peña	15%		282 000	GOJ-TF

STUDY TITLE	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING AGENCY
			SEAFDEC	EXTERNAL	
<b>Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release</b>					
88 Reproductive biology and seed production of Napoleon wrasse <i>Cheilinus undulatus</i>	FL Pedroso	15%	373 740	235 000	GOJ-TF
89 Stock enhancement of seahorses <i>Hippocampus barbouri</i> and <i>H. comes</i>	SMB Ursua	75%	602 309	258 500	GOJ-TF
90 Stock enhancement of the abalone <i>Haliotis asinina</i> in Sagay Marine Reserve	MJHL Ramos	30%	80 000	258 500	GOJ-TF
91 Stock enhancement of mud crabs <i>Scylla</i> spp. in the mangroves in Panay	MJHL Ramos	20%	106 738	258 000	GOJ-TF
92 Community managed sandfish ( <i>Holothuria scabra</i> ) sea ranching and stock release	MFJ Nievaes	20%	172 440	235 000	GOJ-TF
93 Socioeconomic analysis and identification of strategies for managing released stocks of abalone and sea cucumber in Sagay Marine Reserve in Negros Occidental in the Philippines	ND Salayo	17%		211 500	GOJ-TF
<b>SPECIAL PROJECTS</b>					
94 Integrated fisheries resource management (Rinconada Lakes, Philippines and NSW Australia): aquaculture and water component	MLC Aralar	100%		392 143	ACIAR
95 Application of molecular markers in the conservation and management of marine genetic resources in Asia	MRR Eguia	15%	551 400	Part of travel expenses & materials cost for sample analysis in Japan	Japan Society for the Promotion of Science
96 Enterprise development options: organizational, financial and market analysis in milkfish cage culture as livelihood option of fishermen affected by Guimaras oil spill	DHM Tormon	80%		130 169	Petron and CITI Foundation
97 Pilot testing of the "indigenous probiotic" in grow-out shrimp	GL Po	80%	284 000		Government of Japan Trust Fund for 2007-2009 activities
98 Establishment of polyculture system of tiger prawn <i>Penaeus monodon</i> and sandfish <i>Holothuria scabra</i>	S Watanabe	25%		1 040 837	JIRCAS



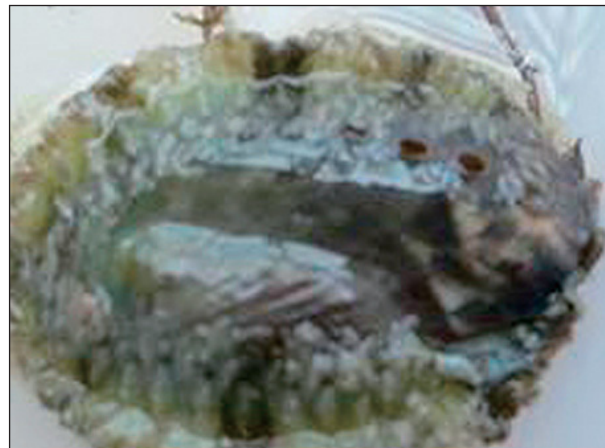
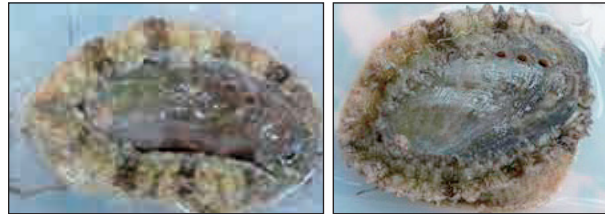
Transport of abalone juveniles using oxygenated bags with 12% reduction in water volume (total capacity of styrobox is 40L). Less water would mean less weight and less transport cost

## DEPARTMENTAL PROGRAMS

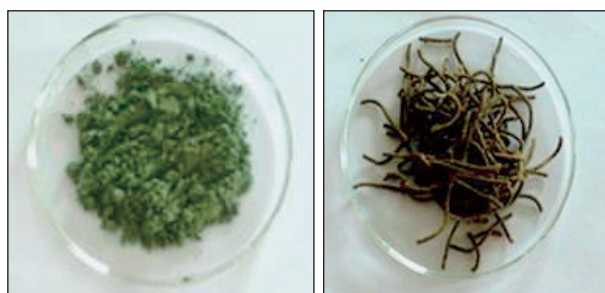
# Integrated mollusc abalone, angelwing clam

In 2010, the program continued to refine abalone hatchery techniques to improve the settlement and survival of postlarvae which are still considered as the bottlenecks of seed production. For broodstock, the focus was on formulated diets to improve overall reproductive performance. For grow-out, verification tests will be done for the two abalone hybrids and the formulated diets developed by AQD. The hybrids are potential replacements for the slow-growing *Haliotis asinina*, while the diets are meant for growing areas that do not have abundant seaweed (*Gracilaria*) supply.

For the angelwing clam *Pholas orientalis*, spawning trials just started.



AQD developed two hybrids, HAFPM and HAFGM (top, L-R), by crossing female *Haliotis asinina* (middle) with male *H. planata* (for HAFPM) (above left) or *H. glabra* (HAFGM) (above right)



If abalone farmers can not get enough fresh seaweeds (the main food of the abalone), they can feed the formulated diets developed by AQD for larvae (left) and growout (right). Colored green, the diet is seaweed-based

## Hatchery

To find the best natural diet for abalone postlarvae, two diatoms (*Cocconeis* sp., two strains; and *Nitzschia*, three strains) were tested for growth and ease of culture. All five strains were exposed to three light intensities (7, 9 and 20  $\mu\text{mole m}^{-2} \text{sec}^{-2}$ ) and four types of enrichment media (Guillard & Rhyther's Complete F/2, F/2 Macro/Technical, Liao & Huang's TMRL and Renaud's Commercial II). Light intensity did not significantly affect cell yields in all strains but the medium did. The Complete F/2 consistently favored growth of both diatoms but it is expensive. *Cocconeis* can only be ingested when abalone post-larvae reached 800  $\mu\text{m}$  or bigger.

To reduce dependence on diatom and allow more control over the nutritional composition of feed, a microparticulate diet for abalone postlarvae was formulated. It had a protein content of 37%, higher than that of diatom (15%), and with an average particle size of 4–5 $\mu\text{m}$ .

To standardize transport techniques, trials for abalone veligers and juveniles (two sizes) were done. The loading densities tested for juveniles were 25-150  $\text{pipe}^{-1}$  with transit times of 1-32 h.

Veligers transported in 1-5 h and packed at 25-100  $\text{ml}^{-1}$  had best survival of 78-94%.

Juveniles (1.0-1.5 cm) transported up to 16 h at densities of 100-150  $\text{pipe}^{-1}$  had best survival of 88-92%.

Bigger juveniles (2.0-2.5 cm) obtained best survival (97%) when transported at a loading density of 25  $\text{pipe}^{-1}$  for 16 h.

To prevent inbreeding, improve seed quality, and develop a strategy for genetic management, new sets of abalone breeders were collected from Palawan, Bohol and Masbate (Philippines). The breeders from Masbate and Palawan produced two batches of  $F_1$  cohorts. The first batch was compared with hatchery-bred (HB) cohorts from existing breeders. Batch 1 and HB had settlement rates of 2-3%, survival of less than 0.5% and specific growth rate of 2.0-2.4%  $\text{day}^{-1}$  after 90 days.

The juveniles from Masbate breeders were later sorted into three sizes: large (>10 mm), medium (6-9 mm) and small (<5 mm). After 120 days of culture, the large juveniles were bigger (30 mm final length), heavier (6.3 g), and had higher survival



(95%) than the medium-sized ones (24 mm, 3.4 g, 74%, respectively).

The bacterial population of biofilms from settlement plates were determined to see its effects on the settlement of abalone. Results showed that non-vibrios dominated (n=63 bacterial isolates) during the dry season hatchery run. Most were gram-negative, and were either *Vibrio harveyi* or *V. parahaemolyticus*. Some were *V. splendidus*, *V. vulnificus*, *V. cholerae*, *V. fischeri*, *Allivibrio salmonicida*, and *Photobacterium profundum*.

In the wet season hatchery run, a total of 26 isolates of dominant bacteria were obtained after 45 days of culture. Identification and pathogenicity tests of the isolates are on-going.

## Nursery

Marine thraustochytrids are known to contain high amounts of docosahexaenoic acid (DHA), a substance which has been proven to improve survival in larviculture. Experiments were conducted to determine optimal conditions for the mass production of different

thraustochytrid isolates. Results for *Schizochytrium* sp. (strain LEY7) showed that commercial glucose can serve as carbon source while yeast extract prepared from NaCl-treated baker's yeast can provide nitrogen and vitamins. The substrates gave cell yields of  $1.5 \times 10^6$  cells  $\text{ml}^{-1}$ .

Two water systems (recirculating or flow-through) using the seaweed *Gracilaria bailinae* as filter and two feed types (SEAFDEC formulated diet & the seaweed *Gracilaria*) for intermediate abalone nursery were compared. Results showed that abalone can be grown either in recirculating or flow-through water systems. In the recirculating system, abalone fed artificial diet grew better than those fed *Gracilaria*, while in the flow-through system, those fed *Gracilaria* grew faster. Survival (93-95%) was higher in those fed *Gracilaria* in both types of water systems.

To reduce cost of land-based nursery rearing, small abalone juveniles (15-20 mm, 0.5-0.9 g) were reared in 4 types of prefabricated plastic trays for 90 days. The highest final growth gain (7 g, 32 mm), survival (85%),

and feed conversion (1:16) were attained in black boxes followed by abalone reared in round mesh cages, black prefabricated plastic trays, and blue boxes.

## Broodstock

The use of good maturation diet plays a major role in producing good quality seeds. Maturation diets for abalone with various protein/energy ratios were developed and are still being tested to improve spawning frequency, hatching rate and quality of trocophore larvae.

For the angelwing clam, four spawning trials were conducted from March to May using >100 mm clams which were induced to spawn by serotonin injection. Early juvenile clams (24 days-old) measuring 3 mm shell length and 2 mm shell width had been produced. They were fed the algae *Chaetoceros calcitrans*, *Isochrysis galbana* or a combination of both.

## Grow-out

Growing abalone in black prefabricated trays was verified. After 210 days, abalone measured an average shell length of 48 mm and body weight of 24 g. There seemed to be decreasing growth trend from day 30 onwards, ie., from 143 to 71  $\mu\text{m day}^{-1}$  and from 144 to 76  $\text{mg day}^{-1}$ . The decrease in growth rate was attributed to the sexual maturation of 30-35 mm abalone and the onset of spawning.

Abalone are slow growers, requiring six months to reach marketable size. To improve the culture of *Haliotis asinina* and other abalones native to the Philippines, AQD produced two presumptive hybrids: (1) HAFPM (*H. asinina* female x *H. planata* male) and (2) HAFGM (*H. asinina* female x *H. glabra* male).

The HAFGM hybrid grew faster, reaching 30 g in 360 days which was 45 days earlier than *H. asinina*. But given another month, both had similar shell length (about 4.5 cm). Eventually, the hybrid out-performed *H. asinina*, needing only 510 days to reach a 5 cm size, two months earlier than *H. asinina*.

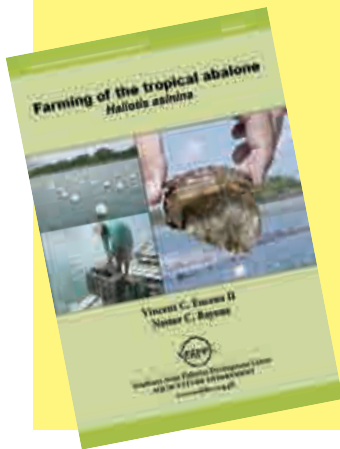
To determine the general health or vigor of the hybrids, two salinity stress tests were conducted. The first stress test directly exposed the 3-4 cm juveniles to low salinities of 30, 25 and 20 ppt for 7 days. Results showed that at 25 ppt, the hybrid juveniles HAFGM and HAFPM all survived while there was 2% mortality in *H. asinina*. At 20 ppt, more HAFPM survived (93%) compared with *H. asinina* (77%) and HAFGM (65%).

The second stress test gradually exposed the 3-4 cm juveniles to lower salinities of 20, 15 and 10 ppt for 5 days. Results showed that at 20 and 15 ppt, more HAFPM survived (98%, 77% respectively) compared with HAFGM (90%, 48%) and *H. asinina* (87%, 68%). At 10 ppt and after 8 h of exposure, HAFPM hybrid showed better survival (83%) compared to HAFGM (47%) and *H. asinina* (62%).

Thraustochytrid cells viewed under the microscope at 100x magnification (left) and biomass produced on honey & commercial glucose as carbon sources



GLUDEVESSE



### TECHNOLOGY TRANSFER FOR ABALONE

AQD offers a yearly course on abalone hatchery and grow-out culture which also includes the important module on seaweed culture. AQD has also published a manual in 2010 on farming the tropical abalone *Haliotis asinina*. AQD's manual on abalone hatchery was already published in 2008

### TECHNOLOGY DEMONSTRATION FOR ABALONE

In 2010, AQD's new, low-cost, small-scale demonstration abalone hatchery produced 126 760 juveniles with total earnings of Php 168 220 (about US\$ 3 800). While its R&D hatchery produced 277 665 juveniles with earnings of Php 244 650 (US\$ 5 560). Numerous visitors and entrepreneurs have come to be updated on abalone hatchery and see the AQD facilities





# Domesticating shrimp, mud crab

The domestication program aims to improve the supply of good quality broodstock and seed of indigenous crustacean species particularly the shrimps *Penaeus monodon* and *P. indicus* and the mud crab *Scylla* species. The program focuses on selective breeding and better husbandry techniques in all phases of culture such as broodstock management, larval rearing, nursery, grow-out and fattening. The activities in this departmental program are linked with the regional program on sustainable aquaculture under the ASEAN-SEAFDEC Fisheries Consultative Group.

## Shrimp

For the selective breeding of the white shrimp *Penaeus indicus*, nauplii from wild broodstock sourced from Tigbauan and Antique (west central Philippines) were reared to adult size. The big-sized males and females were selected and used in reciprocal matings. From each source, 20 females were ablated and monitored. After a month, 25% of the females from Antique (mated by Tigbauan males) and 35% of females from Tigbauan (mated by Antique males) matured but viable nauplii were produced by only 40% and 71% of these females, respectively. Fourth generation adult shrimp from base population stocks originating from Negros will also be selectively bred.

White shrimp *Penaeus indicus* broodstock were fed diets containing marine annelid meal at levels of 0% (control, no annelid meal), 5% and 10% of the diet with or without supplementation of wild annelids. In all

treatments, squid and mussel meat were given. After ablation, maturation to Stages I and II were observed in all treatments but none of the stocks attained Stage III after a month in the tanks when ambient water temperature was 33-34°C. Maturation to Stages III and IV and spawning were observed starting middle of July. Significantly higher %maturations were attained in the control (80%) and 5% annelid incorporation with (100%) or without live annelids (67%) compared to 10% incorporation with (30%) or without live annelids (37%).

Formulated diets containing annelid extracts were also tested for wild-sourced *Penaeus monodon* broodstock. A diet formulated in Japan (Laboratory of Nutritional Chemistry, Kagoshima, Japan) supplemented with either trichloro-acetic polychaete extract or powdered freeze-dried polychaete had the highest efficiency

in stimulating ovarian development as evidenced by the ovary shadow ratios, and resulted in the highest number of spawnings and shortest maturation period. These parameters were not significantly different from broodstock fed the SEAFDEC-formulated diet supplemented with locally available polychaete meal. Broodstock fed fresh frozen polychaetes had significantly lower spawning rates and efficiency in stimulating ovarian development.

Wild-sourced marine annelid *Perinereis quatrefagesi* was used as an ingredient to replace a mixture of fish meal, shrimp meal and squid liver meal in the diets of shrimp and mud crab. Annelid replacement higher than 20% did not enhance growth of *P. indicus* and *Scylla serrata*. At 1.5-4.5% level in the diet, *Perinereis* meal, squid meal and their 1:1 combination promoted higher growth in shrimp and mud crab juveniles than the control diet (no annelid and squid meal). Survival was not affected by diet.

