

# 2012 SEAFDEC/AQD Highlights



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Appointed 29 June 2012 by the SEAFDEC Council to a two-year term, the new AQD Chief **Dr. Felix Ayson**, 51 years old, is a career fisheries scientist specializing in biotechnology, marine fish hatchery and climate change. Dr. Ayson completed his post-doctoral fellowship at Kitasato University in Japan (2000) through a grant from JSPS (Japanese Society for the Promotion of Science); acquired his PhD in Zoology major in fish physiology and endocrinology from the Ocean Research Institute of the University of Tokyo (Japan) in 1994; and obtained his MSc and BSc in Marine Biology from the University of the Philippines Diliman (1987) and University of San Carlos (1981, cum laude), respectively.

As an AQD scientist rising through the ranks (he was first employed as a senior research assistant in 1986), Dr. Ayson has so far published 16 science papers in peer-reviewed international journals as sole author or first author. He has received research grants on rabbitfish from USAID (2001-2004) and AusAID (2004-2005); the latter was for an award-winning proposal on siganid culture for a rural community. More recently, he has received a milkfish grant from USAID-AquaFish CRSP (2007-2009) and is a current collaborator of a DOST-PCAARRD milkfish project with UP Visayas. He has headed AQD's programs on marine fish and climate change, which included research, training & information, and extension activities for aquaculture stakeholders. In between his stints at AQD, he served as the Chief Technical Advisor on aquaculture for the United Nations Food and Agriculture Organization (2007-2010); he was a visiting professor at the Tropical Biosphere Research Center of the University of Ryukyus in Okinawa, Japan (2005-2006); and was a research fellow at Kitasato University.

## Dear stakeholders,

In the year that passed, SEAFDEC/AQD started implementing its programs following the thematic approach. All department program activities were classified under five thematic areas: (1) meeting social & economic challenges in aquaculture; (2) producing quality seed for sustainable aquaculture; (3) promoting healthy & wholesome aquaculture; (4) maintaining environmental integrity through responsible aquaculture; and (5) adapting to climate change. The activities under each program, however, largely remained focused on regionally important aquaculture commodities like the marine and freshwater fishes, shrimps, crabs, seaweeds, abalone and sandfish. AQD is midway in the implementation of four regional programs funded by the Government of Japan-Trust Fund (GOJ-TF) under the Fisheries Consultative Group mechanism namely: promotion of sustainable and region-oriented aquaculture practices, resource enhancement of internationally threatened & over-exploited species in Southeast Asia, accelerating awareness & capacity building in fish health management, and food safety of aquaculture products. In all these activities, our long-term objective is to generate appropriate technologies anchored on solid R&D to ensure the continued production of these various commodities through sustainable aquaculture. In doing so, we help ensure food security and improve the lives of the people especially those in the rural areas.

As an R&D organization, AQD's primary outputs are scientific data in the form of scientific publications that go into technology development. In 2012, AQD scientists published 24 publications in international scientific journals and conference proceedings. A very promising and significant development just off the data mill is that the search for a low or no fish meal containing feeds for milkfish is within reach. AQD's recent findings show superior growth performance of milkfish feed diet containing only 15% fish meal. Reduction in the use of fish meal in feeds without affecting growth augurs well for the aquaculture industry that is already largely dependent on artificial feeds. Another bright spot is the development of immunization regimen against the nodavirus that cause viral nervous necrosis (VNN) in marine fish, a major headache among fish farmers.

The other side of AQD's major function is in the dissemination of technologies generated by the Department. AQD was exceptionally busy in 2012. Various training courses were conducted in the main station in Tigbauan, Iloilo and in our freshwater station in Binangonan, Rizal. Aside from the regular course offerings, the number of specialized training courses organized by AQD increased. These courses are tailor-made to the interests and needs of our stakeholders. AQD scientists and trainers also travelled to various places in the country and to SEAFDEC-member countries like Cambodia to conduct on-site training courses. Our ABOT (*Agree-build-operate-transfer*) aquabusiness mechanism continues to generate interest here and abroad, with most clients interested in production systems for high value marine fish, especially groupers & sea bass, mud crab, abalone, sandfish and tilapia. AQD provided technical assistance for the operation of a privately-funded mud crab hatchery in Samal, Davao (Philippines) which will supply the crablet requirements of mud crab growers in Mindanao where wild stocks have been depleted. Similarly, AQD provided technical assistance in the establishment of mud crab hatchery and nursery facilities, and training of the locals in coastal communities in Timor Leste on the grow-out culture of mud crab in ponds and fattening in pens and cages, a project supported by USAID-ACDI/VOCA. The ICDSA (*Institutional capacity*

*development for sustainable aquaculture*) mechanism showcases our partnership with BFAR by providing technical assistance in their program on ensuring availability of seedstock for mariculture through the establishment and operation of multi-species marine fish hatcheries in strategic locations all over the country, among others.

Farmer-friendly information dissemination remains high in AQD's priorities. Technical manuals on grow-out culture of mangrove red snapper in ponds and nursery of high-value fishes in ponds were published and are now available to interested stakeholders. Manuals on mud crab hatchery and nursery operations, mud crab culture, and cage culture of milkfish have been prepared and submitted to agencies that will fund their publication. Updates on our R&D initiatives are regularly posted in AQD's website, in Facebook and other social networking sites. Our library has expanded its network of partners and information dissemination services to include more digital resources and online services.

As in previous years, we continue to build awareness, nurture and teach the youth about aquaculture, fisheries, biodiversity conservation and science in general, by hosting student on the job trainees and interns from various schools all over the country. Our internship program has been attracting students from other countries as well; we hosted students from the University of Ghent and the University of Melbourne. Our scientists make time to mentor students doing their research. We take pride in training the future aquaculturists, and fisheries and aquaculture practitioners, and perhaps even scientists in the country and in the region.

The lack of budget has always been AQD's problem. This constrained us from modernizing and undertaking some important activities under the different programs that required modern facilities and equipment. Securing external grants from funding agencies and through collaboration with both national and foreign institutions like the DA through BFAR and DA-Biotech PIU, DOST-PCAARRD, ACIAR, FAO, JIRCAS, FRA and RIHN of Japan, USAID, USB, among others, are among the strategies that we are taking to augment our R&D funds. We are currently implementing various projects under the national S&T programs on shrimp, milkfish and mud crab of DOST-PCAARRD in collaboration with the University of the Philippines Visayas (UPV), University of the Philippines Institute of Biology (UP-IB) and other partners in the academe.

All these achievements in the past year were made possible by the hard work, dedication and cooperation of all AQD staff. We will continue to work harmoniously in the coming years in order to surpass our past achievements and to face the challenge for AQD to maintain its leadership in aquaculture not only in SEAFDEC member countries but throughout Southeast Asia.



**Felix G. Ayson**, D. Sc.  
Chief, SEAFDEC/AQD

FRONT COVER: Giant clams stocked by AQD in a San Joaquin (Iloilo) marine protected area which is being managed by a people's organization [PHOTO BY **JP Altamirano**]

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# New agreements with stakeholders

**ACDI/VOCA** (*Agricultural Cooperative Development International / Volunteers in Overseas Cooperative Assistance; Washington DC*): Provide funding and facilitate implementation of a mud crab and fish cultivation project in Timor Leste with AQD's assistance (20 Jan 2012 - 05 April 2012)

**INTECHMER** (*Institut National des Sciences et Techniques de la Mer, France*): Provide funds for the conduct of a student thesis at AQD on feeds for tiger shrimp (27 Feb 2012 - 22 June 2012)

**IFS** (*International Foundation for Science*): provide funds for a PhD dissertation on probiotics for shrimp (April 2012 - April 2014)

**RIHN** (*Research Institute for Humanity and Nature; Kyoto, Japan*): Provide financial support and facilitate implementation of a project on enhancing capability of coastal areas in Southeast Asia (April 2012 - March 2017)

**DENR-PAWB** (*Protected Areas and Wildlife Bureau of the Department of Environment and Natural Resources; Philippines*): Provide financial support and facilitate implementation of a training series on biodiversity conservation (19 - 25 Apr, 17-24 Mar, 28 Aug-4 Sept 2012)

**International Service for the Acquisition of Agri-Biotech Applications** (*Philippines*): Provide funding and facilitate implementation of a training course on biotechnology (29 April 2012 - 3 May 2012)

**Universiteit Gent and VLIR** (*Flemish Interuniversity Council; Brussels, Belgium*): Provide funding for a study on the use of polyhydroxybutyric acid in shrimp larviculture (May 2012 - April 2013)

**University of the Sunshine Coast (Australia), Department of Agriculture, Fisheries and Forestry (Australia) and Research Institute for Aquaculture No. 1 (Vietnam)**: Provide funding and facilitate implementation of studies on grouper maturation, spawning and juvenile production (1 June 2012 - 31 May 2013)

**DOST-PCAARRD and UPV** (*Department of Science and Technology-Philippine Council for Agriculture, Aquatic & Natural Resources Research & Development and University of the Philippines Visayas; Philippines*): Provide funding for a national mud crab program (July 2012 - July 2015)

**Ms. Beatriz Cabadongga / Ms. Zenaida Tan Manzano** (*Philippines*): Provide funds and conduct studies on aspects of seahorse hatchery as graduate theses (Sept 2012 - Oct 2012)

**ACIAR** (*Australian Centre for International Agricultural Research; Australia*): Provide funding and facilitate implementation of a project on sea cucumbers in the Philippines, Vietnam and Australia (1 Oct 2012 - 30 Sept 2016)

**PNRI** (*Philippine Nuclear Research Institute; Philippines*): Conduct joint undertakings in research and exchange of experts (5 Oct 2012 - 5 Oct 2017); includes a study on the potential uses of irradiated seaweeds

**URS** (*University of Rizal System; Philippines*): Implement an aquaculture research, technology and development program (19 Oct 2012 - 19 Oct 2017)

**DA-BFAR and CRMP** (*Bureau of Fisheries & Aquatic Resources of the Department of Agriculture and the Community-based Mangrove Rehabilitation Project in the Philippines; Philippines*): Provide funding and technical expertise for the training on inventory and evaluation of public lands for fishpond development (11 Nov 2012 - 16 Nov 2012)

**Century Marine Products SDN. BHD.** (*Sabah, Malaysia*): Provide funding and assistance during assessment by AQD of potential sites for sandfish hatchery and nursery (Nov 2012)

**Acantilado Aqua Resource Corporation** (*Philippines*): Provide funding during assessment by AQD of potential sites for mud crab hatchery and nursery (Dec 2012)

AQD Chief Dr. Felix Ayson and DOST-PCAARRD Deputy Executive Director Dr. Cesario Pagdilao sign the agreement on a national mud crab program with AQD researchers and PCAARRD officers standing as witnesses



## National mud crab S&T program

DOST (Department of Science & Technology) approved the joint Php19.6 million proposal of AQD and UPV (University of the Philippines Visayas) for a *National mud crab science & technology program*. The ultimate goal is to establish mud crab *Scylla serrata* hatcheries and nurseries in the Philippines to increase availability of seedstock for farming and maintain or improve the country's status as the second largest producer of mud crab in the world.

AQD signed the agreement with PCAARRD-DOST (Philippine Council for Agriculture, Aquatic & Natural Resources Research & Development, which is the monitoring agency for the program) on 12 July at AQD's Tigbauan Main Station in Iloilo.

The three-year program aims to come up with improved diets for broodstock & grow-out, more viable hatchery & nursery technology, and improved grow-out management strategies for the mud crab. Capacity building of stakeholders is included to hasten technology transfer and extension.

The program has AQD's verification & demonstration division head and scientist Dr. Emilia Quintio as program leader. It consists of seven projects: (1) development of techniques for sustainable production of marine annelids as feed for crab broodstock (Dr. Veronica Alava); (2) improvement of larval rearing protocol (Dr. ET Quintio); (3) refinement of efficient diets for nursery culture (Dr. VR Alava); (4) application of strategies for reduction of cannibalism in crab nursery (Dr. Fe Estepa); (5) evaluation of existing feed formulation for grow-out (Dr. Mae Catacutan); (6) development of feeding strategies for grow-out culture in ponds, pens & cages (Dr. Jerome Genodepa, UPV); and (7) development of immunostimulant for crab (Dr. Rex Ferdinand Traifalgar, UPV).



Agreement signing for PNRI and URS on 5 and 19 Oct, respectively

# Research and development programs

Studies	Study leader	Completion	Budget (Php)		Collaborating partner
			AQD	External	
<b>THEMATIC PROGRAMS</b>					
<b>Meeting social and economic challenges in aquaculture</b>					
1	Verification, demonstration and adoption of cage culture of giant freshwater prawn <i>Macrobrachium rosenbergii</i> among smallholder fish farmers in Laguna de Bay	EV Aralar	40%	760 210	
2	Coastal area capability development through community-based stock enhancement in Batan Estuary, Aklan, Philippines	JP Altamirano	10%		1 092 500 RIHN <sup>1</sup>
<b>Quality seed for sustainable aquaculture</b>					
3	Selective breeding of the Indian white shrimp <i>Penaeus indicus</i> : I. Disease resistance in juveniles of captive spawner	FDP Estepa	30%	189 243	
4	Genetics for sustainable milkfish aquaculture: I. Development and application of molecular markers in milkfish broodstock management	MR Eguia	25%	350 000	DOST <sup>2</sup> /UP <sup>3</sup> Institute of Biology
5	National mud crab science & technology program: I. Refinement of mudcrab hatchery technology. II. Improvement of larval rearing protocol	ET Quinitio	25%		2 404 636 DOST
6	Reproduction and seed production of the climbing perch <i>Anabas testudineus</i>	LMaB Garcia		202 200	NSRI <sup>4</sup> , UP Diliman
7	Enhancement of sandfish hatchery and nursery techniques	JP Altamirano	20%	232 528	ACIAR <sup>5</sup>
8	Development of techniques for sustainable production of good quality captive <i>Penaeus monodon</i> broodstock and spawners and high-health fry	FDP Estepa	70%		DOST/UPV <sup>6</sup>
9	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	100%	322 235	
10	Development of molecular genetic markers for <i>Kappaphycus</i> and <i>Eucheuma</i> species	MMD Peñaranda	45%	646 046	
11	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 of <i>H. asinina</i>	MR de la Peña	90% and 5%	454 102	
12	Use of tryptophan supplementation to reduce cannibalism in fish larvae	JM Zarate	40%	400 302	
13	Application of strategies to reduce cannibalism in the mud crab nursery	FDP Estepa	20%		2 625 784 DOST
14	Use of thraustochytrid <i>Schizochytrium</i> sp. LEY7 as live feed enrichment for fish larvae and component in abalone formulated diets: I. Mass production in optimum culture conditions yielding highest lipid and fatty acid contents. II. Utilization as live food enrichment for larviculture of tiger grouper and as component in formulated diets for aquaculture species	MR de la Peña / G Ludevese	65%	238 966	
15	Larval rearing of the silver perch <i>Leiopotherapon plumbeus</i> (Kner, 1864) under laboratory condition	FA Aya	100%	493 646	
16	Cultivation of <i>Cocconeis</i> sp. for settlement, growth and survival of post-larval abalone <i>Haliotis asinina</i>	MR de la Peña	80%	217 041	
17	Refinement of hatchery techniques for the donkey's ear abalone <i>Haliotis asinina</i> : I. Improvement of fecundity and seed quality of breeders recently acquired from the wild. II. Evaluation of genetic stocks for selective breeding of abalone	MR de la Peña	75%	510 319	

<sup>1</sup>RIHN, Research Institute for Humanity and Nature <sup>2</sup>DOST, Department of Science & Technology <sup>3</sup>UP, University of the Philippines

<sup>4</sup>NSRI, National Science Research Institute <sup>5</sup>ACIAR, Australian Centre for International Agricultural Research

<sup>6</sup>UPV, University of the Philippines Visayas

Studies	Study leader	Completion	Budget (Php)		Collaborating partner
			AQD	External	
<b>THEMATIC PROGRAMS</b>					
<b>Quality seed for sustainable aquaculture</b>					
18	Refinement of seed production techniques for high-value marine fish species such as grouper, red snapper, seabass, rabbit fish and pompano	OS Reyes	95%	537 707	
19	Optimization of seed production of milkfish through feeding fortified diets: Effects on eggs and fry quality	OS Reyes / EGT de Jesus-Ayson / FG Ayson	95%	400 000	
20	Domestication and evaluation of the culture potential of native Caridean prawns <i>Macrobrachium lar</i> and <i>M. mamilodactylus</i>	MLC Aralar	70%	289 977	DOST-NRCP <sup>7</sup>
21	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	70%	584 758	
22	Breeding and culture of polychaetes	VR Alava	40%	255 284	
23	Purification and characterization of agarases and carageenases from polysaccharide-lysing bacterial isolates of seaweeds and herbivorous aquaculture species	MMD Peñaranda	65%	200 000	
24	Effect of stocking density and tryptophan diets on survival and growth of mud crab <i>Scylla serrata</i> in nursery phase	VR Alava	50%	651 500	
25	Microparticulate diet as alternative feed in abalone hatchery production: Comparative evaluation in small- and large-scale tank systems	MB Teruel	10%	586 257	
26	Verification of feeding and water management techniques for mudcrab <i>Scylla serrata</i> seed	ET Qunitio	50%	750 700	
27	Nursery rearing techniques for seed production of <i>Kappaphycus</i> "seedlings"	MRJ Luhan	40%	572 277	
28	Culture of <i>Gracilariopsis heteroclada</i> Zhang & Xia in pond and in intertidal area	SS Avanceña	40%	592 667	
29	Verification of the nursery culture techniques for the pompano <i>Trachinotus blochii</i> Lacepede in brackishwater pond: Evaluation of formulated diets with varying lipid levels	JM Ladja	100%	675 000	
30	Mass production of sex-reversed and mixed Nile tilapia ( <i>Oreochromis niloticus</i> ), and hybrid red tilapia fingerlings	DM Reyes Jr	100%	687 830	
31	Large-scale production of donkey's ear abalone, <i>Haliotis asinina</i> juveniles	NC Bayona	85%	844 187	
32	Small-scale fish hatchery production (integrated marine fish demo hatchery)	JM Ladja / LD dela Peña	100%	494 218	
<b>Promoting healthy and wholesome aquaculture</b>					
33	Production characteristics of the giant freshwater prawn <i>Macrobrachium rosenbergii</i> cultured in cages using different grow-out management strategies	MLC Aralar	60%	683 412	
34	Feed development for the golden pompano <i>Trachinotus blochii</i>	MR Catacutan	50%	69 000	
35	Effect of varying levels of coconut meal to replace soybean meal in diets for mud crab <i>Scylla serrata</i>	VR Alava	80%	381 870	
36	Use of soybean meal and soy protein concentrate as alternatives to fish meal in practical feeds for milkfish, <i>Chanos chanos</i>	RM Coloso	90%		1 436 571 United Soybean Board
37	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	75%	396 140	

<sup>7</sup>NRCP, National Research Council of the Philippines

<sup>8</sup>VLIR, Flemish Interuniversity Council

<sup>9</sup>JSPS, Japan Society for the Promotion of Science

<sup>10</sup>LGU, local government unit (Philippines)

Studies	Study leader	Completion	Budget (Php)		Collaborating partner	
			AQD	External		
<b>THEMATIC PROGRAMS</b>						
<b>Promoting healthy and wholesome aquaculture</b>						
38	WSSV polychaete worm carriers: local prevalence, tissue tropism and clearance mechanism	LD dela Peña	30%	405 000		
39	Refinement of hatchery techniques for the donkey's ear abalone <i>Haliotis asinina</i> : Bacterial diversity and algal community structure in biofilms of settlement plates for larvae	LD dela Peña	75%	55 120		
40	The application and mode of action of probiotic <i>Bacillus</i> species in the larviculture of <i>Penaeus</i> : Identification, isolation and characterization of <i>Bacillus</i> species capable to accumulate poly- $\beta$ -hydroxybutyrate (PHB) and degrade acyl homoserine lactone (AHL) for use as probiotics	JLQ Laranja Jr.	15%	382 588	421 184	International Foundation for Science
41	Application and mode of action of polyhydroxybutyric acid (PHB) in the larviculture of <i>Penaeus</i> spp.	GL Ludevese	15%		636 000	VLIR <sup>8</sup>
42	Host responses and defense against <i>Amyloodinium ocellatum</i> infestation in marine fish species and development of control methods	EC Amar	60%	377 939		
43	Screening of antimicrobial activities of crude extracts from Philippine seaweeds	MMD Peñaranda	60%	578 686		
44	Intensive milkfish ( <i>Chanos chanos</i> ) culture in brackish water earthen ponds using alternate day feeding regime	EGD Ayson	90%	1 599 424		
45	Intensive grow-out culture of mangrove red snapper ( <i>Lutjanus argentimaculatus</i> ) in brackish water earthen ponds using SEAFDEC formulated diet	RM Coloso	100%	838 421		
46	Netcage culture of tilapia and freshwater prawn in freshwater dam/reservoir using test diet and commercial feeds	DD Baliao	100%	262 026		
47	Refinement and demonstration of semi-intensive grow-out culture of grouper ( <i>Epinephelus fuscoguttatus</i> ) fed SEAFDEC phased-diet in pond	MR Catacutan	25%	426 147		
48	Demonstration of semi-intensive grow-out culture of pompano ( <i>Trachinotus blochii</i> ) using commercial diet in brackishwater pond	MR Catacutan	80%	436 324		
49	Economics of producing mud crab <i>Scylla serrata</i> juveniles for soft shell crab farming	RP Ragus	50%	526 323		
50	Small-scale grow-out production in netcages of freshwater prawn <i>Macrobrachium rosenbergii</i> and Nile tilapia <i>Oreochromis niloticus</i> in freshwater dam/reservoir for rural aquaculture development	DD Baliao	50%	1 534 299		
<b>Maintaining environmental integrity through responsible aquaculture</b>						
51	Application of molecular markers in the conservation and management of marine genetic resources in Asia	MRR Eguia	90%	328 001		JSPS <sup>9</sup>
52	Hydrographic profiling of Igang Marine Station	JP Altamirano	40%	251 862		
53	Biodiversity in marine cages and platforms for aquaculture in Igang, Guimaras: Species composition and abundance in relation to duration of immersion, farm management, and adjoining habitats	TU Bagarinao	100%	60 000		
54	Stock enhancement of giant clam <i>Tridacna gigas</i> in San Joaquin	JP Altamirano	90%	169 464		LGU <sup>10</sup> (San Joaquin, Iloilo)
55	Determination of optimal conditions for sandfish <i>Holothuria scabra</i> culture	JP Altamirano	30%	116 264		
56	Carrying capacity, decision support tools for freshwater systems in Australia and the Philippines	MLC Aralar	90%		729 094	ACIAR

