

# 2011 SEAFDEC/AQD Highlights



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2011 SEAFDEC/AQD Highlights

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## Summary of accomplishments

**2011** was an important year for SEAFDEC Aquaculture Department (AQD). Its commodity programs were changed into thematic programs beginning 2012. AQD's mandates, however, have not changed. AQD pursues research & development and training & information dissemination for sustainable aquaculture development, poverty alleviation in the countryside, conservation & enhancement of aquatic resources, and ensuring food security in Southeast Asia (SEA).

As a research-and-development organization, AQD measures its success by:

(1) **the output of its scientists / researchers who implemented 86 studies this year and published 36 papers in peer-reviewed science journals and conference proceedings.** AQD has maintained research quality, evident from the accolades given its two researchers in 2011: Dr. Emilia Quintio who won the *2011 Elvira O. Tan Memorial Award* for best published paper in fisheries and Mr. Joseph Leopoldo Laranja Jr who garnered second place in the *Best Research Award for Young Scientist*; both awards given by the Philippine Department of Science & Technology, the latter with Merck Philippines.

AQD worked on six departmental and four regional programs in 2011 (table below).

	Number of studies (and study leaders)	Average completion of studies	Budget (Php)
<b>Departmental programs</b>			<b>33 522 864</b>
Integrated mollusc	13 (8)	72%	5 414 100
Shrimp and mud crab domestication	9 (7)	63%	5 333 635
Marine fish	17 (9)	75%	12 259 644
Seaweed strain improvement	4 (3)	67%	3 132 723
Aquatic ecology	5 (4)	59%	2 938 179
Small-holder freshwater aquaculture	9 (6)	66%	4 444 583
<b>Regional programs</b>			<b>9 634 364</b>
Sustainable aquaculture	9 (9)	51%	3 902 510
Resource enhancement	7 (7)	36%	3 431 756
Fish health	7 (4)	46%	1 904 122
Food safety	2 (2)	62%	395 976
<b>Special projects</b>	<b>4 (3)</b>	<b>84%</b>	<b>2 066 096</b>

**SEAFDEC/AQD is committed to the sustainable development and the responsible stewardship of aquatic resources through science-based research and promotion of aquaculture technologies relevant to Southeast Asia**

AQD has also began working on climate change, with initial results indicating that elevated water temperatures caused abnormalities or mortalities of marine fish larvae reared in hatcheries.

- (2) **the technology extension efforts it has made** [eight clients for its *Agree-build-operate-transfer (ABOT) AquaBusiness* mechanism, one of which had AQD extending its mud-crab technology to farmers in Timor Leste; two sites for its *Institutional capacity development for sustainable aquaculture (ICDSA)* mechanism]
- (3) **the number of training courses and trainee participation in AQD's extension efforts** (26 courses of which two were new; 328 trainees from 10 SEAFDEC member countries and other parts of the world). A notable achievement in 2011 was the series of training sessions for BFAR-RFTCs (Bureau

of Fisheries & Aquatic Resources - Regional Fisheries Training Centers). While AQD has its own training program, it does not have enough resources to cover the whole aquaculture industry. The approach is to train the trainers or government extensionists, and for them to train others so there will be a multiplier effect in technology dissemination.

The Government of Japan Trust Fund programs had also enabled AQD to increase fish health awareness in Lao PDR through an on-site course on freshwater fish health management with emphasis on fish-borne zoonotic parasite detection & identification

- (4) **the number of fishfarmer-friendly or stakeholder-friendly publications written** based on AQD's science-based technolo-

gies (three manuals, one textbook on fish health, one proceedings volume, the annual report, four flyers). AQD continued to update stakeholders on its activities through the official website [www.seafdec.org.ph](http://www.seafdec.org.ph), social networking sites (Facebook, Flickr, YouTube), the mass media, and fairs & exhibits (five events attended). AQD had also improved its information services with the establishment of an institutional repository -- [repository.seafdec.org.ph](http://repository.seafdec.org.ph) -- where AQD's publications since its establishment in 1973 can be accessed and downloaded, while FishWorld, the visitor center, continued to mentor young minds on environment issues

- (5) **the continuing support of AQD's host country**, the Philippines, which gave Php170 million in

**Anatomy of a change** As far back as 2001, the government ministers in charge of food security in SEAFDEC member-countries had recommended thematic programs for SEAFDEC's work on aquaculture and fisheries. In 2010, the progress in the themes was assessed; for aquaculture this was during the *Regional technical consultation on sustainable aquaculture development in SEA towards 2020* held 17-19 March in Bangkok. Following the recommendations of the technical panel, the ministers eventually adopted several resolutions and plans of action that spell out the five thematic areas for aquaculture and for AQD [photos A to C]: (1) meeting social and economic challenges in aquaculture; (2) ensuring supply of quality seeds; (3) healthy and wholesome aquaculture; (4) maintaining environment integrity through responsible aquaculture; and (5) adapting to climate change.

AQD made operational changes in 2011 by first consolidating the results of its commodity-based programs in meetings on 1 August (photo D) and 15-19 August and then assigning the studies that are still in progress or that still needs to be done to the new themes. Then, AQD held thematic program meetings 22-26 August (photo E next page), and came up with a broad plan for 2012-2016 on studies to be conducted, proponents and collaborators. Finally, AQD undertook a *Strategic planning workshop* 6-9 September (photo F next page) and prioritized a workplan based on its available human and financial resources.

AQD's workplan was then deliberated by the *21st meeting of the Philippine Technical and Administrative Committee* on 5 October, and later endorsed by the *34th Program Committee Meeting of SEAFDEC* and the *14th Meeting of the Fisheries Consultative Group / ASEAN-SEAFDEC Strategic Partnership* (14-18 November, Manila). By April 2012, AQD will receive the imprimatur of the SEAFDEC Council on its workplan for 2012-2016



operational funds, and the trust of its present collaborating/funding partners who gave almost Php20 million in project funds. AQD also signed 18 new agreements

AQD had a staff complement of 194 (regular employees, 116), and in support of the three basic mandates, facility-based staff were able to provide services and products for AQD and its stakeholders:

	Samples processed
Disease diagnosis	302 cases
Analytical services	4,853 samples
	Total production
Microalgae	<68,000 liters
Feeds	116 tons
Eggs and newly hatched larvae	75.55 million
Fry and fingerlings	6.17 million
Market-size fish	15.45 tons

AQD's production also showed that its technologies are viable and efforts still need to continue to refine these.

To keep its staff updated on the latest developments in aquaculture and/or for staff development, AQD sent 62 employees to 42 conferences and other events organized by stakeholders. At least 14 of the conferences were science meetings outside the Philippines where researchers presented results of their studies.

To strengthen team spirit, AQD held three communal activities: sportsfest 30 March-1 April, one-week anniversary celebration 4-8 July, and Christmas festivities 9 and 16 December.

In all, AQD owed its success to the hard work and cooperation of employees and the support of AQD's collaborating & funding partners.

### What's next?

AQD's medium-term workplan will begin next year, and studies will be conducted under five program themes:

- (1) meeting social and economic challenges in aquaculture
- (2) ensuring supply of quality seeds
- (3) healthy and wholesome aquaculture
- (4) maintaining environment integrity through responsible aquaculture
- (5) adapting to climate change

AQD is cognizant of the fact that it will be rated on the progress of these programs in 2016 and again in 2020. It has considered the recommendations of technical advisory panels to make an impact assessment of

its R&D activities as well as detail in a roadmap the direction it will take to accomplish its thematic targets. AQD has much leeway in how the targets will be met considering that ASEAN-SEAFDEC only broadly laid down its resolution and plan of action.

AQD's measurable impact will have to be in the improved production capacity, capability and well-being of the small-holder fishfarming community in Southeast Asia. AQD is confident that it will be up to the challenge.

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



## Research & development programs

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER	
			SEAFDEC	EXTERNAL		
<b>DEPARTMENTAL PROGRAMS</b>						
<b>Integrated mollusc</b>						
1	Experimental hybridization of 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%	515 646		
2	Low-cost production of the marine thraustochytrid strain, <i>Schizochytrium</i> sp. LEY7: 1. Mass production in optimum culture conditions yielding highest lipid and fatty acid contents; 2. 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	70%	653 142		
3	Cultivation of <i>Cocconeis</i> sp. for settlement, growth and survival of post-larval abalone <i>Haliotis asinina</i>	MR de la Peña	70%	206 237		
4	Refinement of hatchery techniques for the donkey's ear abalone <i>Haliotis asinina</i> : 1. Improvement of fecundity and seed quality of wild breeders; 2. Standardization of transport techniques for larvae and juveniles; 3. Evaluation of genetic stocks for selective breeding; 4. Bacterial diversity and algal community structure in biofilms of settlement plates for larvae	MR de la Peña	60%	631 146		
5	Suitability of indigenous macroalgal species as feed for donkey's ear abalone <i>Haliotis asinina</i>	HS Marcial	100%	147 676		
6	Stock enhancement of the giant clam <i>Tridacna</i> species in San Joaquin, Iloilo, west central Philippines	JP Altamirano	75%	329 178	135 000	Local government unit of San Joaquin, Iloilo
7	Development of recirculating system for the intermediate nursery rearing and broodstock maintenance of the donkey's ear abalone <i>Haliotis asinina</i>	TRC Mallare	60%	92 320		
8	Development and evaluation of microparticulate diet for feeding post-larval abalone <i>Haliotis asinina</i> Linne on the onset of larval settlement and metamorphosis: Protein/energy levels	MB Teruel	75%	526 751		
9	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	60%	534 351		
10	Verification of growth performance of the tropical abalone <i>Haliotis asinina</i> Linne 1758 reared in prefabricated black plastic trays using three different stocking densities	VC Encena II	80%	444 494		