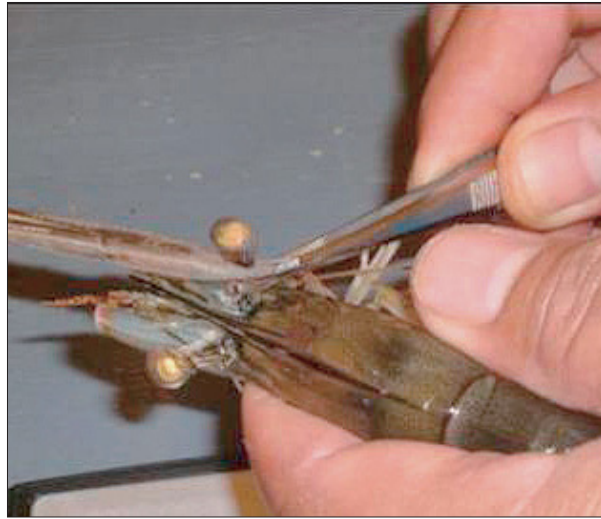
The biology of two species of annelids was studied for better understanding of their requirements for growth and survival. *Perinereis quatrefagesi* (Grube 1878), a semelparous species, was found to reach a maximum total length (TL) of 30 cm and body weight (BW)

of 1.6 g. Five maturation stages were identified based on oocyte size, histology and external morphology in females. Mean fecundity was 20 963 oocytes per female. *Perinereis* collected from the wild contained 53% crude protein (CP) and 16% total lipids (TotL) with 0.4% ARA (20:4n-6), 8.6% EPA (20:5n-3) and 0.6% DHA (22:6n-3). In contrast, *Marphysa mossambica* (Peters 1855), a large iteroparous eunicid polychaete common in mangrove areas, reached a maximum TL of 103 cm and BW of 9 g. Four maturation stages were identified in females. Mean fecundity was 22 125 oocytes per female. Wild *Marphysa* contained 65.5% CP and 14% TotL with 5.5% ARA and 2.5% EPA.

*P. quatrefagesi* spawns once and dies while *M. mossambica* can spawn many times in its lifetime.

*Perinereis* was cultured in tanks and fed either minced fish, hatchery waste, feed mill sweepings and seaweeds. Total lipids increased 2-3 times and contained 0.7-1.1% ARA, 0.6-2.0% EPA and 1.0-1.3% DHA. *Perinereis* has a high potential to replace fish oil in feeds as this was found to contain relatively good HUFA profile. Natural reproduction of *Perinereis* has been attained in the outdoor tank and juveniles were found at a density of 17-25 juveniles m<sup>-2</sup>.





[Clockwise] Broodstock of the Philippine native shrimp *Penaeus indicus*, the ablation of an eyestalk to remove hormones that inhibit maturation, counting of juveniles, and weight-sampling of broodstock

## Mud crab

To improve survival in the hatchery, larval feeding studies were conducted for *Scylla serrata*. Umbrella-stage brine shrimp *Artemia* was tested as a substitute for rotifers in feeding day 2 zoea until megalopa stage. Based on survival, results showed that rotifer is still a more superior food for early zoeal stages. In another experiment, survival was higher in crab larvae fed *Artemia* enriched with DHA protein SELCO (3%) than those fed *Artemia* without enrichment (1%).

However, the duration from zoea 3 to megalopa did not differ.

A diet was formulated for later larval stages of mud crab to reduce the occurrence of molt death syndrome at zoea 5 / megalopa. Larvae were fed formulated diet, natural food (*Artemia* nauplii), or a combination of both. Those fed formulated diet alone were not able to molt to megalopa stage. Those fed *Artemia* and combination diet gave similar growth

and survival which were significantly better than those given the formulated diet.

Different doses of antibiotics were tested in crab hatchery production runs to determine the levels that will improve survival and result in least morphological abnormalities. Oxytetracycline (3.0 and 6.0 ppm) and furazolidone (0.5 and 1.0 ppm) were used in rearing zoea to megalopa. These were reared further to juvenile stage in the nursery facilities without use of antibiotics. After two months of culture, morphological abnormalities such as fused

lateral spines, depressed tip of abdominal flap, asymmetrical abdominal flap, and fused frontal spines were observed. The occurrence of abnormalities was highest in those treated during the larval stage with 1 ppm furazolidone (54%), followed by 3.0 ppm oxytetracycline (21%), 0.5 ppm furazolidone (18%) and 6.0 ppm oxytetracycline (15%).

Cannibalism is one of the major causes of low survival in crab hatchery and nursery, with serotonin implicated as a key physiological regulator of agonistic behavior. A series of experiments was conducted

to determine the effect of tryptophan (trp), a precursor of serotonin, and exogenous serotonin on aggressive behavior and dominance in crab. Bigger mud crabs (3.7-4.8 g), previously established to be dominant over smaller crabs (2.0-2.4 g), were fed formulated diet containing no trp (control, 0%) and 0.5% and 1% trp. These were then matched for confrontation with smaller crabs after 3, 7, 10, 15, 21 and 30 days of feeding. Those fed the diet containing 1% trp had the lowest frequency and intensity of attacks compared with crab receiving the 0% or 0.50% trp diets.

The effect of serotonin injection on the antagonistic behavior of dominant and subordinate mud crab was also investigated. The bigger dominant crabs were paired with smaller subordinate crabs. Injection of  $3 \mu\text{g g}^{-1}$  body weight serotonin to mud crab significantly reduced the

frequency and intensity of attacks by dominant crab, and increased the defensive stance of subordinate crab.

In another experiment, competition for shelter was investigated. Prior to injection, most of the bigger crabs were found inside PVC shelters, indicating dominance over the smaller crab that tended to stay outside shelters. Saline solution (control),  $0.3 \mu\text{g g}^{-1}$  or  $3 \mu\text{g g}^{-1}$  serotonin was injected to bigger crabs, while saline was injected to smaller crabs. During the day, a significantly higher percentage of bigger crabs given saline or  $0.3 \mu\text{g g}^{-1}$  serotonin occupied the shelter compared with those given higher dose of serotonin. However, a similar percentage of saline-injected or serotonin-injected crabs was found outside the shelters during night time, due to their nocturnal feeding behavior.

Nursery culture of mud crab was verified at AQD's Dumangas Brackishwater Station. Megalopa or crab instars obtained from the AQD hatchery were stocked in  $20 \text{ m}^2$  net cages set inside a  $600 \text{ m}^2$  pond. After one month of culture, crablets reached a size of 0.8-1.5 cm internal carapace width (ICW) (phase 1) and 3-4 cm ICW when grown for another month (phase 2). A total of 35 885 juveniles were produced in eight cropping cycles, with survival rates of more than 50% in all runs except for the runs in June (35%) and October (35%).

Feeding experiments were done in ponds to determine growth and survival of *Scylla serrata* (3-6 g) given two diet formulations having the same dietary energy value but with different protein levels. Crab stocked at about  $0.1 \text{ sq m}^{-1}$  were given a daily ration of 80-90% of formulated feed and 10-20% trash fish.

The ration was given for 159 (run 1) and 145 days (run 2). Survival ranged 16-52% in run 1 (cold months) and 31-79% for run 2. The responses of the crabs were not different between the two dietary treatments. Final mean weight ranged from 370 to 443 g, with some crab reaching weights of 800-930 g. Formulated diet at 90% of the ration was able to sustain crab growth.

The same high protein test diet will be used in production runs where mud crab will be cultured together with milkfish.

Crab fattening was also conducted. Three species of lean mud crab were stocked individually in bamboo pens. About 600 pieces were stocked from January to December. Over this period, 430 pieces were harvested. Of the total biomass weight harvested, 16% was *S. serrata*, 33% *S. tranquebarica*, and 44% *S. olivacea*.



Fattening set-up for mud crab at AQD's Dumangas Brackishwater Station (above and top middle); the crab is penned individually (top right)



Crab exhibiting the defensive stance (left) and the dominant stance (above left)



## TECHNOLOGY TRANSFER FOR MUDCRAB AND SHRIMP

AQD conducted a three-week hands-on training on crab seed production and grow-out at its main station in the Philippines; three-day seminars also on seed production in Myanmar in March and in Brunei Darussalam in November; and a special course for a Singapore national at AQD.

For shrimp, a farming course was conducted for two weeks in April.

AQD also issued a new manual on *Mud crab nursery in ponds* in July. Its 2008 manual on *Biology and hatchery of mud crabs, Scylla spp.* is already on its second edition

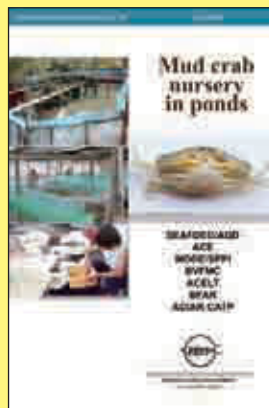


Participants of the crab seed production course held from 14 April to 5 May with AQD mentors and officials standing behind them



AQD scientist Dr. Emilia Quintio (top) and Department of Fisheries (DOF) - Myanmar officer Mr. Ye Win Thaung (above) lecture on aspects of crab seed production in Chaung Tha, Myanmar, 23-25 March, with 17 government fisheries workers in attendance. The seminar was requested and supported by DOF and the Government of Japan Trust Fund.

A second seminar was conducted in Brunei Darussalam, also sponsored by its DOF, and held 22-24 November with more than 85 participants



The special course on crab seed production and grow-out conducted 6-22 October (below); and the shrimp farming course on 12-28 April (below, right)



For information dissemination, AQD published a crab pond nursery manual in 2010 which is the collaborative work of seven institutions involved in community crab projects in Northern Samar, Philippines.

The news about AQD's crab seminar in Brunei Darussalam landed in *Brunei Times* and in *Borneo Bulletin* on 23 and 26 November, respectively





# Marine fish

The goal of the marine fish program is to continually improve culture technologies for sustainable aquaculture development, poverty alleviation in the countryside, and reinforcement of aquatic resources & food security in Southeast Asia. Marine fishes such as milkfish, grouper, seabass, mangrove red snapper, rabbitfish, pompano, spotted scat, Napoleon wrasse, hybrid red tilapia, and seahorse are among the species being studied in the program's 27 research topics.

Marine fish is the largest program at AQD, and is specifically aimed at:

- (a) improving broodstock management, seed production, nursery, and grow-out culture of groupers (*Epinephelus coioides* and *E. fuscoguttatus*), Asian sea bass (*Lates calcarifer*), mangrove red snapper (*Lutjanus argentimaculatus*), rabbitfish (*Siganus guttatus*) and milkfish (*Chanos chanos*)
- (b) developing the breeding and seed production technologies for Asian pompano (*Trachinotus blochii*), spotted scat (*Scatophagus argus*), and Napoleon wrasse (*Cheilinus undulatus*)
- (c) developing practical feed for Barbour's seahorse (*Hippocampus barbouri*) broodstock
- (d) developing polyculture techniques for saline-tolerant, hybrid red tilapia (*O. mossambicus-hornorum* hybrid x *O. niloticus*) in brackishwater ponds

The program also covers the hatchery production of various marine fishes and the production of marine fishes in brackishwater ponds and in floating net cages. These studies are being done in laboratory, broodstock, and hatchery/nursery facilities at AQD's Tigbauan Main Station, brackishwater ponds in Dumangas Brackishwater Station, and in floating netcages at Igang Marine Station

## Broodstock

### Developing a marker for egg quality

Previous studies have shown that insulin-like growth factor II (IGF-II) mRNA expression could be used to predict development during the early embryo stage in marine fishes. This information is being used to develop a non-invasive, simple, and rapid assay utilizing IGF-II mRNA expression as marker for egg quality in marine fishes. Preliminary results showed that the optimum sampling amount for grouper eggs at early embryo stage is 0.05 g and the starting extracted RNA volume for cDNA synthesis using Invitrogen first strand cDNA synthesis kit is 6  $\mu$ L.

### Reproductive biology of pompano and spotted scat

A total of 20 pompano breeders (14 females and 6 males) are being kept at AQD's Igang Marine Station. In January, March and April, sets of 3 females and 1 male were induced to spawn by injection of two doses of 1000 IU HCG  $\text{kg}^{-1}$  body weight. Between 840 000 and 1.5 million eggs were released with fertilization rates of 6 to 70%. Larvae hatched numbered 27 000 - 154 000.

Several sex ratios of pompano were tested (1 male:1 female, 2:1, 1:2, or 3:1). All fish were injected twice with HCG (1000 IU  $\text{kg}^{-1}$  body weight) within a two-day period and allowed to spawn in hapa nets in Igang. Spawning occurred but embryonic development did not proceed, probably due to sudden changes in temperature and salinity when heavy rain fell on the night of spawning. Dosage combinations from 250 to 1 000 IU<sup>-1</sup> kg body weight of HCG were also given over two days. Spawning occurred in all combinations, but embryonic development did not proceed probably because the milt of the F1 males were still thick, indicating unviable sperm cells.

AQD sourced 119 spotted scat (*Scatophagus argus*) spawners from Sagay, Negros Island in west central Philippines in January. In the first sampling during the first lunar quarter of February, biopsy and histology showed that the gonads were immature. By March, some fish had mature gonads and were induced to spawn by injection of 1000 IU HCG  $\text{g}^{-1}$  body weight; however, no spawning occurred. LHRH

was then used, but no eggs hatched. Further, there were *Caligus* sp and *Amyloodinium* infestations in the hatchery.

For the spotted scat held at 25 ppt, the efficacy of twice-injected LHRH (200 kg<sup>-1</sup> body weight) or HCG (1000 IU/kg<sup>-1</sup> body wt) to induce spawning was determined. Spawning occurred with LHRH but, like pompano, no embryonic development proceeded. LHRH doses were lowered; 50, 100, 150 and 200 µg kg<sup>-1</sup> body wt were tested. Still, spawning did not occur.

Salinity range test were made for spotted scat larvae weighing 0.1-0.2 g. Optimum salinity appeared to be about 15-20 ppt with 70-75% of the larvae surviving. Growth increments were 10, 11, 12, and 8% in salinities of 15, 20, 25, and 30 ppt, respectively.

### Biology and seed production of Napoleon wrasse

At the Palawan facilities of AQD's collaborating partner, Napoleon wrasse spawners were kept in 60-ton circular tank with a female-to-male ratio of 7:1. These were fed trash fish with the occasional squid, and water change was done daily. Spawning commonly occurred around 8-10 am or after water change. Spawning was almost daily but hatching rate was very low or oftentimes did not happen.

Hatching occurred 16-18 h after spawning. Egg size was 540 to 570 µm, but larvae developed only until day 4 (when yolk reserves were fully exhausted) due to lack of an appropriate

feeding strategy. Newly hatched larvae were around 1.4-1.8 mm long. At day 2, the eyes were visible, the gut had started to develop, and the mouth gape was about 120-140 mm. At day 3, pigmentation at the posterior end of the body appeared, the mouth and anal opening were visible, and the pectoral fins were already developed. Low fertility and hatching rate maybe due to high number of female-to-male ratio in spawning tank.

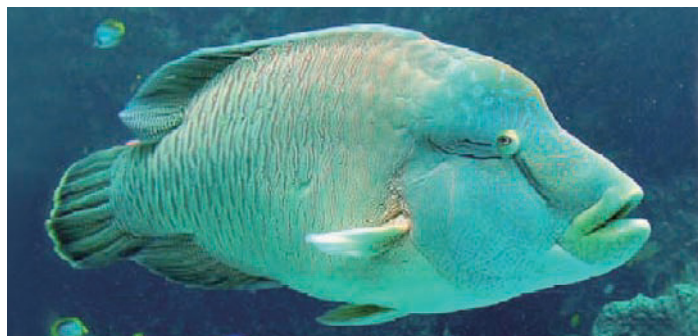
## Hatchery and seed production

### Optimizing milkfish seed production through feeding

Three strategies are being used to improve milkfish hatchery operations: (1) feeding broodstock a vitamin- and-lipid fortified diet; (2) early introduction of SEAFDEC larval diet; and (3) enrichment of rotifers with SEAFDEC formulated enrichment media. The first strategy improved the spawning frequency, egg production and fertilization rate; however, fry survival has been inconsistent. The second and third strategies reduced the incidence of abnormal larvae and resulted in consistent fry survival with lesser incidence of abnormalities.

At AQD's integrated broodstock-and-hatchery complex, milkfish fry survival was 40% (of the target 50%), and the complex produced 450 000 and 1.2 million fry in April and May, respectively.