Studies	Study leader	Completion	Budget		Collaborating partner	
			AQD	External		
THEMATIC PROGRAMS						
Maintaining environmental integrity through responsible aquaculture						
57	<i>Anodontia philippiana</i> and <i>Holothuria scabra</i> as bioremediators in an intensive cage culture system	MJHL Ramos	70%	287 600		
58	Co-culture of seabass <i>Lates calcarifer</i> and seaweed <i>Gracilaria bailinae</i>	HS Marcial	40%	385 391		
59	Polyculture of sea cucumber with selected marine fish species	JM Zarate	70%	215 002		
Adapting to climate change						
60-61	Climate change and aquaculture: I. Effect of increasing seawater temperature and acidity on embryonic development, larval survival and subsequent performance in the hatchery of important tropical marine fish species	FG Ayson	50%	727 475		
	II. Effect of increasing rearing water temperature and acidity on the reproductive performance of some important tropical freshwater / brackishwater aquaculture fish species (tilapia and rabbitfish)		50%	701 338		
62	Biological response of zooplankton commonly used in aquaculture to climate change conditions	H Marcial	20%	467 478		
63	Effect of climate change variables on the embryonic and larval development of mud crab ( <i>Scylla serrata</i> ) and abalone ( <i>Haliotis asinina</i> )	FL Pedroso	30%	137 400		
REGIONAL PROGRAMS FUNDED BY THE GOVERNMENT OF JAPAN - TRUST FUND (GOJ-TF)						
Promotion of sustainable aquaculture and resource enhancement in Southeast Asia (ASEAN-SEAFDEC Fisheries Consultative Group mechanism)						
64	Selective breeding of mudcrab <i>Scylla serrata</i>	ET Quintio	60%	239 097	186 233	GOJ-TF
65	Selective breeding of the tiger shrimp <i>Penaeus monodon</i>	FDP Estepa	60%	133 817	186 233	GOJ-TF
66	Genetic improvement in the giant freshwater prawn, <i>Macrobrachium rosenbergii</i> : Assessment of effective broodstock management schemes for improved growth and reproductive performance	MRR Eguia	70%	143 002	186 233	GOJ-TF
67	Development of hatchery techniques of emerging species with special reference to reproductive biology of pompano and other potential species for aquaculture	FL Pedroso	60%	453 190	186 233	GOJ-TF
68	Establishment of guidelines for optimum feeding management through survey of availability and quality assessment of feed resources	MR Catacutan	100%		186 233	GOJ-TF
69	Development of efficient and low-pollution feeds for grow-out and broodstock (with special reference to giant freshwater prawn)	FA Aya	50%	342 036	186 233	GOJ-TF
70	Establishment of management technology for disease tolerance and sustainable aquaculture environment	EA Tendencia	46%	124 276	186 233	GOJ-TF/ RESCOPAR <sup>12</sup> (Wageningen University)
71	Socioeconomic assessment and impact analysis of transfer and adoption of sustainable aquaculture technologies	DB Baticados	85%	510 418	86 620	GOJ-TF
Food safety of aquaculture products in Southeast Asia						
72	Surveillance of chemical contaminants in aquaculture products and feeds	MR Catacutan	100%		186 233	GOJ-TF
73	Investigation of the situation of antibiotics/chemicals usage and regulations in aquaculture	RM Coloso	30%		64 950	GOJ-TF
74	Withdrawal period of antibiotics in mangrove red snapper <i>Lutjanus argentimaculatus</i> , milkfish <i>Chanos chanos</i> and some freshwater fish species cultured in the tropics	MT Arnaiz	100%		186 233	GOJ-TF



Studies	Study leader	Completion	Budget		Collaborating partner
			AQD	External	

## THEMATIC PROGRAMS

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

75	Establishment of immunization regimen for the prevention of viral nervous necrosis (VNN) in high-value marine broodfish	RV Pakingking Jr	95%	100 000	194 895	GOJ-TF
76	Establishment of novel prophylactic and therapeutic methods for the prevention of viral infections in commercially important maricultured fish	RV Pakingking Jr	62%	100 000	194 895	GOJ-TF
77	Evaluation of carriers for practical delivery of vaccines to shrimp <i>Penaeus monodon</i> and other crustaceans	EC Amar	60%	148 565	194 895	GOJ-TF
78	Survey on the status and needs of primary aquatic animal health care in small scale aquaculture	EC Amar	60%		346 480	GOJ-TF
79	Parasitic and shell diseases of abalone ( <i>Haliotis asinina</i> ) in the Philippines	GE Pagador	70%		129 930	GOJ-TF
80	Surveillance of parasite fauna of economically important freshwater fish in some Southeast Asian countries	GE Pagador	65%		177 571	GOJ-TF
81	Molecular diagnosis and prevention of viruses in economically important fish and shrimp: Susceptibility of different shrimp species to white spot syndrome virus (WSSV)	LD de la Peña	45%	131 206	194 895	GOJ-TF

### Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release

82	Stock enhancement of Napoleon wrasse <i>Cheilinus undulatus</i> with special reference to reproductive biology and seed production	FL Pedroso	30%	453 190	186 233	GOJ-TF
83	Stock enhancement of seahorses <i>Hippocampus barbouri</i> and <i>H. comes</i>	SMB Ursua	65%	336 344	186 233	GOJ-TF
84	Stock enhancement of donkey's ear abalone <i>Haliotis asinina</i>	MJHL Ramos	90%		186 233	GOJ-TF
85	Stock enhancement of mud crabs <i>Scylla</i> spp.	MJHL Ramos	55%	97 000	186 233	GOJ-TF
86	Community managed sandfish ( <i>Holothuria scabra</i> ) sea ranching and stock release	MFJ Nievaes	55%	144 000	186 233	GOJ-TF
87	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	70%		173 240	GOJ-TF
88	Effects of ocean warming on symbiont-shuffling, changes in survival and growth of corals, and community structure in the coral reef areas	JM Zarate	10%		173 240	GOJ-TF <sup>11</sup>

## SPECIAL PROJECTS

89	Development and extension of integrated multi-trophic aquaculture techniques for improvement of livelihood, (second of 5-year project)	S Watanabe	75%		2 105 884	JIRCAS <sup>13</sup>
90	Epidemiology study and elucidation on spread route of shrimp viral diseases in southeast Asian countries	LD de la Peña	15%		474 065	JIRCAS
91	Development of ice-ice resistant strains of <i>Kappaphycus</i> and technology for reduction of epiphytes	MRJ Luhan	20%		2 021 586	ACIAR

<sup>11</sup>GOJ-TF, Government of Japan - Trust Fund    <sup>12</sup>RESCOPAR, Rebuilding Resilience of Coastal Populations and Aquatic Resources

<sup>13</sup>JIRCAS, Japan International Research Center for Agricultural Sciences

## MSECAP




# Meeting social and economic challenges in aquaculture

MSECAP is a program that aims to address the recommendations of the June 2011 *ASEAN-SEAFDEC Conference on sustainable fisheries*. This covers the following areas: (1) enhancing the role of aquaculture in addressing food, income and livelihood security through improved governance, multi-agency collaboration, and comprehensive and interdisciplinary approaches; (2) promoting sustainable aquaculture through enabling policies that support the management of natural and environmental resources; (3) enabling mechanisms, institutions and infrastructure to encourage adoption of better aquaculture practices; (4) understanding and improving linkages from production to marketing and trade of fishery products to support small and medium enterprise (SME) development; and (5) strengthening the capacity of aquaculture stakeholders by mainstreaming specific rural and peri-urban aquaculture programs and policies in local, national and international development programs.

The accomplishments of AQD in this program are described below:

### Prioritizing collaborative R&D in aquaculture in the region

Studies on the promotion, adoption and implementation of aquaculture of new, indigenous and economically important species in inland and coastal communities were conducted on-farm in collaboration with fishers and cooperatives in Laguna de Bay in Luzon and in upland rice-farming communities in Dumarao, Capiz, as well as in coastal communities in Guimaras. Hatchery-bred seeds did not only contribute directly to food production, but also in the restocking of over-fished waterbodies. Action-oriented research through community-based stock enhancement of threatened high-value species such as abalone and sea cucumber in Sagay Marine Reserve in Negros Occidental demonstrated the synergy between the biological and social dimensions of fisheries management. Lessons from these stakeholder participation models are to be replicated in a shrimp stock enhancement initiative in New Washington, Aklan. Preliminary findings revealed that the sustainability of technology adoption to form small and medium enterprises was constrained by the following factors: (1) lack of reliable supply of breeders and seeds in remote rural areas; (2) weak organizational and solidarity commitment, and (3) inadequate financial management. In all of this collaborative on-site R&D activities, the modalities for introducing and implementing aquaculture technologies and stock enhancement using hatchery-bred seeds are being evaluated.



A people's cooperative in Dumarao, Capiz, Philippines sells tilapia [TOP RIGHT] from its cage culture

PHOTOS BY R CASTEL / D BATICADOS

## Allocating R&D resources to address emerging issues

The program has recommended policy and up-scaled ordinances to support and maintain fisheries management mechanisms resulting from on-field studies. For instance, assistance was extended to local government units in formulating ordinance on abalone catch size regulation (6 cm) as one of the strategies for managing enhanced stocks in Sagay Marine Reserve (Negros Occidental, Philippines). Also, to increase adoption of full-cycle aquaculture (FCA) technologies by fish farmers, especially for high-value species, training and IEC (information-education-communication) activities on the use of seeds for aquaculture and provision of seeds from aquaculture were done in all project sites to motivate adoption of FCA.

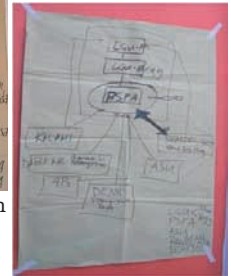
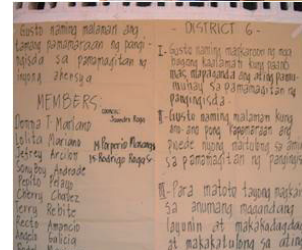
## Enhancing multi-agency collaboration

Initial effort was made to meet this objective through information dissemination. AQD has published and disseminated the program objectives, activities and milestones in SEAFDEC's 'Fish for the People' magazine to inform Member Countries on technology adoption methods, modalities and pathways experienced in various project sites in the Philippines. At the local level, R&D activities under this program were conceived and are being implemented at selected farm sites through participatory schemes with stakeholders such as fishers, farmers, cooperatives, fisherfolk associations, traders, government agencies and policy-makers.

[L-R] AQD researcher guides fisherfolk association on determining goals and purpose of their organization; election of village resource management council officers; briefing and selection of fishers and cooperators for on-farm lake-based cage culture of freshwater prawn in Laguna de Bay; stock sampling of freshwater prawn cages of the Pipindan fisherfolk association



PHOTOS BY IND SALAYO



[FROM THE TOP] Project orientation meeting with fishers, local government and AQD on community-based stock enhancement; community goals and project expectations; and identification of project collaborators and their roles



PHOTOS BY JP ALTAMIRANO / IND SALAYO / D BATICADOS / E ARALAR

Project collaborators participated in stock release at the 4,000 sq m stock enhancement demo-site in Molocaboc Dacu (Sagay, Negros Occidental, Philippines). This demo-site was established June 2011 and became the model for two more release sites that followed in December 2012.

[INSET, FROM THE TOP] Tagged hatchery-bred abalone juveniles (~2.75 cm) released in Sagay Marine Reserve; abalones bigger than 6 cm shell length harvested periodically beginning September 2012, providing funds for fisherfolk organization; and the vice mayor, barangay captain, and fisherfolk-collaborators participating in the fourth stock release in January 2012



PHOTOS BY IND SALAYO





PHOTO BY RT BAUTISTA

## AQD trains resource management council of Molocaboc

For five days beginning 20 February, AQD conducted two separate courses on *Abalone and sandfish stocking & culture technology* with ten BFARMC (Barangay Fisheries & Aquatic Resources Management Council) members of Molocaboc, Sagay, Negros Occidental, Philippines as participants.

These courses, funded by the Government of Japan Trust Fund, included topics on abalone seed production including spawning, egg collection, counting & incubation, larval rearing in tanks, feeding; culture in cages including stocking, feeding & feed conversion ratios and survival; biology & life cycle of sandfish, broodstock selection, and larval rearing. In addition, the participants visited AQD's research station in Ilang and UP Visayas.

Ms. Anicia Abong had this to say: *"Gapasalamat gid ako sa tanan nga SEAFDEC personnel, ging himo nyo gid ang tanan nga daghan gid kami mabal-an, nakalipay gid namo nga ging tagaan kami oportunidad nga magtraining diri sa SEAFDEC."* (We are thankful to all SEAFDEC personnel, who did their best in teaching us. We are happy that we were given an opportunity to train at SEAFDEC.)

## Aquaculture for communities

Seven participants from Cambodia (1), Malaysia (1), Thailand (1), Vietnam (1), India (1), and the Philippines (2) completed AQD's training course on "Community-based freshwater aquaculture for remote rural areas of Southeast Asia" that was held 26 November - 5 December at AQD's station in Binangonan, Rizal, Philippines.

The lectures and practicals included the overview of freshwater aquaculture in Southeast Asia; hatchery, broodstock management & grow-out of commercially-important freshwater species like tilapia, bighead carp, catfish, and freshwater prawn; aquatic ecology; design & construction of tanks, cages, pens, and ponds; preparation of feeds; major diseases affecting freshwater fish; and sustainable management of small-scale farms.

The course was funded by the Government of Japan Trust Fund to help Southeast Asian countries adopt better aquaculture technologies.



## AQD organizes course on land evaluation for fishponds

AQD also conducted a training on *Conducting inventory and evaluation of public lands released for fishpond development purposes* which was held 11-16 November and attended by 31 technical officers of BFAR (Bureau of Fisheries & Aquatic Resources). The training included lectures and hands-on activities on these topics: basic fishpond aquaculture system, farm economics, basic steps in conducting fishpond lease agreement inventory, mangrove biology, basic mapping orientation, and aquasilviculture focusing on best practices for mud crab nursery, grow-out & fattening.

The participants also visited different reforestation sites in Leganes, Iloilo; Ivisan, Capiz; and Ibajay, Aklan. Mr. Jackito Ballebar, of BFAR-5, expressed his gratitude to AQD for extending full support to the program and for being the "best partner of BFAR". He added: "The training and workshop are very good. I hope that the objectives and advocacy of AQD continue so that problems brought about by global warming will be resolved through adoption of the technology by the people in the community."

This activity was funded by BFAR and the Zoological Society of London.

## AQD hosts discussion on fishfarmers' welfare

AQD hosted the *International conference on fisheries and globalization* (ICFG) that was held at AQD's main station in Tigbauan, Iloilo from 19 to 21 September. The three-day conference gathered 32 international organizations from 15 countries in Asia, Africa, and Latin America to analyze the global small-scale fisheries and recommend strategies to promote and protect fish farmers' welfare worldwide.

"AQD is happy to host this meeting," AQD Chief Dr. Felix Ayson said. "Developing sustainable technologies suitable for small-scale farmers is one of the major programs of AQD. The fisherfolk and small-scale farmers are our stakeholders since they play an important role in providing food for the increasing human population."

At the end of the conference, the delegates adopted a declaration that enumerates the key problems facing small-scale fisherfolk and their recommendations for the realization of sustainable fisheries. The conference was organized by People's Coalition on Food Sovereignty, IBON International, Pamalakaya, and Fisheries & Marine Environment Research Institute Inc.

At the community aquaculture course, trainees learn how to select good carp broodstock



PHOTO BY RR PAGADOR

Molocaboc resource management council members observe the operations of AQD's abalone hatchery (TOP), and later tried their hand at spawning sandfish



PHOTO BY IBON INTERNATIONAL



PHOTO BY RT BOMBEO

Participants of the international conference on fisheries and globalization (TOP); land-use trainees visit a mangrove reforestation site in Iloilo, Philippines



QS

## Producing quality seed for sustainable aquaculture

One of the main constraints to enhancing aquaculture production in Southeast Asia is the inadequacy of supply and quality of seed stocks and the required domesticated broodstocks. Issues on the supply of quality seed are of primary concern for the member countries to meet the increasing internal demands for aquatic products and to maintain their positions as major suppliers of aquaculture products to international markets.

In this QS program are studies and activities that will determine optimal conditions and methods for the production of quality seedstock in sufficient quantities. The research activities entail the use of conventional methods of stock improvement such as domestication, broodstock management, strain evaluation and selective breeding or genetic improvement of traditional and emerging freshwater and marine species. The following are the highlights of accomplishments under each program objective:

### **Developing good quality broodstock and implementing proper broodstock management protocols**

As a pre-requisite to selective breeding programs, domestication is pursued through monitoring of the genetic structure of base populations, establishing husbandry techniques, developing suitable diets for the different life stages and culture of live food necessary for good reproductive performance. Studies are being undertaken in shrimps/prawns, mollusks and fishes but at varying phases of development.

CRUSTACEANS. Techniques are being developed for the sustainable production of good quality captive tiger shrimp *Penaeus monodon* breeders. Development of potential broodstock from several sources (Capiz and Masbate) is underway.

In the giant freshwater prawn *Macrobrachium rosenbergii*, efficient and low-pollution diets for use in rearing potential broodstock are being developed and tested. Improvements in the diet formulation have also been done through higher inclusion or replacement levels of fish meal protein with cowpea meal protein in the grow-out diet. Mean body weight of prawns fed diets with 30-45% replacement levels showed the highest mean body weight (~0.58-0.60g) after 65 days of culture in tanks starting from the postlarval stage. Moreover, there were significant differences in terms of growth and survival among the dietary treatments when the prawns were reared in tanks. On the other hand, lake-based cage trials did not result in significant differences in growth and survival using the same dietary treatments. As for the effect of the different diets on reproductive performance,



Fins are partially clipped during sampling of milkfish broodstock for subsequent DNA marker analysis

broodstock fed diets with 30% cowpea replacement level had the most number of berried females and also gave the highest number of eggs (1,934 g<sup>-1</sup> female).

**MOLLUSKS.** Efforts have also been made to improve the maturation diets for donkey's ear abalone, *Haliotis asinina*. Eggs from abalone breeders fed seaweed diet were significantly smaller than those from breeders fed the formulated maturation diet but the percentage protein in eggs spawned from females fed seaweeds did not differ from those fed the maturation diets. It has been noted though that the reproductive performance of wild-sourced abalone breeders generally improved with an increase in dietary protein/energy levels from 27%/3210 kcal/kg energy up to 37%/3570 kcal/kg energy.

**FISHES.** For milkfish *Chanos chanos*, AQD initiated studies on the development of quality broodstock using conventional stock monitoring and management protocols in collaboration with UPV and with funding support from the Philippine Department of Science and Technology (DOST). Pioneering work on genetic documentation of milkfish stocks using microsatellite markers recently started with the screening of primers for 72 potential markers from information obtained through next generation sequencing.

**SEAWEEDS.** Like in milkfish, molecular markers that will identify stocks and consequently aid in determining genetic quality are being developed for several other commercial aquaculture species like mud crabs, shrimp, abalone and the seaweeds *Kappaphycus* and *Eucheuma*. To date, protocols for seaweed DNA extraction and PCR amplification for selected genetic markers (cox 1, cox 2-3 and nuclear ITS 1-2) have been optimized. Studies are also in-progress to improve the existing

seaweed strains through isolation and culture of protoplasts from red seaweeds with potentially superior genetic traits.

**EMERGING SPECIES.** Experiments are in-progress to develop broodstock conditioning methods for the sandfish or sea cucumber. It has been observed that old spawners decreased in body size especially when held in tanks and exhibited reduced reproductive performance. Reconditioning the spawners by returning them to sea pens has indicated recovery in size. Sandfish nursery production is also being improved through refinements in rearing systems (e.g. use of floating hapa net cages in protected coves and PVC pipe modules as cage frames, etc).

Efforts are also being done to domesticate and evaluate the culture potential of the indigenous freshwater prawns (*Macrobrachium lar* and *M. mamillodactylus*). Unlike *M. mamillodactylus*, no successful metamorphosis to the postlarval stage has been obtained for *M. lar*; hence, larval rearing protocols for this species are continuously being refined.

### **Improving seedstock quality and production through refinement of hatchery and nursery management**

**CRUSTACEANS.** Part of the study on the sustainable production and development of shrimp broodstock and high health fry is the survey of hatcheries to determine the status of the industry. Survey disclosed that more than 50% of the shrimp hatcheries that were existing 5-10 years ago are no longer operational. The tiger shrimp *Penaeus monodon* is still the dominant species being cultured.

With regard to mud crab, a collaborative project which is part of the *DOST National mud crab S & T program* was initiated. The project aims to develop optimal

PHOTOS COURTESY OF MR EGUIA



DNA extraction of milkfish and abalone samples [TOP] and loading abalone PCR reaction products (amplified DNA from abalone) onto a DNA automated sequencer for mtDNA sequence analysis

hatchery and nursery protocols (identification of ideal shelter type and other strategies to reduce cannibalism) which later will be disseminated through training and technology transfer. Studies on the verification of feeding and water management methods in mud crab seed production are also on-going.

To prevent the occurrence of diseases, oxytetracycline application (daily, every other day or every 5 days until the megalopa stage) in crab seed production were tested. Higher incidence of molt death syndrome was noted in larvae that were treated more frequently with the antibiotic.

In another study, it was noted that survival of mud crab during metamorphosis from zoea 4 to megalopa was better in groups fed Selco™-enriched *Artemia* compared to those fed unenriched *Artemia*.

The influence of stocking density and tryptophan-supplemented diets on the survival and growth of mudcrab *Scylla serrata* in the nursery phase is likewise being conducted.

Nutritional intervention through tryptophan supplementation in mud crab diets was used to minimize cannibalism during the nursery stage. Results showed that crabs fed mussel and diet supplemented with tryptophan had better survival when stocked at 30 m<sup>-2</sup> during the first month and 5 m<sup>-2</sup> for the second month in the nursery.

**HIGH-VALUE MARINE FISH.** Feeding experiments were conducted to determine the effect of feeding sodium iodide enriched rotifer and *Artemia* on the metamorphosis and survival of larvae of three high-value marine species, namely: mangrove red snapper *Lutjanus argentimaculatus*, pompano *Trachinotus blochii* and grouper *Epinephelus fuscoguttatus*. Survival of red snapper was

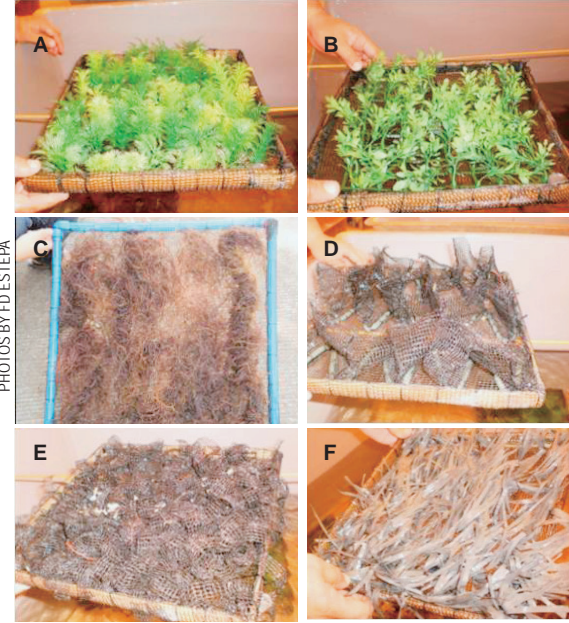
significantly high when fed sodium iodide enriched rotifer and *Artemia* while pompano had better growth (in terms of increased body length) when administered the same diet. Grouper survival also was positively affected by the diet but runs still have to be conducted to confirm the preliminary results.

For milkfish, initial feeding trials comparing the reproductive performance of broodstock fed fortified vs non-fortified (control) diets were conducted. The results showed that broodstock fed diets fortified with ARA (arachidonic acid), beta-carotene and vitamin C spawned more frequently, generally produced more viable eggs and had higher egg fertilization and hatching rates.

**MOLLUSKS.** A strain of thraustochytrid *Schizochytrium* sp. (LEY7) that contains high lipid and omega 3 fatty acid levels (such as DHA) was used for feed enrichment. Results of the feeding trials in abalone showed that thraustochytrids can effectively provide the lipid and essential fatty acids needed for the growth and survival of abalone. Mass production of the aforementioned thraustochytrid strain is on-going.

Mass production methods for natural food organisms (*Nitzschia* sp, *Diploneis* sp and *Cocconeis* sp) for postlarval abalone have also been refined. Feeding trials were also conducted and showed that *Nitzschia* sp. are good candidate species as food for early settlement and *Cocconeis* sp after 15d post-settlement of abalone postlarvae.

Another nutritional intervention to improve abalone hatchery production is the feeding of microparticulate diets to abalone held in large scale tank systems. Preliminary results showed that



PHOTOS BY FD ESTEPA

Shelters used for the preference experiment, a component of the study on the strategies for reduction of cannibalism in the mud crab nursery: a-b, plastic plant decors; c, seaweeds; d-e, nets; f, straw



PHOTO BY FD ESTEPA

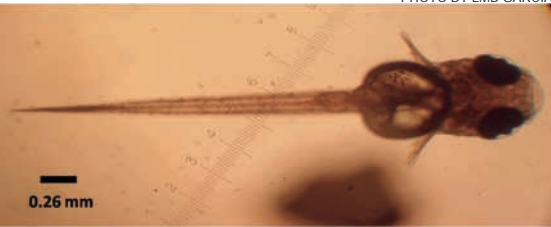
Mud crab nursery set up in AQD's Dumangas Brackishwater Station used for rearing experiments

Black tiger shrimp (50-70 g) reared for domestication in ponds



PHOTO BY FD ESTEPA

PHOTO BY LMB GARCIA



Two-day old larvae of the climbing perch *Anabas testudineus* obtained from hatchery spawns at AQD's Binangonan Freshwater Station in May-June 2012

abalone reared on agar-based microparticulate diet resulted in bigger shell lengths and higher survival rates compared to abalone fed solely on diatoms.