IMPLEMENTED STUDIES (TITLE)		STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER
				SEAFDEC	EXTERNAL	
11	Nursery rearing and culture of the tropical abalone <i>Haliotis asinina</i> Linne 1758	VC Encena II	95%	363 739		
12	Effect of three stocking densities on growth and survival of tropical abalone <i>Haliotis asinina</i> grown in tanks and fed natural food, <i>Gracilariopsis bailinae</i> , and formulated diet	VC Encena II	10%	134,540		
13	Large-scale production of donkey's ear abalone <i>Haliotis asinina</i> juveniles	NC Bayona	90%	699 880		
<b>Mud crab / shrimp domestication</b>						
14	Domestication of the indigenous white shrimps <i>Penaeus merguensis</i> / <i>P. indicus</i>	FDP Estepa	90%	198 026		
15	Development of techniques for sustainable production of good quality captive <i>Penaeus monodon</i> broodstock and spawners and high health fry	FDP Estepa	25%		1 939 984	DOST / UPV*
16	Refinement of feeding and water management strategies in larval rearing of mud crab	ET Quinitio	90%	528 583		
17	Effects of dietary tryptophan on the antagonistic behavior of mud crab <i>Scylla serrata</i>	JLQ Laranja Jr.	80%	552 856		
18	Effect of varying levels of coconut meal to replace soybean meal in diets for mud crab <i>Scylla serrata</i>	VR Alava	50%	385 275		
19	Breeding and culture of polychaetes	VR Alava	50%	409 890		
20	Bench-scale production of fucoidan from Philippine brown seaweeds for use in mariculture and medicinal applications (Year 1). Preliminary testing for bioactivity against white spot syndrome virus (WSSV) in <i>Penaeus monodon</i>	EC Amar	100%	382 860	168 025	Marine Environment and Resources Foundation, Inc
21	Verification of the use of formulated diets for nursery culture of mud crab, <i>Scylla serrata</i> , in brackishwater ponds	JLQ Laranja Jr.	5%	449 636		
22	Production of mud crab ( <i>Scylla serrata</i> ) with milkfish ( <i>Chanos chanos</i> ) and siganid ( <i>Siganus guttatus</i> ) in brackishwater ponds	RPCB Ragus	75%	318 500		
<b>Marine fish</b>						
23	Climate change and aquaculture: Effect of increasing rearing water temperature and acidity on the reproductive performance of some important tropical freshwater/ brackishwater aquaculture fish species (tilapia and rabbitfish)	FG Ayson	20%	726 326		
24	Climate change and aquaculture: 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	35%	681 326		
25	Growth, survival and nutritional composition of grouper fry fed formulated diet	OS Reyes	75%		526 010	Novus International Inc

\*DOST, Department of Science & Technology; UPV, University of the Philippines Visayas

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER	
			SEAFDEC	EXTERNAL		
26	Refinement of seed production techniques for high value marine fish species such as grouper, red snapper, seabass and pompano	OS Reyes	90%	1 460 380		
27	Optimization of seed production of milkfish through feeding fortified diets: Effects on eggs and fry quality	OS Reyes	90%	1 125 606		
28	Digestibility and effective level of meat & bone meal in formulated diet for milkfish, <i>Chanos chanos</i> Forsskal, grown in fresh and seawater	MR Catacutan	100%		186 000	Fats and Protein Research Foundation and National Renderers Association
29	Formulated diets for seahorse	MR Catacutan	30%	40 000		
30	Use of soybean meal and soy protein concentrate as alternatives to fish meal in practical feeds for milkfish, <i>Chanos chanos</i>	RM Coloso	75%		2 817 416	United Soybean Board
31	Improvement of the nutritional value of locally available feed resources for practical aquatic feeds by submerged fermentation and solid substrate fermentation using milkfish gut bacteria and/or selected fungi	RM Coloso	50%	196 159		
32	Host responses and defense against <i>Amyloodinium ocellatum</i> infestation in marine fish species and development of control methods	EC Amar	60%	480 112		
33	Development of nursery culture techniques for the pompano <i>Trachinotus blochii</i> Lacepede in brackishwater pond: Evaluation of formulated diets with varying lipid levels	JM Ladja	50%	462 527		
34	Fingerling production of seabass <i>Lates calcarifer</i> and refinement of nursery culture techniques for the grouper <i>Epinephelus</i> sp. in cages in pond	JM Ladja	100%	517 227		
35	Intensive production of red tilapia hybrid ( <i>O. mossambicus-hornorum</i> hybrid X <i>O. niloticus</i> ) in polyculture with siganid ( <i>Siganus guttatus</i> ) in brackishwater ponds	RM Coloso	100%	470 554		
36	Verification of SEAFDEC grow-out diets for pompano ( <i>Trachinotus blochii</i> ) in cages in ponds	EB Coniza	100%	442 547		
37	Refinement of intensive grow-out culture of sea bass ( <i>Lates calcarifer</i> ) in brackishwater ponds using SEAFDEC formulated diets with higher energy level	RM Coloso	100%	709 489		
38	Refinement and dissemination of intensive grow-out technique for the polyculture of milkfish ( <i>Chanos chanos</i> ), white shrimp <i>Penaeus indicus</i> and crab ( <i>Scylla</i> spp.)	NV Golez	100%	830 502		
39	Demonstration and semi-intensive production of rabbitfish ( <i>Siganus guttatus</i> ) and snapper ( <i>Lutjanus argentimaculatus</i> ) in pond using SEAFDEC grow-out diets	EB Coniza	100%	587 463		

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER	
			SEAFDEC	EXTERNAL		
<b>Seaweed strain improvement</b>						
40	Development of molecular markers for <i>Kappaphycus</i>	MMD Peñaranda	36%	519 247		
41	Evaluation of seaweed <i>Gracilaria bailinae</i> , <i>Kappaphycus alvarezii</i> and <i>Caulerpa lentillifera</i> as bioremediator in intensive shrimp <i>P. indicus</i> culture	HS Marcial	80%	881 542		
42	Seed production of <i>Kappaphycus</i>	MRJ Luhan	100%	1 202 447		
43	Screening of antimicrobial activities of seaweed extracts	MMD Peñaranda	50%	529 487		
<b>Aquatic ecology</b>						
44	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	50%	60 000		
45	Determination of optimal conditions for growth and survival of sandfish juveniles for culture	JP Altamirano	70%	446 386	487 000	ACIAR
46	<i>Anodontia philippiana</i> and <i>Holothuria scabra</i> as bioremediators in an intensive cage culture system	MJHL Ramos	65%	398 433		
47	Identification of fish species suitable for polyculture with sea cucumbers	J Zarate	60%	154 000	688 219	ACIAR / JIRCAS**
48	Enhancement of sandfish hatchery and nursery techniques	JP Altamirano	50%	335 841	368 300	ACIAR
<b>Small-holder freshwater aquaculture</b>						
49	Reproduction and seed production of the climbing perch <i>Anabas testudineus</i>	LMaB Garcia	50%	218 932	397 963	NSRI, UP Diliman***
50	Selective breeding for enhanced traits in saline-tolerant tilapias ( <i>Oreochromis</i> spp). 1. Growth, survival and fillet yield of Mozambique tilapia, commercial tilapia hybrids and saline-adapted Nile tilapia in brackishwater conditions	MRR Eguia	80%	343 234		
51	Larval rearing of the silver perch <i>Leiopotherapon plumbeus</i> (Kner, 1864) under laboratory condition	FA Aya	25%	339 643		
52	Domestication and evaluation of the culture potential of native Caridean prawns: <i>Macrobrachium lar</i>	MLC Aralar	30%	80 200	440 800	DOST-NRCP****
53	Production characteristics of the giant freshwater prawn <i>Macrobrachium rosenbergii</i> cultured in cages using different grow-out management strategies	MLC Aralar	75%	154 200		
54	Carrying capacity, decision support tools for freshwater systems in Australia and the Philippines	MLC Aralar	75%		1 225 146	ACIAR
55	Netcage culture of tilapia and freshwater prawn in freshwater dam / reservoir using test diet and commercial feeds	DD Baliao	60%	341 523		

\*\*ACIAR, Australian Centre for International Agricultural Research; JIRCAS, Japan International Research Center for Agricultural Sciences

\*\*\*NSRI, Natural Sciences Research Institute; UP, University of the Philippines

\*\*\*\*NRCP, National Research Council of the Philippines

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER
			SEAFDEC	EXTERNAL	
56	Seedstock production for freshwater aquaculture: bighead carp, Nile tilapia and giant freshwater prawn	EV Aralar	95%	382 998	
57	Mass production of sex-reversed and mixed Nile tilapia ( <i>Oreochromis niloticus</i> ), and hybrid red tilapia fingerlings	DM Reyes Jr	100%	519 944	

## REGIONAL PROGRAMS

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

58	Selective breeding of mudcrab <i>Scylla serrata</i>	ET Qunitio	35%	342 151	217 972	GOJ-TF*****
59	Selective breeding of black tiger shrimp <i>Penaeus monodon</i>	FDP Estepa	35%	148 171	217 972	GOJ-TF
60	Genetic improvement in the giant freshwater prawn, <i>Macrobrachium rosenbergii</i> (II): Assessment of effective broodstock management schemes for improved growth and reproductive performance	MRR Eguia	80%	143 002	217 972	GOJ-TF
61	Development of hatchery techniques of emerging species with special reference to reproductive biology of pompano and other potential species for aquaculture	FL Pedroso	35%	456 384	217 972	GOJ-TF
62	Establishment of guidelines for optimum feeding management through survey of availability and quality assessment of feed resources	MR Catacutan	32%		217 972	GOJ-TF
63	Development of efficient and low-pollution feeds for grow-out and broodstock (with special reference to giant freshwater prawn)	FA Aya	40%	296 936	217 972	GOJ-TF
64	Mass production of <i>Kappaphycus</i> spp. plantlets	MRJ Luhan	100%		217 972	GOJ-TF
65	Establishment of management technology for disease tolerance and sustainable aquaculture environment	EA Tendencia	45%		334 346	GOJ-TF/ RESCOPAR (Wageningen University)*****
66	Socioeconomic assessment and impact analysis of transfer and adoption of sustainable aquaculture technologies	DB Baticados	56%	510 417	145 299	GOJ-TF

### Food safety of aquaculture products in Southeast Asia

67	Surveillance of chemical contaminants in aquaculture products and feeds	MR Catacutan	30%		181 658	GOJ-TF
68	Withdrawal period of antibiotics in milkfish, <i>Chanos chanos</i> and some freshwater fish species cultured in the tropics.	MT Arnaiz	95%		214 318	GOJ-TF

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

69	Establishment of immunization regimen for the prevention of viral nervous necrosis (VNN) in high value marine broodfish	RV Pakingking	65%	100 000	217 972	GOJ-TF
70	Establishment of novel prophylactic and therapeutic methods for the prevention of viral infections in commercially important maricultured fish	RV Pakingking	50%	100 000	217 972	GOJ-TF

\*\*\*\*\*GOJ-TF, Government of Japan Trust Fund

\*\*\*\*\*RESCOPAR, Rebuilding Resilience of Coastal Population and Aquatic Resources