At AQD's big hatchery, better spawning (20 spawnings vs 12 in control



A Napoleon wrasse breeder (above) and its eggs. So far, wrasse larvae only survive until its yolk reserves are completely used up around day 4 (bottom)



treatment) was observed in breeders given a fortified diet containing beta-carotene and arachidonic acid. Fry survival was also higher in those given the fortified diet.

### Refining seed production of high-value marine fish

The interventions used to improve the seed production of high-value marine fish grouper, red snapper, sea bass and pompano can be summed up as feeding formulated diet and reducing dependence on brine shrimp and minced trash. Specifically, the interventions are: (1) use of capsule arachidonic acid, beta-carotene and vitamin C in broodstock diets, (2) use of SEAFDEC emulsion for the enrichment of rotifers and *Artemia*, (3) co-feeding of natural food and SEAFDEC larval diet at early age of the larvae, and (4) reducing salinity of rearing water to minimize cannibalism.

With these interventions, AQD hatcheries had consistently produced high

quantities of eggs and normal larvae of groupers, snapper, seabass, and rabbitfish. Seabass had the highest survival (28-35%), followed by pompano (15%) and rabbitfish (12%). Snapper (4%) and grouper (<1%), however, had low survival. Problems encountered during larval rearing included outbreak of parasites (*Amyloodinium*) and occurrence of viral necrosis virus in grouper.

### Growth and survival of grouper larvae fed formulated diets

A commercial larval diet called MERA LV was tested at feeding rates of 0.5, 1.0, and 1.5 g ton<sup>-1</sup> of water. Natural food and SEAFDEC-

Photograph © by J.E. Maragos/USFWS

Photos by FL PEDROSO

formulated larval diet served as control. One successful run reached day 60 with survival of grouper larvae at 7%. Average body weight was highest in those given 1.5 g ton<sup>-1</sup> but was not significantly different from those fed 1.0 g ton<sup>-1</sup> and control.

#### Potential of mysid shrimp as live food: nutritional evaluation

Previous results indicated that mysids *Mesopodopsis orientalis* are potential live food substitute for *Artemia* in grouper larviculture because they increase the levels of highly unsaturated fatty acids, docosahexaenoic acid and eicosapentaenoic acid, and digestive enzymes in grouper larvae. Mysids were even found to be superior to enriched *Artemia* biomass.

To develop intensive techniques to mass produce mysids, a laboratory-scale air-lift culture system was first designed. This system used two units of 250-L fiberglass with three sorter netcages and artificial lighting. With phytoplankton (*Tetraselmis/Chlorella*) fed to the mysids, more than 200 hatchlings day<sup>-1</sup> were obtained from the brooders.

Preliminary results on nutritional evaluation showed that wild mysids had higher protein content than cultured mysids.

## Nursery

#### Nursery of grouper, seabass: use of in-pond sorter to reduce cannibalism

In the first trial for grouper *Epinephelus fuscoguttatus*, juveniles reared in cages with in-pond sorter were significantly larger and had better survival than those reared in cages without in-pond sorter after a month of nursery rearing. Specific growth rates were 11 and 8.6%, respectively; survival rates at 14 and 8%.

For nursing the seabass, the same trend held true after 40 days of culture. Specific growth rate of seabass in cages with in-pond sorter was 6.8% compared with 5.6% for those without sorter. Survival, however, were comparable, at 91 and 94%, respectively.

#### Fingerling production of seabass and snapper

A viable fingerling production technology for mangrove red snapper had been demonstrated. Two snapper juvenile sizes (0.4 and 0.6 g) were stocked in 0.5 cm mesh cages in the pond at 100 m<sup>-2</sup>. These were fed commercial diet containing 46-48% protein and 12-14% fat. Feeding rate was 10-4% body weight day<sup>-1</sup> with the ration given 3-4x daily. The bigger juveniles attained the desired 30 g body weight in 90 days, with feed conversion ratio (FCR) of 1.52 and survival of 90%. Fish with smaller sizes attained this weight in 104 days (FCR, 1.22; survival, 86%). At 150 days of culture, bigger juveniles weighed 60 g and the smaller ones weighed 48 g; both, however, had FCR of 1.3. The fingerlings

are being reared in grow-out ponds until they reach 250-300 g.

#### Semi-intensive production of siganids in ponds

A viable technology for semi-intensive production of siganid fingerlings in ponds had been demonstrated. Siganids (6 g) were stocked at 4 m<sup>-2</sup> in ponds with available filamentous algae. After 45 days, formulated diet containing 37-39% protein (1:1 ratio of animal-to-plant protein) was given at 6-4% body weight day<sup>-1</sup> in three rations. At 60 days of culture, rabbitfish attained 30 g body weight which is desirable for stocking in ponds; the FCR was 0.72. At 120 days of culture, average body weight and FCR was 60 g and 1.26, respectively. Some fish are being reared in grow-out ponds until they reach 200-250 g; the others were harvested, dried and sold when they weighed 95 g (150 days of culture).

Asian seabass grown in freshwater in Dingle, Iloilo; night view of seabass nursery culture in illuminated floating cages in ponds at AQD's Dumangas Brackishwater Station; and grow-out culture of marine fish in hapa nets, also at Dumangas



DD BALIAO



RSJ GAPASIN







Feeding experiment for milkfish: the set-up for the meat & bone meal replacement study, and the end of the experiment

## Grow-out and other studies

### Verifying rabbitfish grow-out diets in cages in ponds

Rabbitfish *Siganus guttatus* weighing 103 g and measuring 17 cm were stocked in B-net cages (5 x 5 x 1.3 m) set in a pond at density of 5 m<sup>-2</sup>. These were fed: (1) SEAFDEC-formulated diet, (2) commercial feed, (3) 50% SEAFDEC diet + 50% seaweed, and (4) seaweed. Results showed that survival was almost 100% in all treatments after 120 days, but fish fed SEAFDEC diet had highest average body weight (234 g, FCR of 3.4). The SEAFDEC diet + seaweed was comparable with commercial feed and better than seaweed alone.

### Refining intensive pond culture of sea bass

Sea bass that were stocked at 1 m<sup>2</sup> and given SEAFDEC-formulated diet compared well with those given commercial feed. In this third trial, seabass weighed 369 g after 180 days of culture.

### Milkfish and mud crab polyculture

Milkfish (7 900 pieces) were stocked in a pond with mud crab (300 pc). At harvest, there were about 3.2 tons milkfish and 43 kg of crab. Economic analysis will be done based on the extended run.

### Net cage culture of sea bass in a freshwater lake

Sea bass were grown in floating netcages (5 x 5 x 2.5 m) in Lake Vito, Dingle, Iloilo with a stocking rate of 7 m<sup>-3</sup>. Sea bass were fed SEAFDEC diet or commercial feed to compare growth in freshwater. Results showed that the use of bigger juveniles (15 g) and a longer acclimation period from sea- to freshwater can minimize stress and increase survival. SEAFDEC diet brought about higher average body weight (307 g), better feed conversion ratio (2.2), higher survival (80%) and more biomass (103 kg cage<sup>-1</sup>) after 240 days of culture compared with commercial diet (244 g, 2.8, 75%, 80 kg/cage).

### Phased diets for grouper

Grouper *Epinephelus coioides* were stocked in marine floating netcages and fed SEAFDEC starter, grower, or finisher diets.

The second experiment at AQD's Igang Marine Station started in November 2009 using 25 g grouper juveniles from AQD's Dumangas Brackishwater Station. Fish mortality occurred early in the run due to *Caligus* sp. infestation but was controlled by using freshwater bath treatment containing oxytetracycline, (100 ppm) once a week. Survival stabilized at 75%. Groupers were harvested in September 2010 with survival of 60%. Data is still being analyzed.

A third experiment using 40 g juveniles from AQD's Tigbauan Main Station is ongoing.

### Improving the nutritional value of locally available feed resources

More samples of *Leucaena* (ipil-ipil) leaves were processed to obtain enough samples for small-scale fermentation and feeding experiments. Milkfish juveniles have also been obtained for the feeding and toxicity experiments

using fermented ingredients. Fermentation experiments with ipil-ipil leaf meal for diet formulation for milkfish are on-going.

### Soy products as alternatives to fish meal

Based on results of a previous experiment, a 12-week study looked at the optimum inclusion level of soybean meal in diets with optimum protein-to-energy ratios. Milkfish juveniles (about 8 g average body weight) sourced from Dumangas, Iloilo were reared in 250 L conical fiberglass tanks with flow-through sea water. These were given six test diets varying in the amount of soybean protein replacement for fishmeal protein (from 0 to 50%). After 12 weeks of feeding, best mean weight gain was observed in fish given diets containing soybean meal protein at 0, 10, 40 or 50% replacement. Poorest mean weight gain was observed in those given diets containing soybean meal protein at 30% replacement. Survival ranged 85–98%. Feed samples are being analyzed in Cargill Agri Purina, Inc, South Korea for complete amino acid profile. Proximate analyses of diets as well as the fish samples for initial and final whole body composition are being done.

The third 12-week experiment on the optimum level of soy protein concentrate (SPC) inclusion in diets containing fish meal and soybean meal was started in June. Milkfish (18 g) were acclimated and stocked in eighteen 250 L tanks provided with flow-through aerated seawater. Six SPC levels were tested: 0, 10, 20, 30,

40, and 50%. The fish were fed the floater milkfish diet at 5% of their body wt per day. At 15 weeks, fish fed diets containing SPC at 30% gave optimum growth though this was not significantly different from those given 40% SPC. Survival was 100% in all treatments. Pilot-scale testing of milkfish diet in floating netcages is next.

#### **Digestibility of meat & bone meal for milkfish**

Meat & bone meal (MBM) was tried as an alternative protein source to fishmeal. Six diets incorporating MBM at 0, 7.5, 15, 22.5, 30, or 37.5% were tested on milkfish juveniles in seawater (average fish weight, 1.2 g) or fresh water (fish wt, 3-5 g). Results showed that MBM was accepted by milkfish fingerlings for growth and survival both in sea- and freshwater. However, milkfish fed 37.5% MBM had high feed conversion ratio, low specific growth rate, and low final average weight. Fish fed 22.5% MBM had significantly higher final average weight, percent weight gain and specific growth rate, and lower feed conversion than those fed 37.5% MBM.

#### **White cowpea meal as alternative plant protein source**

In finding alternatives to fish meal, white cowpea meal was tried as partial replacement in grouper (*Epinephelus coioides*) diets. In this third experiment, the effect of feeding frequency (twice or once day<sup>-1</sup>) on grouper

juveniles fed 20% white cowpea meal was assessed. Juveniles weighing 53 g were stocked in six 2 x 2 x 2 m floating netcages at 10 m<sup>-3</sup>. After 228 days, no significant differences in body weight gain (53 g), specific growth rate (0.9 %), feed conversion ratio (2.8 and 3.2), and survival (59 and 62%) were observed between the two treatments. The proximate composition of the fish was also similar. Results indicate that feeding once a day is appropriate for *E. coioides*.

#### **Formulated feed for adult seahorse**

In February, a new batch of seahorses (*Hippocampus barbouri*) was used for the study. These were stocked in 18 tanks, and for each tank 3 males and 3 females were reared. Natural food was given regularly and in mid-March a moist diet containing 5% carrageenan was tried for acceptance. Like diet types previously tested, this one was not acceptable to adult seahorses.

#### **Intensive production of red tilapia hybrid in polyculture with siganid in ponds**

About 4 300 siganids were stocked with 5 280 red tilapia. In this preliminary run, fish were fed SEAFDEC diet (6-4% of body weight day<sup>-1</sup>) and vegetable scraps. After 150 days, siganids attained average body weight of 230 g (total biomass, 815 kg), feed conversion ratio of 2.4 and specific growth rate of 0.6 %. Survival was 74%. Red tilapia weighed 395 g on average (total biomass, 698

kg) and had feed conversion ratio of 2.1 and SGR of 1.8%. Survival was 30% due to mortalities during stocking and parasite (*Tricodina* sp.) infestation which was later controlled by dropping salinity below 10 ppt.

#### **Characterization of innate immune response of grouper to vibrio**

To characterize the grouper (host) immune response against *Vibrio harveyi* (JD2 strain, a gram-negative bacteria), *ex-vivo* assays and changes in mRNA transcripts of some critical immune-related genes were determined. *Epinephelus coioides* juveniles obtained from AQD's marine fish hatchery were acclimated, grown to the experimental size of 80 g in 250 L tanks, and exposed to *V. harveyi*. Initial results showed increasing respiratory burst (RB) activity with progress of infection. Liver total bacterial load (TBC) increased post-exposure, peaked at 24 h, steadily declined thereafter and was undetectable at 120-240 h. Total *Vibrio* count also peaked at 24 h but undetectable after 96 h. RB was inversely correlated with TBC. Lysozyme activity also peaked at 24-48 h, but was nil at 120 h post-exposure. Lysozyme activity positively correlated with TBC. Skin, gills, kidney, liver, and spleen samples had been collected up to day 5 for the analysis of immune response gene expression.

#### **Verification of pompano grow-out diets**

Pompano (initial weight, 100 g) were stocked in cages in ponds at 5 m<sup>-3</sup>. After 105 days, those fed commercial diet (44% crude protein or CP) had significantly highest average body weight (429 g) compared with other treatments (SEAFDEC diets with 44 or 58% CP, and commercial diet with 41% CP). Survival was 95% and did not differ among treatments.

#### **Pompano grow-out culture in floating net cages**

To develop grow-out culture technology in floating net cages, pompano weighing 97 g were stocked in 5 x 5 x 3 m floating net cages at 28 m<sup>-3</sup>. These were fed milkfish commercial feed (T1), commercial milkfish feed + commercial pompano feed (T2), or commercial pompano feed (T3). At last sampling, fish given T1, T2, or T3 had average weights of 218; 405, or 536 g, respectively.

#### **Semi-intensive production of rabbitfish and snapper**

Rabbitfish weighing 100 g was stocked at 5800 ha<sup>-1</sup>. After 105 days on SEAFDEC diet, average weight was 258 g with specific growth at 0.91% day<sup>-1</sup>, and survival of 99%. In contrast, mangrove red snapper juveniles weighing 56 g and stocked at 5 000 ha<sup>-1</sup>, reached 308 g after 120 days on SEAFDEC phased diet. Specific growth rate was 1.4% day<sup>-1</sup>.



## TECHNOLOGY TRANSFER FOR MARINE FISH

AQD conducted the yearly course on *Marine fish hatchery* from 26 May to 1 July at AQD's Tigbauan Main Station for 15 participants. A similar course was arranged for a lone participant from Marshall Islands in the Pacific from 10 August to 9 September.

The *Pond/cage culture* course on the other hand was held 8-12 March, also at AQD's stations in Iloilo (Tigbauan, Dumangas, Igang).

Specific to milkfish were the courses on (1) *Postharvest & marketing* which was done for two batches of women-trainees on 16 and 29 April in Iloilo and (2) *Fish processing* which was held 15-16 April in Guimaras

## PRODUCTION RUNS

AQD produced 1.65 million milkfish fry in 2010 in its integrated broodstock-hatchery, a complex which showcases the marine fish hatchery technologies



Trainees in marfish hatchery learn fish identification and try their hand at induced spawning (above, right). The conduct of the course is supported by the Government of Japan Trust Fund training fellowships



AQD offers special training courses upon request, and one is attended by a trainee from Oman, here receiving a certificate from AQD's research head Dr. EG Ayson

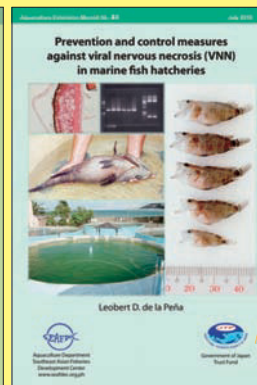
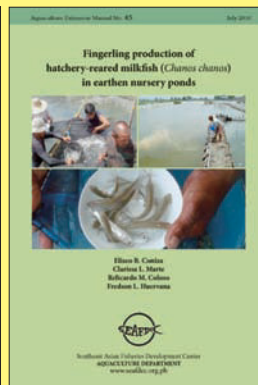
The women and fisherfolk of southern Iloilo and western Guimaras train on postharvest processing for milkfish. The courses were funded by AQUAFISH CRSP, North Carolina State University, and Petron Foundation



Trainees on pond/cage culture focus on brackishwater and marine fishes; above, they visit the cages at Igang and learn how to mend nets as part of the practical exercises



To support its technology transfer activities, AQD released three farmer-friendly manuals in July, on sea bass culture in ponds, milkfish fingerling production in ponds, and prevention & control of viral nervous necrosis in marine fish hatcheries. There's also a flyer on grouper diseases

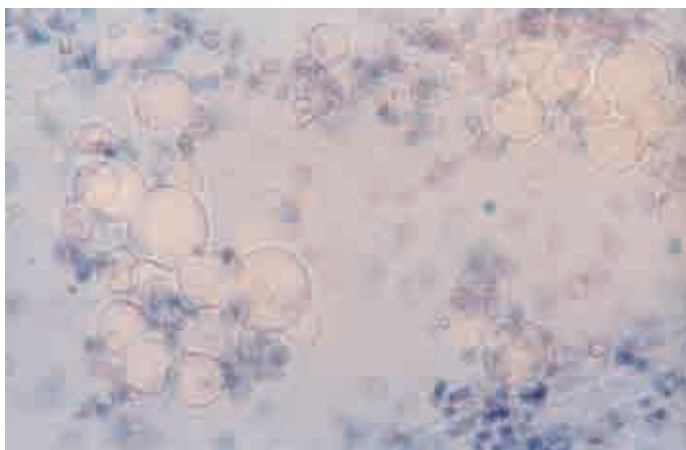




# Seaweed strain improvement

The seaweed *Kappaphycus* is very well-studied because of its economic value, so the AQD program on seaweed focuses on strain improvement using the relatively new area of protoplast research. The goal is to assist the industry procure new planting materials that grow fast and are adaptable to climate change. Three studies investigated the role of seaweed in bioremediation and in fighting fish disease.