Finally, a study that deals with the production of *Gracilariopsis heteroclada*, the primary diet of abalone, was implemented. Using broadcast method, a 100 m<sup>2</sup> area initially stocked with 50 kg *G. heteroclada* seeds produced 375 kg seaweeds after 30 days of culture. On the other hand, the fixed bottom line method yielded 130 kg of seaweeds.

from new sources like Igang in Guimaras Island and Ajuy in northern Iloilo to compare quality of spawned eggs and larvae from broodstock taken from different habitats. These were held in sea pens.

Meanwhile, the initial live food for the larval Napoleon wrasse *Cheilinus undulatus* is being assessed. The distribution of Napoleon wrasse in Bohol was also surveyed. This information is vital to the management of Napoleon wrasse in known natural habitats.

[FROM THE TOP] Sampling of seahorses in Sagay Marine Reserve in Negros Occidental; packing and transport of wild seahorses from Sagay to AQD's main station in Iloilo for breeding purposes; seahorses from wild males



PHOTOS BY SM BUEN-URSUA

EMERGING SPECIES. The reproduction and seed production of climbing perch *Anabas testudineus*, a species indigenous to Laguna de Bay, is currently being studied. Rearing and feeding protocols for seed production are being improved to increase survival rate.

The seahorses, *Hippocampus barbouri* and *H. comes* are continuously being propagated in the SEAFDEC/AQD hatchery for possible release in Taklong Island Marine Reserve, a site which is currently being assessed for its suitability for stock enhancement.

### Developing schemes for the production, management, maintenance and dissemination of genetically selected and improved stocks

Another endemic species, the silver therapon, *Leiopotherapon plumbeus* is being studied to determine the optimum larval rearing protocol. Preliminary work involved qualitative and quantitative assessment of plankton communities in the larval rearing water as well as larval gut analysis to determine the diet preference of silver therapon larvae.

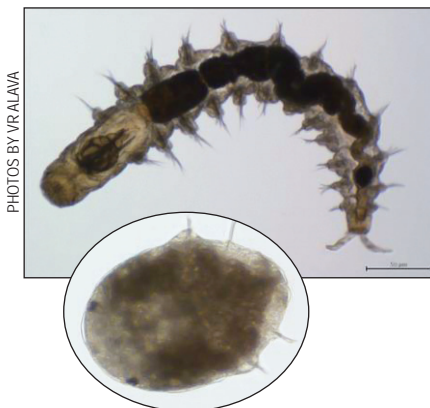
CRUSTACEANS. Selective breeding programs have begun for selected commercial species like the crustaceans. For mudcrab, stress tests are being done to determine strain level differences in terms of better fitness attributes of stocks. For tiger shrimp, F<sub>1</sub> batches from founder stocks collected from several sites (Bohol, Davao and Antique) are currently being grown to broodstock size. Subsequent batches which have attained more than 50 g will be considered for use in the breeding program. For the giant freshwater prawn, the approach for genetic improvement is to assess and determine the effective broodstock management scheme to enhance growth and/or reproductive performance.

Concerning the pompano *Trachinotus blochii*, hatchery techniques are being refined to improve seed production. One of the refinements being done is on the development and evaluation of weaning diets. Likewise, a verification study on the brackishwater nursery pond culture of pompano using formulated diets with varying lipid levels is being conducted.

Research on the biology and reproduction of the spotted scat *Scatophagus argus* or kikerero is being undertaken as well.

To improve sandfish juvenile survival, broodstock were collected

In 2011, a reciprocal mating scheme was tried to improve



PHOTOS BY VR ALAVA

The polychaete *Marphysa* sp metatrocophore [INSET] and 12-segment juvenile. With high protein and lipid contents, this polychaete is a potential feed for crustacean broodstock. Its life cycle is being studied for captive breeding



growth and breeding performance in two lines of the giant freshwater prawn. In 2012, two other broodstock schemes were assessed: (a) frequent male broodstock replacement and (b) sex ratio experiment.

FISHES. Concerning the tilapias, saline-tolerant strains are being screened for subsequent selective breeding of enhanced traits. The growth trial in brackishwater ponds and a sensory evaluation of the four strains grown and harvested from the same pond experiment were completed.

MOLLUSKS. With regard to local commercial abalone species (*H. asinina*), hybridization has been done by crossing this with other Philippine abalone species, *H. varia*, *H. planata* and *H. glabra*, to produce stocks with improved traits. A total of 140 hybrids (HAFVM or hybrids from a female *H. asinina* crossed with male *H. varia*) were produced and hybrids stocked in sea based cages are being monitored continuously for growth performance. Other hybrid abalone juveniles (HAFPM or hybrids from *H. asinina* female crossed with *H. planata* male and/or HAFGM hybrids produced from a cross between *H. asinina* female and *H. glabra* male) were also produced and tested simultaneously with pure *H. asinina* juveniles to compare growth and survival.

To improve the fecundity and seed quality of the abalone *H. asinina*, wild stocks acquired from Masbate and Palawan were used for breeding. The growth of the juveniles coming from these breeders is currently being monitored. Results from these trials will be useful for later genetic selection.

Methods to develop resistant strains of the seaweeds *Kappaphycus* and reduce the presence or growth of epiphytes

are being studied. A grow-out experiment is also being done to determine the growth of tissue-cultured *Kappaphycus* using different commercial fertilizers. Preliminary results showed no significant differences in growth between fertilized and unfertilized stocks.

### Enhancing adoption of economically viable systems to produce sufficient seedstock

Several fish/shellfish production projects are being implemented in SEAFDEC/AQD to demonstrate the viability of small-scale and/or large-scale seed production systems. Mass production of sex-reversed and mixed-sex Nile/red tilapia fingerlings as well as large-scale production of abalone juveniles, are continuously being done.

Meanwhile, from January to December, the SEAFDEC/AQD abalone demonstration hatchery produced 95,210 pcs of 5-8 mm shell length abalone juveniles. The survival rate from veliger to juveniles (90 days of culture) ranged from 0.28 to 1.0%. The juveniles were reared further to 1.1 -1.5 cm shell length and then sold. On the other hand, the study on large-scale abalone juvenile production registered a total yield of 198,501 pcs of 5-8 mm shell length abalone juveniles from January 2012 to December 2012. The survival rate from veliger to 90 days old ranged from 0.11-1.07%. This indicates that the hatchery protocol for the production of early juvenile abalones should still be refined.

Capacity-building of fish farmers and other industry stakeholders on appropriate breeding and larval rearing technologies is another objective of the QS program. To meet this objective, several specialized training courses were offered to local government



PHOTOS BY SS AVANCEÑA



[TOP] A kilogram of the seaweed *Gracilariopsis heteroclada* cultured in a pond grows into an average weight of 14.5 kg (specific growth rate of 8.91% day<sup>-1</sup>) after 30 days of culture using fixed bottom line method. [ABOVE] In the intertidal site, an enclosure was constructed to protect *G. heteroclada* cultures from grazers



PHOTOS BY F AVA

[TOP] A 16-day old therapon larvae; [ABOVE] outdoor concrete tank used for rearing therapon

PHOTOS BY N BAYOMA



representatives, private sector investors, feed company staff (BMEG) and fisherfolk. These were on sandfish, abalone, mudcrab, marine fish, tilapia and the giant freshwater prawn. Apart from these customized courses, on-the-job trainees were also accommodated in the AQD hatcheries during this period. Technical assistance was also provided to local and international private sector clients through the *Agree-build-operate-transfer aqua negosyo* mechanism.

Collection of abalone veligers (TOP, LEFT) and stocking these in settlement tanks

## Eight finish marine fish hatchery course

Eight participants from four countries completed the month-long international training course on "Marine fish hatchery" conducted 26 June – 01 August by SEAFDEC/AQD at its main station in Tigbauan, Iloilo.

The course covered lectures and practical activities on rearing marine fishes such as seabass, pompano, rabbitfish, grouper and milkfish. The course also included extensive hands-on exercises on the culture live food organisms (phytoplankton & zooplankton) that are crucial in hatchery operations.

The elected class chair, Mr. Dwight Lu, thanked all the AQD staff from the lecturers, technical assistants, technicians in hatcheries to the training coordinators for the skills they acquired and guidance they received in the 37 days that they were at AQD. "We learned a lot... and hopefully, when we go back to our respective places, we can (successfully) operate hatcheries and share the knowledge so we can have a more sustainable source of fish (through aquaculture)," said Mr. Lu.

The participants were from the Philippines, Malaysia, Vietnam and Brunei Darussalam, most of whom were sponsored by the Government of Japan – Trust Fund, Government of Brunei, and BFAR & local government units in the Philippines.

## Hatchery and larval food production

In 2012, AQD's research and demonstration marine fish hatcheries produced almost 10 million fry of ten species. Some of the by-products of research were sold to the private sector.

Species	Production (pieces)		Income (Php)
	Larvae	Postlarvae or fry	
Mudcrab	--	86,236	501 173
Pompano	100 000	186 236	480 486
Red snapper	--	1500	16 250
Grouper	5 100 000	12 034	175 075
Rabbit fish	50 000	39 400	142 794
Seabass	250 000	385 760	94 334
Milkfish	46 848 617	6 481 470	1 308 161
Tilapia	--	118 411	75 607
Freshwater prawn	--	432 260	363 240
Bighead carp	--	2 150 000	130 000
Total production & Income	52 348 617	9 893 307	Php <b>3 287 120</b>

To support AQD's hatcheries and research activities, AQD's larval food laboratory served 86,465 liters of microalgal starters and 52.33 kg (wet weight) of *Artemia* biomass. The laboratory also sold 1,174 liters of microalgal starters/rotifers to 78 clients comprising of the private sector (local, 64%; foreign, 6%); academe (26%); and government institutions (4%). Earnings amounted to Php 216,070.

Of the 1,174 liters of liquid starters sold, *Skeletonema tropicum* made up 37%; *Chaetoceros calcitrans*, 25%; *Nanochlorum* sp, 19.5%; *Brachionus rotundiformis*, 9.7%; *Isochrysis galbana*, 4.2%; *Navicula*

*rammossisima*, 2.4%; *Thalassiosira* sp, 2.1%; *Tetraselmis tetrahele*, 1.5%; *Amphora* sp, 0.3%; *Rhodomonas* sp, 0.1%. Microalgal paste (4 kg) was also produced: *Nanochlorum* sp, 2 kg; *C. calcitrans*, 1 kg; *T. tetrahele*, 1 kg. Ten test tube cultures of *C. calcitrans* and two of *Nanochlorum* sp were sold.

Fertilizers/ media sold: 157 liters TMRL, 90 li F medium, 38 li CF2 and 6 li Conwy.



(FROM THE TOP) Marine fish hatchery trainees induce the spawning of seabass and grouper, collect eggs after spawning for stocking in larval rearing tanks, and scale up the culture of natural food to feed fish larvae

# Training activities under the QS program

## Hatchery and grow-out culture courses: 13 sessions

In addition to the marine fish hatchery training, AQD put together courses that cover the hatchery, nursery and grow-out continuum. The 2013 courses included marine / brackish-water fishes (milkfish, abalone, sandfish) and freshwater fishes (giant freshwater prawn, tilapia and catfish) [PHOTOS AT RIGHT, TOP TO BOTTOM]. There was also a course on algal culture, a most important component of hatchery operations since fish larvae grow best when fed natural food. Courses on marine / brackishwater fishes were held at AQD's Tigbauan Main Station in Iloilo while those for freshwater fishes were at AQD's Binanganon Freshwater Station in Rizal.




Training course / session date / funding	Number of attendees / gender <sup>1</sup> / age range	Trainee classification	Countries represented
<b>Marine fish hatchery</b> 26 June - 01 August; funded by Government of Japan - Trust Fund (GOJ-TF)	8 (3 F + 5 M) 26-48 yrs old	Government, private (entrepreneur)	Philippines (4) Malaysia (1) Vietnam (1) Brunei Darussalam (2)
<b>Milkfish hatchery, nursery and grow-out operations</b> 13-15 June; funded by BMEG	23 (3 F + 20 M) 24-54 yrs old	Private (BMEG sales specialists / managers, aquaculturists)	Philippines
<b>Sandfish (<i>Holothuria scabra</i>) seed production, nursery and management</b> Two sessions: 11-25 April; 15-29 Oct Funded by governments and private sector	12 (M) 23-59 yrs old	Government, private (farm operators, entrepreneurs)	Australia (1) Malaysia (5) Switzerland (1) Philippines (2) USA (3)
<b>Abalone hatchery and grow-out</b> 10-30 May Funded by GOJ-TF and private sector	7 (M) 27-51 yrs old	Government, research, private organizations	Cambodia (1) Philippines (5) Vietnam (1)
<b>Mud crab hatchery, nursery and grow-out operations</b> 28 May-19 June; privately-funded	9 (1F + 8M) 24-57 yrs old	Private (military, entrepreneurs), academe (school head, student)	Malaysia (1) Philippines (6) Sri Lanka (2)
<b>Freshwater prawn hatchery and grow-out operations</b> Three sessions: 20-24 Feb; 18-30 June; 20-24 Aug Funding from GOJ-TF, governments, private sector	20 (14 M + 6 F) 26-64 yrs old	Private (fishcage operator, technician); government (fisheries / aquaculture officers), academe (lecturer)	Cambodia (2) Lao PDR (1) Malaysia (2) Philippines (8) Singapore (1) Thailand (1)
<b>Tilapia hatchery and grow-out operations</b> Two sessions: 07-09 March; 31 July-03 Aug Privately-funded (eg. BMEG)	31 (24 M, 7 F) 21-64 yrs old	Private (BMEG sales / marketing personnel, fishpond owner)	Philippines
<b>Catfish hatchery and grow-out operations</b> 08-12 Oct; privately-funded	7 (6M, 1F) 19-47 yrs old	Private	Philippines
<b>Algal culture</b> 05 Aug-05 Sept; Funded by Nigerian Institute for Oceanography & Marine Research	1(M) 36 yrs old	Academe	Nigeria



<sup>1</sup>M = male; F = female





**HWA**  
**Promoting healthy  
and wholesome  
aquaculture**

The healthy and wholesome aquaculture program aims to address the role of aquaculture in providing the protein needs of the growing human populace. Although R&D efforts on this aspect have already resulted in phenomenal growth of the aquaculture industry in the past decade, there is still a need for further studies to be done to address the challenges posed by ecological, economic and climatic changes. Improving production and sustainability will benefit future generations.

The strategies invoked in the HWA program will concentrate on nutrition to promote healthy farmed aquatic animals; diagnosis, control, monitoring and surveillance of diseases in aquatic animals; environmental integrity; certification and food safety. The optimization and sustainability of aquaculture production shall be based on *Best management* and *Good aquaculture practices* to ensure the least impact on the environment.

**Finding different sources of fish meal substitutes and developing effective feed management schemes that incorporate sound management**

SOYBEAN MEAL AND SOY PROTEIN CONCENTRATE IN MILKFISH DIET. Optimization of the SEAFDEC-USB milkfish diet using optimum levels of fish meal, soybean meal, and soybean concentrate and applying phased feeding for starter, grower, and finisher stages has been completed. Juvenile milkfish (40 g) were stocked ( $20 \text{ m}^{-3}$ ) in floating bamboo net cages (2 units of  $10 \times 10 \times 3 \text{ m}$ ) in Igang, Guimaras. Fish were fed either SEAFDEC-USB or commercial floater diet at 6-4% of body weight thrice daily at 0800, 1200, and 1600 H. After 105 DOC (days of culture), milkfish fed SEAFDEC-USB diet weighed 483 g (1,050% mean weight gain) and attained a feed conversion ratio (FCR) of 1.56. In contrast, milkfish fed commercial diet weighed 258 g (548% gain) and had an FCR of 2.27. Survival was the same for both, 97%.

Differences between the two treatments in average body weight, % mean weight gain, and FCR were highly significant. Fish fed the commercial diet were harvested later when they reached >400g (mean weight gain of 1,002%; FCR, 3.25).

Rough estimates done on experimental and commercial feed showed positive returns for the treatment using the SEAFDEC-USB diet but not for the commercial diet. Water samples at the deployment sites of the floating net cages showed normal levels of ammonia-N, nitrite-N, and phosphate-P in seawater samples but elevated levels of sulfide (0.40 ppm) were observed at the end of culture period. Sediments showed elevated levels of organic matter (1.5-3.4%) and total sulfate (630-1023 ppm).

COPRA MEAL IN MUDCRAB DIET. For *Scylla serrata*, a feeding trial following a completely randomized design of six dietary treatments, each with 12 individual replicate crabs was conducted. Treatments consisted of isonitrogenous (40% crude protein) and iso-energetic (18.5 KJ g<sup>-1</sup>) diets containing soaked copra meal that replaced soybean meal protein at 0, 10, 20, 30, 40 and 50% levels. Similar-sized crab juveniles were stocked individually in 1-liter containers installed inside fiberglass tanks. Crabs were fed the maintenance diet until each one molted. Newly molted crabs were weighed and fed the test diets until termination at 30 days from the third molt. Crabs were checked daily; and body weight, exuvia weight and carapace width were measured after each molting, at intermolt and at termination. Results showed that soybean meal protein can be replaced by copra meal protein even up to 50% level. There was no significant difference among these diets in terms of survival (98 and 100%), molt interval (molt-0 to molt-3: 108 and 106 days), gain in internal carapace width (44 and 46 mm), and body weight gain (14 and 17 g).

IMPROVEMENT OF NUTRITIONAL VALUE OF LOCAL FEED SOURCES THROUGH FERMENTATION USING BACTERIA AND FUNGI. Recipe for the fermentation set-up: 6% (w/v, weight per volume) substrate, 6% (v/v) inoculum and 94% (v/v) media. Media used (w/v) was 0.6% MgSO<sub>4</sub>, 0.6% KCl and 1.2% starch. Microbial fermentation was at a higher scale using 9L volume of set-up. Treatments were: A, 10<sup>6</sup> CFU/mL; B, 10<sup>3</sup> CFU/mL; and C, negative control. The inoculum used was *Bacillus cereus* (isolated from gut of milkfish *Chanos chanos* Forsskal). Enzyme assays of fermentation supernatant showed that treatment A gave

enzymatic activities higher than the negative control. When treatments A and B were corrected by the negative control, there were low activities for protease, phytase, cellulase and amylase and moderate activity for lipase in treatment A. When volume of fermentation was increased to 9L, the activities decreased and only treatment A yielded positive values. Results have been variable for the scale up experiments, and conditions need to be standardized.

FEED MANAGEMENT AND PERIPHYTON-BASED PRODUCTION FOR FRESHWATER PRAWN. Juvenile *Macrobrachium rosenbergii* (2.5 g) were stocked in hapa net cages (2 x 2 x 1 m) at 15 pcs m<sup>-2</sup>. Treatments consisted of different total effective substrate area expressed as percentage of cage bottom (0, 40, 80, and 120%) with 4 replicates/treatment. Prawns relied solely on natural food. After 1 month of sampling, no significant differences in the various growth parameters were observed.

Another experiment was conducted to determine stocking densities of *M. rosenbergii* which can be supported solely by periphyton productivity in cage culture. Juveniles of *M. rosenbergii* (3 g) were reared in 2 x 2 x 1 m hapa net cages using three stocking densities (5, 10, and 15 prawns m<sup>-2</sup>). Vertical net substrates provided with floaters and counter weights were installed in each cage. After six months, significantly higher mean weight, daily growth rate and specific growth rates were observed at the lowest stocking density (5 pcs m<sup>-2</sup>) compared with the other two treatments. No significant effects on survival among the three stocking densities were observed, analysis of periphyton and natural food biomass for six months of culture showed no significant differences among the different stocking densities.



Stocking of freshwater prawn postlarvae in a reservoir in Dingle, Iloilo [TOP]; transport and stocking of tilapia fry also in the reservoir

Set-up of prawn and tilapia netcage verification study in Aglosong Dam in Concepcion, Iloilo



## Developing aquafeeds for selected species at specific growth stages especially for species or stages for which no feed have been formulated

FEED DEVELOPMENT FOR THE GOLDEN POMPANO. Nine test diets were formulated for *Trachinotus blochii* fry (1.6 g) using practical feed ingredients. Protein levels were 54, 46 and 38% and for each, there were 3 lipid levels (8, 11 and 14%) tested. Fry were stocked in 250L tanks at 3 replicates/dietary treatment. Results showed that after 14 weeks, survival rates of pompano were almost 100%. Final average body weight ranged 30-58g. The feed conversion ratio, specific growth rate, and % weight gain of fish on diets containing 46 or 54% were significantly better than those fish fed 38% crude protein regardless of lipid level. Estimated P/E ratio of the nine test diets ranged from 102 to 145.7 mg protein kcal<sup>-1</sup>. The sparing effect of protein by carbohydrates was noted at higher protein levels.

A sackful of SEAFDEC-formulated diet for tilapia



## Promoting better understanding of the concept of feed conversion ratio (FCR) and adequate nutrition and efficient feeding practices among fish farmers to promote fish health

ALTERNATE DAY FEEDING REGIME FOR SEMI-INTENSIVE CULTURE OF MILKFISH. In the second run of the experiment, 6,500 milkfish (*Chanos chanos* Forsskal) fingerlings were stocked and distributed in four ponds at AQD's Dumangas Brackishwater Station. Pond A has 49 g fish; pond B, 50 g; pond C, 25 g and pond D, 26 g. Sampling was done when all the natural food were depleted. Alternate feeding was done in ponds B and C and daily feeding in ponds A and D. Sampling was done every 15 days and feed adjusted using a sliding feeding rate of 6-2.5% per body weight. All ponds were fed commercial feed. Results showed that growth rate of milkfish in the daily feeding rate was much faster compared with alternate pond feeding. Absolute growth rates were 2.1 g day<sup>-1</sup> for pond A (daily feeding); 1.3 for pond D (daily) and 0.9 for both ponds B and C (alternate).

COMMERCIAL DIET FOR POMPANO. The first demonstration run of semi-intensive grow-out culture of pompano (*Trachinotus blochii*) using commercial diet in brackishwater ponds was completed from stocking to harvest. After 83 days of culture, pompano juveniles with initial average weight of 163 g and fed commercial diet reached an average body weight of 336 g and average total length of 26 cm.

SEAFDEC/AQD PHASED DIET FOR GROUPERS. For the demonstration of semi-intensive grow-out culture of grouper (*Epinephelus fuscoguttatus* / *E. coioides*) in ponds, juveniles

weighing 10 g and measuring 8.6 cm were stocked in nursery cages set in a pond at AQD's Dumangas Brackishwater Station. The fish were fed SEAFDEC/AQD phased diet. After 60 days of culture, the fish attained average body weight of 79 g and average total length of 16 cm. They were transferred and stocked in a pond divided by a net into four compartments (with area of 700 m<sup>2</sup>) to grow them to market size.

SEAFDEC FORMULATED DIET FOR MANGROVE RED SNAPPER. For the intensive grow-out culture of mangrove red snapper (*Lutjanus argentimaculatus*) in brackishwater earthen ponds, fingerlings were reared in 2 x 3 x 1 m B-net cages for three months with feed given 3x a day. Net was changed every 10 days at the same time the fish were bathed in freshwater alternately with 20 ppm potassium permanganate to eliminate external parasites. Snapper fingerlings weighing 30-45 g were stocked separately in two ponds: 4,232 pcs for semi-intensive culture in a 8,500 m<sup>2</sup> pond and 5,000 pcs for intensive culture in a 5,000 m<sup>2</sup> pond. Daily feeding was given 3x to 2x/day until harvest. Sampling was done every 15 days and the feed was adjusted using 6 to 2.5% feeding rate per body weight. Results showed that after 150 days of culture, there was slower growth of mangrove red snapper in intensive pond culture (303 g and 1.57 absolute growth) compared with semi-intensive pond culture (355 g and 2.13 absolute growth).