IMPLEMENTED STUDIES (TITLE)	STUDY LEADER	COMPLETION	BUDGET (Php)		COLLABORATING PARTNER	
			SEAFDEC	EXTERNAL		
71	Evaluation of carriers for practical delivery of vaccines to shrimp <i>Penaeus monodon</i> and other crustaceans	EC Amar	39%		217 972	GOJ-TF
72	Parasitic and shell diseases of abalone ( <i>Haliotis asinina</i> ) in the Philippines	GE Pagador	40%		127 165	GOJ-TF
73	Surveillance of parasite fauna of economically important freshwater fish in some Southeast Asian countries	GE Pagador	40%		116 248	GOJ-TF
74	Molecular diagnosis and prevention of viruses in economically important fish and shrimp	LD de la Peña	45%		217 972	GOJ-TF
75	Status and needs of primary aquatic animal health care in small-scale aquaculture	EC Amar	40%		588 821	GOJ-TF
<b>Resource enhancement of internationally threatened and over-exploited species in Southeast Asia through stock release</b>						
76	Stock enhancement of Napoleon wrasse <i>Cheilinus undulatus</i> with special reference to breeding and seed production techniques	FL Pedroso	15%	456 384	181 657	GOJ-TF
77	Stock enhancement of seahorses <i>Hippocampus barbouri</i> and <i>H. comes</i>	SMB Ursua	35%	823 883	199 792	GOJ-TF
78	Effects of ocean warming on symbiont-shuffling, survival and growth of corals, and community structure in coral reefs	G Ludevese / J Zarate	5%		431 878	GOJ-TF
79	Stock enhancement of donkey's ear abalone <i>Haliotis asinina</i>	MJHL Ramos	70%	193 115	199 792	GOJ-TF
80	Stock enhancement of mud crabs <i>Scylla</i> spp.	MJHL Ramos	50%	256 328	199 792	GOJ-TF
81	Community managed sandfish ( <i>Holothuria scabra</i> ) sea ranching and stock release	MFJ Nievales	35%	144 000	181 657	GOJ-TF
82	Socioeconomic analysis and identification of strategies for managing released stocks of abalone and sea cucumber in Sagay Marine Reserve in Negros Occidental, Philippines	ND Salayo	45%		163 478	GOJ-TF
<b>SPECIAL PROJECTS</b>						
83	Application of molecular markers in the conservation and management of marine genetic resources in Asia	MRR Eguia	60%	402 600	Expenses in Japan	JSPS (Japan Society for the Promotion of Science)
84	Enterprise development options	DHM Tormon	100%		110 522	Petron and CITI Foundation
85	Establishment of polyculture system of tiger shrimp <i>Penaeus monodon</i> and sandfish <i>Holothuria scabra</i>	S Watanabe	100%		977 787	JIRCAS
86	Development and extension of integrated multi-trophic aquaculture techniques for improvement of livelihood (year 1 of a 5-year project)	S Watanabe	75%		977 787	JIRCAS



Photo by HM MARCIAL

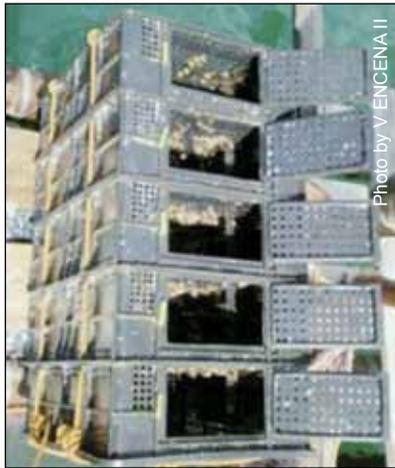


Photo by V ENCENA II



[L-R] Abalone broodstock; prefabricated plastic trays for rearing abalone in the nursery; monitoring the grow-out cages of abalone at AQD's Igang Marine Station

## Integrated mollusc program

In 2011, the program continued to focus on the donkey's ear abalone *Haliotis asinina*, the fastest-growing among the commercially important tropical abalone species. Broodstock diets were tested; hatchery techniques were refined to improve the settlement and survival of postlarvae; the search for better or alternative feed for the nursery continued; while hybrids developed by AQD had been grown to market size and tested for acceptability.

### Broodstock

The use of good maturation diet plays a major role in producing good quality seeds. Maturation diets with various protein/energy ratios were developed to improve spawning frequency, hatching rate and quality of trocophore larvae. Reproductive performance of wild-sourced abalone broodstock generally improved with an increase in dietary protein/energy levels from 27% crude protein (CP) / 3210 kcal kg<sup>-1</sup> energy up to 37% CP / 3570 kcal kg<sup>-1</sup> energy. At the highest level of dietary protein/energy tested (42% CP / 3750 kcal kg<sup>-1</sup> energy), however, some reproductive parameters such as mean instantaneous fecundity, mean spawning frequency and mean spawning time interval started to level off or decrease. Higher gonadosomatic indices characterized the early gonad maturation of abalone fed diets with higher levels of protein and energy. Percent hatching rate ranged from 38 to 52%.

### Hatchery

To find alternative diatom diets to be used in abalone hatchery, the growth physiology of *Cocconeis* and *Nitzschia* sps. were studied. After finding the optimum light requirement and cheap enrichment medium for cell growth, the chemical composition of the diatoms were established to determine their nutritional value. Highest protein and carbohydrate content were recorded in *Nitzschia* sp. (strain SEA 212) enriched with F/2 medium using technical grade reagents (protein: 4.33 x 10<sup>-3</sup> pg cell<sup>-1</sup>; carbohydrate: 3.70 x 10<sup>-3</sup> pg cell<sup>-1</sup>) and *Nitzschia* sp. (strain SEA 33) enriched with F/2 (protein: 4.08 x 10<sup>-3</sup> pg cell<sup>-1</sup>; carbohydrate: 3.49 x 10<sup>-3</sup> pg cell<sup>-1</sup>). The chlorophyll a content of both diatoms was also high compared with that of other strains tested using different enrichment media. Mass production of *Nitzschia* species (three strains) and *Cocconeis* sp. (one strain)

were conducted separately in three 1.5-ton tanks with 100 settlement plates hung on each tank; and the cultures enriched with F/2 medium consisting of basic macro nutrients and the cheaper technical grade nutrients. Results showed low cell growth of *Nitzschia* (from 0.13 to 1.33 x 10<sup>5</sup> cells cm<sup>-2</sup>) compared with *Cocconeis* sp. (1.43 x 10<sup>5</sup>).

To reduce dependence on diatom and allow more control over the nutritional composition of the feed, an agar-based microparticulate diet (MPD) was evaluated for post-larval abalone. Larval settlement was not significantly different in MPD with higher agar concentrations (10 and 12.5 mg ml<sup>-1</sup> agar) tested at three different feeding frequencies. At lower levels of agar in the diet however (5 and 7.5 mg agar), larval settlement and survival were significantly higher in abalone that are fed daily. Higher agar concentration in MPD resulted in low

abalone survival, though not significantly different from those fed natural diet. Post-larvae given microparticulate diet with 7.5 mg ml<sup>-1</sup> agar on a daily basis were bigger compared with those fed every other day and every 2 days.

To standardize transport techniques for larvae and juveniles, the effect of lowering water temperature on the survival of abalone larvae during simulated transport was evaluated. Higher survival (5h, 94%; 10h, 80%; 15h, 74%) of larvae was observed when temperature (18-21°C) was low, regardless of transport duration. At higher temperature (22-25°C) and at ambient temperature (29.5-30°C), transport duration significantly affected larval survival (5h, 92%; 10h, 60%; 15h, 0% and 5h, 91%; 10h, 2%; 15h, 0%, respectively).

Results of experiment on transport of abalone juveniles (3-3.5 cm) showed significantly high survival after 16h of transport in two stocking densities tested (10 ind pipe<sup>-1</sup>, 96%; 20 ind pipe<sup>-1</sup>, 91%). Low survival (10 ind pipe<sup>-1</sup>, 14%; 20 ind pipe<sup>-1</sup>, 15%) was observed when transport time was extended to 32h.

To prevent inbreeding, improve the quality of seeds, and develop a strategy for genetic management of abalone, a new set of breeders was collected from Palawan and Masbate in the Philippines. The settlement rate, growth and survival of F<sub>1</sub> cohorts of the newly acquired breeders were compared with the hatchery-bred (HB) cohorts. No trend was observed with larval settlement, but regardless of

size category, HB juveniles showed higher growth than juveniles produced from breeders from Masbate and Palawan.

To establish information on potential pathogens, microbial species that may boost abalone production, or define their synergistic action, samples of biofilms from settlement plates and water samples from rearing tanks were periodically obtained in three hatchery cycles (90 days, wet and dry seasons). No trend was observed in bacterial counts based on the stages of abalone culture. For water samples, luminous bacterial count (LBC) were observed to be generally higher during the dry than in wet season. For biofilm samples from abalone rearing plates, bacterial counts were generally higher by 10-100 times in dry than in wet season. Identification of bacterial isolates obtained during the dry season by API 20NE revealed the predominance of *Vibrio vulnificus* (33%) and *Vibrio alginolyticus* (18%).

### Nursery

Marine thraustochytrids with their high DHA (docosahexaenoic acid) content can provide an alternative source of PUFA (high polyunsaturated fatty acids) which are known to provide better growth and survival of cultured species. Using commercial glucose as cheap source of carbon and extract of baker's yeast treated with rock salt as source of nitrogen, thraustochytrids were exposed to different combinations of salinity (15, 25, 30 ppt), pH (4, 6, 8) and temperature (20, 25, 30°C). At 25°C, highest freeze-dried biomass of 3.83 mg ml<sup>-1</sup> was obtained when cultures were exposed to salinity-pH combination of 30 ppt and pH 4. Lowest freeze dried biomass of 1.19 mg ml<sup>-1</sup> was obtained when cultures were exposed to salinity-pH combination of 15 ppt and pH 8. The lipid and protein content at the best temperature-salinity-pH combinations of 25°C, 30 ppt, pH 4 was high (lipid, 19%; protein, 34%) with 39% DHA of the total fatty acids.