MRJ LUHAN



Seaweed protoplast as seen under the microscope, 20x magnification

## Protoplast isolation

Protoplasts were isolated using combinations of cell-wall lytic enzymes. Fresh abalone and acetone powder in combination with cellulase enzyme mixture improved the density of the isolated protoplast. Temperature also highly affected density.

## Genetic markers

Molecular-based techniques for genetic identification and differentiation of six red seaweed species and variants are being developed. In the tests to optimize DNA extraction and PCR protocols, DNA yield were compared using freshly frozen, freeze-dried, and powdered forms of seaweed samples. All samples had good DNA yield (up to 105 ng  $\mu\text{l}^{-1}$ ) and purity, with the freshly frozen and freeze-dried samples showing comparably higher DNA yield than the dried-powdered form. Removal of salt (by extra washing), addition of Proteinase K, and the use of elution buffer did not increase DNA yield, suggesting that these steps may not be necessary. More optimization tests are ongoing.

## Bioremediation

To determine the amount of nutrients that seaweeds can take out from a shrimp culture system, total nitrogen (TN) and total phosphorus (TP) production or output of *Penaeus indicus* were determined. The shrimps were fed SEAFDEC-formulated diet with 6% and 6.6% assayable nitrogen and phosphorus, respectively. Postlarvae (PL) produced the highest TN (2.11 mg g-shrimp<sup>-1</sup> day<sup>-1</sup>) in rearing water while juveniles weighing 1-3 g and adults weighing 15-20 g produced similar quantities (1.8 mg). PL also produced highest TP (3.2 mg g-shrimp<sup>-1</sup> day<sup>-1</sup>) in the rearing water. In contrast, adults produced highest TN and TP in the form of feces (1.8 and 2 mg g-shrimp<sup>-1</sup> day<sup>-1</sup>) respectively, while PL and juveniles produced similar quantity of TN (0.5 mg). PL produced 1.1 mg g-shrimp<sup>-1</sup> day<sup>-1</sup> TP in feces while juveniles produced 1.15. Uneaten feed contributed much of the TP and TN in the culture system.

To determine the potential of *Penaeus indicus* - *Caulerpa racemosa* polyculture in pond, a salinity tolerance test was conducted for the seaweed. *C. racemosa* was able to withstand salinities as low as 20 ppt and attained the highest specific growth rate when stocked at 8 kg ton<sup>-1</sup> water.

MM PENARANDA



Screening for the anti-*Vibrio harveyi* activity of seaweed varieties

## TECHNOLOGY TRANSFER FOR SEaweEDS AND MICROALGAE

AQD's seaweed culture experience goes hand-in-hand with abalone culture, so the abalone courses always carry a seaweed module.

For microalgae, a special course on isolation and purification was held for a lone participant from the Sultanate of Oman from 14 April to 5 May.



### Antimicrobial screening

Six seaweed species / varieties of *Kappaphycus* and *Euचेuma* collected from different regions of

the Philippines were tested for antimicrobial properties. In the initial screening, no significant zone of inhibition was observed against the luminous bacteria, *Vibrio*

*harveyi*, by disc diffusion assay. The same screening will be repeated using more concentrated crude ethanol extracts to confirm results. Future tests on

crude seaweed extracts will include koi herpes virus, *Aeromonas hydrophila*, *Streptococcus iniae*, and *Vibrio alginolyticus*.



MM PENARANDA

Seaweed varieties under study at AQD [above L-R, 1st then 2nd row]: "tungawan" and vanguard varieties of *K. alvarezii*, giant brown and giant green varieties of *Euचेuma cottonii*, sacol green variety of *K. striatum*, and *E. spinosum*



# Aquatic ecology

AQD's aquatic ecology program envisions science-based and environment-friendly aquaculture technologies by 2012. To achieve this goal, studies were designed such that environmental factors are integrated in all AQD researches. Specifically, these studies aim to assess impacts of aquaculture on the environment, to assess impacts of different pond practices on biodiversity in ponds and adjoining mangroves and shores, and to develop bioremediation measures to mitigate negative impacts of aquaculture to the environment.

MJH LEBATA-RAAMOS



*Anodonta philippiana* used as bioremediator in an intensive milkfish cage culture at AQD's Igang Marine Station, Nueva Valencia, Guimaras

TU BAGARINAO



A brackishwater pond at AQD after harvest, and bycatch *Muraenaesox cinereus*

## Milkfish culture in cages

The marine bivalve clam *Anodonta philippiana* and the sandfish *Holothuria scabra* are possible bioremediators in intensive cage culture systems like for milkfish. To date, four cages stocked with the same density of milkfish and fed the same amount and type of food were monitored every three weeks for temperature, salinity, pH, DO, sulfide, nitrate, nitrite, ammonia, phosphate and organic matter. A constantly increasing ammonia, phosphate and sulfide concentrations was observed which started to decrease upon the start of partial milkfish harvest. This trend was attributed to the volume of feeds deposited on the substrate. However, nitrate and nitrite concentrations were highest only at the start of sampling and soon declined to low concentrations until the last sampling. In contrast, nitrate and nitrite concentrations were highest in the control as compared with the milkfish cages while ammonia, phosphate and sulfide were significantly lowest. Temperature, salinity and DO were similar in all cages and depths while pH was similar in all cages but significantly different between depths. Although pH readings were within the range of oceanic pH, mean surface pH was significantly higher than the pH near the substrate, 12-14 m below the surface.

## Biodiversity in the brackishwater ponds and the adjoining mangroves in Dumangas, Iloilo

This research 'rides on' the ongoing technology verification projects at AQD's Dumangas Brackishwater Station (DBS). Bycatch (non-crop) species from ponds were obtained for identification and enumeration. A high diversity of non-crop species grows in the DBS ponds and is harvested at considerable numbers and biomass. Chlorinated ponds, however, had much lower diversity and volume of non-crop species. Some 87 species of fishes in 45 families have been found in the DBS ponds, eight of them crop species, and the others naturally seeded by the tides and later harvested as bycatch. The larger crustaceans in the DBS ponds consisted of 39 species in 14 families, including several penaeid and palaemonid shrimps and portunid crabs. Mollusks included 46 species of bivalves in 15 families, and 29 species of gastropods in 11 families. Catch from small-scale fishing 'pahubas' (low tide) around the mangroves outside DBS included many of the same species caught inside the DBS ponds.

## Identification of fish species suitable for polyculture with sandfish

Four-week experiments looking at the effects of fish-to-sandfish ratio and sandfish size at stocking were





Sandfish juveniles on coralline substrate (coral and shell rubble, coarse sand), typical of *Thalassia* seagrass beds (left) and on sandy-muddy substrate, typical of coastal mudflat with *Halodule* seagrass

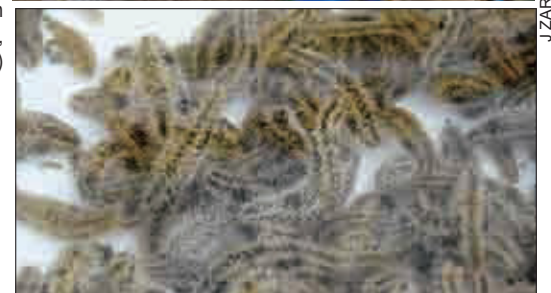
completed with pompano (*Trachinotus blochii*), sea bass (*Lates calcarifer*) or milkfish (*Chanos chanos*) in 250L fiberglass tanks. Though all three species were found to be compatible for co-culture with sandfish, growth of both fish and sandfish were best with the sea bass and milkfish. Between sea bass and milkfish, sea bass was easier to handle and more resistant to sampling stress. The same experiments are currently conducted with mangrove snapper (*Lutjanus argentimaculatus*), after which the appropriate fish species to be used for the production runs in ponds will be chosen.

Sandfish polyculture with white shrimp (*Penaeus indicus*) fry and juveniles was also tried. It was found that shrimp fry were incompatible with sandfish, as they continuously crawled over the sandfish, irritating them, eventually causing evisceration and death; no sandfish survived the 4-week experiment. In contrast, hand, shrimp juveniles were compatible with sandfish when placed at a low density (10 juveniles tank<sup>-1</sup>), but not at higher shrimp densities.

### Optimal conditions for growth and survival of sandfish juveniles

Daily burrowing and surfacing cycle of sandfish juveniles was established. Almost all (92-97%) sandfish juveniles burrowed in the substrate from 0300 to 0900 H and started (20%) to surface at around 0900 H. Sandfish juveniles move to the surface of the substrate to feed. The mean peak feeding time (1800 to 0300 H) is longer than their mean peak burrowing time (0300–0900 H). Experiments showed that sandfish juveniles preferred to burrow in sandy-muddy substrates. During peak burrowing times, 35% preferred to burrow in mudflat-type (sandy-mud) substrate with *Halodule* grass, 26% preferred seagrass-bed-type substrate with *Thalassia* grass, 18% preferred coarse and granulated sand without grass, while only 16% burrowed in mangrove soil. High feeding preferences were observed in grass substrates. Growth performance was poor in mangrove pond substrate. Both substrates of *Halodule* and *Thalassia* grass gave positive growth for sandfish in the first two weeks but growth considerably declined soon

Experimental tubs used in the substrate preference study for sandfish juveniles (top, right); set-up for the sandfish-marine fish polyculture trials and sandfish juveniles (right, bottom)



after because of depletion in natural food. Constant average growth was observed in the control barren tank because algae rapidly grew, providing additional food for the sandfish. In contrast, the control showed great variability in sizes of sandfish.

### Social acceptability of marine cage culture

A household survey using semi-structured interview questionnaire was conducted in four fishing communities affected by the 2006 oil spill in Guimaras. The respondents were randomly drawn from a

list provided by the Office of the Municipal Agriculturist of Nueva Valencia. They were either participants or non-participants in the SEAFDEC/Petron/LGU collaborative project on milkfish cage culture as a livelihood option. Results indicated that cage culture is socially and economically acceptable. Respondents also believed that the negative impacts of aquaculture to the environment can be addressed appropriately if cage culture is managed effectively and efficiently.



**Collaborating sandfish partners inaugurate the new sandfish hatchery at AQD's Tigbauan Main Station:** GOJ-Trust Fund manager and AQD Deputy Chief Dr. Teruo Azuma, Dr. Satoshi Watanabe of JIRCAS, AQD Chief Dr. Joebert Toledo, Dr. David Mills of ACIAR/WorldFish and Mr. Nguyen Dinh Quang Duy of Vietnam's RIA-3

## A NEW SANDFISH HATCHERY

AQD built and inaugurated on April 28 a new sandfish hatchery for R&D and production runs. AQD was assisted by Vietnam's Research Institute of Aquaculture-3 in designing the facility while technology development was a joint effort by AQD, University of the Philippines Visayas, ACIAR through the WorldFish Center, Government of Japan Trust Fund, and JIRCAS.

In 2010, AQD produced more than 87 900 juveniles (36-79 days old). The mature sandfish, numbering 24 males & 16 females and mostly from Guimaras, spawned ten times from April to November. Though more than 19 million eggs were fertilized and stocked for larval rearing, the survival in the hatchery averaged 0.5%



**AQD's first batch of eight sandfish trainees hails from Tanzania, United Kingdom, Malaysia and the Philippines:** getting sandfish broodstock at AQD's Igang Marine Station and monitoring the stages of larval development

## FIRST TRAINING COURSE AND MANUAL ON SANDFISH

With its new hatchery facility, AQD lost no time in organizing its first training course on *Seed production and nursery of sandfish Holothuria scabra* from 12 to 26 October in Iloilo, Philippines.

AQD published a manual on sandfish seed production in Vietnam in July, written by RIA-3 and co-published with the sandfish partners



[Left, clockwise]  
**Outdoor rearing tanks and partial harvest at the hatchery**





# Smallholder **freshwater** aquaculture

The program involves research, technology verification / demonstration and training activities that are focused on the development of optimal breeding, seed production and grow-out culture strategies for regionally important freshwater commodities such as the giant freshwater prawn, Asiatic carps, tilapia, catfish and indigenous freshwater fishes. Apart from improved fish/prawn seedstock production and husbandry schemes that are packaged into aquaculture business technologies, the program also promotes the implementation of effective health management strategies for all farmed species for sustainable production.

## Genetic enhancement of giant freshwater prawn

A study was conducted to compare two genetic strains of giant freshwater prawn *Macrobrachium rosenbergii* in terms of their reproductive efficiency and growth performance. Spawning sets of similarly aged stocks of Old Calumpit (OC F<sub>3</sub>) and New Calumpit (NC F<sub>1</sub>) prawn were placed separately in concrete tanks and in lake-based hapa net cages at 1male:4females per tank or cage. Results showed no particular trend as to the best stock (OC or NC) in relation to breeding parameters such as number of berried females, hatchlings & broodstock mortalities; postlarval survival or seed yield and the number of days to postlarval metamorphosis.

Meanwhile, for the growth comparison, 40 pcs of two month-old OC and NC juveniles were stocked in 12 units each of

lake- and tank-based 1 x 1 x 1 m cages under different feeding treatments. The tank experiment compared daily and alternate feeding. For the first run, strains stocked at an initial average weight of 0.5 g survived well when fed daily (72% for OC and 69% for NC) after six months. Whereas the highest growth or weight gain for prawns fed daily was noted in the NC stock (9 g) while poorest growth was noted in OC fed alternately (weight gain=7 g). Growth and survival in the two feeding schemes were not significantly different.

The growth trial in cages involved feeding and no feeding. Results of the first run showed that growth and survival were best for fed OC prawns which reached an average body weight gain of 12 g at 70% survival rate after six months. Unfed stocks, regardless of strain, exhibited poor growth (weight gain at 5 g for OC and 6 g for NC)

and survival (20% for OC and 39% for NC).

To further determine the effect of domestication on the two stocks, DNA extracts from pleopod samples of OC and NC stocks used in the growth experiments were characterized and assessed genetically at the Onagawa Field Science Center of the Tohoku University. MtDNA sequence information using COI and COII marker data for both OC and NC stocks showed low variability. It is possible that these may not be the best markers for determining genetic changes brought about by domestication in the two prawn stocks.

## Improving seed production and lake-based cage culture

Seed production methods for commercial prawn species (*Macrobrachium rosenbergii* *dacqueti*) have been refined to suit Philippine conditions, with AQD conducting three larval rearing runs in 2010. Newly-hatched larvae were stocked in three 1-ton fiberglass tanks with 12 ppt greenwater. Larvae were fed *Artemia* nauplii from day 1 to 7 and *Artemia* plus egg custard from day 8 until they became postlarvae. Results showed that survival ranged 28-96%; production, 25-63 larvae liter<sup>-1</sup>, and number of days to metamorphosis, 24-37 days. Water temperature was at 24-31°C. Postlarval

MRR EGUJA



Giant freshwater prawn *Macrobrachium rosenbergii* (above); DNA extraction work at Tohoku University, Onagawa, Japan



production for three runs totalled 654 552 pieces.