COMMERCIAL AND SEAFDEC/AQD FEEDS FOR TILAPIA AND FRESHWATER PRAWN. A study on the netcage culture of tilapia and giant freshwater prawn in a dam/reservoir using commercial and SEAFDEC/AQD feed was undertaken in Brgy. Camambugan, Dingle, Iloilo. The set-up had 6 units of 5 x 5 x 2.5

m stationary netcages stocked at 15 m<sup>-3</sup> each with tilapia and prawn fed formulated diet. Results of two runs showed that the growth, survival, and feed conversion ratio (FCR) were better in both tilapia and prawn fed the SEAFDEC/AQD formulated diet compared with those fed the commercial feed. Costs-and-returns analysis showed that the AQD diet also performed better in terms of combined final biomass and net income. The return-on-investment using the diet was 40% with payback period of 1.4 years. The same study will be continued in two other barangays in Dingle and in Concepcion, Iloilo.

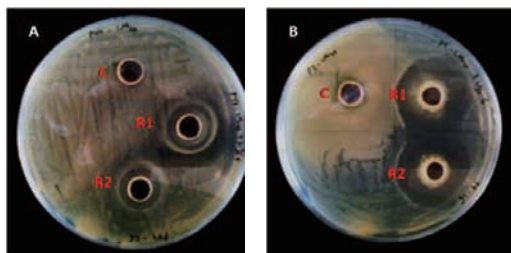
JUVENILES FOR SOFT-SHELL MUDCRAB FARMING. The first run of a study to determine the feasibility of producing crablets for soft-shell mud crab (*Scylla serrata*) farming was completed after 72 days of culture. Of the 322 crabs harvested, 64% had average body weight of ≤79 g followed by 22% of 80-110 g and 13% of ≥111g. Fifty crabs (5.25 kg) were used for the soft-shell crab farming trial. The crabs were placed individually in perforated plastic boxes and fed until they molted. Around 36% of crab mortality was attributed to handling / harvest stress and escape of crabs from the boxes. The soft-shelled crabs were sold while the hard-shelled crabs were used for selective breeding.

[FROM THE TOP, L-R] Netcages serving as nursery of mud crabs; individually packed feeds for crablets; pond harvest; a crab in the process of molting; a healthy crab; the crab set-up (covered nets) at AQD's Dumangas Brackishwater Station.



PHOTOS BY JIM DELA CRUZ

PHOTOS BY J.L. LARANJA JR



In vitro susceptibility of *Vibrio campbellii* LMG 21363 to the cell free extracts of *Bacillus* P4-1 (A) and P4-47 (B) isolates. C, control; R1, R2 are replicates

## Investigating the efficacy of probiotics and rationalizing the need and application of diagnostics that will ensure biosecurity within culture systems and keep out exotic pathogens, especially trans-boundary pathogens

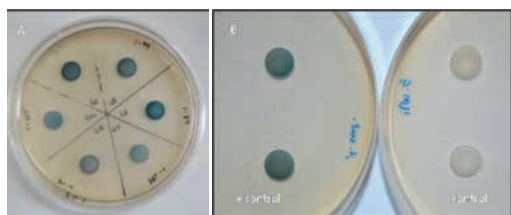
**PROBIOTICS FOR SHRIMP.** Poly- $\beta$ -Hydroxybutyrate (PHB)-accumulating bacteria were isolated from shrimp pond sediments (Bacolod City, Negros Occidental); shrimp hatchery sediments (AQD's Tigbauan Main Station); and fish cage sediments and marine (sea) sediments (AQD's Igang Marine Station) using Luria Bertani medium (LB<sub>20</sub>) with 2% glucose for 24 h at 30°C. Total PHB accumulation was measured by PHB chemical assay. A total of 70 promising *Bacillus* spp. were selected and qualitatively screened for PHB accumulation using Sudan black B staining. The isolates that exhibited substantial PHB-accumulating ability were eventually subjected to quantitative PHB accumulation test. Three isolates (P4-47, P4-1 and P4-28) showed the highest PHB yields of 0.76, 0.75, and 0.71 mg PHB ml<sup>-1</sup>, respectively. Bacterial isolates P4-47 and P4-1 were consequently chosen as experimental probiotic *Bacillus* spp. in the *in vitro* susceptibility assay and feeding experiment. Cell-free extracts of both *Bacillus* isolates inhibited the growth of pathogenic *Vibrio campbellii* LMG 2136. Additionally, groups of 21-day old *Penaeus monodon* postlarvae were fed artificial diet containing either *Bacillus* P4-1 or *Bacillus* P4-47 isolates, or none (control). Live suspensions of *Bacillus* P4-1 and P4-47 isolates were sprayed into the pellets, air-dried, and finally coated with cod liver oil. Bacterial quantity sprayed on the feeds was about

10<sup>8</sup> CFU g<sup>-1</sup>. After 30 days of culture, survival rate was highest in shrimp fed formulated diet containing P4-47 isolate (89%) followed by P4-1 (88%) and control (83%). Furthermore, the average body weight and body length of shrimps fed formulated diet supplemented with *Bacillus* P4-1 and P4-47 isolates were at par with shrimp fed solely formulated diet.

**WSSV AND POLYCHAETES.** To study polychaete worms as carriers (local prevalence, tissue tropism and clearance mechanism) of the white spot syndrome virus (WSSV), samples were collected from five sites (n≥30): Leganes, Guimbal, and San Joaquin in Iloilo; Manapla in Victorias City; EB Magalona in Negros Occidental. Two genera of polychaete worms, i.e. *Marphysa* spp. (mudworms) and *Perineris* spp. (sandworms), were collected and subjected to WSSV detection by polymerase chain reaction (PCR) amplification. All samples examined so far were negative for WSSV.

**BACTERIA AND ALGAE IN ABALONE SETTLEMENT PLATES.** The bacterial communities that developed on larval rearing plates during the dry and wet seasons were isolated and identified using API 20NE. Bacteria during the dry season were identified as *Aeromonas sobria* (39%), *V. alginolyticus* (18%), *V. vulnificus* (15%) and *Vibrio* spp. (12%). Others were *Comamonas testosteroni*/*Pseudomonas alcaligenes* (6%), *Aeromonas* spp. (3%), *P. stutzeri* (3%) and *Sphingomonas paucimobilis* (3%). In contrast, bacteria identified during the wet season were *V. vulnificus* (50%) and *Vibrio* spp. (12%). Some were *V. alginolyticus* (8%), *Weeksella virosa*/*Empedobacter brevis* (8%), *A. sobria* (4%), *Brevundimonas vesicularis* (4%), *Pasteurella*

PHOTOS BY J.L. LARANJA JR



[LEFT] Bacterial colonies showing a bluish-black color after Sudan Black B staining which indicates presence of PHB in the cells. [RIGHT] Reference bacteria for the qualitative screening of bacterial isolates; *Alcaligenes eutropha* (+ control), a known PHB-accumulating bacterium and mutant *Escherichia coli* (- control), a bacterium that cannot produce PHB



*multocida* (4%), *P. stutzeri* (4%) and *Shewanella putrefaciens* (4%). In addition, the algal communities found in the biofilms of abalone rearing plates during the dry season were *Melosira* spp. (43%), *Navicula* spp. (26%) and *Amphora* spp. (18%). During the wet season, *Melosira* spp. (42%), *Navicula* spp. (22%) and *Amphora* spp. (16%) were present.

**Promoting the wider use of conventional diagnostic as well as new methods especially for newly reported, emerging diseases**

EPIDEMIOLOGY OF SHRIMP VIRAL DISEASES IN SOUTHEAST ASIA. This study aims to elucidate the geographic distribution and the transmission route of shrimp viral diseases in Southeast Asia. Gills and pleopods of *Penaeus monodon* samples taken from 10 of the 15 farms in Zamboanga peninsula and from several provinces in the Philippines were fixed in 95% alcohol for the detection of shrimp viruses by polymerase chain reaction (PCR) amplification. Additionally, 14 shrimp farmers in Zamboanga were interviewed: one who's running a tiger shrimp semi-intensive monoculture, two who are into extensive monoculture and 11 with extensive polyculture with milkfish/crab. One of the farms was experiencing mortality during the sampling/interview. None of the farmers observed signs of yellow head disease in the present crop.

**Finding effective alternative safe drugs/chemicals (including natural products) to manage aquaculture diseases in lieu of harmful chemicals and drugs whose use has been discouraged or banned due to quality and safety issues**

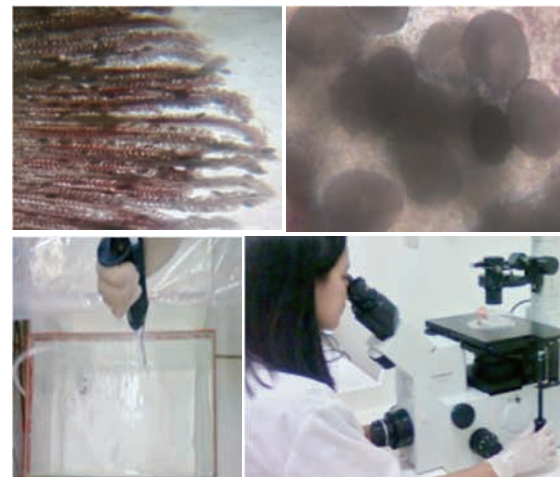
DEFENDING AGAINST AMYLOODINIUM. To elucidate the host response and develop control methods against *Amyloodinium* infection in marine fishes, *A. ocellatum* was isolated from naturally infected *Lates calcarifer* juvenile and maintained by *in vivo* passage through cohabitating infected with healthy sea bass *Lates calcarifer* juveniles (2 g). Tomonts were isolated from the skin and gills and counted to quantify the degree of infestation. About  $2 \times 10^5$  tomonts were collected from each experimentally infected fish. Tomonts were thereafter inoculated in duplicate seawater tanks containing 10 fish at 0, 20, 40, 80, and 160 cysts per liter. The cysts were allowed to hatch at ambient salinity and temperature and the number of dinospores present in each tank was counted. Fish were observed daily and 10-day cumulative mortality was recorded. The LD<sub>50</sub> corresponded to 48 tomonts per liter of water. However, a progressive decline in parasite density colonizing skin and gill surfaces with each transmission cycle was observed. Factors such as poor hatching of tomont due to bacterial and fungal contamination resulting in low dinospore counts, or development of resistance as fish increase in age and size may play a role in successful infection of the healthy fish by the parasite. Similar results were seen in cohabitation experiments using bigger fish (>50 g) where infection rates gradually declined with each passage until no further mortalities were observed. To

PHOTOS BY LD DE LA PENA



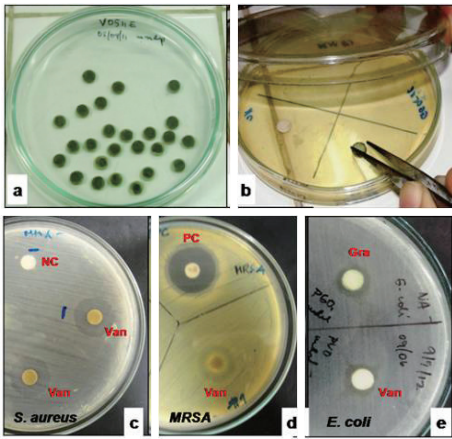
Two dominant genera of polychaetes: the mudworm *Marphysa* spp [TOP] and *Perinereis* spp

PHOTOS BY E AMAR



[CLOCKWISE] Gill of sea bass *Lates calcarifer* infected with *Amyloodinium*; tomonts isolated from fish gills; monitoring the hatching of tomont to collect dinospores; inoculation of dinospores in tanks for LD<sub>50</sub> determination

PHOTOS BY MM PENARANDA



Antibacterial screening of red seaweed organic extracts by disc assay method. (a) Ethanol extract of *Kappaphycus alvarezii* loaded onto sterile paper discs (5 mg/disc). (b) Mueller-Hinton Agar (MHA) plates swabbed with test bacteria and then inoculated with test extracts. (c-e) Zones of inhibition of *K. alvarezii* vanguard variety and/or *Gracilaria* sp. against *Staphylococcus aureus* (c), Methicillin-resistant *S. aureus* (MRSA) (d), and *E. coli* (e). PC indicates the zone of inhibition against an antibiotic positive control (chloramphenicol-30 or penicillin-10). No inhibition was observed in all negative controls (NC)

maintain the parasite *in vivo*, an LD<sub>50</sub> experiment using dinospores as inoculum was carried out. Tomonts were obtained from experimentally infected fish by briefly immersing (2-4 min) the fish in distilled water to dislodge the trophonts from the gills and skin. Hatching of dinospores was monitored and the supernatants containing the dinospores were collected daily for 3 days. Dinospores were then inoculated into tanks containing 10 fish (5 g) at these densities: 250, 500, 1000, 2000, 4000, and 8000 per liter. Determination of innate humoral immune parameters and expression of immune response genes by reverse transcriptase polymerase chain reaction (RT-PCR) are ongoing.

ANTIMICROBIALS FROM RED SEAWEEDS. A total of 15 extracts were prepared using ethanol from four variants of *Kappaphycus alvarezii*, three variants of *K. striatum*, a variant of *Euclidean denticulatum* (spinosum), and an unknown variant of *Gracilaria* sp. A modified dichloromethane-methanol extraction protocol was also tested in powdered samples of *K. alvarezii* var. vanguard and *Gracilaria* sp. Aqueous extracts were prepared from powdered samples of *K.*

*alvarezii* var. giant brown, giant green, tungawan, and vanguard; *K. striatum* var. sacol green; and *E. denticulatum* var. spinosum. Additionally, a new batch of crude water extracts was prepared using fresh *K. alvarezii* var. vanguard and *Gracilaria* sp. samples. Promising results were observed for some extract preparations of *K. alvarezii* (vanguard variant) and *Gracilaria* sp. (unknown variant) against the human bacteria *S. aureus*, MRSA, or *E. coli*. None of the red seaweed extracts tested to date showed significant antibacterial activity against *Vibrio alginolyticus*, *V. harveyi*, *V. parahaemolyticus*, and *A. hydrophila*. In addition, antiviral test against spring viremia of carp virus (SVCV) was conducted using commercially-available carrageenan. Pre-treatment of wells with 1% carrageenan 30 minutes prior SVCV inoculation resulted in significantly lower virus titer compared with those pre-treated with minimum essential medium. Post-treatment of 1% carrageenan 30 minutes after SVCV inoculation also resulted in significant CPE reduction. However, no significant CPE reduction was observed in wells when SVCV was co-incubated with carrageenan.

## Farmer-friendly extension manuals



**Grow-out culture of mangrove red snapper (*Lutjanus argentimaculatus* Forsskal, 1775) in ponds**, 30 pages, authored by Mr. Eliseo Coniza, Dr. Mae Catacutan and Ms. Pedrita Caballero. This extension manual tells of the procedures in farming mangrove red snapper and its costs-and-returns

**Cage nursery of high-value fishes in brackishwater ponds (sea bass, grouper, snapper, pompano)**, 24 pages, authored by Ms. Jocelyn Madrones-Ladja, Mr. Noel Opina, Dr. Mae Catacutan, Mr. Emmanuel Vallejo and Mr. Victorino Cercado. This extension manual describes nursery pond requirements, nursery rearing procedures, common diseases of young marine fish, and economic analysis of cage nursery as an enterprise separate from hatchery and grow-out culture.

# Extension activities under the HWA program

## On-farm feeds and fish health:

### 4 courses

AQD went to Cambodia two times this year: (1) in October to hold a freshwater fish health course and (2) in December for the feeds & feeding training. It also conducted two more courses related to the HWA program in the Philippines [SEE TABLE].

AQD also co-organized four more activities: (1) *Small-scale aquaculture and livelihood ventures* in Kalibo, Aklan on 6 March; (2) *Biotechnology 101* at its Iloilo main station, 30 April to 2 May; (3) *Biotechnology for communicators* in Iloilo City, 15 November; and (4) *Microbial genetics for microbial ecologists*, also in AQD's main station, 21 May to 1 June.

With 40 attendees, the livelihood seminar featured high-value marine fishes and seaweeds and was a joint undertaking of AQD with the North Carolina State University, AquaFish Collaborative Research Support Program, and Aklan provincial government.

The biotech course, on the other hand, updated Philippine government pesticide/fertilizer regulators on genetically modified crops, food safety issues and biotech tools. AQD co-organized this with the Department of Agriculture's Biotechnology Program Implementation Unit.

The forum for communicators disseminated the benefits of biotechnology and mobilized advocates. Attended by 155 representatives of the academe, media and government, it was co-organized with the Biotechnology Coalition of the Philippines and the Biotechnology for Life Media & Advocacy Resource Center.

The microbe course was organized with the New Mexico State University (NMSU, USA) with funding support from the American Society for Microbiology. NMSU-Department of Biology associate head Dr. Michele Nishiguchi conducted the lectures and lab exercises. A total of 24 participated from AQD and universities in Iloilo.

Training course / session date / funding	Number of attendees / gender <sup>1</sup> / age range	Trainee classification	Countries represented
<b>Farm-based feed preparation and feeding management</b> [Onsite course] Phnom Penh, Cambodia 4-7 December Organized by AQD in collaboration with the Fisheries Administration of Cambodia; funded by GOJ-TF	31 (29 M + 2 F)	Government officers and three farmers	Cambodia
<b>Freshwater fish health management</b> [Onsite course] Conducted at IFReDI (Inland Fisheries Research & Development Institute), Cambodia 22-25 October Funded by AQD and GOJ-TF	13 (11 M + 2 F)	Staff of IFReDI and one fish farmer	Cambodia
<b>Principles of health management in aquaculture</b> (Online, distance learning course) 03 September 2012-17 February 2013 Funded by GOJ-TF and AQD, with some paying (private) participants	12 (5F + 7M) 22-49 yrs old	Government, academe, private sector	Brunei (2) Italy (1) Malta (1) Philippines (4) Singapore (4)
<b>Bacteriology</b> (AQD's Tigbauan Main Station, Iloilo) 06 - 22 February; funded by University of the Philippines Visayas	1 (F) 24 yrs old	Academe	Philippines

<sup>1</sup>M = male; F = female

The feed course in Cambodia [BELOW LEFT] made the trainees happy. Says Mr. Ros Kunth, a government fisheries officer: "We have found the course to be a practical program; (we acquired) knowledge from the excellent (and) unique teaching (by AQD researchers) and (from) the curriculum design... We will try as much as we can to deliver all knowledge to small-scale farmers in every (community) to help them increase their income and reduce their poverty... Thank you for what you have done for us."



PHOTO BY GE PRAGADOR

AQD conducts training on fish health in Cambodia in October: Trainees dissect freshwater fish that they earlier collected from a pond [ABOVE]



PHOTOS BY EGDJ AYSON



## Production from feedmill, cages and ponds

### Service to the industry and consumers

FEEDS. AQD's pilot-scale feedmill was able to produce nearly 8.8 tons of feeds based on requests by fishfarmers (27%) and by proponents of AQD studies (73%). The total feed milled was valued at more than Php 1.2 million. Most of these were milkfish broodstock/larval/grow-out diets using AQD's own research-verified formulation. See table and photos at right.

MARKET-SIZED FISH. As by-products of research and from technology demonstration activities, more than 8,000 kg of market-sized fish (total value of about Php 1.88 million) were produced by AQD in its Igang, Dumangas and Binangonan stations in 2013:

Commodity harvested	Production of market-sized fish (kg)
Abalone	50
Mudcrab	31
Pompano	14 627 (juveniles, in pcs)
	2 510
Red snapper	2 143
Grouper	17
Sea bass	46
Siganid	11
Milkfish	8 799
Mixed freshwater species	140
<b>TOTAL</b>	<b>13 746</b>



Red snapper harvest from AQD ponds; varying sizes of milled diets



### Production of AQD's pilot-scale feed mill

Diets	Quantity (kg)		
	AQD	Private sector	Total
Abalone	11	12	23
Grouper	2 511	1 584	4 095
Mud crab	86	40	126
Milkfish	29 249	20 005	49 254
Pompano	11 935		11 935
Prawn	249	109	358
Sea bass	4 765	347	5 112
Shrimp	92	865	957
Siganid	613	5	618
Snapper	11 031	24	11 055
Tilapia	3 785	46	3 831
Feed ingredients	257	27	284
Mixed feeds	14	336	350
<b>TOTAL</b>	<b>64 598</b>	<b>23 400</b>	<b>87 998</b>



PHOTO BY ZC OROZCO

## Diagnostic and laboratory services

From animals, feeds and food products to water, soil and oil, AQD's Disease Diagnostic Laboratory, Microtechnique Laboratory and LFAAT (Laboratory for Advanced Aquaculture Technologies) analyzed them all.

A total of 280 diagnostic cases were examined, with 16-50% of samples positive for nine viruses (see table). Income from fish health laboratories amounted to nearly Php 0.88 million, up by 28% compared to 2011.

LFAAT analyzed 2,658 samples (or 4,454 analytes) (see table) and earned Php 0.84 million for its work.

Fish health diagnostic services	Number of samples
<b>Shrimp</b> (144 samples), <b>fish</b> (45), <b>crab and other crustaceans</b> (39), <b>water</b> (34), <b>mollusk</b> (9) <b>and others</b> (annelid, mouse, frog heart etc; 9 samples) The pathogens found in the samples included: WSSV, IHNV, IMNV, TSV, GAV, YHV, WD, VNN by PCR; and MBV by malachite green staining method. There were also samples positive for parasites	<b>280</b> (16-50% are disease-positive)
<b>Slides prepared for histology</b>	<b>854</b> (1222 slides)
<b>Analyses done by LFAAT</b>	<b>Samples (analytes)</b>
<b>Proximate</b> (crude protein, crude fat, crude fiber, moisture, ash and nitrogen free extract) <b>and mineral</b> (calcium and phosphorous) <b>composition</b>	541 (1527)
<b>Water physical and chemical properties</b> (pH, alkalinity, ammonia-N, ammonium-N, chlorophyll, dissolved oxygen, nitrite, nitrate, phosphates, total hardness, total suspended solids, sulfide, pesticide residues)	1519 (1519)
<b>Soil physical and chemical properties</b> (pH, organic matter, available iron, available sulfur, available phosphorous, carbon, nitrogen, and sulfur)	249 (249)
<b>Microbiological</b> (aerobic plate count, <i>Salmonella</i> , <i>S. aureus</i> , coliform, <i>E. coli</i> , <i>Vibrio</i> , yeasts and molds, water potability)	265 (265)
<b>Scanning and transmission electron microscopy</b>	84 (147)
<b>Fatty acid profiling</b> (from C12:0 to C22:6n3)	43 (688)



**MEITRA**  
**Maintaining  
environmental  
integrity through  
responsible  
aquaculture**

This thematic program MEITRA was developed to address issues on the negative impacts of aquaculture on the environment and how these impacts will be minimized. The overall goal is to develop environment-based aquaculture technology by integrating environmental factors in SEAFDEC/AQD research activities and to maintain environmental integrity by promoting responsible aquaculture practices.

**Assessing impacts of aquaculture on biodiversity, and water and sediment qualities in the culture areas and adjacent ecosystems both in marine and freshwater systems**

The bathymetric survey of Igang Bay (where one of AQD's stations is located) has been completed. The deepest areas identified at 70 m were at a distance of 1000 m from the shore. Through the survey, three important levels were identified: (a) areas exposed when tide level is at 0 m; (b) areas which have the minimum required depth for fish cages, with 6 m level and (c) areas recommended for cage cooperation because the depth is 10 m. The mapping of seagrass beds and coral areas in the same site were also done. Dive surveys for ecosystem coverage have been initially done for bottom sediment type under fish cage areas. Water quality for AQDs Igang Marine Station (IMS) were also monitored.