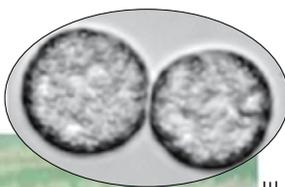
An experiment was conducted to investigate the application of freeze-dried biomass of the marine thraustochytrid

strain, *Schizochytrium* sp. LEY7, as enrichment for the live food *Artemia* used in snapper larviculture. A 35-day feeding trial was conducted on 20-day old snapper fry using the following live food enrichment: diet A (thraustochytrid-enriched *Artemia*), diet B (hatchery-prepared emulsion-enriched *Artemia*), diet C (A1 DHA SELCO-enriched *Artemia*) and diet D (control, non-enriched *Artemia*). After 35 days of culture, survival was highest in fry fed diet A (66%) followed by diet B (54%) while lowest in fry fed diets C (31%) or D (28%). Results of a salinity stress test showed lower morbidity in fry fed diet A compared with fry fed diets B, C or D.

To improve the operation of the intermediate abalone nursery, the flow-through system (FTS) was compared with a recirculating system (RCS) that uses seaweed (*Gracilaria bailinae*) as biofilter. Abalone was also fed either formulated diet or its natural diet *Gracilaria*. After 123 days of culture, results showed that abalone fed formulated diet in RCS was not significantly different from abalone fed *Gracilaria* in FTS in terms of body weight (BW, 2.5-3 g) and shell length (SL, 23-24 mm). However, these were significantly higher than abalone fed *Gracilaria* in RCS and formulated diet in FTS (BW, 2.3-2.4 g; SL, 23 mm). Abalone fed *Gracilaria* had also higher survival rates (FTS, 95%; RCS, 93%) compared with abalone fed formulated diet (FTS and RCS, 71%).

The suitability of *Gracilaria bailinae*, *Hydropuntia edulis*, *Caulerpa lentillifera*, *Ulva fasciata*; two varieties of *Kappaphycus alvarezii* (var sacol and var vanguard); and *Eucheuma spinosum* as feed for juvenile and adult abalone was evaluated over a 90-day feeding trial. Results showed that *G. bailinae*-fed juvenile and adult abalone obtained the highest daily increase in shell length (DISL) (juvenile, 16 mm day<sup>-1</sup>; adult, 15 mm day<sup>-1</sup>) and daily increase in body weight (DIBW) (juvenile, 5 mg day<sup>-1</sup>; adult, 43 mg day<sup>-1</sup>). Meanwhile, *C. lentillifera*-fed juveniles attained the lowest DISL and DIBW (4 mm day<sup>-1</sup> and 0.4 mg day<sup>-1</sup> respectively) and adult abalone fed *C. lentillifera* lost weight (1.6

Thraustochytrids on a culture plate and up close



PHOTOS BY G. LUDEVESE

mm day<sup>-1</sup> DISL, -0.9 mg day<sup>-1</sup> DIBW). Survival of juveniles and adults ranged 94-100% and 65-95%, respectively, and was not significantly different between treatments.

To reduce cost of land-based nursery rearing of abalone, small-sized abalone juveniles (SL, 12 mm; BW, 0.4 g) were reared in four types of nursery cage designs (black box; round mesh cage; prefabricated black plastic tray and blue box) at two stocking densities (500 pieces and 1,000 pieces m<sup>-2</sup>) for 90 days. Results showed highest growth (SL, 34 m; BW, 8 g), survival (87%) and low feed conversion ratio (7.8) in juveniles reared in prefabricated black plastic tray at a stocking density of 500 pieces m<sup>-2</sup>.

### Grow-out

Growing abalone in sea cages was verified, and three stocking densities were tested: 50, 100 and 200 pieces m<sup>-2</sup>. After 180 days, results show highest final body weight and shell length (50 mm SL; 30 g BW) in the lowest stocking density tested but this was not significantly different than in mid-density (100 pieces m<sup>-2</sup>). Lowest growth was attained in the highest density (44 mm SL and 21 g BW). Survival and feed conversion ratio were not significantly different among treatments.

To improve growth and taste of abalone meat, hybridization trials were conducted by crossing *H. asinina* with other Philippine native abalones. Two presumptive hybrids were produced - HAFPM (*H. asinina* female x *H. planata* male) and HAFGM (*H. asinina* female x *H. glabra* male). Growth of HAFGM F<sub>1</sub> cohorts and pure *H. asinina* were monitored to determine the characteristics of the offsprings of the hybrid. In terms of body weight, significant increase was estimated to stop at day 315 (18 g) for the hybrid compared with pure *H. asinina* (14 g at day 345). In terms of shell length, both strains stopped growing significantly at 330 days of culture, showing that HAFGM F<sub>1</sub> cohorts had higher SL (4 cm) compared with pure *H. asinina* (3.6 cm).

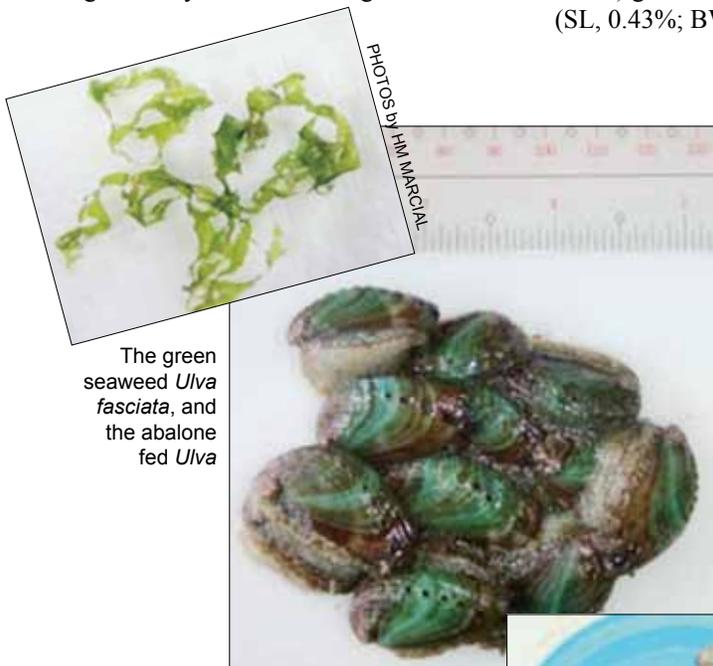
Hybrid abalone juveniles (HAFPM F<sub>2</sub> cohorts) and pure *H. asinina* were stocked in sea-based cages at AQD's Igang Marine Station to compare growth (SGR). After 240 days of culture, the shell length of pure *H. asinina* (0.24% of SL) was comparable to that of HAFPM hybrid (0.2%). But pure *H. asinina* (0.74%) gained more body weight than HAFPM hybrid (0.48 %). Survival of pure *H. asinina* (83%) was also higher than that of the hybrid (74%).

The HAFGM hybrid (SL, 0.36%; BW, 1.2 %) grew slower than pure *H. asinina* (SL, 0.43%; BW, 1.33%) but faster than

the HAFPM hybrid after 120 days of culture. However, survival of HAFGM (95%) was higher than that of pure *H. asinina* (84%).

Sensory evaluation using graphic rating scale was done to assess the quality of cooked abalone meat. The strength and preference of odor of hybrids was not significantly different as those of pure *H. asinina*. In terms of taste/ flavor, the umami taste attribute was slightly pronounced while the body/fullness of taste was slightly strong in hybrids, but these were not significantly different among the strains tested. However, there was a significant difference in the mouthfeel, preference and over-all acceptability of taste among the strains tested, showing that pure *H. asinina* was superior in taste than the two presumptive hybrids.

The visual appearance of the live abalone strains was also evaluated in terms of foot color, surface texture and shell color. The foot color of HAFGM is slightly unpigmented which is not significantly different from that of pure *H. asinina* and HAFPM hybrid that can be described as moderately pigmented. However, the shell color of the strains tested differed, showing pure *H. asinina* and hybrid HAFGM as slightly red while HAFPM as slightly green.



The green seaweed *Ulva fasciata*, and the abalone fed *Ulva*

Taste test for the two new abalone hybrids developed by AQD



Tropical abalone *Haliotis asinina*: (L-R) hybrid F1 *H. glabra*; hybrid F1 *H. planata*; and pure *H. asinina*



# Technology extension for abalone

AQD offered the *Abalone hatchery and grow-out* training course twice in 2011 at its Tigbauan Main Station in Iloilo. The first session was conducted from 29 March to 18 April with 21 participants sponsored by BFAR-RFTC (Philippine Bureau of Fisheries & Aquatic Resources - Regional Fisheries Training Center). The second session was conducted from 7 to 27 July with GOJ-Trust Fund support. This had nine participants coming from Cambodia (1), Thailand (1), and the Philippines (7); three of them were granted fellowships.

In the second session, a new topic (food safety in abalone production) and a new practical activity (planting seaweed, the preferred natural food of abalone) were added in response to the course evaluation made by trainees.

For abalone trainees, the course was quite comprehensive: topics and practical sessions included broodstock management, spawning, larval rearing and grow-out culture in sea cages, among others. [Below] Trainees prepare settlement plates for abalone larvae



[Above] Trainees count diatoms which are natural food given to abalone larvae



Feeding larvae and checking on the settlement plates



Special topics included food safety and seaweed planting. [Left] Trainees check on the seaweed lines at AQD's Igang Marine Station



## Techno-demonstration

In 2011, AQD's commercial abalone hatchery produced 314,937 juveniles (5-8 mm shell length) with total earnings of Php290,395 (US\$6,753).

In addition, AQD's second abalone hatchery -- dubbed a demonstration hatchery because it was built in 2009 to showcase a low cost abalone facility for potential investors -- produced 157,631 juveniles (5-8 mm SL) with total earnings of Php134,803 (US\$3,135).

# Shrimp and mud crab domestication program

The program continued to address the problem of declining supply of good quality broodstock and seed of indigenous crustacean species particularly the tiger shrimp *Penaeus monodon* and white shrimp *P. indicus* and the mud crab *Scylla* species. The approach was improvement of husbandry techniques in all phases of culture: broodstock management, larval rearing, nursery, grow-out and fattening.

For shrimps, studies in 2011 further refined methods in domestication; and for mud crab, studies focused on improving survival and quality of produce from the hatchery, nursery and grow-out. These studies and activities were also linked to the regional program on sustainable aquaculture under the ASEAN-SEAFDEC Fisheries Consultative Group.

## Shrimp

In a collaborative study with UPV funded by \*DOST-PCAARRD, *P. monodon* broodstock from Luzon, Visayas and Mindanao were collected for genetic characterization using microsatellite DNA analysis. Statistical analysis showed that there was no significant difference in the genetic variability among populations from Zambales, Himamaylan (Negros), Casanayan (Roxas), Mabini (Bohol), Puerto Princesa (Palawan), Masbate, Digos (Davao), Butuan, Hinatuan, and Ozamis. Pairwise  $F_{ST}$  estimates among the populations showed that the shortest genetic distance is between stocks from Ozamis and Casanayan (distance = -0.001) and the greatest distance is between stocks from Zambales and Butuan (distance = 0.047).