A new study on the development of diets for giant freshwater prawn postlarvae, and juveniles is evaluating four formulated diets. The formulations involve the partial replacement of fish meal with cowpea meal at varying levels (0, 15, 30 and 45%), and the use of the readily available Peruvian fish meal instead of local fish meal.

### Improving and promoting tilapia culture

Preliminary rearing trials in tanks to evaluate growth, survival and fillet yield of Mozambique tilapia, commercial tilapia hybrids and saline-adapted Nile tilapia in brackishwater conditions were made at AQD's Binangonan Freshwater Station. The three species were stocked and reared separately for four months in triplicate tanks (n=30 tank!). Results of this first growth experiment in brackishwater tanks showed that Nile tilapia generally have better meristic

traits (weight gain, increments in standard length, head width, body depth and body thickness) than red tilapia and Mozambique tilapia. The Mozambique tilapia, the most saline-tolerant of the three, had the highest survival in brackishwater at 100%.

A trial to raise the three species in brackishwater pond-based cages is on-going at AQD's Dumangas Brackishwater Station.

In AQD's Tigbauan Main Station, Nile and red tilapia seedstock are being produced continuously. Sex-reversal methods are adopted in production. Although tilapia seedstock are regularly available, the demand for fingerlings is just picking up after months of poor sales. The low demand earlier in Iloilo seemed to be influenced by the prolonged warm climate (El Nino) which has caused the salinity in brackishwater ponds to be unsuitable for tilapia.

Meanwhile, a growth experiment for tilapia held in cages placed in a freshwater reservoir in Dingle, Iloilo

continued. Tilapia are fed a SEAFDEC or a commercial diet, with results showing comparable growth and feed efficiency. Polyculture of tilapia and freshwater prawn in cages has been set up in the same freshwater reservoir in Dingle and is on-going.

### Developing culture techniques for indigenous freshwater fishes

The reproductive biology of silver therapon *Leiopotherapon plumbeus* found in several freshwater habitats in Luzon was being investigated. Silver therapon samples from Taal Lake had the highest mean body weight, mean body length and gonado-somatic index compared with stocks from Candaba, Laguna Lake and Sampalok Lake. Histological examination of the therapon ovaries revealed three maturation stages and, as typically observed in teleosts, ovarian development was seen as a progressive increase in ovarian follicular diameter due to yolk accumulation in the oocytes. Induced spawning trials were made.

Wild and tank-reared silver perch received at mid-day an intra-muscular injection of either saline (control) or one of two doses (10 and 50 IU) of human chorionic gonadotropin (hCG). From 40% to 80% of vitellogenic females with tertiary yolk oocytes (0.38-0.41 mm initial diameter) and paired with milting males (n=5 females and 10 males per treatment group) spawned 18-27 hours after hormone injection. Saline-injected fish did not spawn. Spawned eggs (mean of 569-1920 total eggs collected) had mean fertilization rates of 53-86% and hatch rate of 23%. Eggs incubated in mildly aerated water at 28-30°C hatched about 11-13h post-fertilization.

As potential food for first-feeding silver therapon, culture of a protozoa and a small algae is on-going while farming trials in lake-based net cages continue. Results of the latter study showed that therapon had similar mean body weights when fed trash shrimp feed or commercial prawn feed. Growth was higher for both treatments over the unfed control.

For indigenous freshwater prawn species, research was co-funded by the National Research Council of the Philippines and will focus



MRR EGUJA



FA AYA

Cages (left) and feeding experiment for giant freshwater prawn

## TECHNOLOGY TRANSFER FOR FRESHWATER AQUACULTURE

AQD conducted two courses in 2010: (1) *Freshwater aquaculture*, held 23-24 April at AQD's Binangonan Freshwater Station, and (2) *Community-based freshwater aquaculture*, held 8-18 November at AQD's Tigbauan Main Station.

Four flyers on seed production and grow-out culture of tilapia and Philippine native catfish were also published



EVARALAR JR

EVARALAR JR

The freshwater course at AQD is inclusive of all the commodities under research-&-development, including (clockwise) bighead carp broodstock management, hatchery, cage farming; and red tilapia, to name a few

## RESEARCH BY-PRODUCTS

Seedstock produced from some of AQD studies were sold to local fish producers. For instance, freshwater prawn grow-out farmers were sold 22 000 postlarvae worth PhP 208 750 (US\$ 4 638). At the end of 2010, there were still some 30 000 postlarvae left



The second course on *Community-based freshwater aquaculture* was conducted under the auspices of the ASEAN Foundation's Human Resource Development project. The trainees represented eight SEAFDEC member-countries (left, bottom) who visited a community in Iloilo (above) to learn from small-holder fishfarmers



on the domestication and evaluation of the culture potential of the native Caridean prawn, *Macrobrachium lar*.

### Health management

Studies to identify and control freshwater and marine fungi affecting *Macrobrachium* spp. broodstock and larvae were done. Three of four isolates from various larval stages had characteristics that classify them as *Lagenidium*. One isolate that affects eggs of berried females from freshwater collection sites is still unclassified.



# Sustainable aquaculture

The *Promotion of sustainable and region-oriented aquaculture practices* project focuses on biologically, environmentally & socioeconomically acceptable, region-oriented technologies to secure stable supply of fish products for Southeast Asia and to meet world-wide demands. The project activities include:

- (a) genetic improvement of commercially important species and development of hatchery technology;
- (b) development of environment-friendly feeds using regionally available ingredients;
- (c) establishment of environment-friendly aquaculture technology;
- (d) socioeconomic assessment and impact analysis of transfer and adoption of sustainable aquaculture technologies, and
- (e) technology extension and demonstration

This project succeeded the former *Development of technologies and human capacity building for sustainable aquaculture* project which was completed in 2009. The main differences between the two projects are in the: (1) development of more practical – from laboratory-based to commercially viable – technologies; (2) establishment of environment-friendly, cost-effective and regionally available technologies; and (3) further dissemination and capacity building.

The following are the major outcomes:

- (a) F1 and F2 mud crab *Scylla serrata* have been produced. In addition, an effective evaluation technique for larval quality useful for selective breeding was established.
- (b) As part of selective breeding of tiger shrimp *Penaeus monodon*, F1 were successfully produced by crossing wild-sourced broodstock obtained from sites previously identified to have stocks with high genetic variability.
- (c) In examining the impact of domesticating hatchery-bred stocks, preliminary results indicated that fifth generation giant freshwater prawn *Macrobrachium rosenbergii* still possess production traits that are comparable with newly domesticated ones.
- (d) Laboratory culture conditions of *Kappaphycus* plantlets have been optimized, and these will anchor the establishment of mass production technology.
- (e) Low salinity rearing resulted in better survival and growth for spotted scat, *Scatophagus argus*, an emerging species for which hatchery techniques are being established.

- (f) After a survey in the Philippines, feed ingredients which are rich sources of carbohydrates were found.
- (g) Presence of mangroves inside the pond or in the receiving environment or the use of probiotics and disinfectants seemed to be no guarantees against disease outbreaks during tiger shrimp culture
- (h) A forum organized in a study site undergoing serious environmental degradation helped enhance farmers' knowledge on tilapia culture and encouraged the community in utilizing (by composting) the giant water lettuce which has covered a big part of a river.

For human capacity building in SEAFDEC member countries, four training courses were implemented:

- (a) *Marine fish hatchery*, 26 May–1 July
- (b) *Abalone hatchery*, 8–28 July
- (c) *Community-based freshwater aquaculture for remote areas of Southeast Asia*, 08–18 November
- (d) *On-site feed preparation*, 24–26 November

Moreover, with support of GOJ-TF, one scientific paper and an extension manual were also published:

- (a) *Domestication of the mud crab Scylla serrata* by ET Quintino et al., *Aquaculture International* (published online first)
- (b) *Seed production of sandfish (Holothuria scabra) in Vietnam* by NDQ Duy published by AQD, WorldFish, Vietnam-RIA3, GOJ-TF



AQD scientist Dr. Mae Catacutan explains to trainees in Myanmar how to prepare feed ingredients based on the formulation. The course on feed preparation was funded by GOJ-TF and was conducted in collaboration with Myanmar's Department of Fisheries



## Food safety

Considering the growing public awareness on food safety of aquaculture products, AQD and the other departments of SEAFDEC are taking the lead in establishing regional guidelines on the correct use of antibiotics and other chemical inputs in aquaculture.

The *Food safety in aquaculture products in Southeast Asia* project also aims to: (1) determine the levels of commonly used chemicals in aquaculture products such as fish and shrimps; and (2) investigate the status of antibiotics and chemical use in Southeast Asian countries.

The main outcomes in 2010:

- (a) The withdrawal periods of commonly used antibiotics – oxytetracycline and oxolinic acid – administered at a dose of 75 and 30 mg kg<sup>-1</sup> fish day<sup>-1</sup> for 10 days were experimentally confirmed to be 22 and 27 days, respectively. While the study does not recommend indiscriminate antibiotic use, milkfish farmers in the tropics are nevertheless cautioned to

stop using antibiotics at least 22 or 27 days prior to harvest so that there is zero residue in fish.

- (b) Through analyses of the chemical contaminants in aquaculture products obtained in the Philippines, only two samples (of 34 samples already analyzed) had positive results for oxytetracycline and oxolinic acid, while analyses of other samples are still on-going.



Antibiotic residue analysis at AQD using high-performance liquid chromatograph

## Fish health

The main objectives of the *Accelerating awareness and capacity-building in fish health management in Southeast Asia* project are delivery of information and industry-wide capacity building for aquafarmers in resource-deprived countries, and innovative research to guarantee food safety and sustainable production.

This project succeeded the one from GOJ-TF4 programs entitled *Development of fish disease surveillance system*.

The major outcomes:

- (a) As part of the activity to identify the gaps and needs in fish health management in order to equip small-scale fishfarmers and other industry stakeholders, a surveillance of diseases and food safety was conducted in Myanmar. Results made clear the need to strengthen the expertise of government fish health staff in order to effectively disseminate available information on fish health management.
- (b) Screening cultured freshwater fishes for the presence of pathogenic parasites especially zoonotic ones was conducted in Myanmar in December 2010, and the results are now being analyzed.
- (c) Plasmid positive control for white spot syndrome virus (WSSV) was developed and can be used initially in conventional PCR assay. Having positive plasmid controls, a standard in commercial

PCR kits, will improve analysis as this can be used in determining the standard curve in q-PCR, and hence quantify the target virus.

- (d) Immunization of seabass, grouper, and pompano with the inactivated betanodavirus vaccine effectively induced the production of serum neutralizing antibodies that peaked at 2 months but gradually declined to significantly low levels at 12 months post-vaccination. Booster vaccination of these fish with the same vaccine resulted in increased antibody titers, indicating effective amplification of humoral anamnestic responses to re-exposure to the vaccine. In addition, results essentially indicated the feasibility of establishing a vaccine regimen in sea bass, grouper and pompano broodstock so that vertical transmission of the virus in hatcheries can be prevented.

- (e) To establish novel prophylactic and therapeutic methods for the prevention of viral infections in tropical fishes, 3, 5, 13, and 2 bacterial strains were isolated from the kidneys of healthy pompano, grouper, carp, and rearing water of carp, respectively. Screening of these bacterial strains for anti-betonavirus activity is ongoing. Aside from these, a yellow-pigment producing bacterium, experimentally confirmed to be highly pathogenic to healthy pompano juveniles, was isolated from the eye of pompano with exophthalmia.
- (f) Field trials confirming applicability of practical shrimp vaccination technologies to pond grow-out conditions demonstrated that growth and survival were improved with the use of formalin-inactivated vaccine against WSSV.
- (g) The parasitological survey on cultured abalone *Haliotis asinina* obtained monthly from grow-out cages at AQD's Igang Marine Station found a number of less significant pathogens in existence. These included ciliates (most prevalent at 35%) found within the gill filaments and on abalone foot surfaces with no pathology. Very little inflammatory response was associated with this infection. Burrowing polychaetes (Serpulidae, Dorvilleidae and Spionidae) were also found on the shell.
- The fish health project also implemented two training courses:
- (a) *Distance learning course on principles of health management in aquaculture* or AquaHealth Online, 26 July–17 December
- (b) *On-site training on basic fish health management of freshwater fishes with emphasis on zoonotic parasites*, 6–8 December, in Tharketa, Myanmar in collaboration with Department of Fisheries-Myanmar
- These are the publications output of the project:
- FARMER-FRIENDLY MATERIALS**
- (a) *Prevention and control of parasites in groupers*, a flyer published by AQD
- (b) *Prevention and control measures against viral nervous necrosis (VNN) in marine fish hatcheries* by LD de la Peña LD, a manual published by AQD
- (c) *The proactive way to live with WSSV* by R Usero & LD de la Peña, *Aquaculture Asia Pacific Magazine* 6: 8-11
- SCIENTIFIC PAPERS**  
[for complete citation, see pages 48-49]
- (a) Erazo-Pagador & Cruz-Lacierda (2010)
- (b) Erazo-Pagador (2010)
- (c) Pakingking et al. (2010)
- (d) Tendencia et al. (2010)
- (e) Tendencia et al. (2010)
- (f) Tendencia & de la Peña (2010)
- (g) Somga et al. (2010)
- (h) *Identification of stressors that affect white spot syndrome virus (WSSV) infection/outbreak in pond cultured *Penaeus monodon** by EA Tendencia & JAJ Verreth, *Israeli Journal of Aquaculture-Bamidgeh* (in press)
- (i) *Effect of different sizes of saline red tilapia hybrid *Oreochromis niloticus* x *O. mossambicus* on the growth of luminous bacteria *Vibrio harveyi** by EA Tendencia & MR de la Peña, *Philippine Agricultural Scientist* (in press)
- (j) *Temperature fluctuations, low salinity and water microflora are risk factors for WSSV outbreaks in pond culture of *Penaeus monodon** by EA Tendencia & JAJ Verreth, *Israeli Journal of Aquaculture-Bamidgeh* (in press)

Fish health training in Myanmar conducted by AQD in collaboration with Myanmar DOF and with funding from GOJ-Trust Fund



GE PAGADOR

# Resource enhancement

The project *Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release* addresses:

- (a) the world-wide concern on the resource conservation of internationally threatened and over-exploited species in Southeast Asia
- (b) the sustainable utilization and exploitation of natural coastal resources in the region through environment-friendly stock enhancement

To achieve these, the project conducts R&D on stock enhancement of seahorse, Napoleon wrasse, sandfish, abalone & mud crab, and organizes community training.

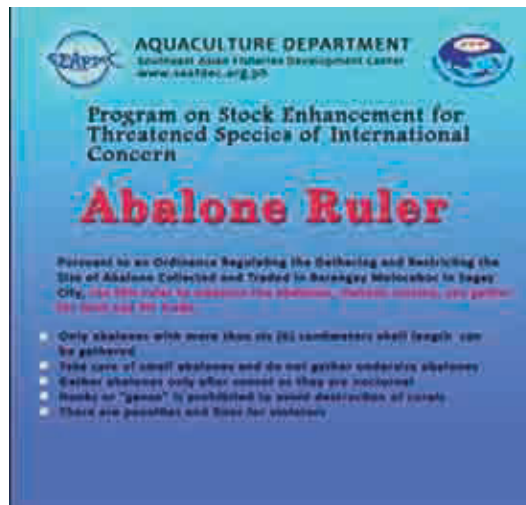
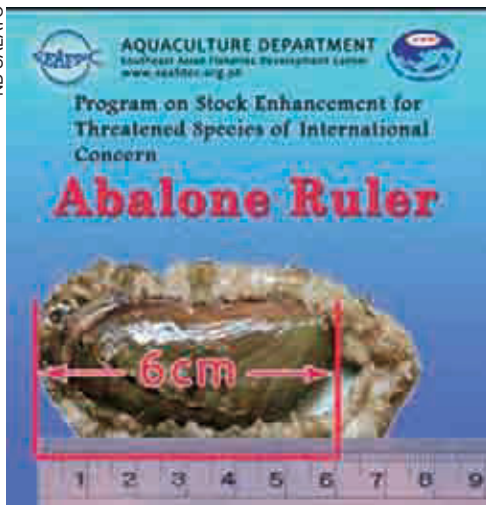
This project succeeded the one on *Stock enhancement of threatened species under international concern* which was completed in 2009. The focus of the new studies is refinement of hatchery and nursery technologies to produce stocks for eventual release.