The assessment and documentation of species in and around the marine cages and adjoining habitats at Igang Marine Station has been conducted. The study documented 805 species from 292 families from samplings conducted in 2011-2012. Different species combination were found in seagrass beds, rocky bases of islands and in cages and drums of the floating cages. Some seagrass beds were heavily silted. IMS species inventory is remarkably high, despite heavy usage of the Igang coves for fishing and the intertidal areas for gleaning, and despite 30 years of operation of AQD's marine cages. Cage aquaculture adds structural substrate, food items, and refuge for a variety of species, and can enhance biodiversity in the marine habitats it occupies, if the cage operators can find ways to let the extraneous species go free alive. Unfortunately, there is no data on the biodiversity of IMS in 1980 with which to compare present data.

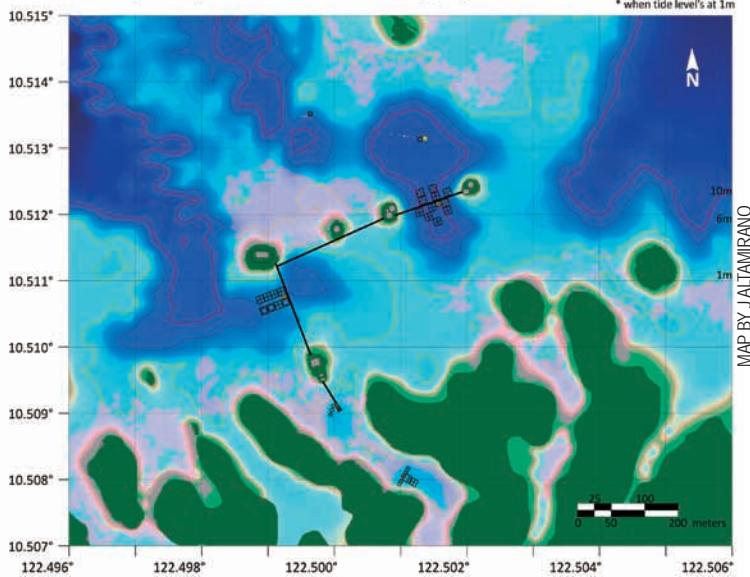
Preliminary IMS depth profile indicating three important levels: 1 m level (yellow line) are areas exposed when tide level is at 0 m; 6 m level (blue line) indicates minimum required depth for fish cages; 10 m level (red line) indicates recommended depth for cage operation. Brown and green color indicates land, lighter blue color indicates shallow areas, darker blue color indicates deeper areas. Seagrass beds are in pale magenta. Further confirmation and refinement will be done in 2013

## Identifying appropriate extractive species that may be used in IMTA

Various extractive species and their co-culture with other commercially important species are being investigated. Among them the sandfish *Holothuria scabra*, the bivalve mollusk *Anodonta philippiana*, and the seaweed *Gracilaria bailinae*.

Experiments conducted for the past two years have shown that milkfish (*Chanos chanos*), seabass (*Lates calcarifer*), pompano (*Trachinotus blochii*) and mangrove snapper (*Lutjanus argentimaculatus*) are compatible with sandfish (*H. scabra*) in a small-scale, tank setting, while rabbitfish (*Siganus guttatus*) and groupers (*Epinephelus fusco*) were unsuitable. The second production run, conducted with sandfish and/or milkfish (*Chanos chanos*), was initiated in late 2011 and was completed in mid 2012. While the growth and survival of the milkfish was good, the growth and survival of the sandfish was not, though better than with the seabass run. Heavy mortalities were experienced, with some pens having no sandfish left by the end of the run. A number of factors may have contributed to this poor performance. A number of crabs, large shrimp and a few rabbitfish were found in the pens which may have picked at the sandfish until they eviscerated and died. Also, all surviving sandfish had lesions on their ventral surface by the end of the experiment; they may have been injured by the roughness of the b-net used for the construction of the pens.

Preliminary Bathymetric Profile\* of the Igang Marine Station (IMS) 2012



[COUNTERCLOCKWISE] A net is changed; biofoulants in a changed net; sponges growing on a mooring line; *Dactyloptena orientalis* in a grouper cage net



Another production run was initiated at AQD's Igang Marine Station with pompano (*Trachinotus blochii*) as the fish species. Based on the results of the milkfish run, the pen bottoms were lined with a fine mesh hapa net before stocking. This was done in an attempt to lessen the chance of injury of the sandfish, and to retain more excess feed and fish waste for the sandfish to feed on. Fish growth and survival was good, although an infestation of sea hares caused heavy fish mortalities in two of the pens early on. Extra fish were used to re-stock one pen. The run has just been completed, and data showed much faster growth of the sandfish, with most achieving a size greater than 100 g which can already be used as broodstock.

A pond with a sandy bottom in Igang, Nueva Valencia, Guimaras, was chosen as the pond-based study site. Pens and a sampling hut were

constructed. One hundred milkfish fingerlings were stocked into each of six pens (three of fish only and three of fish and sandfish), and 75 sandfish juveniles were stocked into each of six pens in mid-September 2012. Thus far, growth and survival of sandfish appear to be good, though during the second sampling, the sandfish seemed softer, with thinner skin than usual. Some sandfish also eviscerated during sampling, which has been rare with the runs in pens behind the AQD station. Numerous shrimp were also collected, as well as snails with pointed shells, the presence of which may be detrimental to the sandfish.

The co-culture of seaweed *Gracilaria bailinae* with seabass is also being investigated. The nutrient production of seabass has been determined with total nitrogen (TN) production as  $0.11-0.57 \text{ mg L}^{-1}$  and total phosphate (TP) as  $0.01-0.67 \text{ mg L}^{-1}$ . An experiment to determine production of seabass in monoculture and in co-culture with seaweed started in September with seabass stocked at  $1 \text{ pc m}^{-2}$  and seaweed at  $1 \text{ kg m}^{-2}$ . After 75 days of culture, specific growth rate (SGR) of seabass ranged  $2.4-2.6\% \text{ day}^{-1}$  and  $2-2.2\% \text{ day}^{-1}$  in polyculture and monoculture, respectively; while seaweed SGR ranged  $1.7-4\% \text{ day}^{-1}$ . Ammonia, nitrite, and phosphate ranged from

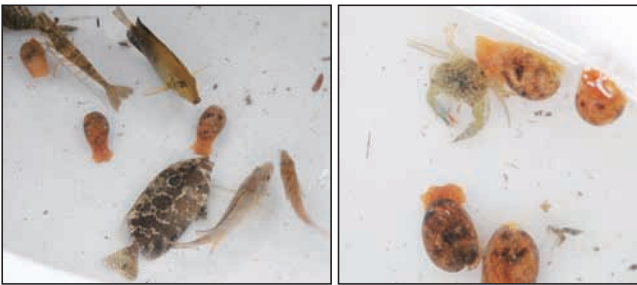
$0.009-4.55 \text{ mg l}^{-1}$ ,  $0.015-0.21 \text{ mg l}^{-1}$  and  $0.034-0.49 \text{ mg l}^{-1}$ , respectively in polyculture ponds; and  $0.008-6.56 \text{ mg l}^{-1}$ ,  $0.015-0.08 \text{ mg l}^{-1}$ , and  $0.034-0.43 \text{ mg l}^{-1}$ , respectively, in monoculture ponds.

To test their assimilation or reduction of sulfide, the bivalve *Anodontia philippiana* (AP) and the seaweed *Gracilaria bailinae* (GB) were co-cultured with milkfish (MF) in ponds. Ponds were stocked with MF alone or in various combinations with AP and GB (MF+AP, MF+GB, MF+AP+GB). All of the AP died within a month of stocking. MF+AP+GB had the highest phosphate levels ( $0.3 \text{ ppm}$ ) while MF+AP had the lowest. No differences in ammonia, nitrite and nitrates were found in all treatments. MF growth rates ranged  $15-90 \text{ g per month}$  and survival  $50-92\%$ . More trials will be conducted, this time using sandfish *H. scabra* as the extractive species to replace GB.

PHOTO BY J ZARATE



[ABOVE] Pens and sampling hut for co-culture of milkfish and sandfish. [BELOW, CLOCKWISE]: Recovered during sampling in three different fish-sandfish co-culture trials are rabbitfish, shrimp and other species; crab and snails; shrimp, snails with pointed shells and tilapia juveniles. All seem to have picked on sandfish and caused their evisceration and/or death



PHOTOS BY J ZARATE

[LEFT] Preparation for spawning sandfish at AQD's main Iloilo station. [BELOW] Sandfish nursery at AQD's marine station in Guimaras



PHOTOS BY J ALTAMIRANO





Giant clams stocked in San Joaquin, Iloilo [TOP].  
 [MAPS] Clam restocking sites at Brgy Cataan MPA  
 and Brgy Lawigan-Igcadlum MPA [BOTTOM]

## Developing and promoting efficient and suitable environment-friendly culture systems

For sandfish culture, sites have been assessed in Ajuy (Iloilo) and Igang (Nueva Valencia, Guimaras) through small-scale experimental pond and pen culture set-ups. In Ajuy, initial results at one pond had growth rates averaging  $0.25 \text{ g d}^{-1}$  without feeding in the first month; survival was also high at 75-100%. In Igang, the first month showed sandfish growing at an average of  $0.51 \text{ g d}^{-1}$  with 100% survival when stocked at  $20 \text{ m}^{-2}$ . More trials will be conducted next year to assess optimal initial culture size and stocking density.

Also in Ajuy was the trial on pen culture of sandfish. Two sandfish pens ( $4 \times 4 \text{ m}$ ) have been constructed at an open cove and inside a nearby pond. Higher growth rates ( $0.71 \text{ g d}^{-1}$ ) were recorded for the open sea pen compared with that of inside the pond ( $0.38 \text{ g d}^{-1}$ ). But escapes and predation was high in the open site where no sandfish were observed after 5 weeks. On the other hand, pens placed inside ponds recorded 100% sandfish recovery.

Initial assessments for sandfish sea ranching in Panobolon Island (Nueva Valencia, Guimaras) (four sites) and in Pulapina (Concepcion, Iloilo) (three sites) was started jointly with partners such as UP-Marine Science Institute. Criteria included sea grass cover, substrate quality, sea cucumber population density and other biota composition; risk factors; and environmental stresses. Generally, two sites in Panobolon and another two in Pulapinya showed high potential and will be further discussed with stakeholders.

The carrying capacity of inland water bodies in the Philippines is being modeled using the *Cage aquaculture decision support tool* (CADS Tool). The model was initially developed for marine cage systems and is being refined in collaboration with Australia's Department of Primary Industries of New South Wales, University of New South Wales and University Technology Sydney through ACIAR funds. An initial trial of the CADS tool has been done for Lake Bato and for some lakes.

MAP BY J ALTAMIRANO using maps.google.com as reference



## Conducting biological and ecological studies on species with potentials for resource enhancement

A number of species are being studied for resource enhancement activities. These are the giant clam *Tridacna gigas*, abalone *Haliotis asinina*, and three species of mud crab *Scylla serrata*, *S. olivacea* and *S. tranquebarica*.

Nursery rearing of 214 clams (*Tridacna gigas*) started in April 2011 in San Joaquin, Iloilo. Mortalities from transport stress and subsequent typhoons and NE monsoon resulted in 83 mortalities by January 2012. Restocking sites have been identified in reefs close to the nursery cages, where natural population of wild clams was also observed; these are in two MPAs (marine protected areas) at Brgy Cataan and the one shared by Brgy Lawigan and Brgy Igcadlum. Three clam garden sites at Brgy Cataan MPA, named as Garden 1, 2 and 3 were stocked with 30, 33, and 28 clams, respectively. Recently, ten clams (22-25cm shell length, SL) were also transferred to the MPA of Brgy Lawigan and Brgy Igcadlum. High predation rates were recorded. Those clams that were preyed upon were usually found piled at a certain "feeding" area while some were also randomly scattered. The shells were cracked and broken, signifying a large and powerful predator, presumably a large sea turtle able to lift the heavy clam and tore through its hard shell. There were also sightings of hawksbill turtles around the clam sites.

Total clam count at the end of 2012 was only 26 with average growth rate of 9.8 mm per month. Individual net cage enclosures have been placed to prevent further predation.

Wild clams were also monitored. A total of 40 wild clams (mainly *T. squamosa* and *T. maxima* species) were marked for protection and monitoring at the Cataan MPA, while nine have been tagged in Lawigan. Sizes of these wild clams ranged 8–36 cm SL. Average growth rate (*T. squamosa*) was about 1 cm per month.

To collect information on mud crab population and fisheries, a new site in Brgy. Rojas (Ajuy, Iloilo) was identified for a stock enhancement study. From January 2012, a total of 904 crabs have been collected weighing 114 kg, mostly composed of *Scylla tranquebarica*. Of the total catch, 48% were males. Of the females, 83% were immature, 8% were gravid, 8% were mature and only 0.2% were spent. No berried females were observed in the catch. Maximum individual daily yield was 2,030 g and maximum CPUE (catch per unit effort) was 1.6 crab gear<sup>-1</sup> d<sup>-1</sup> or 294 g gear<sup>-1</sup> d<sup>-1</sup>. In addition, no significant difference in yield and CPUE between bamboo traps and crab pots was observed. Collection of tissue samples for genetic characterization is on-going.

Monthly monitoring of growth and survival of released wild and hatchery-bred abalone *H. asinina* is being conducted in Sagay Marine Reserve (Negros Occidental). From January 2012, a total of 65 abalone have been collected from all 10 transects. Of these, 98 % were wild and 2% wild released recaptures (recaptured-wild). Males comprised 35% and 65% were females. Forty percent of the samples were from the transect 4 which has the highest percentage cover of dead branching corals with encrusting algae. This preference has been noted in previous years; abalone may be utilizing coral branches as shelters and encrusting algae as food.

Abalone tissue samples (n=72) collected from the stock enhancement site in the Sagay Marine Reserve (SMR) from Oct 2010 to Sept 2011 were analysed for genetic variation using mitochondrial DNA sequence and microsatellite marker information. These samples represented abalones found in the SMR three months onwards after the release of hatchery bred individuals for stock enhancement. The release was made in August 2010 and monthly on-site monitoring and sampling have been done.

Prior to the analysis of the SMR data, information based on the same parameters for genetic diversity were obtained from the wild (n=44) and hatchery stocks (n=111) collected pre-stock enhancement. Preliminary analysis using mtDNA sequence markers revealed a total of 36 haplotypes based on combined COI (cytochrome oxidase I) and COII (cytochrome oxidase II) mtDNA sequence marker information. Of the 36 haplotypes, 18 haplotypes were found in the wild stocks, nine haplotypes in the hatchery stocks and 27 haplotypes in the SMR samples. Four haplotypes were common in all three stocks, eight haplotypes were common in the wild and the SMR samples, two haplotypes were common in the hatchery and SMR samples while 13 new haplotypes were found only in the SMR samples. Haplotype diversity levels in the three stocks were 0.93 (wild), 0.6 (hatchery) and 0.9 (SMR). Results of the analysis of molecular variance however showed that 96% of the observed haplotype variation was due mostly to differences within stocks rather than between stocks. Wild and hatchery reared stocks can be distinguished using COI and COII markers.

## Extension activities under the MEITRA program

Under the MEITRA program, AQD held a 1-week training course on biodiversity for three clusters (see table) with a total of 81 attendees. Two AQD scientists were also the resource persons in the 2-day training on *Aquasilviculture* organized by LGU-Ibajay and the Zoological Society of London 19-20 October in Ibajay, Aklan. Another six scientists were at the *1st International river summit* held 30 May-1 June in Iloilo City where they joined more than 1,200 participants from 35 countries in discussing sustainable river basin management practices.

In support of the *Month of the ocean and international day for biological diversity* celebration spearheaded by DENR (Department of Environment), two AQD scientists gave lectures at the marine biodiversity lecture series organized by the University of the Philippines Diliman in Quezon City on 8 May. Dr. Ma. Junemie Hazel Lebata-Ramos and Dr. Teodora Bagarinao talked about biodiversity of mangroves and molluscs, respectively.

Training course / session date / funding	Number of attendees / gender <sup>1</sup> / age range	Trainee classification	Countries represented
<p><b>Biodiversity conservation projects for locally managed protected areas and principles of stock enhancement &amp; habitat rehabilitation</b></p> <p>Held at AQD's stations in Tigbauan and Igang; Nogas Island (Antique); and Concepcion (Iloilo)</p> <p>Three clusters: 19–25 April; 17–24 May; 28 Aug–04 Sept</p> <p>Funded by the DENR-ICRMP (Integrated Coastal Resource Management Project)</p>	<p>81 (40 M + 41 F) 21-63 yrs old</p>	<p>Staff from local government units, DENR and DA-BFAR; private organizations; people's organizations</p>	<p>Philippines</p>



Practicals for biodiversity trainees [L-R]: identifying mangrove species, preparing transect line to measure coral reef area; and assessing nearshore diversity. Says Ms. Myrna Erlinda Arbiol, DENR-Davao coastal marine management division chief: “I am so privileged to be a part of this (training). I am happy to share this experience with my superiors at the DENR. I would like to thank the resource speakers for sharing to us their expertise and to AQD management for accommodating us.”

## New IMTA facilities

### AQD and JIRCAS inaugurate new experimental facility

AQD ceremonially opened the JIRCAS-donated experiment facility for *Integrated multi-trophic aquaculture* (IMTA) on 16 October at its Tigbauan Main Station, Iloilo. JIRCAS is the Japan International Research Center for Agricultural Sciences that is funding a 5-year R&D on IMTA.

IMTA refers to the farming of different aquaculture species (potentially including sandfish *Holothuria scabra*) together in a way that allows the waste of one species to be recycled as feed for another. As AQD Chief Dr. FG Ayson said, “IMTA is one approach that would make intensification of aquaculture sustainable by limiting aquaculture’s effects on the environment. To the staff who will be using this facility, we will await new and exciting results... AQD thanks JIRCAS for the new facility, donation of laboratory equipment, and for the present collaboration.”

JIRCAS Program Director Dr. Masayoshi Saito, on the other hand, encouraged researchers to conduct more studies to provide information needed for the practical application of IMTA and to maximize aquaculture productivity and environmental mitigation. Dr. Saito also thanked AQD researchers for their joint studies with JIRCAS.



JIRCAS-donated IMTA experimental facility at AQD has twelve units of 4-ton tanks with water filtration system. (INSET, L-R) AQD Visiting Scientist Dr. Satoshi Watanabe, JIRCAS Fisheries Division Director Dr. Yukio Maeno, JIRCAS Program Director Dr. Masayoshi Saito, AQD Chief Dr. Felix Ayson, AQD Deputy Chief Teruo Azuma, and AQD Research Division head Dr. Relicardo Coloso ceremonially cutting a ribbon to open the IMTA facility



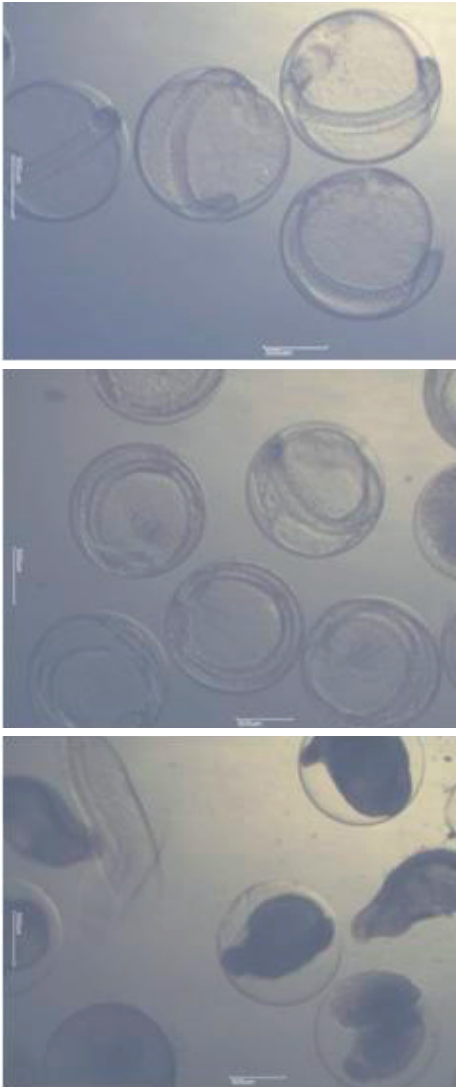
# CC Adapting to climate change

The changing global weather patterns brought about by increased global emission of carbon dioxide into the atmosphere are predicted to have serious impacts on many life forms on earth. In 2012 alone, an estimated all-time high of 34 billion tons of carbon dioxide emission was already recorded, an increase of 3% compared to 2011. The high level of carbon dioxide in the atmosphere has already resulted in global warming and has changed the chemistry of the world's oceans in ways that are already harming the coral-reef ecosystem and shell-building organisms. These changes could lead to broad impacts on marine ecosystems. The extreme weather disturbances, like more frequent and stronger typhoons, long dry spells resulting to droughts, frequent heavy rains resulting to severe flooding, that are observed in recent years are some of the phenomena that are linked to climate change.

The changes in the climate are projected to impact broadly across ecosystems increasing pressures on all livelihoods and food supply chains, including the fisheries and aquaculture sectors. The future food supply will be a central issue as food resources come under greater pressure. In particular, the sustainability of aquaculture will be further challenged in this scenario since the effect of these climatic changes on the aquaculture organisms in general, the different aquaculture systems and structures, the various support systems to aquaculture operations, and to the fish farmers, are largely unknown. The small-scale fish farmers in the region that produce the great bulk of the aquaculture production are largely vulnerable since they are dependent on aquaculture operations for food and income. Some urgent adaptation measures are therefore required in response to the threats to food and livelihood provision that may arise due to the changing climatic conditions observed around the globe.

The overall goal of the CC program is to identify the accompanying changes in the environment brought about by the changing climate that may affect the aquaculture sector, prepare the sector to the possible effects that these changes may have on aquaculture operations, minimize and mitigate the adverse impact(s) of climate change in aquaculture, and ensure the continued operation of all aquaculture production systems under changing climatic conditions.

PHOTOS BY FGAYSON



Embryonic development proceeded normally at ambient temperature (TOP) and at 31°C (MIDDLE). Embryonic development was aborted when embryos were incubated at 33°C and no hatching took place (BOTTOM). Hatching rate of milkfish embryos was best (>80%) when incubation was done in ambient temperature

## Gathering scientific information on the susceptibilities of various aquaculture species to the combined effects of increasing seawater temperature and acidity

INCREASING TEMPERATURE AND RABBITFISH BREEDING. Very little information is available on how gonadal maturation and spawning in tropical aquaculture fishes is affected by elevated water temperature. This was first investigated in rabbitfish, *iganus guttatus*. Three groups of rabbitfish breeders (n=80/group, sex ratio of 1:1) were separately stocked in three units of 10-ton rectangular concrete tanks. For the first 3 months, water supply in all the tanks was at ambient temperature (27-29°C). As expected, gonadal development and spawning performance of the three groups were high. Starting on the 4<sup>th</sup> month, the water temperature in two tanks was increased to 31°C and 33°C, and gonadal development and spawning performance were continuously monitored monthly. A water heater was installed in each of the tanks and the desired water temperature was maintained automatically by a thermostat. Water was also re-circulated to minimize heat loss. When the temperature was increased, gonadal development and spawning were very much affected in the groups maintained at 33°C water. Most females had oocytes that were atretic. During seven months of exposure to the elevated temperature of 33°C, spawning was observed only on two occasions and in both times, the spawned eggs did not hatch. The gonadal development and spawning performance of breeders in 31°C were not much affected. Clearly, spawning of rabbitfish breeders was affected when exposed to temperature of 33°C.