*P. indicus*  $F_1$  adults that had been reared completely in captivity were stocked with those from other families so that reciprocal matings can occur. At least seven mass pairings involving five families were done to produce  $F_2$ . Twenty batches of  $F_2$  have been produced from reciprocal matings. About 30% of the spawnings did not result in nauplii production because eggs were unfertilized, although the



Biosecure ponds (plastic-lined) where tiger shrimp post-larvae are stocked (left); larval tanks for rearing different families of white shrimp

thelyca were opaque white, indicating that the spawners were mated. Hatching rates greatly varied and ranged from 23 to 92%. Several rematurations were observed, but the number of eggs and nauplii, and hatching rates did not show increasing or decreasing trends with rematuration. During the period when temperatures reached 34°C, larval survival was very low and no maturation was observed.



PHOTOS BY FD ESTEPA

\* DOST-PCAARRD: Department of Science & Technology Philippine Council for Agriculture, Aquatic & Natural Resources Research & Development

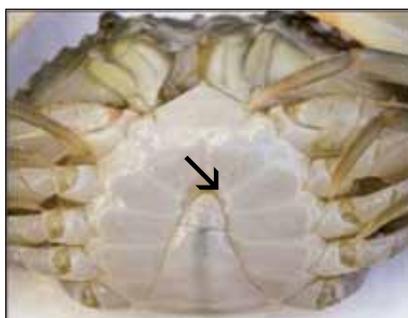
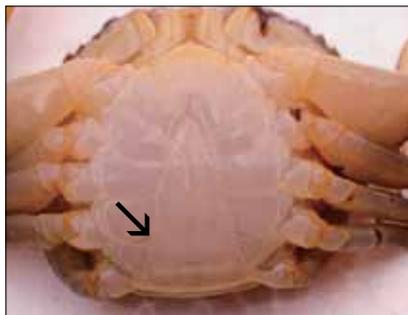
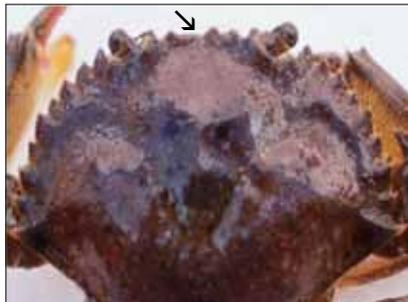
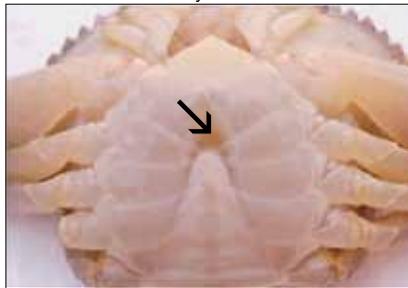
## Mud crab

During larval rearing, the efficiency of formulated feed (FF) in reducing the occurrence of the Molt Death Syndrome -- one of the major causes of mortality at Z5 (zoea) to megalopa, was investigated. Z3 were fed either (1) egg yolk + 2 *Artemia* nauplii ml<sup>-1</sup>; (2) FF + 2 *Artemia* nauplii ml<sup>-1</sup>; (3) FF + 1 *Artemia* nauplii ml<sup>-1</sup>; or (4) 2 *Artemia* nauplii ml<sup>-1</sup> (control). Mean survival at the end of the test (crab instar) were similar in all treatments and ranged from 3 to 5%. Molting rates, as determined by stage indices, were similar in all treatments.

Elevated water temperature (31°C) was used for larval rearing of mud crab to determine if this will enhance molting of zoea 5 to megalopa, and megalopa to crab instar and will reduce incidence of Molt Death Syndrome in Z5 to megalopa stage. Newly molted zoea 5 were reared until megalopa in seawater with constant temperature levels of 27, 29 (ambient), and 31°C. Survival at 27°C was significantly lower than those obtained at 29°C and 31°C. The same trend was observed when megalopae were reared to crab instar in the three test temperatures. Molting rates from zoea 5 to megalopa and megalopa to crab instar had the same trend as the survival.

Enrichment of 3-5 day old *Artemia* before feeding to crab larvae was tested to determine if this will improve performance. Survival rates from zoea 4 to megalopa were compared among larvae fed *Artemia* enriched with SEAFDEC formulation, Selco for 8 and 15 h, or algae (control). Based on two runs, survival was highest in larvae fed *Artemia* enriched with Selco for 15 h followed by those fed *Artemia* enriched with Selco for 8 h. Growth was faster when larvae were fed *Artemia* enriched with either Selco or SEAFDEC formulation than with algae-fed *Artemia*.

PHOTOS by ET QUINTIO



Deformities in crablets caused by the use of antibiotics in the hatchery (from top): depressed abdominal flap, fused frontal spines, gap between sternites, and asymmetrical flap

Experiments were done to determine if survival, growth or occurrence of morphological abnormalities are affected by the use of antibiotics during larval rearing. Zoea 1 to megalopa were treated with different levels of oxytetracycline or OTC (0, 3, 6, 9, and 12 ppm) and furazolidone (0, 0.5, 1, and 1.5 ppm), two antibiotics commonly used in hatcheries. The larvae exposed to 0, 9 and 12 ppm OTC did not reach the megalopa stage. The survival of larvae exposed to 3 ppm (2.8%) and 6 ppm (2.1%) OTC were not significantly different. Growth indices for larvae treated with 3 ppm (5.9) and 6 ppm (5.8) OTC were likewise not different. Zoeae exposed to 0, 1.5 and 2 ppm furazolidone did not survive until megalopa. Survival at megalopa stage was significantly higher in zoea treated with 0.5 ppm (7%) than that in zoea treated with 1 ppm (2%) furazolidone. Growth indices for both 0.5 ppm (5.9) and 1 ppm (5.5) treatments were similar. Morphological deformities such as bent dorsal, rostral and furcal spines were observed in larvae exposed to both OTC and furazolidone.

Crab instar, previously exposed to antibiotics at the larval stage, then grown further for a month showed that survival did not differ significantly between 3 ppm (69%) and 6 ppm (71%) OTC treatments. Growth was significantly faster in crabs previously exposed to 3 ppm (4 g) than 6 ppm (3 g) OTC. The occurrence of deformities was significantly higher in crablets treated with 6 ppm (20%) than in 3 ppm (5%) OTC. For furazolidone-treated larvae, survival did not differ significantly between 0.5 ppm (51%) and 1 ppm (60%) levels. Growth was significantly faster in crabs previously exposed to 0.5 ppm (5 g) than in 1 ppm furazolidone (2 g). Morphological abnormalities such as fused lateral and/or frontal spines, depressed tip of abdominal flap, asymmetrical abdominal flap and gap between sternites were observed. Occurrence of abnormalities was higher in crabs exposed to higher concentrations of OTC or furazolidone.

Dietary tryptophan (Trp) was previously shown to reduce aggressive behavior in juvenile crabs. The effect of feeding high levels of Trp on food intake was investigated this year to determine if Trp can be incorporated in feeds to reduce cannibalism. Crablets (1.5- 2.2 cm ICW), stocked individually in containers, were fed formulated diets (AD) containing 0.32, 0.5, 0.75, 1 and 1.5% Trp at 20% of their body weight per day for 30 days. Feed intake of diets with different levels of Trp was found to be similar in all treatments. Likewise, growth response as assessed through % moltings and molt intervals and increments did not significantly differ among treatments.

The use of tryptophan (Trp) in nursery rearing of mud crab was verified. The level in the diet that gave best results in previous experiments, 0.75% Trp, was used. Crab instars were reared in hapa nets at a stocking density of 50 ind m<sup>-2</sup> for 30 days. Crabs were fed mussel meat (MM), formulated diet (AD) containing 0.32% Trp (0.32 Trp), AD containing 0.75% Trp (0.75 Trp), and MM + AD containing 0.75% Trp (MM+0.75Trp). Survival was significantly higher in crablets fed a diet containing 0.75 Trp (53%) than in those fed diet containing 0.32 Trp (36%) but this was not significantly different from survival of crablets fed MM or MM+0.75Trp.

In another test, crab instars were fed AD containing 0.32% Trp (0.32Trp), mussel meat alternately with AD containing 0.32% Trp (MM+0.32Trp), AD containing 0.75% Trp (0.75Trp), and mussel meat alternately with AD containing 0.75% Trp (MM+0.75Trp). Survival was significantly higher in crabs fed a diet containing 0.75Trp (50%) than in crabs fed a diet with 0.32Trp (36%) but this was not significantly different from survival of crabs fed MM+0.32 Trp or MM+0.75Trp.

The use of formulated growout diet (36.5% protein) is being verified in the polyculture of mud crab with milkfish. After 180 days, a total mud crab biomass of 50 kilos (average body weight, ABW, of 430 g) was harvested with a survival of 13%. Milkfish total biomass was 84 kg

(ABW, 206 g) and survival of 100%.

The potential of freeze-dried marine annelid or sandworm *Perinereis quatrefagesi* meal (SWM) as a feedstuff and replacement for marine protein sources (fish meal, shrimp meal and squid meal or squid liver meal) in juvenile crustacean diet formulations was determined. SWM is high in protein (53%, total lipids (14%) and essential fatty acids (0.4% ARA, 8.6% EPA, 1.2% DPA and 0.6% DHA). For both white shrimp juveniles and mud crab, replacement of 20% of the marine protein sources with SWM did not significantly decrease growth or survival. At lower levels of incorporation (1.5 to 3% of the diet), SWM, squid meal and their 1:1 combination resulted in higher growth in white shrimp and mud crab juveniles compared with the control diet (no SWM and squid meal). Survival was not affected by diets.