Residents of Molocaboc Island in Negros Occidental attend the resource enhancement seminar; the abalone ruler (front and back) that measures the catch size limit set for the Molocaboc residents through a local ordinance

- The following are the major outcomes achieved in 2010:
- (a) As part of the study on refining the seahorse feeding scheme to improve hatchery production, *Hippocampus comes* broodstock and juveniles (1-6 months old) were fed mysids, *Artemia*, *Acetes*, and their combinations. Seahorse fed mysids proved to have better reproductive performance (parturition interval and parturition occurrence), and better growth & survival for juveniles.
  - (b) In the study on spawning and morphology of initial life stage of Napoleon wrasse *Cheilinus undulatus*, one of the highest valued and over-exploited fish species in tropical waters, it was noted that spawning occurred frequently in captivity, but the hatching rate was very low and the survival period after hatching was only until day 4 when yolk was fully exhausted. Although various types of food were tested in 2010, none proved sufficient.
  - (c) As an initial step to community-managed sandfish *Holothuria scabra* sea ranching and stock release, the site of Molocaboc Island in Negros Occidental, Philippines was assessed and fisherfolk partners for the study were identified. Moreover, knowledge of the partners was strengthened through seminars on the biology, ecology and culture of sandfish. Production

ND SALAYO





of juveniles from broodstock obtained from the release site was also done.

- (d) Based on the monthly monitoring survey of abalone *Haliotis asinina* in Carbin Reef, Negros Occidental, bigger hatchery-reared abalone proved to show higher survival when released in the wild and to exhibit the same habitat preference as their wild conspecifics. A high density of abalone in areas covered with branching corals was observed.
- (e) In a chosen mangrove site (Bryg. Nanding Lopez, Dumangas, Iloilo) for stock enhancement of mud crab *Scylla* spp., abundance by species and efficiency of the fishing gears were clarified: *S. olivacea* was the most abundant species and bamboo traps were more efficient than crab pot.
- (f) A study that assessed strategies for managing enhanced stocks of abalone and sandfish in Sagay Marine Reserve in Negros Occidental, Philippines, was successful in helping promulgate a science-based ordinance on abalone catch-size regulation in Barangay Molocaboc, Sagay. Abalone rulers distributed to fisherfolk, together with continuing awareness

seminars, aimed to enhance compliance to the regulation. The researchers also facilitated the long-over due formation of the Barangay Fisheries and Aquatic Resources Management Council (BFARMC) in Molocaboc which is critical in managing the community-based stock enhancement demonstration site organized with stakeholders.

Under this project, two scientific papers were published, and one is in press:

- (a) *Growth and survival of hatchery-bred giant clam (Tridacna gigas) in an ocean nursery in Sagay Marine Reserve, Philippines* by MJH Leбата-Ramos et al., Aquaculture International 18: 19-33
- (b) *Temperature and size range for the transport of juvenile donkey's ear abalone Haliotis asinina Linne* by SMA Buen-Ursua & G Ludevese, Aquaculture Research (published online first)
- (c) *Effects of UV-treated and chlorinated seawater and formalin-treated food organisms on survival and growth of newborn seahorses Hippocampus comes* by Buen-Ursua SMA et al., Israeli Journal of Aquaculture - Bamidgeh (in press)

## SPECIAL PROJECTS



Stocking tilapia in Laguna de Bay netcages

M.L.C. ARALAR

### Resource management of lakes

The AQD-ACIAR (Australian Centre for International Agricultural Research)-BFAR (Bureau of Fisheries and Aquatic Resources) collaborative study has set up tilapia grow-out cages in Lakes Bato and Buhi in Bicol. This study is part of the *Integrated fisheries resource management in the Rinconada lakes: aquaculture and water quality component*.

A separate grow-out run was made in Laguna de Bay to evaluate growth and survival of Nile tilapia under low feeding rates with daily and skip feeding. No significant differences in growth of Nile tilapia were observed between the groups fed daily and the skip-feeding scheme (daily growth, 0.9 g day<sup>-1</sup>; specific growth rate, 2.1%). Mean final weight was 128 and 125 g for the

daily and skip feeding. The condition factor of the two groups of fish also did not show any differences. No significant differences in the standing crop (1186 and 1143 g) and pieces-to-a-kilogram (8) between the daily and skip-feeding treatments, respectively, were observed. Final survival did not differ significantly (92%). Feed conversion ratio, however, was significantly lower in skip-feeding compared with daily feeding.

A new study being co-funded by ACIAR has started and this will focus on the carrying capacity, decision support tools for freshwater systems in Australia and the Philippines. Results generated from this research will be beneficial particularly for setting policies in the sustainable management of freshwater systems (like Laguna de Bay) which are used for aquaculture.

### Indigenous probiotic

The “SEAFDEC indigenous probiotic” derived from four bacterial isolates that inhibited *Vibrio harveyi* in vitro from a previous study were mass produced and inoculated into test ponds. The experimental 500 m<sup>2</sup> ponds, 1.5 m deep, were located at the Brackishwater Aquaculture Center of the University of the Philippines Visayas, Leganes, Iloilo. Shrimp *Penaes monodon* postlarvae (PL22) were stocked in three test ponds and three control ponds at a stocking density of 15 m<sup>-2</sup>. At the same time, equivalent volume of the bacterial media was inoculated into the control ponds a day before stocking and every two weeks. Aeration was provided in all ponds. Total bacterial counts (TBC), luminous bacterial counts (LBC), shrimp weight and survival as well as physico-chemical parameters of the rearing waters were monitored on days 0, 15, 30, 45 and 60. Results showed that mean LBC in pond waters and among shrimp were significantly higher in the control ponds than in the probiotic-treated ponds. These results indicated that the probiotic treatment effectively reduced the LBC of pond waters and of shrimps in test ponds.

### Co-culture of shrimp and sandfish

To establish co-culture methods of sandfish and tiger shrimp to mitigate pond eutrophication and prevent disease outbreaks, JIRCAS (Japan International Research Center for Agricultural Sciences) funded laboratory and field studies at AQD.

A study was conducted to determine the food and sediment suitable for sandfish. Juveniles were found to grow well on shrimp feed and when raised on sand substrate. Sandfish can also feed on shrimp pond detritus, shrimp feces and benthic diatom. Addition of ground oyster shell to the substrate seemed to enhance the growth of sandfish juveniles.

Bioremediation efficiency of sandfish in co-culture with shrimp was also studied. Sandfish juveniles were found to reduce AVS (acid volatile sulfur) level in the sediment by both organic matter consumption and bioturbation of the substrate. Oxygen consumption rate during decomposition was smaller in sandfish feces

than in the original food (i.e. pond detritus), indicating that sandfish can mitigate eutrophication of shrimp pond sediment. Water parameters, such as NH<sub>4</sub><sup>+</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup> and PO<sub>4</sub><sup>3-</sup> were not affected by the presence of sandfish.

Initial trials of shrimp / sandfish co-culture showed that growth and survival of shrimp and sandfish grown together or separately did not significantly differ. However, survival is affected by environmental factors like salinity (positive correlation for sandfish) and dissolved oxygen (positive correlation for shrimp). Feed input resulted in significantly increased sulfide levels in both monoculture and in co-culture. Sulfide was significantly different among treatments with the highest concentration in shrimp monoculture, co-culture, and then sandfish monoculture. Ammonium concentrations followed the same trend but did not significantly differ among treatments. Shrimps cultured in mangroves were also the least affected by the white spot syndrome virus which affected neighboring culture ponds. Results showed a promising culture system that may be integrated with the mangroves.

Size and condition measurements are important

in order to optimize rearing practices. Sandfish are highly variable in size and weight because they can expand and contract at will and during periods of stress, making accurate measurements difficult to obtain. To this end, the relationships between nutritional condition of sandfish and protein, carbohydrate & cholesterol concentrations in coelomic fluid (CF) were determined. During the 10-day starvation trials, CF protein and cholesterol in juvenile sandfish initially increased and then decreased while carbohydrate and CF density significantly increased. Thus, these can be used as indices of nutritional condition of sandfish juveniles instead of condition factor (body weight / size) which decrease with starvation.

Another set of starvation experiments were conducted to correlate digestive enzyme levels with nutritional condition of sandfish. Similarly, it was found that of the enzymes tested, levels of alpha amylase decreased as soon as the feed deprivation began, and remained lower than the control concentrations over the 2-week trial. These results suggest that alpha amylase concentrations can also be used as an indicator of nutritional status in sandfish.



Measuring water parameters (right) at the sandfish-shrimp co-culture set-up in the mangroves (far right)

MJH LEBATA-RAMOS



# AquaBusiness for entrepreneurs

The *ABOT (agree-build-operate-transfer) AquaNegosyo* program is a scheme that aims to disseminate science-based aquaculture technologies to encourage private sector investments in aquafarming for livelihood generation and food security. Technology packages are promoted to potential local and international business investors by providing technical assistance in every phase of on-farm operations, from site selection to fish stocking, feeding, water and health management, monitoring, harvesting and post production.

Assistance of AQD technical experts to investors by way of the ABOT Aquanegosyo scheme is extremely beneficial to the industry in general as it basically helps:

- (a) increase on-farm aquaculture production
- (b) promote environment friendly aquaculture practices
- (c) support the clients' technical needs, from planning to harvest
- (d) field a multi-disciplinary team comprising of scientist-experts in breeding, seed production, fish health and feed formulation as each project may require

The technologies being promoted by AQD for adoption by clients are results of AQD's years of R&D work which have been field-tested or verified and then packaged into financially viable schemes. The business packages cover hatchery and grow-out schemes for both freshwater (tilapia, carp, catfish, freshwater prawn), brackishwater & marine (abalone, mudcrab, grouper, milkfish, seabass, snapper, tiger shrimp and seaweed) commodities

From the time of its inception in 2007 to date, there have been 23 clients who availed of the program. Many of these clients required mainly site assessment and preliminary technical assistance while at least six (6) requested for technical support which lasted for a year to four years.

From January to September 2010, *ABOT AquaNegosyo* served five clients on different activities:

AQD has been invited to several local fora to promote the ABOT program. These fora were held on 15 and 21 September in Palawan and Iloilo upon the invitation of the Department of Science and Technology and the University of the Philippines Aquaculture Society, respectively.

AQD also promoted ABOT in two the Philippines' biggest fairs, the *Agri-Aqua-*

Entrepreneur	Activities	Location (timeframe)
Mr. Alain Alafriz	Site assessment for fish hatchery, pond development	Batangas (2010)
Mr. Juan Nepomuceno	Marine fish stock monitoring (milkfish)	Sorsogon (2008 to present)
Ms. Betty Lua	Marine fish and shrimp projects (milkfish, pompano and shrimp)	Cebu (2007 to April 2010)
Mr. PBC Tan	Site assessment for freshwater prawn culture	Bulacan (2010)
Mr. Peter Castro	Site assessment for aquasilviculture and/or marine fish farming	Camarines Norte (2010)



BC BAYLON

AQD signed a closure agreement with ABOT client Ms. Betty Lua on 27 April in the client farm in Cebu. As a result of AQD's more than two years of technical assistance, the client's milkfish harvest has increased from 2 tons in 2007 to 8 tons in 2008 and to 36 tons in 2009. AQD helped develop 34 out of 80 hectares. Ms. Lua said she was "very thankful that SEAFDEC is open to sharing their technology with us" and "giving us a chance to develop and fully utilize the area"

The various activities were undertaken in 30 mandays and earned for AQD a gross income of PhP 165 665 or US\$ 3 765 (US\$1 = PhP 44). From among these projects, those of Mr. Alafriz and Mr. Castro might proceed to long-term projects as soon as terms have been defined and agreed upon with the signing of agreements. Meanwhile, Mr. Nepomuceno's project in Sorsogon has been on-going since 2008.

*Foodlink* held 7-9 October and the *Fish for life festival* held 18-20 October. Both were held in Manila.

Project proposals have been submitted to two potential clients in Madagascar and Mauritius interested in mudcrab and multi-species marine fish hatchery and grow-out.



# For communities

The *Institutional capacity development for sustainable aquaculture* (ICDSA) program completed two projects in 2010, both funded by ACIAR (Australian Centre for International Agricultural Research) on (1) enhancing adoption of mudcrab production technologies in Northern Samar; and (2) enhancing adoption of improved grouper production technologies in Misamis Occidental.

Two more projects on milkfish and tilapia are continuing in Guimaras and Capiz with Citi / Petron Foundation and the local community, respectively.

## Northern Samar project:

IMPACTS ON PRODUCTION, ECONOMICS, COMMUNITY, ENVIRONMENT AND POLICY / INSTITUTION

- (a) On a 100 m<sup>2</sup> pond area, the potential production ranges 400-700 crablets using the SEAFDEC-recommended nursery protocol. This can be profitable. Mudcrab nursery will also add value to small crab and can be used for stocking by growers and crab fatteners. More export-quality crabs can be sold by Samar producers
- (b) The trained beneficiaries can go into mudcrab nursery as an additional livelihood with assistance from the non-government organization partners, SEAFDEC and micro-finance companies. Communities adopting mudcrab culture will benefit in terms of improved microeconomic activity because adopters will have higher disposal income

- (c) With crab nursery, constant collection of mudcrab seed stock from the wild that can result in recruitment failure will be reduced. Crab culture in mangrove areas where they co-exist is a more environment friendly system since construction and use of ponds are not encouraged
- (d) There would be improved participation in resource use and management. A sustainable mudcrab industry can attract tourists and investors to the community. Ultimately, the increased production of crabs in the province will redound to higher provincial tax collection
- (e) Less resource use conflicts in the community in the banning of illegal transport of crablets outside of the province; and improved relationship between law-enforcers and the community.
- (f) The establishment of crab hatcheries to support the crab farming industry will have a great impact on the ecological and socio- economic conditions traditionally linked to crab fishing
- (g) Better policies and ordinances in managing and controlling the outflow of crablets in the province



ETQUINITIO



Crablets produced in Northern Samar and one of the crab nursery ponds in mangroves

## Misamis Occidental project:

IMPACTS ON PRODUCTION, ECONOMICS, COMMUNITY, ENVIRONMENT AND POLICY / INSTITUTION

- (a) The actual grouper production showed that an 8 x 8 x 3 m fish cage has a production capacity of 2 000 kg in one run. With good production practices, the capacity to produce grouper is substantial to meet local and export demands
- (b) Six technical staff members of the Misamis Occidental partners (Gata Daku and PACAP-MOAVEC) underwent one-month training at AQD stations in Iloilo on grouper cage culture. They compose the core technical staff that now serve as trainers and build the capacity of interested fisherfolk and investors. Moreover, the project trained 100-120 fisherfolk from Sinacaban and Panaon on grouper cage culture. With more hands-on training, these fisherfolk can be tapped in manning and managing fish cage farms in the province.



Community grouper cages and marine fish hatchery in Misamis Occidental, both assisted by AQD in design & construction, operations and skills training

- (c) The methodology of assessing the mariculture site will provide operators and researchers bases of monitoring the changes caused by pollution
- (d) The scientific data can be used by LGUs and project managers to formulate policies and management schemes to ensure that the coastal areas are well-protected and used in a sustainable manner. Community protocols on environment monitoring are being prepared for cage operators
- (e) The technical and financial data from the project provide the fisherfolk and investors basis for their decision to go into grouper culture. As shown in the costs-and-returns, cage culture can provide additional income to beneficiaries both as an enterprise and employment. In the long term, grouper cage culture may even resulted in higher tax collection of local government units
- (f) Crafting of effective and well-defined use rights of fishery resources among various users

**Milkfish cage culture for fisherfolk in Guimaras**

**MARKET SURVEY.** A market survey was conducted in Capiz to assess its potential as outlet for milkfish produced in Guimaras. There are at least two micro-enterprises and one canning company that needs a daily supply of 20 tons of milkfish for export.

**PROFITABILITY.** While the 2009 phase of the project under AQD supervision was profitable (four beneficiary barangays each earned Php 66 956 from milkfish culture in 10 x 10 x 6 m cages), the second phase in 2010 relocated the cages in the fishers' respective barangays. Results showed that only one barangay profited (Php 31 945) while the rest incurred losses. An analysis of the factors affecting losses/gains is on-going.

Meanwhile prices of milkfish in major milkfish producing and trading areas were assessed. Results showed that western Visayas (Php 100-120 kg<sup>-1</sup>) remains to be the most lucrative market for milkfish followed by Pangasinan (Php 80-120 kg<sup>-1</sup>) and Manila (Php 75-120 kg<sup>-1</sup>). This shows that Guimaras fisherfolk can get good prices nearby.