In the natural environment, water temperature follows a diurnal fluctuation, slightly lower temperature is observed during night time compared to day time. This diurnal temperature fluctuation was applied to captive breeders. The first group of breeders, which serves as the control, was subjected to the normal ambient water temperature with day time water temperature at 28-29°C and night time water temperature of 27-28°C. The second group of breeders was subjected to a day time (7 AM - 4 PM) water temperature of 31°C and night time (5 PM - 6 AM) of 29°C (or 31-29°C cycle). The third group was subjected to a day time temperature of 33°C and night time temperature of 31°C (or 33-31°C cycle). Gonadal development and spawning performance of the three groups were monitored monthly. Under these conditions, there was a significant improvement in the gonadal maturation and spawning success of the breeders that were subjected to 33-31°C cycle. Gonadal development and spawning success in this group were high and comparable to the control and the 31-29°C cycle groups. These results indicated that rabbitfish can still spawn at 33°C as long as the temperature is not constant.

INCREASING TEMPERATURE AND LARVICULTURE OF MARINE FISHES [MILKFISH, RABBITFISH, ASIAN SEA BASS]. The effect of elevated water temperature on embryonic development was investigated in important marine fishes like milkfish, rabbitfish and the Asian sea bass. Newly-fertilized eggs spawned in ambient water temperature were incubated in three temperature groups, namely, ambient (control), 31 and 33°C. Each temperature group had five replicates and the experiment was conducted 3-4

times. Embryonic development success and hatching rate were always high when embryos were incubated in ambient temperature (28-29°C). Embryonic development was aborted in all three species when fertilized eggs were incubated at 33°C. Although embryonic development proceeded normally in embryos incubated in 31°C, hatching rate was lower compared with those incubated in ambient temperature.

The effect of elevated temperature on larval survival after 10 days of rearing milkfish, rabbitfish and sea bass was also investigated. Newly-hatched larvae that were hatched in ambient water temperature were reared for 10 days in 250-l fiberglass tanks with water temperatures of 28-29 (ambient, control), 31 and 33°C. Stocking density was 30 larvae l<sup>-1</sup> and larvae were fed rotifers. Each treatment had three replicate tanks and the experiment was repeated 3 times. Average survival was significantly low (less than 2%) in milkfish and rabbitfish when reared in both 31 and 33°C. Among the three species, sea bass larvae survived the best at higher temperatures of 31°C (18% average survival) and 33°C (6.5% average survival).

**INCREASING TEMPERATURE AND LARVICULTURE OF MUDCRAB.** The effect of elevated water temperature on survival of different larval stages of mud crab *Scylla serrata* was investigated. Different stages of mud crab larvae were exposed to ambient temperature (28-29°C, control), 31°C and 33°C. Each treatment had four replicates and two experimental runs. Mud crab zoea 1 survived very well in 31°C. The older stages, zoea 3 and zoea 4, preferred ambient temperature. Lowest survival was observed in zoea larvae reared in 33°C. Survival was significantly lower in 33°C than in 31 °C and ambient temperature.

**INCREASING TEMPERATURE AND LARVICULTURE OF ABALONE.** The effect of elevated water temperature on survival and settlement of abalone (*Haliotis asinina*) larvae was also investigated. Pre-settling abalone larvae were exposed to three temperatures, replicated thrice: ambient temperature (control), 31°C, and 33°C. The experiment was conducted twice. Elevated temperature (33°C) had no significant effect on survival and settlement rate of abalone larvae. Average settlement rates were as follows: 1.3 individuals/plate for control, 2.9 individuals/plate for 31°C and 1.9 individuals/plate for 33°C.

PHOTOS BY FG AYSON



[TOP] Recirculating tank system used for looking at the effects of higher water temperatures (29-33°C) on the reproductive performance of rabbitfish. Note the water heater (small orange box) and its thermostat (big orange boxes). [ABOVE] Set-up for the larval rearing experiments where the water is maintained by small heaters with thermostat. This set-up is used for milkfish, seabass and rabbitfish

### **Gathering scientific data on the effects of climate change to production of natural live food organisms for hatcheries and for pond culture systems**

**INCREASING TEMPERATURE-pH-SALINITY AND GROWTH- REPRODUCTION OF ROTIFERS.** In a multi-factorial experiment, the interactive effects of temperature (29, 30, 31°C), pH (7.5, 7.8, 8.0) and salinity (20, 30, 38 ppt) were examined in rotifers, an important zooplankton that is commonly used in fish hatcheries. Population growth was significantly higher in 33°C and 20 ppt, and lower in pH 7.5. No interactive effects were observed. The size of the rotifers was also not significantly different among treatments. Likewise, no abnormality in swimming behavior and morphology was observed. These initial data indicate that rotifers may tolerate the unfavorable conditions that are predicted to happen in the future due to climate change.

**GOJ-TF**

# Promotion of sustainable and region-oriented aquaculture practices

The ASEAN-SEAFDEC Fisheries Consultative Group mechanism funded by the Government of Japan - Trust Fund (GOJ-TF) implements the program on *Promotion of sustainable aquaculture and resource enhancement in Southeast Asia* at AQD. The program has four projects: (1) *Promotion of sustainable and region-oriented aquaculture practices*; (2) *Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release*; (3) *Accelerating awareness and capacity-building in fish health management in Southeast Asia*; and (4) *Food safety of aquaculture products in Southeast Asia*.

The first project aims to promote sustainable aquaculture practices in Southeast Asia through biologically, environmentally and socioeconomically acceptable, region-oriented manner, and to secure stable supply of aquaculture products for not only the regional but also the worldwide demands.

The project has the following activities: (1) genetic improvement and development of hatchery technology for commercially important species; (2) development of environment-friendly feeds using regionally available ingredients; (3) establishment of managing technology of aquaculture environment; (4) socioeconomic assessment and impact analysis of transfer and adoption of sustainable aquaculture technologies; and (5) technology extension and demonstration.

The following were the major outcomes:

- (a) To evaluate the resistance of the mud crab *Scylla serrata*, newly hatched zoeae and juveniles were subjected to stress test using formalin solutions (30 and 40 ppm) and challenge test using the luminescent bacteria *Vibrio harveyi*, respectively. All batches that did not reach megalopa stage showed cumulative mortalities greater than 40% while those that metamorphosed to megalopa had less than 10% cumulative mortalities at 3 h during the stress test.
- (b) Tiger shrimp *Penaeus monodon* broodstock collected from areas with natural stocks previously identified as having suitable genetic profile for breeding were screened for viruses and used as base population. A challenge test against WSSV (white spot syndrome virus) was conducted for the additional batches of F<sub>1</sub> that were produced. Mortalities of 1-3g juveniles stabilized within 4-5 days.
- (c) New broodstock management methods for giant freshwater prawn *Macrobrachium rosenbergii* were implemented and are being evaluated: (1) frequent male broodstock replacement and (b) sex ratio experiment.



PHOTOS BY ET QUINITIO

As a step towards selectively breeding mudcrabs [TOP LEFT], newly hatched zoea [TOP RIGHT] are subjected to a formalin stress test before the good batches are raised in large-scale tanks [ABOVE] to eventually become new broodstock

- (d) To develop hatchery techniques of pompano *Trachinotus blochii*, effects of administration of thyroid hormone and illumination on larval rearing were examined. Application of thyroid hormone improved growth and survival of pompano larvae. Highest growth and survival were observed in 500 lux.
- (e) The second feeding experiment for the giant freshwater prawn *M. rosenbergii* verified the efficacy of 45% replacement of fish meal protein with cowpea meal protein in prawn diets without adverse effect on growth performance. This was consistent with the results of a previous trial.
- (f) In the Philippines, the most common feed ingredient in areas visited was corn followed by seed meals. However, tilapia digested more the nutrients in ingredients of animal origin compared to those of plant origin.
- (g) Among small-scale shrimp farmers, higher production of tiger shrimp *P. monodon* is achieved when shrimp are fed

with phytoplankton instead of commercial pellets. Phytoplankton could have improved the shrimp's immune competence to resist diseases, thus resulting in higher survival.

- (h) The study on the socio-economic impact of aquaculture technologies extended to calamity-stricken rural communities revealed that aquaculture venture is a profitable business either done individually or by a cooperative or association if managed properly, while there were environmental, technological and institutional issues deterring technology adoption such as climate change, institutional issues, and quality of fry as the more prevalent concerns.



PHOTO BY EGDJ AYSON

### Technology extension and demonstration

SEE ALSO ACTIVIES UNDER THE PROGRAMS ON PRODUCING QUALITY SEED AND HEALTHY & WHOLESOME AQUACULTURE

- (1) **Abalone hatchery & grow-out** training course (10-20 May, 7 participants)
- (2) **Giant freshwater prawn production** training course (18-30 June, 7 participants)
- (3) **Marine fish hatchery** training course (26 June - 01 August, 10 participants)
- (4) **Community-based freshwater aquaculture for remote areas of Southeast Asia** training course (26 November - 05 December, 7 participants)
- (5) **Farm-based feed preparation and feeding management** onsite training in Cambodia (04 - 07 December, 31 participants) [ABOVE PHOTO]

[BELOW] GOJ-TF funds a feed survey so that researchers can formulate and field test diets with quality ingredients that are within the reach of farmers; corn and seed meals are the most common ingredients sold



PHOTOS BY MR. CATACTAN



AQD conducts studies to improve broodstock management methods for giant freshwater prawn; a berried prawn



PHOTOS BY FAYA

**GOJ-TF**

# Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release

The main objectives of this project are to: (1) establish brood-stock management and mass production technology and develop methodology of stock enhancement of internationally threatened species; (2) establish release strategies of regionally over-exploited species and verify the effectiveness of community managed sea ranching and socioeconomic strategies; (3) establish adaptive measures supporting resource enhancement for a changing environment; and (4) disseminate and demonstrate resource enhancement practices.

The project has the following activities: (1) stock enhancement of CITES-listed species; (2) stock enhancement of regionally over-exploited species; and (3) adaptive measures for coral replenishment.

The following were the major outcomes:

- (a) The cytochrome b gene fragment of mitochondrial DNA from seahorse (32 samples) consisting of 480 base pairs was sequenced.
- (b) Stock and site assessment for Napoleon wrasse (*Cheilinus undulatus*) conducted in different dive sites in Bohol confirmed that juveniles can be found in reefs (8-12 meters deep) with hard branching coral adjacent to seagrass area.
- (c) Mean density (D) of natural population of sandfish *Holothuria scabra* within 50 meters from the perimeter of the project's nursery area in 2012 was twice (D=6 per 100 m<sup>2</sup>) that in 2011 (D=3 per 100 m<sup>2</sup>). This suggested improving population. However, the size structure of natural population remained skewed to small size cohorts with <100 g comprising 70%. Sea cucumber fishery remains intense in Molocaboc Island with landed catch reported almost daily and sandfish constituting a significant bulk (up to >50%) of the total volume traded.
- (d) For 2012, no hatchery-reared abalone *Haliotis asinina* was recaptured though some were observed outside the ten permanent transects. Of the monthly abalone samples, 43% were from the transect with the highest percentage cover of dead branching corals with encrusting algae.
- (e) Baseline assessment of wild population of mud crabs *Scylla* spp. commenced last January 2012 at a new site in Brgy. Rojas, Ajuy, Iloilo. Three species of *Scylla* were sampled—*S. olivacea* (87%), *S. serrata* (12%) and *S. tranquebarica* (1%). Yield and CPUE (catch per unit effort) in terms of both quantity and biomass did not significantly differ between the two types of traps used, bamboo traps and crab pots.
- (f) The 4,000 hatchery-bred abalone juveniles released in June 2011 with the participation of the community have grown to >6 cm. Fishers practice periodic partial harvesting since September 2012 to sustain the stocks. The abalone catch size regulation agreed by stakeholders was promulgated as barangay ordinance in 2010 and up-scaled to city regulation in 2012.
- (g) Site assessment for coral community analyses, temperature profiling in the coral reef, survey of coral composition using the line-intercept-transect (LIT) method, and zooxanthellae extraction from tissue samples had been done.

## IEC (information-education-communication) activities

The program implemented: (1) training on abalone culture, SEE PAGE 27; (2) monthly monitoring of the released stocks, and continuous dialogue with the community around Sagay Marine Reserve in northern Negros, Philippines; and (3) introduction of abalone cage culture to the community to augment livelihood and complement stock enhancement activities to help identify strategies for managing released stocks



AQD supports community-based sandfish nursery and grow-out culture in Sagay, Negros Occidental



**GOJ-TF**

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

The main objectives of this project are acceleration of delivery of information and awareness-building among the aquafarmers, and technological development on aquatic animal health management so as to ensure a holistic contribution to a stable supply of safe aquaculture products in the Southeast Asia.

These activities made up the project: (1) accelerating awareness about fish health management in resource-deprived countries through industry-wide capacity building; and (2) innovative research to guarantee food safety and sustainable production.

The major outcomes are as follows:

- (a) A survey of farmer-respondents was conducted in Cambodia in conjunction with a training course focusing on freshwater fish health management and detection of zoonotic pathogens. There is low level of awareness of fish health management and other production issues among farmers in Cambodia except when these farms are owned by farmers working for the Department of Fisheries.
- (b) A total of 455 freshwater fish samples in the Philippines (specifically in Region 10 or Bukidnon) and in Cambodia were examined for the presence of fish-borne zoonotic trematode (FZT) metacercaria. Fish samples in the Philippines included: tilapia *Oreochromis* sp, catfish *Clarias* sp, carps *Cyprinus* spp and snakehead *Ophicephalus striatus*. In Cambodia, the following were sampled: silver barb *Barbonymus gonionotus*, rohu *Labeo rohita*, silver carp *Hypophthalmichthys molitrix*, tilapia *Oreochromis niloticus*, snakehead *Channa striata*, midnight gouramy *Trichogaster trichopterus*, bighead carp *Aristichthys nobilis*, common carp *Cyprinus carpio*, catfish *Pangasianodon hypophthalmus*, and red-tail tinfoil barb *Barbonymus altus*. FZT metacercariae were detected in snakehead *Ophicephalus striatus* samples from Philippines, while all fish samples from Cambodia did not harbor any metacercariae.

International workshop on fish health management: accelerating awareness and capacity-building in Southeast Asia (1-2 March; Iloilo City, Philippines) with 222 attendees

CONTINUED ON PAGE 43



## Technology extension and demonstration

- (1) International workshop on **Fish health management: accelerating awareness and capacity-building in Southeast Asia** (1-2 March 2012, 222 participants; Iloilo City)
- (2) Distance learning course on **Principles of health management in aquaculture** (also known as AquaHealth Online, AHOL) (3 Sep 2012 - 17 Feb 2013, 12 participants)
- (3) On-site basic training on **Freshwater fish health management with emphasis on fishborne zoonotic parasites** (22-25 October 2012, 12 participants; Phnom Penh, Cambodia)



AT THE INTERNATIONAL FISH HEALTH WORKSHOP: [SEATED, L-R] AQD's Dr. Joebert Toledo, SEAFDEC Secretary General Dr. Chumnarn Pongsri, AQD Deputy Chief Dr. Teruo Azuma, and the present BFAR National Assistant Director Ms. Drusila Esther Bayate; with country report presenters and plenary lecturers like Dr. Eduardo Leaño, Dr. Celia Pitogo, and Dr. Teruo Miyazaki

Dr. Clarissa Marte [LEFT] and Dr. Yukio Maeno give their impressions on the workshop. Dr. Marte notes that technological and resource capability of staff & laboratories should be increased especially for countries with limited resources. She further suggests that information dissemination be intensified online; while Dr. Maeno says that fish health networking is an effective way of disseminating information



Malaya Business Insight editor and writer Mr. Paul Icamina [ABOVE] leafs through the second edition of AQD's textbook on fish health management published in late 2011

### Scientists and stakeholders discuss fish health issues

Fishfarmers can protect their stocks from disease outbreaks by practicing good aquaculture management. This was the message of the International workshop on fish health management held 1-2 March 2012 in Iloilo City. The workshop was organized by AQD with funding from the GOJ-Trust Fund. A total of 222 participants comprised of scientists, researchers and industry stakeholders attended the workshop.

Aquatic animal diseases are huge problems that hinder aquaculture production. In China alone, around \$1 billion is lost yearly to fish diseases.

SEAFDEC Secretary General Dr. Chumnarn Pongsri noted that the heavy use of chemicals and drugs in aquaculture is a non-sustainable answer to diseases. "Avoid unnecessary use of these drugs, and apply proper withdrawal periods of antibiotics to help keep aquaculture products safe for consumers," he advised.

Fish vaccination is an option to control diseases, and has been introduced in countries like Indonesia and the Philippines. This can prevent the occurrence of potential diseases like streptococcosis, koi herpes virus, and vibriosis. At AQD, a vaccine against viral nervous necrosis has been developed and tested in pompano, grouper and seabass.

Other innovative approaches such as RNA interference for silencing gene expressions in viruses, use of lectins to boost the fish immune response, and aptamer technology were also discussed during the workshop. Lectins from some teleosts, for example, are said to be good biomarkers for innate immunity for fish health management. Aptamers on the other hand have the ability to bind to fish viruses; thus, can be used to prevent unwarranted outbreaks of viral diseases.

The workshop also emphasized the need for an enhanced regulation and better monitoring of diseases in accordance with the protocols of the OIE (Office International des Epizooties). Disease reporting is necessary so that countries can provide online reports and access diseases of regional concern.

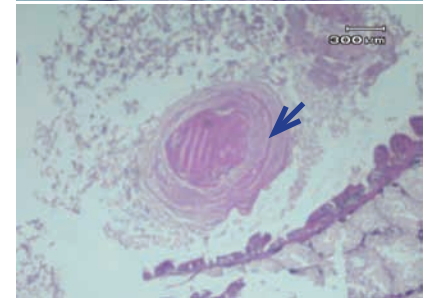
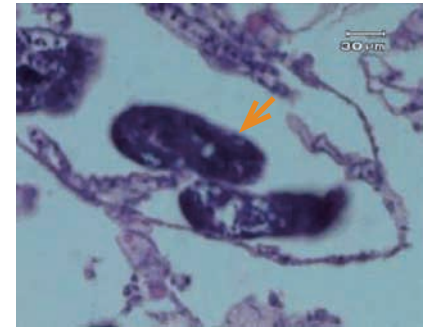
Workshop participants also identified the gaps on fish health management particularly in accelerating awareness and innovative research on fish pathogens. One of the problems highlighted by Lao PDR and Myanmar was the absence of laboratory facilities capable of performing molecular, histological, and microbial methods to detect pathogens. On the other hand in countries like Malaysia, Philippines, Thailand, and Cambodia, there is lack of fish health experts or qualified fish pathologists.

The workshop recommends capacity-building activities such as intensive hands-on training on fish pathology; continuous collaboration with relevant agencies; and information sharing to improve fish health management, food security, and aquaculture sustainability.

- (c) Optimization of q-PCR methods for the detection of WSSV, RSIV, KHV, VNN and IMNV using infected tissues were completed while the method using the plasmids are on-going. The WSSV infected tissue is ready for the infection experiment to determine the viral threshold level and the susceptibility of different shrimp species.
- (d) Sea bass *Lates calcarifer* juveniles were intraperitoneally injected with the formalin-inactivated nervous necrosis virus (NNV) vaccine and the NNV-neutralizing antibodies titers in the sera of these fish were monitored. The annual booster vaccination was continued successively for 4 years until some of these fish became sexually mature. Eggs from the vaccinated and unvaccinated broodstocks showed neutralizing antibody titers of 1:192 and <1:40, respectively, suggesting that the current vaccination regimen is a practical approach to prevent the horizontal transmission of NNV to broodfish and vertically to their offspring.

- (e) The anti-nervous necrosis activity of the extract from the seaweed *Ulva pertusa* collected from floating fish net cages in AQD's Igang Marine Station was investigated *in vivo* using pompano (*Trachinotus blochii*) juveniles. The preliminary results indicate the potential use of *U. pertusa* extract as prophylactic/therapeutic agent against viral nervous necrosis in pompano juveniles.
- (f) The efficacy of oral delivery of vaccine using liposome, chitosan, and alginate microspheres as practical vaccine carriers was tested in shrimp. In terms of survival rate, only VP 28 plasmid DNA-Inclusion Bodies (IB)+chitosan, IB+alginate, and naked IB had values above 50% which is the threshold value for vaccine efficacy.
- (g) The most common parasites in abalone are the shell-boring polychaetes belonging to the family Dorveillidae (prevalence, 27%), which were found in only in hatchery-bred stock. Condition index (CI) calculated monthly showed significant decline in abalone heavily infested with shell-boring polychaetes.

Ciliates [ARROW] in the gill tissue of abalone *Haliotis asinina*; no inflammatory response was noted. Abalone has a basophilic, bean-shaped nucleus



PHOTOS BY GE PAGADOR

Metacestodes *Tylocephalon* sp. [ARROW] found within the foot surface of abalone

## Extension and demonstration [FOOD SAFETY]



Food safety trainees during their lecture and practical sessions; 14 attended the first offering

## AQD offers new course on food safety for the first time

"In all aspects, the course is excellent," said Dr. Mohammad Kamal, National Expert BEST-Better Fish Quality, UNIDO (United Nation Industrial Development Organization) upon completing the first International training on food safety of aquaculture products which was held 12 - 16 November at AQD's main station in Iloilo.

Also completing the course were participants from Bangladesh (9, who learned of the course from AQD's website), Cambodia (1), Thailand (1) and the Philippines (3).

The course which was partly funded by the Government of Japan Trust Fund, covered lectures and practical activities on good aquaculture practices; good post-harvest practices; detection of antibiotics & pesticide residues; analyses of heavy metals & microbiological load; fish nutrition, fish health management, food safety and climate change. The group also toured the Unifish processing plant at San Dionisio, Iloilo.

# GOJ-TF Food safety of aquaculture products in Southeast Asia

Samples of fish and other aquaculture products are collected and analyzed to detect the presence of antibiotic residues



PHOTOS BY MR. CATAUTAN

The use of antibiotics and other chemicals in aquaculture is widely practiced to help meet the increasing demand for aquaculture production to avoid the outbreak of disease. However, the need to respond to environmental mitigation and consumer protection concerns for food safety is accordingly stringent and immense. Considering the growing awareness on issues of food safety of aquaculture products, it is an urgent matter that SEAFDEC should take the lead in establishing regional guidelines on the right usage of antibiotics and other chemical inputs in aquaculture.

The objectives of this project are: (1) contribute in the establishment of guidelines on the production of safe aquaculture products from Southeast Asia; (2) determine the presence and levels of commonly used chemicals in aquaculture in aquaculture products such as fish and shrimps; (3) investigate the status of antibiotics and chemical use in aquaculture in Southeast Asian countries; and (4) compile and disseminate SEAFDEC guidelines on the use of antibiotics and chemicals in aquaculture to the ASEAN region.

This project has these activities: (1) determination of withdrawal period of antibiotics in some fish species cultured in the tropics; (2) surveillance of chemical contaminants in aquaculture products and feeds; (3) investigation of the situation of antibiotics/chemicals usage and regulations in aquaculture; and (4) formulation of guidelines on appropriate administration and regulation of antibiotics/other chemicals.

The major outcomes are as follows:

- The withdrawal periods of oxytetracycline (OTC) and oxolinic acid (OXA) in mangrove red snapper, *Lutjanus argentimaculatus*, were studied. Using the time decay curve from the data obtained in the experiment, it was found that it took 21 and 18 days, respectively, to wash out OTC and OXA residues from the muscle of snapper.
- A total of 69 aquaculture products from the three regions of the Philippines were obtained and processed to detect residues of two antibiotics (OTC and OXA) and 18-20 organochlorine pesticides (OCPs). OXA was detected in more samples compared with OTC; one sample had OXA levels exceeding the PEL (permissible exposure limits) and MRL (maximum residue limits). The most common OCP detected was Methoxychlor in samples from Luzon, Visayas, and Mindanao.
- AQD participated in the finalization of *ASEAN Guidelines on chemical use in aquaculture and measures to eliminate the use of harmful chemicals*. The meeting was held in Kuala Lumpur, Malaysia on 10-12 July. Results from on-going AQD studies on withdrawal periods for antibiotics in tropical fish and shrimp species were shared with the participants.

# ABOT AquaNegosyo Technical assistance for fishfarmers

In 2012, the ABOT (Agree-build-operate-transfer aquabusiness) mechanism received 17 queries from Colombia, South Africa, Colombia, Pakistan, Hong Kong, Singapore, Maldives, Sri Lanka, New Zealand and Angola. Another 25 queries were received from the Philippines. All were sent an information flyer and the client information form with 10% of inquirers filling up and submitting the latter.