The importance of marine annelids or polychaetes is recognized in crustacean broodstock nutrition and management. Thus, techniques for culture of two species are being developed. Wild-sourced juvenile *P. quatrefagesi*, a gonochoric semelparous species (the males and females are distinguishable only when they are sexually mature) commonly found in southern Iloilo, reproduced naturally after four months in aquaria. Among the different diets used, formulated diet fines (feed mill sweepings) or decomposed seaweed *Gracilaria* were better than trash fish or fish hatchery waste. Sandworm total lipids increased from an initial 14% to 18-22% with the n-3 and n-6 HUFA remaining at high levels. Reared in various types of substrates of gravel, layers of corrugated plastic sheets, cheese cloth alone and sand (control), sandworm had higher survival



Set-up for the tryptophan study



Marine annelids: *Marphysa mossambica* (first two above) and *Perinereis quatrefagesi* (bottom)

PHOTOS BY FD ESTEPA

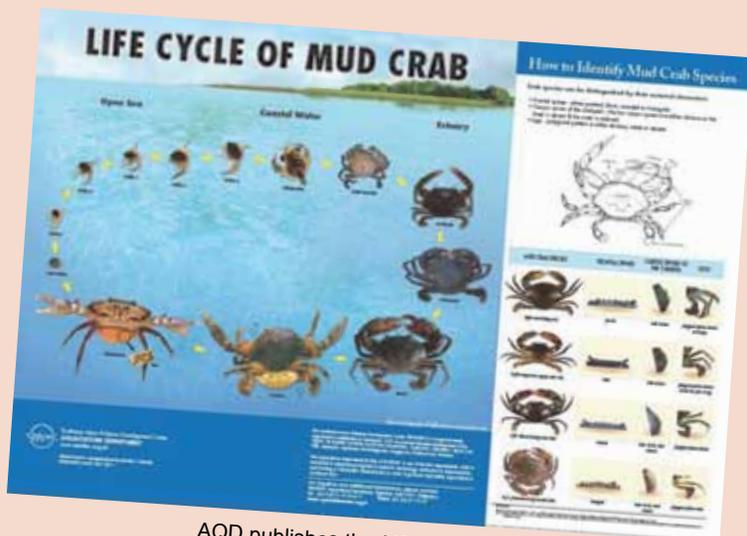
in the sand and gravel substrates. A daily high tide-low tide period was simulated in tanks and this proved to promote higher survival of sandworm than those subjected to minimal water change. Except in non-sand substrate set-up, tanks were provided with stone false bottom to ease draining and flushing of water and minimize build-up of anaerobic products within the substrates.

*Marphysa mossambica*, a large gonochoric iteroparous species (which reproduces annually and exhibits a seasonal pattern of gametogenesis) of marine annelids collected from northern Iloilo, has spawned naturally in TMS indoor tanks provided with unmodified muddy sand substrate. Spawning behavior has yet to be determined in detail, but eggs are fertilized and deposited into the gelatinous mass (jelly cocoon) that is anchored by a stalk at the burrow entrance. Larval development (prototrochophore, early metatrochophore, late metatrochophore and nectochaeta) occurs inside the jelly cocoon and when the stalk breaks, the cocoon wall collapses thus releasing the larvae and juveniles.

# Technology extension for shrimp and mud crab

AQD offered two courses on mud crab in 2011. The *Crab hatchery and grow-out* training was conducted from 27 June to 19 July with funding support from BFAR-RFTC (Philippine Bureau of Fisheries & Aquatic Resources - Regional Fisheries Training Center). There were 25 participants: 23 technical staff of RFTC and two from Vietnam and Korea.

The second training was on *Mud crab culture* conducted from 26 September to 1 October in Chaung Tha, Myanmar, and funded by GOJ-TF and held in collaboration with the Department of Fisheries (DOF). This training had 6 participants from Brunei (3), Cambodia (1), Myanmar (1), Thailand (1); and 11 observers from DOF-Myanmar.



AQD publishes the *Life cycle of mud crab*, a poster by AQD scientist Dr. ET Qunitio

## AQD @Timor Leste



Trainees in Timor Leste try their hand at constructing mud crab cages

AQD through its *Agree-build-operate-transfer* program provided technical assistance to ACDI/VOCA (Agricultural Cooperative Development International Development / Volunteers in Overseas Cooperative Assistance) for a mud crab and fish cultivation project in Timor Leste. In 2011, AQD scientist Dr. Emilia Qunitio was in Timor from 21 August to 3 September to give lectures on mud crab biology, hatchery and grow-out (including aquasilviculture) to 13 staff of ACDI/VOCA and the Ministry of Agriculture & Fisheries (MAF). Practical sessions were also held for 20 MAF staff, coastal community members and crab producers' group. Potential sites for crab hatchery and culture were also assessed.

AQD conducts a crab training in Myanmar



BFAR-RFTC trainees prepare a pond for mud crab (middle) and stock megalopae in hapa nets within a pond

On a beach in Timor Leste, the various mud crab culture systems are discussed



# Marine fish program

AQD has developed several technologies for breeding, seed production, nursery and grow-out culture of various marine fishes that are already adopted by fish farmers. Although these technologies are already working, they are continuously refined to make them more cost-effective. It is also the aim of the program to develop new technologies for new cultivable species.

The specific objectives of the program are:

(1) to improve the technologies for broodstock management, seed production, nursery, and grow-out culture of important marine fishes such as milkfish (*Chanos chanos*), groupers (*Epinephelus coioides*, *E. fuscoguttatus*), Asian sea bass (*Lates calcarifer*), mangrove red snapper (*Lutjanus argentimaculatus*) and rabbitfish (*Siganus guttatus*);

(2) to develop breeding, seed production, nursery and grow-out culture techniques for new fish species of high economic value like snubnose pompano (*Trachinotus blochii*), scat (*Scatophagus argus*) and Napoleon wrasse (*Cheilinus undulatus*);

(3) to develop polyculture techniques in ponds for saline-tolerant hybrid red tilapia (*O. mossambicus-hornorum* hybrid x *O. niloticus*) with other appropriate fish species, and polyculture of milkfish with crustaceans such as crabs; and

(4) to develop practical feed for Barbour's seahorse (*Hippocampus barbouri*) broodstock.

The studies are conducted in the laboratory, fish broodstock & hatchery facilities at AQD's Tigbauan Main Station (TMS), brackishwater ponds in Dumangas Brackishwater Station (DBS), and in floating net cages in Igang Marine Station (IMS).

Milkfish harvest at AQD's Igang Marine Station; pompano harvest at AQD's Dumangas Brackishwater Station



Photo by RM COLOSO

## Broodstock development / management

For pompano, a new high-value species with aquaculture potential, successful spawning in captivity has been observed in 2010 but it was not consistent. During hormone-induced spawning, the response of both sexes was variable, and often, egg fertilization rates were low, indicating that the present hormonal therapy to induce spawning needs improvement. With the possibility that sperm quality may be the cause of low fertilization, 10 male fish were implanted with 3 mg kg<sup>-1</sup> methyl testosterone. The males will be used in subsequent spawning trials.

Scat (*Scatophagus argus*) is another new species for aquaculture with high economic value. Very little is known about the reproductive biology of this species; and as such, developing a captive breeding technology is the primary objective. Immature stocks taken from the wild are presently held in a brackishwater pond and periodically sampled to check for sexual maturity. From the latest sampling, 7 maturing females having oocytes with diameter of 0.1-0.21 mm were observed. However, there were no milting males.

Like pompano and scat, Napoleon wrasse is new to aquaculture and economically valuable. As it is listed under CITES\* as “threatened”, the work on broodstock development is to provide the seed for stock enhancement. The wrasse spawns spontaneously in captivity; the problem, however, is the very low fertilization and hatching rates of eggs. The current sex ratio of 7:1 (female:male) is probably one of the causes. More males have to be collected while broodstock nutrition needs to be studied. For the latter, nutritional supplements (combination of vitamin C, beta-carotene, arachidonic acid) were given to broodstock to improve egg fertilization and hatching rates.

\*CITES, *Convention on international trade in endangered species of wild flora & fauna*

\*\*ARA, arachidonic acid

AQD formulates feed for milkfish raised in sea cages

## Seed production

To improve larval survival, disinfection of grouper eggs prior to incubation was tested. In one trial, eggs were either treated with 25 ppm of 10% povidone iodine or not at all, and the hatched larvae reared in 3-ton tanks. After 45 days, the mean survival of larvae in the iodine-treated group was 1%; and in the untreated, 0.57%.

Although milkfish fry production in the hatchery has significantly improved over the years, AQD continued to make refinements. The approach are two-fold: (1) improving the nutritional quality of the broodstock feed by the addition of more micronutrients, and (2) improving the quality of live feed during the first feeding period. Micronutrients like phospholipids, beta-carotene, vitamins E and C are added to the broodstock feed and their effects on the quality of the eggs and fry are evaluated. In milkfish broodstock that were fed fortified diet containing beta carotene, ARA\*\* and Vitamin C, the eggs had slightly better fertilization rate (51%) compared with control (48%). The percentage normal larvae was also slightly better (93% against 91%).

During larval rearing, larvae were fed rotifers enriched with SEAFDEC-formulated emulsions BR1 and BR2. After 25 days, survival of fry fed rotifer-enriched BR1 and BR2 were 41% and 47%, respectively. In another trial, survival was higher in larvae fed enriched rotifers (41%) compared with those fed un-enriched rotifers (33%).

Larval rearing for Napoleon wrasse has been found to be difficult. Though a big fish, its eggs (0.54-0.57 mm) and larvae (1.4-1.8 mm in length) are small. An appropriately-sized live food needs to be found for the small fish mouth, starting with a feed mixture of egg proteins, squid meal, *Spirulina* and beta-carotene.

## Nursery

Fingerling production of the Asian sea bass (0.51 g, 3.5 cm) was tested in net cages set in ponds with the fish fed commercial feeds with 46-48% crude protein and 12-14% crude fat. After 4.5 months of culture, the fry grew to an average weight of 59 g and length of 16 cm. Survival (30%) was low due to an infestation of an ectoparasite *Caligus* sp., in the first month of culture.

For grouper *Epinephelus* sp., fingerling production was tried in net cages in ponds using two formulated feeds containing 47% (feed A) or 53% (feed B) crude protein. Two batches of fry were used: small (0.8 g, 3.1 cm) and big (1.4 g, 4.2 cm). After two months of culture, the small fry grew to similar sizes in both feed groups (25-26 g, 10-11 cm) though survival in feed A was slightly higher at 10% compared with feed B at 7%. With the big fry, feed A seemed better in terms of survival (18% against 14%) though the final average weight (30-33 g) and length (12 cm) were not far apart. As in previous experiments, it was also observed that mortality was minimal after grouper reached 10 g, indicating that cannibalism may have eased at this size.