**ORGANIZATIONAL ANALYSIS.** AQD collaborated with Taytay sa Kauswagan, Inc. to strengthen and empower existing fisherfolk organizations and to provide financial assistance to the beneficiary barangays in Nueva Valencia. From July to October, a baseline survey on fisherfolk organizations using governance, management, financial resources, service delivery, external relations, and organization & program sustainability components was conducted. Results showed low organizational capacity at 20-35%.

From 16-25 November, a community-based enterprise assessment was conducted through focus group discussions with 15-20 people in each barangay. Results showed the barangays' entrepreneurial strength as follows: 46% for cage culture in Magamay; 38% for gasoline trading and 48% in fish cage in Sto. Domingo, 34% mangrove project and 50% for fish cage culture in Igang; and 54% for fish cage culture in San Antonio.

**GENDER STUDY.** Survey results showed that women, like men, can take part in fish cage culture. They are effective in training and

demonstration, feeding, harvesting, marketing and post harvest activities. They were rated efficient in training and demonstration, marketing and post harvest activities. Older women and those who belonged to small households were active in training and demonstration. For cage construction, stocking and feeding, women with higher income showed more interest than those with low income. Women exposed in fishing activities were more effective in net mending. Women who were less engaged in fishing were effective in fish marketing. Women in small households were effective in value adding.

**ENTERPRISE DEVELOPMENT.** A new project on *Sustainable community and enterprise development program for fisherfolk* was implemented in partnership with Taytay sa Kauswagan, Inc. in 2010. Beneficiaries were still the four barangays affected by the oilspill in 2006.

**Skills training on deboning and smoking milkfish.** This was conducted 15-17 April with 19 participants. The aims were to let the association members see the extra profit in value-



added products, and to teach women the procedures for deboning and smoking milkfish.

A second session was conducted from May 26 to June.

**Organizational profiling, assessment, planning, and review of rules.** From 14 to 24 May, basic data of five fisherfolk organizations were updated with the assistance of 37 members from the Igang Small Farmers & Fisherfolk Association (ISFFA), 19 members from Sto. Domingo Fisherfolk Association (SDFA), 22 from Magamay Small Fisherfolk Association (MASFA), and 25 from San Antonio Association.

From 23 to 25 June, a second assessment examined governance, management, financial resources, service delivery, external relations, and sustainability. This led to an *Organizational planning* exercise that was conducted

27 July to 4 August where the five fisherfolk associations formulated their vision-mission-goals and made their organizational development plans based on strengths-weaknesses-opportunities-threats.

The *Review of organization's by-laws and policy formulation* came next for the Maliliit and Mahihirap group of San Antonio and Santo Domingo Fisherfolk Association. The review allowed the members to be aware of their association policies and to formulate guidelines on future fish cage projects like schedule of duties, feeding, net cleaning and others.

**Skills training: simple bookkeeping and proposal making.** The first one was conducted 11-25 November with the president, treasurer, auditor and bookkeeper of the five organizations in attendance. The objectives were to let the officers

understand their financial status, install an accounting system and make a book of accounts.

The *Proposal making* training, on the other hand, was conducted 16-25 November to educate the organizations' leaders about formulating proposals, budget and counterpart funds/services for their projects.

**Community-based enterprise assessment.** Conducted 19-26 November, the objective was to assess the level of community enterprises and to help officers and members openly discuss the details of how their organizations manage their community-based enterprises in terms of products, production systems & capacities, business systems & capacities, marketing capability, profitability, collective business agenda, and contribution to community development.



Water lettuce almost choking the tilapia cages in the Dumarao River

### Freshwater aquaculture in Dumarao, Capiz

Although adoption of tilapia culture as an additional livelihood had proceeded well, problems were encountered by AQD and the Dumarao community. There were the appearance of water lettuce that covered the river, siltation (run-off from the mountain) and flooding, among others.

The well-attended training on value-added milkfish; and a community harvest of milkfish from a sea cage





## TRAINING AND INFORMATION

# Training courses

AQD conducted 22 training courses which were attended by 321 industry stakeholders coming from ten SEAFDEC member-countries (except Japan) and 16 non-member countries



AQD Deputy Chief Dr. Teruo Azuma who oversees the GOJ-TF which funded five of the nine regular and onsite courses



Course, funding or requesting party, date, venue	Total participants (male + female), age range	Countries represented by participants
<b>REGULAR COURSE OFFERING</b>		
<b>Cage / pond culture of selected marine species</b> 8-26 March 2010 AQD stations in Iloilo and Guimaras	6 (5 M + 1 F), 31-68 years old	China (1), Federated States of Micronesia (1), Saudi Arabia (1), Philippines (3)
<b>Crab hatchery and grow-out</b> 14 April-5 May 2010 AQD Tigbauan Main Station	6 males, 31-52 years old	Malaysia (1), Singapore (1), Sultanate of Oman (1), Philippines (3)
<b>Marine fish hatchery</b> <i>Funded by Government of Japan Trust Fund (GOJ-TF)</i> 26 May-1 July AQD Tigbauan Main Station	15 (13 M + 2 F), 30-54 years old	Brazil (2), Federated States of Micronesia (1), Saudi Arabia (2), Sultanate of Oman (2), Indonesia (1), Myanmar (1), Thailand (1), Sudan (1), South Korea (1), Philippines (3)
<b>Abalone hatchery and grow-out</b> <i>Funded by GOJ-TF</i> 8-28 July AQD Tigbauan Main Station	11 (10 M + 1 F), 29-56 years old	Malaysia (2), South Korea (1), Philippines (8)
<b>Principles of health management in aquaculture</b> (AquaHealth Online) <i>A distance learning course funded by GOJ-TF</i> 26 July to 17 December 2010	17 (11 M + 6 F), 20-55 years old	Cambodia (1), Guyana (1), Myanmar (1), Nigeria (1), Thailand (1) and Zimbabwe (1), Hongkong (5), Singapore (3) and Philippines (3)
<b>COLLABORATIVE / ONSITE TRAINING</b>		
<b>Community-based freshwater aquaculture for remote rural areas of Southeast Asia</b> <i>Funded by GOJ-TF</i> 8-18 November AQD Tigbauan Main Station	8 (6 M + 2 F), 25-53 years old	Malaysia (1), Thailand (1), Myanmar (1), Cambodia (1), Lao PDR (1), Indonesia (1), Philippines (2)
<b>Sustainable coastal resource management</b> <i>In collaboration with the Zoological Society of London (ZSL), DENR, DA, BFAR and other partner agencies</i> Two sessions: 26-28 May and 16-18 June 2010 AQD Tigbauan Main Station	64 (41 M + 37 F), 18-72 years old	Philippines (64)
<b>Post-harvest and marketing of milkfish</b> <i>With funding support from AquaFish/CRSP</i> Two sessions: 16 April and 29 April AQD Tigbauan Main Station	28 females	Philippines (28)
<b>Farm-based feed preparation and feeding management</b> <i>With funding support from GOJ-TF and in collaboration with the Department of Fisheries - Myanmar</i> 24-26 November Hlaw Gar Fishery Station - DOF, Yangon, Myanmar	52 (39 M + 13 F)	Myanmar (52)

## CLIENT-DRIVEN TRAINING

<b>Tilapia hatchery and nursery operations</b> <i>At the request of the private sector</i> Two sessions: 4–8 January and 28 November–2 December AQD Binangonan Freshwater Station	4 (3 M + 1 F), 31–49 years old	Philippines (4)
<b>Diagnosis of viral diseases of fish and crustaceans</b> <i>At the request of Hongkong Special Administrative Region (HK-SAR)</i> 22–27 February AQD Tigbauan Main Station	1 male, 34 years old	HK-SAR (1)
<b>Diagnosis of diseases of fish and crustaceans</b> <i>At the request of HK-SAR</i> 22-26 February AQD Tigbauan Main Station	1 female, 38 years old	HK-SAR (1)
<b>Freshwater fish breeding and farming</b> Two sessions: 17 May–4 June and 15 November–3 December AQD Binangonan Freshwater Station	6 (5 M + 1 F), 18–51 years old	Burkina Faso (2), China (1), Ghana (2), Philippines (1)
<b>Shrimp farming with emphasis on shrimp health management</b> <i>At the request of the Saudi Arabia-based National Prawn Company</i> 12-28 April AQD Tigbauan Main Station	6 males, 30–49 years old	Saudi Arabia (4), Sudan (1), Philippines (1)
<b>Livelihood training in aquaculture: freshwater prawn and tilapia farming</b> ["Unang pagsasanay sa pag-aalaga ng ulang at tilapia"] Two sessions: 23-24 April and 29-30 October (freshwater prawn only, at the request of Lunsad Multi-Purpose Cooperative, Rizal) AQD Binangonan Freshwater Station	50 (41 M + 9 F), 30–74 years old	Philippines (50)
<b>Algal isolation and purification</b> <i>At the request of the Sultanate of Oman</i> 14 April – 05 May AQD Tigbauan Main Station	1 male, 25 years old	Oman (1)
<b>Seahorse hatchery</b> <i>At the request of a PhD student from Ecuador</i> 20 June–4 July AQD Tigbauan Main Station	1 female	Ecuador (1)
<b>Hatchery of selected marine fish</b> <i>At the request of the private sector</i> 10 August–10 September AQD Tigbauan Main Station	2 males, 29 and 31 years old	Malaysia (1), Marshall Islands (1)
<b>Abalone hatchery and grow-out</b> <i>At the request of the private sector</i> 29 September–19 October AQD Tigbauan Main Station	1 male, 27 years old	France (1)
<b>Crab seed production and grow-out</b> <i>At the request of the private sector</i> 6–22 October AQD Tigbauan Main Station	1 male, 28 years old	Singapore (1)
<b>Seed production and hatchery of sandfish (<i>Holothuria scabra</i>)</b> <i>At the request of the private sector</i> 12-26 October AQD Tigbauan Main Station	8 (6 M + 2 F)	United Kingdom (1), Tanzania (1), Malaysia (2), Philippines (4)
<b>Fish nutrition</b> <i>At the request of the Sultan Qaboos University in Oman</i> 22 November–4 December AQD Tigbauan Main Station	1 male	Oman (1)

## INTERNSHIP / ON-THE-JOB-TRAINING / STUDY TOURS

<b>Internships</b> at AQD hatcheries, laboratories and stations	35 (20 M + 15 F)	France (2), USA (1), South Korea (1), Indonesia (1), Malaysia (1), Philippines (29)
<b>Student on-the-job training (OJT)</b> , a requirement in the academic curriculum	147 (72 M + 75 F), 14-22 years old	Philippines (147 students from 22 schools / universities)
<b>Observation / study tours</b>	103 total people in 23 groups	Africa (1), Palau (1), Papua New Guinea (7), Ireland (1), Japan (18), and Thailand (1), Cuba (2), France (4), Korea (7), USA (1), Philippines (60)

# Publications Videos AQD Website



AQD produced farmer-friendly materials (six manuals and five flyers, see preceding pages), published two books and three institutional reports (2010 annual report, station videos), continued issuing a newsletter, updated its website – [www.seafdec.org.ph](http://www.seafdec.org.ph) – and attended five fairs to increase its visibility and to reach stakeholders.

**Reforming Philippine Science**, 94-page book that discusses the importance of science as the foundation of technological development and economic progress. It also illustrates the usefulness of a properly published scientific research. Written by RK Suarez and F Lacanilla



**The Pawikan Album**, 83 page documentation of 93 sea turtles captured from around AQD's Tigbauan Main Station, with documentary photographs of 67 individual turtles. Written by AQD FishWorld



**SEAFDEC/AQD Highlights 2009**, 44-page report of AQD's accomplishments in 2009. Also downloadable from the AQD website



**Igang Marine Station and Dumangas Brackishwater Station**, 5-min videos about two of AQD's four stations. The set of *AQD Magic*, the institutional video, is now complete. AQD videos may also be viewed / downloaded from YouTube



[www.seafdec.org.ph](http://www.seafdec.org.ph), the AQD website, was updated 16 times in 2010. It was viewed by more than 48 000 browsers (unique visitors), and had 128 downloadable materials



**AQD Matters**, the corporate newsletter, was issued to 733 people (including 224 employees) on AQD's e-mailing list each month. Seven issues were made in 2010



- Fairs and exhibits.** AQD attended five events in 2010:
- (1) BIMP-EAGA High Value Aquaculture Business Conference 5-7 April in General Santos City;
  - (2) Aquaculture Technology 2010 Convention 6-8 April in Panglao, Bohol;
  - (3) Shrimp Congress 17-19 March in Bacolod City; (4) FishLink 20-22 September in Iloilo City; and
  - (5) 2nd Vis-Min Agriculture & Aquaculture Expo 12-14 November in Cebu City.
- Depending on event theme, posters were designed for these fairs (see top)



# LibraryDataBank FishWorldVisitors



J. ZARATE

AQD continued to provide library & databanking services, building up library collection by 4% in 2010 [records accessible through the OPAC (online public access catalogue): 58 743] through purchases, subscriptions, and gifts & exchanges agreements. AQD is also a member of five library networks including IATUL (International Association of Technological University Libraries) and IAMSILIC (International Association of Aquatic and Marine Science Libraries and Information Centers).

AQD also planned for the expansion of its library; groundbreaking of the multi-media wing / conference hall at AQD's Tigbauan Main Station was done in July.



TU BAGARINAO

AQD FishWorld offered R&D internship for high school students (15 students from three schools availed of the program in summer 2010) and organized the yearly AquaWeek Sci-Art Contests (23 schools, 100 students, 85 teachers participated in July).

There were 14 394 visitors to AQD in 2010, including scientists / researchers from around the world who delivered seminars at AQD's Tigbauan Main Station:

- Dr. Shinsuke Morioka**, JIRCAS / Japan: *Importance of swampy-plane small fishes: A case study on fundamental biology of two short-lived species, Brachygobius mekongensis and Parambassis siamensis*, 9 February
- Dr. Yukio Hanamura**, JIRCAS / Japan: *Biological and ecological characteristics of hyperbenthic crustaceans in mangrove estuaries: perspective from studies in Malaysia*, 9 February
- Dr. Masashi Kodama**, National Research Institute of Fisheries Science / Japan: *Production and decomposition characteristics of particulate organic matter (POM) and its implications for hypoxia in the eutrophicated enclosed estuary, a case study of Ariake Bay, Japan*, 9 March
- Dr. Michele Nishiguchi**, New Mexico State University / USA: *Deciphering symbiotic conversations: ecological and evolutionary dynamics between a bobtail squid – Vibrio mutualism*, 15 April
- Dr. Ma. Michelle Penaranda**, University of Washington / USA: *Basis of host-specific virulence of U and M genogroup infectious hematopoietic necrosis virus (IHNV)*, 19 April
- Ms. Gladys Ludevese**, Ghent University / Belgium: *Stable isotope and mineral profile as an estimate of prey preference in two coral species grown in captivity*, 22 April
- Mr. Elson Aca**, World Wildlife Fund / Philippines: *Whale shark conservation in the Philippines*, 9 July
- Dr. Cincin Sia Young**, Mosquito – Dengue Fighters Association (MDF) / USA: *Dengue and its prevention*, 3 August
- Mr. Antoine Fry**, Institute of Political Science / Grenoble, France: *Governance options to manage coastal resources: lessons from three municipalities in the Visayas*, 5 August
- Dr. Kentaro Niwa**, National Research Institute of Fisheries Science / Japan: *A novel technique to collect gut contents for studying digestive mechanism in the abalone*, 5 August
- Dr. Anacleto Argayosa**, UP Diliman's Institute of Biology: *Lectins and nine lives*, 22 September
- Dr. Fahrul Huyop**, University Technology Malaysia: *Biodegradation of xenobiotics by dehalogenase from Rhizobium sp. RC1*, 14 October
- Dr. Nguyen Dinh Quang Duy**, Research Institute for Aquaculture No. 3 / Vietnam: *Grow-out culture of sandfish*, 19 October

## SEAFDEC Secretariat visits.

AQD assisted the Secretariat film footages of aquaculture activities to update the center's institutional video. AQD likewise hosted for the Secretariat the 2010 Information Staff Exchange Program meeting in Manila 6-8 October