International queries were focused on high-value fish (groupers, seabass and snappers), crab, abalone, tilapia and sandfish hatchery/nursery while local clients were interested in the mechanics of the ABOT program. Three international clients were sent the letter of agreement (LOA) for site assessment; AQD then went to Malaysia, India and Timor Leste.

The newly built hatchery in Baucau, Timor Leste



In Malaysia, the assessment of a sandfish hatchery facility for Century Marine Products in Sabah was done 5-6 November by AQD associate scientist Dr. JP Altamirano; while in India, AQD sent researchers Ms. OS Reyes and Ms. JM Ladja to assess the proposed multi-species hatcheries and pond facilities of Trisect Investment & Trading Private Ltd (Mr. A. Tanna) from 11 to 17 December. For Timor Leste, AQD sent ABOT consultant Engr. PL Torres Jr to inspect the on-going hatchery project with the ACDI/VOCA.

PHOTO BY DANI FERNANDES / ACDI/VOCA

PHOTOS BY J. MADRONES-LADJA



Assessment of hatchery and pond facilities in India for Trisect Investment and Trading Private Ltd: [L-R] Mr. Abhijat Tanna, Director, with AQD technical team Ms. JM Ladja and Ms. OS Reyes; the Lakshmi Ganapathi Golden Hatchery in Visakhapatnam, India; pond facility in Balasore, Orissa. The species for culture is seabass



PHOTO BY K. NG

PHOTO BY J. ALTAMIRANO

Dr. JP Altamirano checking on a sandfish spawning induction trial (ABOVE); sea cucumber broodstock monitoring at a west Sabah sandfish hatchery

# ICDSA Technical assistance to communities

The ICDSA (Institutional capacity development on sustainable aquaculture) which is being implemented in partnerships with the local government unit, donor communities, fisherfolks/farmers and other stakeholder groups provides a mechanism for the assessment of socioeconomic and environmental impacts of AQD aquaculture technologies and, for building the capacity of beneficiary communities.

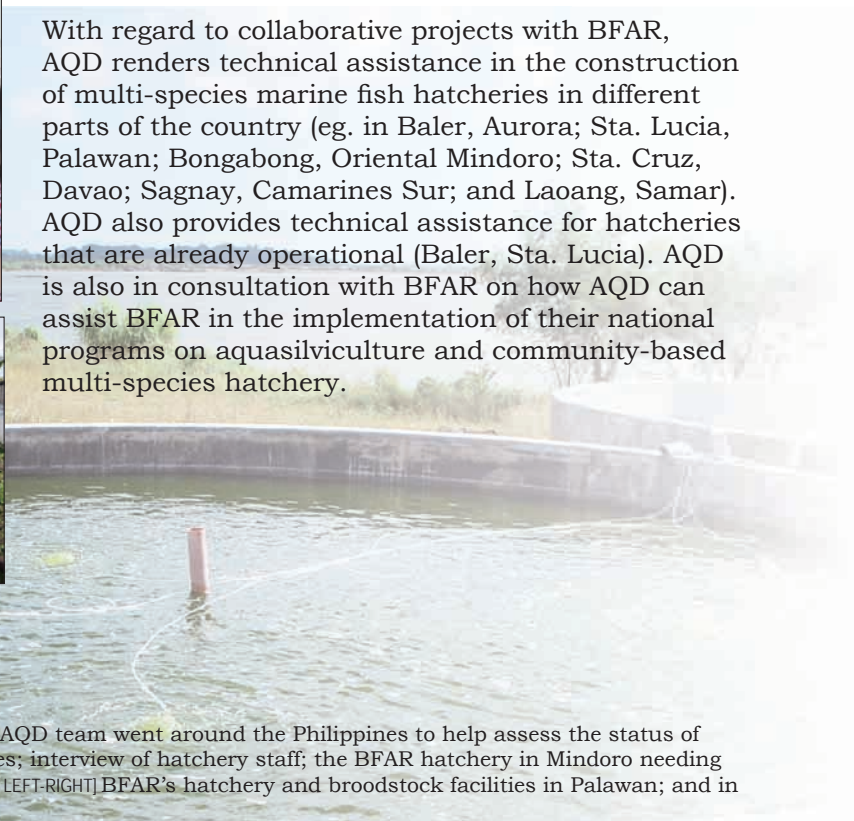
The second phase of the *Community-based milkfish cage culture* project involving fisherfolk organizations in Nueva Valencia, Guimaras funded by Petron Foundation was completed. A proposal for the third phase which entails the establishment of mini-mariculture parks for family-based milkfish cage culture enterprise was also prepared. On the other hand, exploratory meetings were held for other projects including an abalone culture project in Palawan; grouper and abalone culture in Romblon; abalone and tilapia culture as well as community-based fisheries resources management in Albay; and an aquaculture livelihood project in Masbate.

With regard to collaborative projects with BFAR, AQD renders technical assistance in the construction of multi-species marine fish hatcheries in different parts of the country (eg. in Baler, Aurora; Sta. Lucia, Palawan; Bongabong, Oriental Mindoro; Sta. Cruz, Davao; Sagnay, Camarines Sur; and Laoang, Samar). AQD also provides technical assistance for hatcheries that are already operational (Baler, Sta. Lucia). AQD is also in consultation with BFAR on how AQD can assist BFAR in the implementation of their national programs on aquasilviculture and community-based multi-species hatchery.

PHOTOS BY EGDJ AYSON



[ABOVE, TOP-BOTTOM] An AQD team went around the Philippines to help assess the status of marine fish hatcheries; interview of hatchery staff; the BFAR hatchery in Mindoro needing rehabilitation. [BELOW, LEFT-RIGHT] BFAR's hatchery and broodstock facilities in Palawan; and in Camiguin

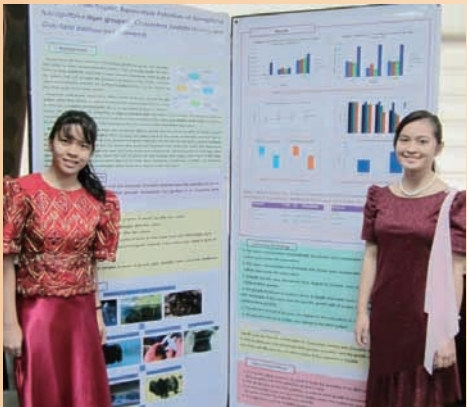


PHOTOS BY EGDJ AYSON

## Training & information

# On-the-job training, internship and research mentorship

In Malaysia, Ms. ZG Zaragosa (left) and Ms. R Tabobo pose at the poster of their award-winning research work



AQD assisted Ms. Raymee Tabobo and Ms. Zyra Grace Zaragosa, young researchers from the Philippine Science High School - Western Visayas Campus in the conduct of their research project titled "Integrated multi-trophic aquaculture potentials of *Epinephelus fuscoguttatus* (tiger grouper), *Crassostrea iredalei* (oyster), and *Gracilaria bailinae* (red seaweeds)." The students bagged the outstanding award for significant project at the 8th Regional congress search for SEAMEO (Southeast Asian Ministers of Education Organization) young scientists held 6-9 March in Penang, Malaysia. At AQD, their adviser was scientist Dr. Ma. Junemie Hazel Lebata-Ramos.

Mr. MA Dejando holds his certificate of award; flanking him are his high school adviser Mr. Marvin Rojo, AQD's Dr. JD Toledo, and his AQD researcher-adviser Ms. SM Buen-Ursua



AQD assisted Mr. Michael Angelo Dejando from Oton National High School - Special Science Class in the conduct of his 2011 study on the "Survival of mysid shrimps *Mesopodopsis orientalis* in different iodine concentrations and exposure time." His research won 2nd place (life science - individual category) during the 2012 National children's science congress held in Puerto Princesa, Palawan from 1 to 3 February.

AQD has continued to demonstrate its significant contributions to aquaculture development in the region through building institutional capacities and developing a critical mass of experts on aquaculture technologies.

### REGULAR AND CLIENT-DRIVEN COURSES.

The 19 training courses with a total of 25 sessions conducted in 2012 had 308 participants. Representing 17 countries, the participants were mostly male (75%) and coming from AQD's host country Philippines (71%), Cambodia (14%), Malaysia and Bangladesh (3% each), among others. FOR DETAILS, SEE THE COURSES UNDER THE THEMATIC PROGRAMS ON PAGES 12, 18-19, 27, 34; AND UNDER GOJ-TF ON PAGES 39, 40, 43.

ON-THE-JOB TRAINING, INTERNSHIP, STUDY TOUR. AQD also offered (a) **student on-the-job training** availed of by 249 students from 32 schools/universities in Luzon (8), Visayas (18) and Mindanao (6); (b) **internship** availed of by 42 individuals (38 from the Philippines and one each from Australia, Viet Nam, USA, France); and (c) **study tours** (46 groups) availed of by 440 persons (383 from the Philippines and 57 foreign nationals).

RESEARCH MENTORSHIP. AQD assisted 17 students from nine schools/universities in designing and conducting thesis research mostly at the masteral, collegiate and high school levels [SEE BOX NEXT PAGE]. In 2012, three students bagged national and international awards for their work in schoolyear 2011-2012.

One of the student tour-groups from the University of the Philippines



## AQD supports thesis students

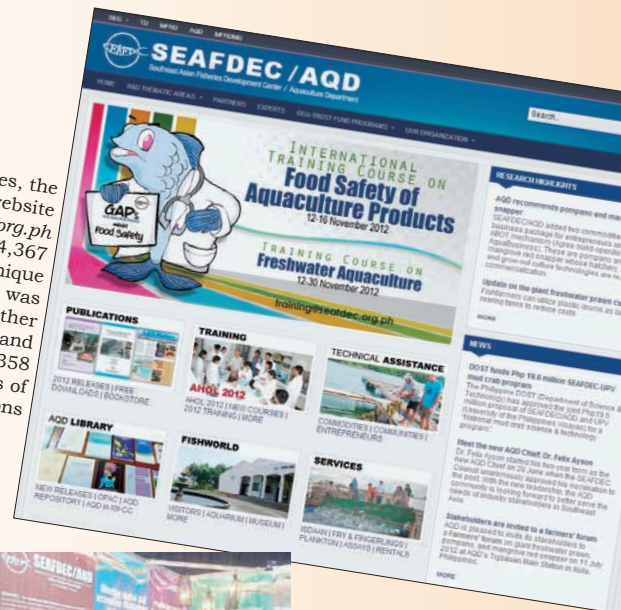
[University, title of work, name/s of student/s, course, AQD adviser]

- (1) West Visayas State University; "In vitro anticoagulant activity of the local earthworm aqueous extract"; by AR Rabang, MT Anglopez (group representatives); Doctor of Medicine; Engr. MT Arnaiz, adviser
- (2) University of the Philippines Visayas
  - (a) "Effects of aquaculture chemicals on the survival and development of marine annelids, *Marphysa* sp. early age juveniles"; by MA Mandario; MS Fisheries; Dr. VR Alava, adviser
  - (b) "Effect of different bio-augmentation agents on the composition of bacterial floc in tank culture of shrimp (*Penaeus monodon*)"; this included a side study on the "Antimicrobial properties of bio-floc towards *Vibrio harveyi*"; by RD Dianala; MS Fisheries; Dr. EC Amar, adviser
  - (c) "Optimization of culture conditions for maximum poly-B-hydroxybutyrate (PHB) production of *Bacillus* spp. isolated from shrimp pond sediments"; by NB Bautista; MS Chemistry; Mr. JL Laranja Jr, advisor
  - (d) "Nutritional evaluation of ubod from buri (*Corypha elata* Roxb)"; by J Panizales; BS Chemistry; Engr. MT Arnaiz and Ms. RM Albacete, advisers
  - (e) "Characterization of bika (*Ampelocissus martini* Planch) seed oil"; by AJ Osunero; BS Chemistry; Engr. MT Arnaiz and Ms. RM Albacete, advisers
- (3) Central Philippine University; "Biodiversity of thraustochytrids from fallen senescent mangrove leaves from Iloilo River (specifically Treñas Boulevard)"; by R Capilastique, MJ Catacutan, NM Santua, MG Suaberon; BS Biology; Ms. MR de la Peña, adviser
- (4) St. Paul University of Iloilo; "Isolation, screening and selection of efficient Poly-β-hydroxybutyrate (PHB)-accumulating bacteria from selected aquaculture environments"; by T Nacionales; BS Biology; Mr. JL Laranja Jr, adviser
- (5) University of San Agustin; "Hard-shell capsule from the extract of gulaman (*Gracilariopsis heteroclada*)"; by HP Espinosa, L Francisco, J Gabayeron, GM Guerrero, GR Gapanaga, N Gison II, G Golez; BS Pharmacy; Ms. MRJ Luhan, adviser
- (6) John B Lacson Foundation Maritime University; "Phytoplankton composition in ballast water tanks of foreign-going vessels"; by JR Garzon (group representative); BS Marine Transportation; Ms. MR de la Peña, adviser
- (7) Philippine Science High School; "Determining and comparing the carrageenan extracted from *Kappaphycus alvarezii* ('tambalang') between non-infected and ice-ice infected seaweeds"; by A Alibadbab, MAP Cohen, CA Rosales; Ms. MRJ Luhan, adviser
- (8) Iloilo National High School - Special Science Class
  - (a) "Immuno-stimulating properties of 'tawa-tawa' (*Euphorbia hirta*) in tiger shrimp (*Penaeus monodon*) challenged by WSSV"; by M Toledo, W Suaboksan Jr, JJ Redome Jr; Dr. EC Amar, adviser
  - (b) "Echinoderms of Guimaras Island, Philippines: species and size composition, microhabitats and abundance"; by RD Erada, K Navallasca; special science class; Dr. TU Bagarinao, adviser
  - (c) "Food preference and feeding behavior of mud crab (*Scylla serrata*)"; by LR Borja, AJ Daraug, CA Ramos; Dr. FDP Estepa, adviser
  - (d) "Comparison of different transport methods on the survival rate of juvenile shrimp (*Penaeus indicus*)"; by TG Lubas, JCB Anasario; special science class; Dr. FDP Estepa, adviser
  - (e) "Growth and survival of milkfish (*Chanos chanos*) larvae influenced by the quality of rearing water in relation to diet type"; by MY Galo, JF Senosa, MAR Sumile; Ms. MR de la Peña, adviser
- (9) Guimbal National High School; "Phytochemical analysis and antibacterial effect of *Alasuerte*"; by ME Calantas, CNL Jance, RM Tinasas, JM Mangaoang, N Gelario, TK Gentolea; special science class; Engr. MT Arnaiz



AQD made available to the public its annual report 2011, strategic plans 2012-2016 document, and a monthly newsletter (805 people/institutions on its e-mailing list). All three titles and 12 issues (as well as seven more updated and reprinted institutional flyers) have e-copies downloadable from its website

Updated 74 times, the AQD website [www.seafdec.org.ph](http://www.seafdec.org.ph) had a total of 54,367 unique visitors in 2012, was linked to 10,070 other webpages, and had 5,358 downloads of its e-publications



AQD co-organized the biennial Philippine shrimp congress (9-11 May, Bacolod City) where it presented papers and posters, produced the congress materials, sold books, and competed in the cooking contest (AQD won first prize for its seaweed-shrimp spring roll). AQD also attended the country's biggest agriculture trade fair AgriLink-AquaLink-FoodLink held 4-6 October in Manila [TOP PHOTO] as well as Sagay City's Sinigayan Bugay Sagay Agro Fair held 17-19 March and Davao City's 14th Trade Expo held 26-27 Oct



# Training & information Information dissemination

SCIENCE PAPERS. To enhance visibility locally and internationally and disseminate viable technologies, AQD has published over 200 scientific papers (from 2005-2012), of which more than half are in internationally peer reviewed scientific journals (ISI-CC-covered journals). In 2012, a total of 24 science papers were published [SEE PAGE 52 FOR THE LIST].

PRESENTATIONS IN SCIENCE FORA AND ATTENDANCE IN STAKEHOLDER MEETINGS. AQD staff attended 21 technical conferences and training sessions to present papers and to train on various aspects of aquaculture. These are considered staff development activities with information shared and knowledge learned.

AQD also inputted into meetings organized by stakeholders to ensure collaboration and non-duplication of research efforts. [SEE ALSO PAGE 53]

FARMER-FRIENDLY PUBLICATIONS, MONTHLY NEWSLETTER, AQD WEBSITE, MASS MEDIA, FAIRS AND EXHIBITS. AQD produced/ disseminated two new manuals on high-value fish [SEE PAGE 26] and updated/reprinted its seven institutional flyers. Manuals on *Mud crab hatchery and nursery operations*, *Culture of mud crabs*, *Milkfish cage culture operations*, and various reports on DBP-funded *Sustainable mariculture investment program (SMIP) survey* were completed and sent to the corresponding funding agencies.

AQD also published the monthly newsletter *AQD Matters*, frequently updated its website [www.seafdec.org.ph](http://www.seafdec.org.ph) resulting in a significant increase in the number of monthly unique visitors, posted stories about events in Facebook, facilitated press releases about AQD events and initiatives (e.g. recent developments in milkfish and mud crab culture), and participated in four fairs & exhibits.

All these activities address AQD's mandate of timely dissemination of information and at the same time help enhance AQD's visibility to its various stakeholders.

[BELOW] AQD's information dissemination through the social networking site Facebook (account name, Devcom Section; 931 friends) was done with 53 news posts. AQD also continued to maintain a YouTube account where its videos gathered more than 196,271 views



AQD hosted seven days of media documentation by a national daily newspaper; it was also independently covered by 138 news articles online and in newspapers

[LEFT] At AQD's anniversary week (9-12 July), technologies were disseminated through a Farmer's forum with AQD researchers discussing freshwater prawn, pompano and red snapper and fielding queries from fishfarmers. In the same week, AQD ceremonially launched its new publications for the year and welcomed stakeholders to an open house of its main station in Iloilo. AQD fielded a total of 1,393 queries sent through email and as website comments about its training courses, technologies, publications and library references



**AQD LIBRARY.** The Library offers digital and online reference services (catering to requests through email, chat, phone and even through Facebook and Twitter), current awareness services (sending alerts through email on topics and current acquisition), selective dissemination of information (sending out of abstracts among others), and a library instruction & information literacy program.

The Library also continues to update its On-line Public Access Catalogue (OPAC) and SEAFDEC/AQD Institutional Repository (SAIR); and has recently launched the Destiny library manager. A significant increase in the number of visits

from SEAFDEC member countries to SAIR has been noted between 2011 (from the time SAIR was launched in July) and 2012, indicating that more stakeholders are now able to access information materials from AQD. The library collection has also been expanded through book purchase and journal subscriptions, use of digital resources (e.g. ASFA, TEEAL), special collection of FAO publications, and library exchange/donation. This is made possible through networking with other libraries and library associations. With its growing collection, improved services and wider reach, the Library is able to serve an increasing number of clients from various sectors (AQD research staff, students, people from the academe and entrepreneurs interested in aquaculture, fisheries and related fields).

**AQD FISHWORLD: *Museum of Aquatic Biodiversity.*** The museum reference collections continued to be used by students and teachers for their theses and for contests. Additional specimens were collected from Igang and Lawi, Guimaras; Sagay, Negros Occidental; and Sandakan, Sabah.

*Work on endangered megafauna.* In 2012, four green turtles, four olive ridleys, and a hawksbill caught by fishing gears between Iloilo and Guimaras were documented and released. Two weakened olive ridleys were brought to FishWorld for care. The big female had sunken eyes, did not eat anything, and died after 20 days; it was found full of eggs that it was not able to lay in a proper sand pit on the beach. The juvenile one recovered and grew well over 8 months and was released after the storm season. FishWorld also received a dead Risso's dolphin stranded at the AQD beach and heard of a stranded sunfish at Igang that was towed back to sea.

*R&D internship.* From 10 April to 4 May, FishWorld conducted the R&D Internships for 17 juniors and seniors from the Philippine Science High School, Iloilo National High School, and Colegio de San Jose. The R&D internship builds a core group of students with an enhanced awareness of, and appreciation for, the marine environment and particularly for aquaculture and fisheries as sources of food, income, and employment.

*AquaWeek Sci-Art 2012.* These annual contests (since 1995) require students, teachers, and parents to study about aquaculture, fisheries, and marine biodiversity. This year, 192 students and 120 coaches from 18 elementary schools and 10 high schools participated in nine contests on 23-27 July. Parents



AQD's library & data banking services staff; Mr. SB Alayon is 3rd from right

**Outstanding library program and librarian.** SEAFDEC/AQD Institutional Repository (SAIR) was awarded the 2012 PAARL Outstanding library program while Mr. Stephen Alayon, senior information assistant, was recognized as *Outstanding academic/research librarian for 2012*. PAARL or the Philippine Association of Academic and Research Librarians Inc is an organization that represents the librarians of institutions supporting scholarly research and/or formal education on the collegiate level and above. AQD is a PAARL member



Hon. Mario Montejo (IN RED), Secretary of the DOST (Department of Science & Technology), visited on 29 February to get updated about DOST-funded studies on milkfish and shrimp; while Dr. Chumnarn Pongsri (SECOND FROM LEFT IN TOP RIGHT PHOTO), Secretary-General of SEAFDEC, came with Secretariat senior officials 11-13 December and talked to AQD staff in a general assembly



[FROM THE TOP, L-R] AQD FishWorld hosted the Malacology Society of the Philippines for its 6th conference and conducted the training in the Collection and identification of coastal mollusks 15-19 December; high school interns at FishWorld; live animal exhibit; a sea turtle on its way to be released

helped in the preparations for the contests and also learned a few things. Winners came from many different schools and were well-rewarded.

**Live animal exhibits.** The live animals in the aquaria, ponds, and tanks at FishWorld are important permanent exhibits that children and other visitors enjoy, despite the basic conditions (only aeration and periodic water change, no filters, no pumps, no lights). The live animals include about a hundred species of marine fishes and invertebrates, including the species that AQD does research on, and small animals saved from fishing gears.