## Grow-out

The first experiment in 2011 on testing the milkfish diet with the optimum levels of fish meal, soybean meal, and soy protein concentrate based on previous results has been completed. Juvenile milkfish (average body weight 40g) were stocked (20 m<sup>-3</sup>) in floating bamboo net cages (two units of 10 x 10 x 3 m cage) at AQD's Igang Marine Station. Milkfish were fed SEAFDEC-USB floater diet (diet 1) or commercial milkfish floating starter feed (diet 2) at 5-2.5% of the body weight per day, thrice daily at 0800, 1200, and 1600 H. After 135 days of feeding, milkfish fed diet 1 had average body weight (ABW) of 484 g; weight gain (WG) of 1129%; feed conversion ratio (FCR) of 2.08; and mortality of less than 1%. Milkfish fed diet 2 had ABW of 249g; WG of 461%; FCR of 3.45; and mortality of less



than 1%. The differences in ABW, WG, and FCR were significant. Milkfish fed USB diet were harvested in two batches in November and December 2011. Milkfish fed the commercial diet were fed until they reached about 400g (in January 2012). Seawater analysis around the cage site showed normal levels of ammonia-N, nitrite-N, and phosphate-P, but elevated levels of sulfide were observed towards the end of the culture period. Sediment and fish samples are being analyzed.

To improve the intensive grow-out culture of Asian sea bass in brackishwater ponds, the use of SEAFDEC-formulated feed with higher energy level was investigated. Unfortunately, the stocks became infected with VNN (viral nervous necrosis) that caused them to grow slowly. After 180 days of culture, VNN-positive stocks weighed only 214 g compared to normal stocks that weighed 345 g (average weight of all VNN-negative runs). Heavy mortalities were also observed during the early stage of culture (1-3 inches body length).

The AQD grow-out feed formulated for pompano was compared with commercially available feeds in a verification study in ponds. Pompano juveniles with initial average body weight of 71 g and average total length of 17 cm were stocked in poly-green net (0.5 in mesh size) cages (5 x 5 x 1.5 m) at density of 5 fish m<sup>-3</sup> and fed SEAFDEC feed A (46-47% CP; 12% CF) and feed B (41-42% CP, 12% CF), or a commercial feed (feed C). After 45 days, pompano reached an average body weight of 142 g, 140 g and 153 g when given feed A, B and C, respectively. Fish average length were the same for all feed type (21 cm).

Intensive production of red tilapia hybrid (*O. mossambicus-hornorum hybrid* x *O. niloticus*) and siganid (*Siganus guttatus*) was done in brackishwater ponds. A total of 8,760 pieces of red tilapia hybrid fingerlings (9 g, 8 cm) acclimated to 35 ppt were stocked in two compartments (A and B). The stocks were fed 3x a day with SEAFDEC-formulated feed at 6% of fish

body weight (BW). Feeding was adjusted to 4% after the fish attained 100 g BW, and finally at 2% when they reached 200 g BW. After 4.5 months, the stocks in compartment A weighed an average of 476 g and measured 27 cm whereas the stocks in B were 397 g and 25.4 cm. Survival was 83% in compartment A and 48% in B.

In the same two compartments, 4,380 pieces of siganid fingerlings (8 g, 7 cm) were also stocked in each. Fish in compartment A were fed a combination of 80% SEAFDEC-formulated feed and 20% veggie scraps. The veggie scraps was given *ad libitum* whereas the formulated feed was given at the same feeding rate as in red tilapia. The fish in compartment B were fed only SEAFDEC feed. After 4.5 months, fish in compartment A had an average weight of 178 g and average length of 18 cm whereas fish in compartment B weighed 183 g and measured 19 cm. Survival rate was 96% in compartment A and 85% in B.

#### Other studies

The study on the digestibility and effective level of meat & bone meal (MBM) in formulated feed for milkfish grown in freshwater (FW) and seawater (SW) was continued. The optimum level of MBM for good growth and survival of milkfish fingerlings without histological changes in the liver, muscle and intestine was verified in fish grown in FW. A control diet and five test diets were formulated to be isonitrogenous (37% CP) and these were fed to triplicate groups of milkfish (<5 g) stocked at 15 fish per 250-liter tanks. The control feed (feed 1) had no MBM while feeds 2, 3, 4, 5 and 6 contained MBM at 7.5%, 15%, 22.5%, 30% and 37.5%, respectively. These levels of MBM replaced fish meal protein in the control diet from 14.4%, 28.8%, 43.2%, 57.6% and 72%, respectively.

Milkfish accepted all the test diets. Survival in all treatments was 100% until termination of feeding on the 12<sup>th</sup> week. Milkfish fed the highest level of MBM (37.5%) had significantly low % weight gain (WG=353%) and specific growth rate (SGR=3.2) compared with the control feed (WG=669%). Milkfish given feed 3 (15% MBM) and feed 5 (30% MBM)

have WG and SGR that were similar with control feed. The FCRs and hematocrit (% red blood cells) levels were not different except for feed 6 (37% MBM) which was significantly the lowest. The hepatosomatic index and viscerasomatic index were the same in all treatments.

The apparent digestibility of MBM in both SW and FW were determined in sub-adult milkfish (60-90 g). Preliminary results showed that MBM protein was more digestible in SW (94-98%) than in FW (70-61%). Increasing dietary level of MBM from 7.5% to 30% seemed to decrease diet apparent protein digestibility in FW unlike in SW where this remained stable at about 95%. The assimilation efficiencies of diets with different levels of MBM in both FW and SW were similar and seemed to decrease as dietary MBM increased. The control diet, however, was assimilated by milkfish in FW at 94% while it was only 67% in SW. Dietary crude fat was highly assimilated in FW.

For better health management, the immune response of Asian sea bass to the parasite *Amyloodinium*, including the expression of immune-related genes, was investigated. Healthy sea bass fry from AQD marine fish hatchery were maintained in parasite-free, bio-secure facility; while naturally infested larvae/juveniles were collected from infested facilities for co-habitation with healthy fish. The parasite was allowed to complete its life cycle in tanks to produce free-swimming infective dinospores. These dinospores were used to infect 10 g seabass so the fish could serve as inoculum source.

To determine if the parasite could live indefinitely by *in vivo* passage, infested fish were co-habitated with naïve fish. Fish that died due to cause-specific parasite infestation were removed and replaced with new recipient fish. Preliminary intra-specific pathogen transmission trials were conducted by artificially infecting seabass with naturally infected rabbitfish. Tomonts were isolated from the mucus and counted to quantify the degree of infestation.

In a separate experiment, the number of inoculated dinospore was quantified to determine the 50% endpoint and host response parameters.

## Notes on climate change research for marine fish

Climate change is already affecting the planet in many ways. Certainly, this will have an impact on fisheries and aquaculture but specifically how this will affect aquaculture and impact on the fish farmers are still unclear. Cognizant of the seriousness of the problem, AQD initiates an investigation that looks at the effect of increasing rearing water temperature and acidity on the reproductive performance and early development of some important tropical cultured fishes.

The effect of elevated water temperature (29, 31, 33°C) on embryonic development was examined in newly-fertilized eggs of milkfish and Asian sea bass. Eggs of both species exposed to 33°C showed signs of deterioration roughly 5-6 hours from the start of incubation, and aborted embryonic development was observed in most eggs as incubation time progressed. The few eggs that hatched in 33°C were mostly abnormal larvae (curved). Aborted embryonic development was also observed in eggs incubated at 31°C but not as much compared with those incubated at 33°C. Normal embryonic development and hatching were observed in eggs incubated at 29°C.

The effect of elevated water temperature on early larval performance was also examined. Newly-hatched larvae of milkfish and Asian sea bass were reared for 10 days in 250-liter fiberglass tanks at water temperatures of 29, 31 and 33°C, and following SEAFDEC larval rearing protocols. Results from preliminary runs on both milkfish and sea bass showed very much reduced survival of larvae after 10 days of rearing in the test temperatures. Milkfish fry survival in 31°C and 33°C were 1 and <1%, respectively, compared with 21% in ambient or 29°C. For sea bass, survival after 10 days of rearing at 33°C was 6% whereas at 29°C it was 61%.

### AQD publishes two flyers

- SEAFDEC/AQD responds to climate change through responsible aquaculture
- Pilot project on milkfish cage culture as livelihood option for Guimaras fisherfolk



## Technology extension for marine fishes

AQD conducted three sessions of its training on *Marine fish hatchery*. Funded by BFAR-RFTC (Philippine Bureau of Fisheries & Aquatic Resources - Regional Fisheries Training Center), the first session was from 19 May to 24 June 2011 with 21 participants composed of 20 RFTC technical staff and one privately sponsored Iranian national.

Funded by GOJ-TF, the second session was conducted 20 June–26 July with 10 participants from Cambodia (1), China (2), India (1), Singapore (3), Sri Lanka (1), and Philippines (2). Of the 10, three from Cambodia, Philippines and Singapore had GOJ-TF fellowships, one from Sri Lanka was funded by FAO-Colombo, two from China were on a cost-sharing scheme between AQD and FFRC, and the other participants from India, Singapore, and Philippines were privately sponsored.

The third session was conducted 14-30 September at the request of an entrepreneur from Davao City, Philippines.

AQD also offered courses on:

(1) *Milkfish farming* which was funded by FAO-Kiribati and held 26 September to 10 October. In addition to two Kiribati nationals, a Filipino joined the training

(2) *Pond / cage culture of selected marine species* was conducted at the request of a U.S. national who was joined by a Filipino entrepreneur. The course was held 5-15 December

(3) *Milkfish culture in floating cages* was held 25 February for members of a people's organization called KAMAMADO ("Katilingban sang magagmay nga mangingisda sa Dolores") in Nueva Valencia, Guimaras, Philippines

Furthermore, AQD scientists served as resource speakers to the *Technology forum on high-value species, climate change and marine mammal stranding response* that was organized by DA-BFAR Region 2 and RFTC-Aparri. The forum was held 3-4 May in Tuguegarao City in northern Philippines.

### AQD hatchery production

AQD's two marine fish hatcheries produced more than 75 million eggs and newly hatched larvae and nearly 6 million fry and fingerlings. The bulk was milkfish but also included tiger grouper (*E. fuscoguttatus*), rabbitfish, seabass, pompano and red snapper. These were either used in marine fish studies or sold to the private sector





Trainees in the GOJ-TF funded marine fish hatchery course collect milkfish eggs; trainees from BFAR-RFTC assess fish condition; and milkfish farming trainees monitor water quality in a fishpond in Iloilo



AQD's feed mill staff now use the new extruder machine and vibration fluidized bed dryer



### Expanded feed mill

AQD expanded its pilot feed mill and officially inaugurated it on 22 June. At capacity of 300 kg of feeds per hour, the (new) extrusion machine (for floating feeds) and the (old) pelletizer (for sinking feeds) have doubled AQD's capacity to mill diets for its verification & demonstration studies. In 2011, more than 116 tons of feeds were produced: milkfish feeds (78 tons), tilapia (14 tons), seabass (7 tons), pompano and snapper (<5 tons each), grouper (2.5 tons), siganid (2.3 tons), shrimp & prawn (1.4 tons), mudcrab (450 kg) and abalone (64 kg). Four commercial milkfish hatcheries in Iloilo, Negros and Luzon are also supplied AQD-formulated broodstock diets. All the diets are based on AQD's decades-long R&D on fish nutrition and feed development.