- Acosta B, Gupta MV. 2010. Chapter 8: The genetic improvement of farmed tilapias project: impact and lessons learned. In: De Silva SS, Davy FB (eds.). *Success Stories in Asian Aquaculture*. Ottawa, Canada: International Development Research Centre (IDRC); Bangkok, Thailand: Network of Aquaculture Centres in Asia Pacific (NACA); Dordrecht, New York: Springer; pp. 149-202
- Aldon MaET, Fermin AC, Agbayani RF. 2011. Sociocultural context of fishers' participation in coastal resources management in Anini-y, Antique, west central Philippines. *Fisheries Research* 107: 112-121
- Altamirano JP, Primavera JH, Banaticla MRN, Kurokura H. 2010. Practical techniques for mapping small patches of mangroves. *Wetlands Ecology and Management* 18: 707-715
- Arratia G, Bagarinao T. 2010. Early ossification and development of cranium and paired girdles of *Chanos chanos* (Teleostei, Gonorynchiformes). In: Grande T, Poyato-Ariza FJ, Diogo R (eds.). *Gonorynchiformes and Ostariophysan Relationships: A Comprehensive Review (Series on Teleostean Fish Biology)*; Enfield, New Hampshire, USA: Science Publishers; pp. 74-106
- Buen-Ursua SMA, Ludevese G. Appropriate temperature and size range of transport of juvenile donkey's ear abalone *Haliotis asinina* Linne from the hatchery to restocking sites. *Aquaculture Research* (online first)
- de Jesus-Ayson EGT. 2010. Milkfish hatchery and nursery production in the Philippines. In: Liao IC, Leño EM (eds.). *Milkfish Aquaculture in Asia*. Keelung, Taiwan: National Taiwan Ocean University; Keelung, Taiwan: The Fisheries Society of Taiwan; Selangor, Malaysia: Asian Fisheries Society; Louisiana, USA: World Aquaculture Society; pp. 61-70
- de Jesus-Ayson EGT. 2010. Milkfish R&D in the Philippines. In: Liao IC, Leño EM (eds.). *Milkfish Aquaculture in Asia*. Keelung, Taiwan: National Taiwan Ocean University; Keelung, Taiwan: The Fisheries Society of Taiwan; Selangor, Malaysia: Asian Fisheries Society; Louisiana, USA: World Aquaculture Society; pp. 47-59
- de la Peña MR, Bautista JJ, Buen-Ursua SM, Bayona N, Titular VST. 2010. Settlements, growth and survival of the donkey's ear abalone *Haliotis asinina* (Linne) in response to diatom diets and attachment substrate. *Philippine Journal of Science* 139: 27-34
- Erazo-Pagador G, Cruz-Lacierda ER. 2010. The morphology and life cycle of the gill monogenean (*Pseudorhabdosynochus lantauensis*) on orange-spotted grouper (*Epinephelus coioides*) cultured in the Philippines. *Bulletin of European Association of Fish Pathologists* 30: 55-64
- Erazo-Pagador G. 2010. A parasitological survey of slipper-cupped oysters (*Crassostrea iredalei*, Faustino 1932) in the Philippines. *Journal of Shellfish Research* 29: 177-179
- Eusebio PS, Coloso RM, Gapasin RSJ. 2010. Nutritional evaluation of mysids *Mesopodopsis orientalis* (Crustacea: Mysida) as live food for grouper *Epinephelus fuscoguttatus* larvae. *Aquaculture* 306: 286-294
- Garcia LMaB, Hilomen-Garcia GV, Calibara RLM. 2010. Culturing seahorse (*Hippocampus barbouri*) in illuminated cages with supplementary Acetes feeding. *The Israeli Journal of Aquaculture-Bamidgeh* 62: 122-129
- Garcia YT, Salayo ND. 2009. Price dynamics and cointegration in the major markets of aquaculture species in the Philippines. *Asian Journal of Agriculture and Development* 6: 49-81
- Gonzaga J, Anderson A, Richardson N, Nocillado J, Elizur A. 2010. Cloning of IGF-I, IGF-II and IGF-IR cDNAs in mullet (*Mugil cephalus*) and grouper (*Epinephelus coioides*): Molecular markers for egg quality in marine fish. *Asian Journal of Biological Sciences* 3: 55-67
- Hamid AAA, Hamdan S, Pakingking RV, Huyop F. 2010. Identification of *Pseudomonas* sp. strain S3 based on small subunit ribosomal RNA gene sequences. *Biotechnology* 9: 33-40
- Hayashi L, Hurtado AQ, Msuya FE, Bleicher-Lhonnour G, Critchley AT. 2010. A review of *Kappaphycus* farming: prospects and constraints. In: Israel A, Einav R, Seckbach J (eds.). *Seaweeds and their role in globally changing environments: Part 6. Cultivation of seaweeds in globally changing environments. Cellular Origin, Life in Extreme Habitats and Astrobiology* 15: 251-283
- Israel DC. 2007. The current state of aquaculture in Laguna de Bay. PIDS Discussion Paper Series No. 2007-20; Manila, Philippines: Philippine Institute for Development Studies; pp. 1-63
- Laranja JLQ Jr, Qunitio ET, Catacutan MR, Coloso RM. 2010. Effects of dietary L-typtophan on the agonistic behavior, growth and survival of juvenile mud crab *Scylla serrata*. *Aquaculture* 310: 84-90
- Luhan MRJ, Sollesta H. 2010. Growing the reproductive cells (carpospores) of the seaweed, *Kappaphycus striatum*, in the laboratory until outplanting in the field and maturation to tetrasporophyte. *Journal of Applied Phycology* 22: 579-585
- Marte CL. 2010. Milkfish aquaculture in the Philippines: An overview. In: Liao IC, Leño EM (eds.). *Milkfish Aquaculture in Asia*. Keelung, Taiwan: National Taiwan Ocean University; Keelung, Taiwan: The Fisheries Society of Taiwan; Selangor, Malaysia: Asian Fisheries Society; Louisiana, USA: World Aquaculture Society; pp. 33-46
- Ogata H. 2009. Message - Proceedings of the SEAFDEC International Workshop on Emerging Fish Diseases in Asia; 6-7 December 2007; Bangkok, Thailand. *Israeli Journal of Aquaculture-Bamidgeh* 61: 159-160 (editorial material)



- Pakingking RV Jr, Bautista NB, de Jesus-Ayson EG, Reyes O. 2010. Protective immunity against viral nervous necrosis (VNN) in brown-marbled grouper (*Epinephelus fuscoguttatus* [i.e. *fuscoguttatus*]) following vaccination with inactivated betanodavirus. *Fish and Shellfish Immunology* 28: 525-533
- Polidoro BA, Carpenter KE, Collins L, Duke NC, Ellison AM, Ellison JC, Farnsworth EJ, Fernando ES, Kathiresan K, Koedam NE, Livingstone SR, Miyagi T, Moore GE, Nam VN, Ong JE, Primavera JH, Salmo SG III, Sanciango JC, Sukardjo S, Wang Y, Yong JWH. 2010. The loss of species: Mangrove extinction risk and geographic areas of global concern. *PLoS ONE* 5: e10095; pp. 1-10
- Primavera JH, Binas JB, Samonte-Tan GPB, Lebata MJH, Alava VR, Walton M, Le Vay L. 2010. Mud crab pen culture: replacement of fish feed requirement and impacts on mangrove community structure. *Aquaculture Research* 41: 1211-1220
- Quinitio ET, de la Cruz JJ, Eguia MRR, Parado-Estepa FD, Pates G, Lavilla-Pitogo CR. 2011. Domestication of the mud crab *Scylla serrata*. *Aquaculture International* 19 (2): 237-250
- Reyes OS, Duray MN, Santiago CB, Ricci M. 2010. Growth and survival of grouper *Epinephelus coioides* (Hamilton) larvae fed free-living nematode *Panagrellus redivivus* at first feeding. *Aquaculture International* 19: 155-164
- Romana-Eguia MRR, Ikeda M, Basiao ZU, Taniguchi N. 2010. Growth comparison of Asian Nile and red tilapia strains in controlled and uncontrolled farm conditions. *Aquaculture International* 18: 1025-1221
- Salayo ND. 2010. Milkfish marketing in the Philippines. In: Liao IC, Leaño EM (eds.). *Milkfish Aquaculture in Asia*. Keelung, Taiwan: National Taiwan Ocean University; Keelung, Taiwan: The Fisheries Society of Taiwan; Selangor, Malaysia: Asian Fisheries Society; Louisiana, USA: World Aquaculture Society; pp.105-127
- Seike S, Toledo JD, Umino T, Nakagawa H. 2005. Variation of otolith strontium concentration in elongate surgeonfish, *Acanthurus mata*. *International Technology Exchange, Inc. (ITE) Letters on Batteries New Technologies and Medicine* 6: 250-255
- Somga, JR, de la Peña LD, Suarnaba VS, Sombito CD, Paner MG, Capulos GC, Santa Maria PI, Po GL. 2010. KHV-associated mortalities in quarantined koi carp in the Philippines. *Bulletin of the European Association of Fish Pathologist* 30: 2-7
- Tendencia EA, Bosma RH, Usero RC, Verreth JAJ. 2010. Effect of rainfall and atmospheric temperature on the prevalence of the whitespot syndrome virus in pond-cultured *Penaeus monodon*. *Aquaculture Research* 41: 594-597 (short communication)
- Tendencia EA, Bosma RH, Verreth JAJ. 2010. WSSV risk factors related to water physico-chemical properties and microflora in semi-intensive *Penaeus monodon* culture ponds in the Philippines. *Aquaculture* 302: 164-168
- Tendencia EA, de la Peña MR. 2010. Potentials of *Kappaphycus striatum* (Schnitz) and *Gracilaria heteroclada* Zhang (Ad Xia) to control the growth of luminous bacteria *Vibrio harveyi*. *The Philippine Agricultural Scientist* 93: 109-115 (research note)
- Tendencia EA, dela Peña MR. 2010. Effect of different sizes of saline red tilapia hybrid *Oreochromis niloticus* x *O. mossambicus* on the growth of luminous bacteria *Vibrio harveyi*. *The Philippine Agricultural Scientist* 93:463-467. (research note)
- Toledo JD. 2009. Overview - SEAFDEC International Workshop on Emerging Fish Diseases in Asia; In: *Proceedings of the SEAFDEC International Workshop on Emerging Fish Diseases in Asia*; 6-7 December 2007; Bangkok, Thailand. *Israeli Journal of Aquaculture-Bamidgeh* 61: 157 (editorial material)
- Yunque DAT, Tibubos KR, Hurtado AQ, Critchley AT. Optimization of culture conditions for tissue culture production of young plantlets of carrageenophyte *Kappaphycus*. *Journal of Applied Phycology* (online first)



AQD researchers explain their work (clockwise from top, left): Dr. Relicardo Coloso, Dr. Edgar Amar, Ms. Shelah Mae Buen-Ursua, Mr. Vincent Encena II, Dr. Rolando Pakingking Jr and Dr. Emilia Quinitio



# Statement on sources / application of funds

<b>SOURCES OF FUNDS</b>	
Government of the Philippines	Php 150 000 000
Government of Japan Trust Fund	10 437 017
Fish health	2 312 201
Food safety	1 610 283
Sustainable aquaculture	4 647 340
Resource enhancement	1 867 193
External grants	25 339 496
ACIAR - resource management study	236 346
ACIAR - carrying capacity study	1 225 127
ASEAN Foundation - HRD	118 967
ASEAN Foundation - RTC	181 543
Aurora State College - Baler hatchery	500 000
BFAR - on-site training / tech assist	565 470
BFAR - hatchery in Palawan	4 594 452
BFAR-BIOTEC - biotech laboratory	5 000 000
FAO - technical paper preparation	1 375 510
FAO - workshop on on-farm feed	4 072 637
Fats & Protein Research	266 940
ICDSA - RAISED (Romblon)	10 498
ICDSA - Surigao Norte	46 469
ICDSA - Rapu-rapu assessment	49 500
ICLARM (Worldfish) - sandfish	630 803
JIRCAS - co-culture study	434 981
JIRCAS - S Watanabe study	1 240 837
PETRON - enterprise development	200 000
PETRON - milkfish cage culture	1 099 063
PETRON / Citi Foundation / TSKI	532 050
NCSU - alternative feeding study	1 372 488
University of Wageningen	419 810
USB - soybean and soy protein study	1 166 006
Internally generated funds	27 537 117
Income - RD	7 001 724
Income - TID	4 787 828
Income - TVDD	5 802 830
Income - AFD	9 355 562
Income - Management	589 173
Committed funds from prior year	43 223 904
<b>Total sources of funds</b>	<b>256 537 534</b>

<b>APPLICATION OF FUNDS</b>	
General / administrative & non-project expenses	Php 135 714 450
AFD	45 301 140
Management	18 384 187
RD	53 863 232
TID	14 068 610
TVDD	4 097 280
Program / project expenses	32 801 437
RD	17 842 256
TID	2 630 769
TVDD	12 328 413
GOJ-TF	10 437 017
Fish health	1 339 460
Food safety	756 530
Sustainable aquaculture	3 716 816
Resource enhancement	2 166 807
GOJ committed funds / advances	2 457 403
Externally funded projects	20 945 987
ABOT collaborative projects	166 845
ACIAR - grouper projects	223 057
ASEAN Foundation - HRD	188 899
ASEAN Foundation - RTC	321 805
Aurora State College - Baler hatchery	281 411
BFAR - biotech laboratory	5 913 303
BFAR - growout of white shrimp	12 364
BFAR - hatchery in Palawan	1 365 225
FAO - technical paper	1 264 562
FAO - workshop on on-farm feed	2 648 214
Fats & Protein Research	257 426
ICDSA	215 913
ICLARM (WorldFish) - sandfish	645 044
JIRCAS	1 663 172
NACA - live reef food fish trade	61 460
NCSU - alternative feeding study	1 446 658
Novus International - grouper study	222 263
PETRON - milkfish cage culture	817 099
PETRON - milkfish cage culture	1 088 979
PETRON / Citi Foundation / TSKI	274 934
UNESCO - guidebook	75 995
University of Wageningen	444 415
USB - soybean study	1 346 946
Committed funds	56 638 644
Advances for on-going activities	2 029 952
Capital outlay/repairs	54 608 692
<b>Total application of funds</b>	<b>256 537 534</b>

# AQD **community** affairs



## **Plant. Clean. Teach.**

The AQD community was one in planting trees in Tigbauan, Iloilo in July and in Daja, Maasin in September; in the clean-up and information drive against dengue in five schools also in Tigbauan in August and September



## **Celebrate. Learn.**

To keep the body strong, AQD split into two teams to compete in its sportsfest in June and July. To keep its management strong, supervisors underwent a workshop on effective and liberating leaders at the end of July. AQD as of December 2010 has 297 total employees; 151 in research, 25 in training & information; 56 in technology verification & demonstration; 46 in administration & finance; and 19 in the management group.



## About SEAFDEC

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 to promote fisheries development in the region. The member-countries are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. The policy-making body of SEAFDEC is the Council of Directors, made-up of representatives of the member countries.

SEAFDEC has four departments that focus on different aspects of fisheries development:

- The **Training Department** (TD) in Samut Prakan, Thailand (1967) for training in marine capture fisheries
- The **Marine Fisheries Research Department** (MFRD) in Singapore (1967) for post-harvest technologies
- The **Aquaculture Department** (AQD) in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- The **Marine Fishery Resources Development & Management Department** (MFRDMD) in Kuala Terengganu, Malaysia (1992) for the development and management of fishery resources in the exclusive economic zones of SEAFDEC member countries

AQD is mandated to:

- Conduct scientific research to generate aquaculture technologies appropriate for Southeast Asia
- Develop managerial, technical and skilled manpower for the aquaculture sector
- Produce, disseminate and exchange aquaculture information

AQD maintains four stations: the Tigbauan Main Station and Dumangas Brackishwater Station in Iloilo province; the Igang Marine Station in Guimaras province; and the Binangonan Freshwater Station in Rizal province. AQD also has a Manila Office in Quezon City.

*SEAFDEC Aquaculture Department  
Tigbauan Main Station  
Tigbauan 5021 Iloilo, Philippines*

*Email: [aqdchief@seafdec.org.ph](mailto:aqdchief@seafdec.org.ph)  
Tel. (63 33) 511-9170; 511-9171  
Fax (63 33) 511-8709; 511-9070*

**[www.seafdec.org.ph](http://www.seafdec.org.ph)**