**AQD VISITORS.** There were 26,317 visitors to AQD in 2012, mostly students (65%), private sector / NGO groups (33%), fisheries officers from SEAFDEC member countries (<1%), representatives from international organizations and others. The following visitors gave research seminars to AQD staff:

- Mr. Carlo Lazado**, Marine Genomics Research Group, Faculty of Biosciences & Aquaculture, University of Nordland / Norway: Next-generation sequencing of mRNAs in Atlantic cod, 12 Jan
- Dr. Tomoyuki Okutsu**, Japan International Research Center for Agricultural Sciences / Japan: (1) Production of trout offspring from triploid salmon parents - surrogate broodstock technique using xenogenic transplantation of spermatogonia; (2) Molecular cloning and characterization of Dmcl, a gene involved in gametogenesis, from the whiteleg shrimp *Litopenaeus vannamei*, 8 Feb
- Dr. Teruo Miyazaki**, Graduate School of Bioresources, Mie University / Japan: 1. Histopathological study on nephropathy associated with melamine and cyanuric acid in fishes; 2. Introduction of poxvirus diseases in fishes, 29 Feb
- Dr. Philip Ian Padilla**, University of the Philippines Visayas / Philippines: Biomedical Research in Japan and in the US, 9 March
- Dr. Akiko Ikeguchi**, Yokohama University / Japan: Comparative study of tidal flat culture in the western Pacific islands with biogeographic perspective, 12 March
- Dr. Masachi Kodama**, National Research Institute of Fisheries Science, Fisheries Research Agency / Japan: Composition of suspended particulate matter and food environment of Manila clam, *Ruditapes philippinarum* in Banzu intertidal sand flat, Japan, 22 March
- Dr. Michele Nishiguchi**, Department of Biology, New Mexico State University / USA: From saltwater to genes and back again - How beneficial bacteria can help decipher the evolutionary mechanisms that drive symbiosis, 24 May
- Dr. Ernesto Almira**, University of the Philippines National Institute of Molecular Biology & Biotechnology and Philippine Genome Center / Philippines: Democratizing Next Generation DNA Sequencing Technology, 24 July
- Capt Gert Heyns**, Coast Guard Auxiliary Western Visayas / Philippines: Cardiopulmonary Resuscitation, 24 July
- Dr. Ma. Cecilia Conaco**, Stony Brook University and University of California / USA: Genomic Events Accompanying the Pelagobenthic Transition in a Marine Sponge, 28 Aug
- Mr. Philip Cruz**, Herbanext Laboratories, Inc / Philippines: Rationalizing Natural Products R&D in Aquaculture, 11 Oct
- Dr. Isao Tsutsui**, Japan International Research Center for Agricultural Sciences / Japan: Development of co-culture system of giant tiger prawn and unexploited benthic organisms, 17 Oct
- Dr. Kaoru Hamano**, National Research Institute of Fisheries & Environment of Inland Sea / Japan: Yellow-head virus (YHV) infection and transmission in shrimp cultivation in Thailand, 17 Oct
- Ms. Beryl Lorraine Mañus**, Microlab Philippines / Philippines: Product demo, 17 Oct
- Dr. Janus Ong**, University of the Philippines - Philippine General Hospital: Updates on Hepatitis B & C Virus, 19 Oct

## 2012 Published science papers

- (1) Amar EC, Kiron V, Akutsu T, Satoh S, Watanabe T. 2012. Resistance of rainbow trout *Oncorhynchus mykiss* to infectious hematopoietic necrosis virus (IHNV) experimental infection following ingestion of natural and synthetic carotenoids. *Aquaculture* 330:148-155
- (2) Amar EC, Faisan JP Jr. 2012. Induction of immunity and resistance to white spot syndrome virus (WSSV) in shrimp *Penaeus monodon* (Fabricius) by synthetic oligodeoxynucleotide and bacterial DNA. *The Philippine Agricultural Scientist* 95:267-277
- (3) Apines-Amar MJS, Amar EC, Faisan JP Jr, Pakingking RV Jr, Satoh S. 2012. Dietary onion and ginger enhance growth, hemato-immunological responses, and disease resistance in brown-marbled grouper, *Epinephelus fuscoguttatus*. *Aquaculture, Aquarium, Conservation & Legislation – International Journal of the Bioflux Society – AACL Bioflux* 5: 231-239
- (4) Bagarinao TU. 2011. The sea turtles captured by coastal fisheries in the northeastern Sulu sea, Philippines: Documentation, care, and release. *Herpetological Conservation and Biology* 6:353-363
- (5) Bosma RH, Tendencia EA, Bunting SW. 2012. Financial feasibility of green-water shrimp farming associated with mangrove compared to extensive shrimp culture in the Mahakam Delta, Indonesia. *Asian Fisheries Science* 25: 258-269
- (6) Catacutan MR, Pagador GE, Doyola-Solis EF, Ishikawa M, Teshima S. 2012. Level of L-ascorbyl-2-monophosphate-Mg as a vitamin C source in practical diets for the Asian sea bass, *Lates calcarifer*. *The Israeli Journal of Aquaculture-Bamidgeh* 64: [IIC:64.2012.782] 7 p
- (7) Cruz-Lacierda ER, Erazo-Pagador G, Yamamoto A, Nagasawa K. 2011. Parasitic caligid copepods of farmed marine fishes in the Philippines. In: Bondad-Reantaso, Jones MG, Corsin JB, Aoki T (eds). *Diseases in Asian Aquaculture VII*. Selangor, Malaysia: Fish Health Section, Asian Fisheries Society; p 13-28
- (8) Gapasin RSJ, Alava VR, Marte CL. 2012. Nursery culture of grouper (*Epinephelus coioides* Forsskal) and sea bass (*Lates calcarifer* Bloch) in brackishwater ponds: co-feeding of zooplankton and formulated diets containing L-tryptophan. *Journal of Applied Aquaculture* 24:221-234
- (9) Garcia LMB, Hilomen-Garcia GV, Celino FT, Gonzales TT, Maliao RJ. 2012. Diet composition and feeding periodicity of the seahorse *Hippocampus barbouri* reared in illuminated sea cages. *Aquaculture* 358-359: 1-5
- (10) Lebata-Ramos MJH, Solis EFD, Sibonga RC, Watanabe S. 2012. Co-culture trials of sandfish *Holothuria scabra* and black tiger shrimp *Penaeus monodon* in mangroves. In: Tanaka K, Morioka S, Watanabe S (eds). *Sustainable Stock Management and Development of Aquaculture Technology Suitable for Southeast Asia*. Tsukuba, Japan: Japan International Research Center for Agricultural Sciences; JIRCAS Working Paper 75; p 87-95
- (11) Lebata MJH, Walton ME, Biñas JB, Primavera JH, Le Vay L. 2012. Identifying mangrove areas for fisheries enhancement; population assessment in a patchy habitat. *Aquatic Conservation: Marine and Freshwater Conservation* 22: 652-664
- (12) Lio-Po GD. 2011. Recent development in the study of and surveillance of koi herpesvirus (KHV) in Asia. In: Bondad-Reantaso, Jones MG, Corsin JB, Aoki T (eds). *Diseases in Asian Aquaculture VII*. Selangor, Malaysia: Fish Health Section, Asian Fisheries Society; p 13-28
- (13) Madrones-Ladja JA, Catacutan MR. 2012. Netcage rearing of the Asian seabass *Lates calcarifer* (Bloch) in brackishwater pond: the technical and economic efficiency of using high protein diets in fingerling production. *The Philippine Agricultural Scientist* 95: 79-86
- (14) Madrones-Ladja JA, Aldon ET, Baliao DD. 2012. Broodstock transplantation: An approach for stock enhancement of the “Kapis” shell, *Placuna placenta* along Panay Gulf, central Philippines. *The Philippine Agricultural Scientist* 95: 192-198
- (15) Mills DJ, Duy NDQ, Junio-Meñez MA, Raison CM, Zarate JM. 2012. Overview of sea cucumber aquaculture and sea ranching research in the South-East Asian region. In: Hair CA, Pickering TD, Mills DJ (eds). *Asia-Pacific Topical Sea Cucumber Aquaculture Proceedings of an International Symposium*; 15-17 February 2011; Noumea, New Caledonia; Canberra, Australia: Australian Center for International Agricultural Research; ACIAR Proceedings No. 136; p 22-31
- (16) Perez MP, Pido MD, Graces LR, Salayo ND. 2012. Towards sustainable development of small-scale fisheries in the Philippines: Experiences and lessons learned from eight regional sites. Penang, Malaysia: WorldFish; Lessons Learned Brief 2012-10
- (17) Salayo ND, Perez ML, Graces LR, Pido MD. 2012. Mariculture development and livelihood diversification in the Philippines. *Marine Policy* 36: 867-881
- (18) Tendencia EA, Bosma RH, Sorio LR. 2012. Effect of three innovative culture systems on water quality and whitespot syndrome virus (WSSV) viral load in WSSV-fed *Penaeus monodon*. *Aquaculture* 350-353: 169-174
- (19) Tendencia EA, Bosma RH, Primavera JH, Verreth JAJ. 2012. Effect of different mangrove-to-pond area ratios on influent water quality and WSSV occurrence in *Penaeus monodon* semi-intensive farms using the greenwater culture technique. *Aquaculture* 362-363: 72-79
- (20) Watanabe S, Kodama M, Zarate JM, Lebata-Ramos MJH, Nievaes MFJ. 2012. Ability of sandfish (*Holothuria scabra*) to utilize organic matter in black tiger shrimp ponds. In: Hair CA, Pickering TD, Mills DJ (eds.). [SEE ABOVE]; p 113-120
- (21) Watanabe S, Zarate JM, Lebata-Ramos MJH, Nievaes MFJ. 2012. Evaluation of nutritional condition of juvenile sandfish (*Holothuria scabra*). In: Hair CA, Pickering TD, Mills DJ (eds.). [SEE ABOVE]; p 50-56
- (22) Watanabe S, Zarate JM, Lebata-Ramos MJH, Nievaes MFJ, Kodama M. 2012. Utilization of organic waste from black tiger shrimp, *Penaeus monodon*, by sandfish, *Holothuria scabra*. In: Tanaka K, Morioka S, Watanabe S (eds). [SEE ABOVE]; p 81-86
- (23) Williams MJ, Agbayani R, Bhujel R, Bondad-Reantaso MG, Brugère C, Choo PS, Dhont J, Galmiche-Tejeda A, Ghulam K, Kusakabe K, Little D, Nandeesha MC, Sorgeloos P, Weerantunge N, Williams S, Xu P. 2012. Sustaining aquaculture by developing human capacity and enhancing opportunities for women. In: Subasinghe RP, Arthur JR, Bartley DM, De Silva SS, Halwart M, Hishamunda N, Mohan CV, Sorgeloos P (eds.). *Farming the Waters for People and Food. Proceedings of the Global Conference on Aquaculture 2010*; Phuket, Thailand; 22-25 September 2010; Rome: FAO; Bangkok: NACA; p 785-874
- (24) Zarate J, Niwa K, Watanabe S. 2012. The relationship between nutritional stress and digestive enzyme activities in sea cucumber *Holothuria scabra*. In: Tanaka K, Morioka S, Watanabe S (eds.) [SEE ABOVE]; p 97-105

## Attendance to meetings and staff development activities

**Aqua America 2012 - Joint Special Session on Aquatic Veterinary Medicine: Reducing the Risk of Disease** (29 February-2 March 2012; Las Vegas, Nevada) organized by American Veterinary Medical Association and World Aquatic Veterinary Medical Association

**The Philippine Gracilariaceae Taxonomy Workshop** (22-25 February 2012; University of San Carlos (USC), Cebu City, Philippines) organized by the USC Department of Biology

**International Seminar on Marine Science and Aquaculture -- Sustainable Development & Management of Aquatic Resources in a Changing Climate** (13-15 March 2012; Borneo Marine Research Institute, University of Malaysia Sabah, Kouta Kinabalu, Sabah, Malaysia) organized by Borneo Marine Research Institute, Universiti Malaysia Sabah

**Philippine Association of Microscopists, Inc. (MICROSCOPHIL) Conference - Advancing National Development through Microscopy Research** (29-30 March 2012; Manila, Philippines) organized by MICROSCOPHIL

**Student Exchange Program to Foster Expertise on Fisheries** (16 April-25 May 2012; Kagoshima University, Japan) organized by Faculty of Fisheries, Kagoshima University and University of the Philippines Visayas

**Australasian Aquaculture 2012 Conference** (1-4 May 2012; Melbourne, Australia) organized by Skretting Australasian Aquaculture 2012

**8th International Abalone Symposium** (6-11 May 2012; Hobart, Tasmania, Australia) organized by Scientific Committee of IAS

**8th Philippine Shrimp Congress - Proven Technologies and Promising Innovations** (9-11 May 2012; Bacolod City, Philippines) organized by DA-BFAR Central Office, BFAR VI, DOST Region VI, Negros Prawn Producers Marketing Cooperative Inc, SEAFDEC/AQD, UPV-CFOS

**International Institute of Fisheries Economics and Trade (IIFET) 2012 - Visible Possibilities: The Economics of Sustainable Fisheries, Aquaculture and Seafood Trade** (16-20 July 2012; Dar es Salaam, Tanzania) organized by IIFET

**Global Aqua 2012 International Conference -Securing our Future** (1-5 September 2012; Prague, Czech Republic) organized by European Aquaculture Society & World Aquaculture Society

**Training-Workshop on Techniques in Cultivation of Microalgae** (16-18 May 2012; University of the Philippines Los Baños, Laguna, Philippines) organized by Philippine Phycological Society, Inc.

**Environment Friendly Aquaculture and Stock Enhancement in the Southeast Asia under the framework of Asia-Africa Science Platform Program** (26 July-19 August 2012; Hokkaido University, Japan) organized by the Faculty of Fisheries Sciences, Hokkaido University

**Short-term Training to Asia-Africa Platform Program** (2-28 September 2012; Hokkaido University, Hakodate, Japan) organized by the Faculty of Fisheries Sciences, Hokkaido University

**Follow up Training on Histopathology** (11-17 April 2012; Mie University, Japan) organized by the Graduate School of Bioresources, Mie University, Japan

**Sandfish Culture Training** (3-9 September 2012; Bolinao Marine Laboratory, Bolinao, Pangasinan, Philippines) organized by Marine Science Institute

**Workshop on Press Release and Technical Writing** (9-10 February 2012; University of the Philippines Diliman, Quezon City, Philippines) organized by Development Center for Asia Africa Pacific

**National Training-Workshop on Resource description and Access** (30-31 August 2012; De La Salle - College of Saint Benilde Hotel, Malate, Manila, Philippines) organized by Philippine Association of Academic and Research Librarians, Inc. and National Commission for Culture and Arts - National Committee on Library and Information Services

**Congress of Southeast Asian Librarians (CONSAL) XV** (28-31 May 2012; Bali, Indonesia) organized by CONSAL

**Effective and Efficient Professional Purchasing and Procurement Skills** (15-16 August 2012; Makati City, Philippines) organized by ARIVA Events Management Incorporated

**6th HR (Human Resource) Training and Congress** (22-23 August 2012; SMX Convention Center, Pasay City, Philippines) organized by ARIVA Events Management Incorporated

**14th Institute of Integrated Electrical Engineers (IIEE) Western Visayas Regional Conference** (20-21 March 2012; Malay, Aklan, Philippines) organized by IIEE of the Philippines, Inc. (REGION VI-Western Visayas)

## AQD inputs into stakeholders' meetings

To ensure collaboration and cooperation among R&D institutions and stakeholders in Southeast Asia, 50 of AQD's senior staff went to 14 international and 65 local meetings. Most notable of which were:

- (1) 11th NACA technical advisory committee meeting (4-7 March); and NACA's regional consultation on shrimp early mortality syndrome (EMS) (8-12 Aug). Both were held in Bangkok, Thailand
- (2) NACA-FAO meeting on aquaculture assessment (2-6 July; Bangkok); FAO workshop on aquaculture for food security, poverty alleviation and nutrition (9-15 Sept; Kuala Lumpur, Malaysia)
- (3) USAID project review (20-23 May; Manila, Philippines); and ASEAN-USAID public private dialogue on sustainable fisheries and aquaculture (5-8 Dec; Bangkok)
- (4) PhilFIN board of trustees meeting and brainstorming session (13-16 June; Cagayan de Oro, Philippines); PhilFIN workshop and meeting (19-21 Nov; Manila)
- (5) National consultation-workshop on the proposed amendments to fisheries legislation (30-31 July; Cebu, Philippines); hearing of the committee on fisheries & aquaculture at the House of Representatives (21 Nov; Manila)
- (6) Multi-stakeholder consultation for the Philippines - R&D agenda on climate change (18-20 April; Manila); 11th NAFC committee meeting on climate change (23 Nov; Manila)
- (7) Roundtable consultation on the refinement of organic agriculture RDE agenda & action plans and validation of available technologies, tools & practices (27-29 Nov; Manila)

## Financial statement

# Sources and application of funds

### SOURCES OF FUNDS

<b>Contributions from Government of the Philippines</b>	<b>Php 170 000 000</b>
<b>Government of Japan Trust Fund</b>	
Sustainable aquaculture	3 581 175
Resource enhancement	1 624 735
Fish health	1 939 755
Food safety	1 620 590
	<b>8 766 255</b>
<b>External grants</b>	
ABOT AquaNegosyo	337 681
ACDI-VOCA-USDA (Timor Leste project on mud crab)	961 970
ACIAR - Seaweed culture and post harvest waste utilization	3 650 333
ACIAR - Grouper breeding and juvenile production	2 704 390
ACIAR / ICLARM - Culture of sandfish	683 085
DA Biotech - Agarases and carrageenases	436 000
DBP - Technical assistance on mariculture projects	2 090 290
DOST - Improvement of larval crab rearing protocol	2 404 636
DOST - Diet formulations for mudcrab grow-out	1 925 424
DOST - Diet refinements for crab nursery culture	1 444 484
DOST - Sustainable production of crabs	1 298 645
DOST - Reduction of cannibalism in crab	2 625 784
IFS - Application of probiotics using <i>Bacillus</i> species	421 184
JIRCAS - Epidemiology on shrimp viral diseases	474 065
JIRCAS - Polyculture of fish, bivalves	413 900
JIRCAS - Establishment of polyculture system of tiger shrimp	2 105 885
NCSU - Alternative feeding strategies for milkfish (phase II)	696 178
RIHN- Coastal area capability development	1 032 500
University of Ghent - Thesis research on polyhydroxybutyric acid	109 449
University of Wageningen - Management of shrimp diseases	54 089
USB - Study on soybean meal and soy protein concentrates	1 436 571
	<b>27 306 543</b>
<b>Internally generated funds</b>	
Income - Research Division	5 986 049
Income - Training & Information Division	5 601 334
Income - Technology Verification & Demonstration Division	4 737 948
Income - Administrative & Finance Division	7 171 264
Income - Management Office	231 791
	<b>23 728 386</b>
<b>Committed funds from prior year</b>	<b>90 257 814</b>
<b>Total sources of funds</b>	<b>Php 320 058 998</b>

### APPLICATION OF FUNDS

<b>General / administrative and non-project expenses:</b>	<b>(Php)</b>
Research Division (RD)	57 948 248
Technology Verification and Demonstration Division (TVDD)	22 135 564
Training and Information Division (TID)	6 519 957
Administrative & Finance Division	33 712 680
Management Office	17 893 820
	<b>138 210 269</b>
<b>Program / project expenses</b>	
RD	7 786 814
TVDD	1 800 308
TID	3 715 166
	<b>13 302 288</b>
<b>Projects of GOJ-TF</b>	
Sustainable aquaculture	2 731 070
Resource enhancement	1 018 075
Fish health	2 671 028
Food safety	635 714
GOJ-TF committed funds / advances	1 710 368
	<b>8 766 255</b>
<b>Externally funded projects</b>	
ABOT Aqua Negosyo	143 280
ACDI-VOCA-USDA funded mudcrab/fish cultivation project in Timor Leste	1 304 895
ACIAR - Seaweed culture and post harvest waste utilization	2 918 743
ACIAR - Grouper breeding and juvenile production	273 361
ACIAR - Sandfish hatchery and nursery techniques	647 382
ACIAR - Optimal conditions for sandfish	696 775
ACIAR - Integrated fisheries resource management	713
ACIAR - Study on freshwater systems	433 710
ACIAR - Identification of fish species suitable for polyculture	65 058
ACIAR - Polyculture of sea cucumber and marine fish species	240 047
ASCOT - Baler Multi-species Marine Fish Hatchery	37 838
BFAR - for LFAAT / biotech laboratory	8 821 836

TABLE CONTINUED

# AQD personnel distribution

As of 31 December 2012, AQD had a total personnel complement of 190 (regular employees, 113; fixed-term employees, 77)

## AQD officers in 2012

TABLE CONTINUED

BFAR - Expansion of the multi-species hatchery in Sta. Lucia	31 656
BFAR - Technical services for multi-species hatchery in Sagnay	20 011
BFAR - Technical services for multi-species hatchery in Laoang	91 867
BFAR - Technical services for multi-species hatchery in Davao del Sur	340 906
BFAR - Milkfish hatchery in Bongabong, Oriental Mindoro	266 007
BFAR - Trainors' training on hatchery/nursery of selected culture species	(1 567)
DA Biotech - Agarases and carrageenases	428 181
DBP - Technical assistance on mariculture projects	1 050 156
DOST and NRCP - Domestication of tiger shrimp	2 013
DOST - Sustainable production of tiger shrimp broodstock, high-health fry	3 374
DOST - Improvement of mud crab larval rearing protocol	1 591 076
DOST - Diet formulations for mudcrab grow-out	707 911
DOST - Diet refinement for crab nursery culture	516 019
DOST - Production of marine annelids as feed for mudcrab broodstock	451 585
DOST- Reduction of cannibalism in mud crab	1 003 967
FAO - International workshop on-farm feeding and feed management	277 528
IFS - Application of probiotics using <i>Bacillus</i> species	210 634
JIRCAS - Epidemiology of shrimp viral diseases	431 602
JIRCAS - Polyculture of fish, bivalves	195 261
JIRCAS - Polyculture system of tiger shrimp	2 122 697
NCSU - Alternative feeding strategies for milkfish (phase II)	126 572
Novus International - Study on grouper	1 129
PETRON - Pilot project on milkfish cage culture as livelihood option	97 849
RIHN - Coastal area capability development	458 319
UNESCO - Guidebook to Philippine mangroves	369 316
University of Wageningen - Management of shrimp diseases	5 812
University of Ghent - Thesis research on polyhydroxybutyric acid	409 430
USB - Study on soybean meal and soy protein concentrates	1 442 166
	<b>28 235 115</b>
<b>Committed funds</b>	
Advances for on-going activities	4 065 582
Capital outlay / repairs	127 479 489
	<b>131 545 071</b>
<b>Total application of funds</b>	<b>Php 320 058 998</b>

*AQD Chief* Dr. Felix Ayson /  
Dr. Joebert Toledo

*Deputy Chief* Dr. Teruo Azuma

*Head, RD* Dr. Relicardo Coloso

*Head, TVDD* Dr. Emilia Quinitio /  
Dr. Leobert de la Peña

*Head, TID* Dr. Evelyn Grace Ayson /  
Dr. Myrna Teruel

*Head, AFD* Ms. Kaylin Corre /  
Ms. Renee Valencia

*Head, BFS* Dr. Frolan Aya /  
Engr. Emiliano Aralar

*Head, DBS* Dr. Emilia Quinitio /  
Mr. Hanani Torilla

*Head, IMS* Mr. Mateo Paquito Yap /  
Mr. Albert Gaitan

*Head, Manila Office* Dr. Ma. Rowena Eguia /  
Ms. Grace Garcia

### Program leaders

*Meeting socio-economic challenges in aquaculture* Dr. Nerissa Salayo

*Producing quality seed for sustainable aquaculture* Dr. Ma. Rowena Eguia

*Promoting healthy & wholesome aquaculture* Dr. Myrna Teruel and  
Dr. Edgar Amar

*Maintaining environmental integrity through responsible aquaculture* Dr. Ma. Lourdes Aralar

*Adapting to climate change* Dr. Felix Ayson

*Regional programs* Dr. Teruo Azuma

### Section heads

[RD]

*Breeding & seed production* Dr. Fe Dolores Estepa /  
Dr. ET Quinitio

*Fish health* Dr. Edgar Amar

*Nutrition & feed development* Dr. Mae Catacutan

*Farming systems & ecology* Dr. Ma. Junemie Hazel Ramos /  
Dr. Jon Altamirano

*Socioeconomics* Ms. Didi Baticados /  
Dr. Nerissa Salayo

[TVDD]

*Demonstration & packaging* Ms. Jocelyn Ladja /  
Dr. Leobert de la Peña

*Technology verification* Dr. Veronica Alava /  
Mr. Dan Baliao

[TID]

*Training* Dr. Evelyn Grace Ayson /  
Dr. Myrna Teruel

*Development communication* Ms. Milagros Castañeros

*Library & data banking services* Mr. Stephen Alayon

[AFD]

*Engineering* Engr. Zaldy Suriaga

*Human resource management* Ms. Nira Grace Llona /  
Ms. Renee Valencia

*Budget-cashiering* Mr. Jiji Rillo

*Accounting* Ms. Marivic Guevara /  
Ms. Amelita Subosa

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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



# www.seafdec.org.ph

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 member countries.

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

- **Training Department (TD)** in Samut Prakan, Thailand (1967) for training in marine capture fisheries
- **Marine Fisheries Research Department (MFRD)** in Singapore (1967) for post-harvest technologies
- **Aquaculture Department (AQD)** in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- **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: Tigbauan Main Station and Dumangas Brackishwater Station in Iloilo province; Igang Marine Station in Guimaras province; and Binangonan Freshwater Station in Rizal province. AQD also has a Manila Office in Quezon City.

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Tigbauan  
Main  
Station



Binangonan  
Freshwater  
Station



Dumangas  
Brackishwater  
Station



Igang  
Marine  
Station