### Fish kill

A *Fish kill forum* was held on 5 August in Quezon City by the University of the Philippines and AQD with funding from PCAMRD and DA-BFAR. Representatives from the academe, government and the private sector listened to reports on fish kills in Taal and other freshwater lakes and in the sea cages off Bolinao, Pangasinan. The conclusion was that all the studies on carrying capacity of bodies of water will still be useless if local governments cannot enforce the agreed-upon limits for cage and pen operations, and if fishfarmers continue overfeeding.

AQD also conducted a briefing on the ecological status of Tagabuli Bay in southern Philippines to warn the community of a fish kill should ecological limits be disregarded. This was done 13 August in Digos City, Davao del Sur.

PHOTOS by the UNIVERSITY OF THE PHILIPPINES



# Seaweed strain improvement program



PHOTOS BY MRJ LUHAN

The program addresses decreasing industry production by developing new strains that seaweed farmers can use to replace poor quality seedstock. AQD has so far established and optimized conditions for the isolation of protoplasts (and spores) from the green seaweed *Kappaphycus*, and is working on optimizing the conditions for regenerating or growing isolated protoplasts in the laboratory and in the field (ie. sea cage culture trials). In 2011, studies were also done on the use of *Gracilaria*, *Kappaphycus* and *Caulerpa* as biofilters and the antibacterial activity of extracts from *Kappaphycus* and *Eucheuma*.

Conditions for the isolation of protoplasts from *Kappaphycus alvarezii* and *K. striatum* were optimized, after which the regeneration of isolated protoplasts was observed in liquid and semi-solid medium. The effects of plant growth regulators on protoplast regeneration were also determined. After eliminating bacteria and ciliate contamination, different mannitol concentrations, PGR (plant growth regulator) and fertilizers were tested. Results showed that higher concentration of mannitol was more effective in maintaining stability of the cell membrane. The use of PGR gave higher survival after two weeks of protoplast culture.

For the nitrogen uptake study of *Gracilariopsis heteroclada* and *Caulerpa lentillifera*, a second run using *G. bailinae* was done. Results showed that total ammonia and ammonium in the water were reduced by 80% and almost 95% after 1h and 2h, respectively; and these remained low or undetectable after 6h.

The capacity of *G. heteroclada* to absorb dissolved nutrients in an intensive white shrimp (*Penaeus indicus*) culture system was also tested. Shrimp (3-15 g; 980 pieces) were raised in 100-ton tanks with its waste water channelled into a sedimentation tank before going into seaweed tanks (60-L) at different flow rates (0-5 changes day<sup>-1</sup>). Water samples in the inlet (water coming into the seaweed tanks) and outlet (out of the tanks) were

collected daily for 5 days for dissolved nutrient analyses. Dissolved inorganic nitrogen (ammonia, ammonium, nitrate and nitrite) in the inlet ranged from 4.65-5.92 ppm, while total phosphate ranged from 1.04-1.43 ppm. Dissolved inorganic nitrogen in the outlet ranged from 0.45-1.37 ppm, while total phosphate ranged from 0.10-0.69 ppm.

*Kappaphycus alvarezii* var. vanguard was grown for 45 days in a 1 x 1 x 3 m netcage in Igang, Guimaras using two fertilizers [Acadian seaplant (ASL) and sodium nitrate]. Fertilization was by immersion overnight of the seaweed before stocking. Growth and photosynthetic rates between fertilized seaweeds were not significantly different, but gel strength and % carrageenan yield were significantly higher in fertilized than in unfertilized seaweed.

Dissolved inorganic N was derived from nitrite nitrogen (NO<sub>2</sub><sup>-</sup>-N), nitrate nitrogen (NO<sub>3</sub><sup>-</sup>-N) and total ammonia nitrogen (TAN) available in the water. N absorbed from the water and incorporated in the tissue was highest in the seaweed treated with sodium nitrate (25%) but was not significantly different from the N content of seaweed treated with ASL (22%). The amount of N absorbed and incorporated in tissue was also significantly higher in fertilized seaweed than in control.

[FROM TOP] Luxuriant growth of fertilized *Kappaphycus alvarezii* after 15 days; use of light-and-dark bottle technique to determine photosynthesis; and *K. alvarezii* grown in sea cages at AQD's Igang Marine Station

To identify commercially-important seaweeds that could be potential sources of antimicrobial (or bioactive) substances, nine varieties of seaweeds were screened: *Kappaphycus alvarezii* variants barako (Guimaras), giant brown (Zamboanga and Sorsogon), giant green (Zamboanga), tungawan (Zamboanga), and vanguard (Zamboanga), *K. striatum* variants sacol (Calatagan), sacol green (Guimaras) and sacol brown (Sorsogon), and *E. denticulatum* (Guimaras). To date, crude ethanol and water extracts were tested against four fish pathogens -- *Vibrio harveyi*, *V. alginolyticus*, *V. parahaemolyticus*, and *Aeromonas hydrophila* -- and three human pathogens: *Escherichia coli*, *Staphylococcus aureus*, and methicillin-resistant *S. aureus* (MRSA).

Promising results had been observed for ethanol extracts of the vanguard variety of *K. alvarezii* against MRSA.

To develop molecular-based techniques for genetic identification and differentiation of red seaweed species and their variants, DNA needs to be extracted from seaweed tissues first. But extraction was difficult due to the presence of cell wall polysaccharides that co-precipitated with the DNA and the subsequent interference during PCR amplification or with restriction endonuclease digestion. To date, different modifications of the QIAGEN DNeasy Plant Mini Kit protocol have been tested.

One modification was the pre-treatment of fresh and powdered seaweed samples with

different concentrations of cellulase, or a combination of cellulase and proteinase to degrade cell walls. But no significant increase in DNA yield was observed with the addition of enzymes.

Another modification was a flash-freezing scheme which gave distinct, visible genomic bands. So far, genomic DNA extraction had been successful for six varieties of *Kappaphycus* and *Euचेuma*, *Kappaphycus alvarezii* var. barako (from Guimaras), tungawan and vanguard (both from Zamboanga); *K. striatum* var. sacol green (Guimaras) and sacol brown (Guimaras); *Euचेuma cottonii* var. giant brown (Zamboanga and Sorsogon); and *E. spinosum* (Guimaras) Successful genomic DNA extraction was also obtained for *Gracilaria* sp. sample.



## Technology extension for seaweeds and microalgae

AQD conducted a training of trainers on *Seaweed (Kappaphycus) farming* that was funded by BFAR-RFTC and held 26 April–10 May (below, left) at AQD's Tigbauan Main Station in Iloilo. The 21 participants were all staff of RFTC in Albay, Aparri, Cebu, Davao, Palawan, Samar and Zamboanga (Philippines).

In addition, two special courses on *Culture of microalgae* (9 May–10 June) and *Natural food culture* (7-26 July) were organized for two Filipinos.

Seaweed and milkfish farming was the focus of a series of workshops on *Small-scale aquaculture and livelihood ventures* conducted first in Pandan, Antique (below right, with 30 attendees, 26-27 January). The workshop series was organized by AQD with AquaFISH CRSP (a USAID-funded project), BFAR and local government units as sponsors. It featured lectures / practicals on high-value marine fish & updates on milkfish culture; seaweed farming (for men) & value-addition (for women); and gender issues. In addition to Pandan, the workshops in the Philippines were held in Hamtik, Antique; Leganes, Iloilo; Roxas City; Puerto Princesa and Narra, Palawan; and Nueva Valencia, Guimaras. For Indonesia, it was held in Banda Aceh. In each session, about 25 men and 25 women participated, mostly farmers, fishers and housewives.



## Microalgae for hatcheries

AQD produced nearly 68,000 liters of microalgae, mostly used in AQD studies and hatchery operations: *Tetraselmis tetrahele* (64%), *Chaetoceros calcitrans* (26%), *Navicula ramossissima* (7%) and *Isochrysis galbana* (3%). About 218 liters mostly of *Skeletonema tropicum* and *C. calcitrans* were bought by 87 private, university and government hatcheries in the Philippines, Myanmar, Malaysia, Saudi Arabia, Oman and Iran. AQD's larval food laboratory also provided fertilizers, culture media and plankton profiling at minimal cost, earning the phycology lab Php 229,189 (US\$ 5,330) in 2011.

# Aquatic ecology program

This program aims to conduct basic studies on the biology, ecology and culture of various species (eg. sandfish *Holothuria scabra*, imbao *Anodontia philippiana*, and kapis or lampirong *Placuna placenta*) and to generate environment-friendly aquaculture technologies.

## Biodiversity

Rapid assessment and documentation were conducted of the flora and fauna in, on, and around the cages and in the adjoining seagrass beds and rocky islets of AQD's Igang Marine Station and Igang Mariculture Park. Some 438 species in 182 families in 13 major taxa have been collected or photographed.

Different species combinations were found in the three habitats types – the seagrass beds vs the rocky bases of the islands vs the cages and drums. Many species found attached to the cage structures were not found in the other two habitat types. It seemed that cage structures provide additional habitat for attachment of seaweed spores and settlement of planktonic larvae of various sponges, tunicates, bryozoans, molluscs, and other invertebrates that otherwise could not find space in the occupied adjoining habitats. This is a positive effect of aquaculture on biodiversity. The fishes that go in and out of the cages partake of the feeds given to the aquaculture species, but filter-feeding cage-attached species and grazing snails probably remove some of the wasted feeds and feces from the cage. A thick coating of cage biofoulants inhibits good water flow into the cages and add to the biological oxygen demand.

## Bioremediators

An experiment was designed to identify invertebrate species which may be used in an IMTA (integrated multi-trophic aquaculture) system. For the first run, sandfish *Holothuria scabra*, imbao *Anodontia philippiana* and lampirong *Placuna placenta* were reared as follows: treatment 1 = sandfish + imbao + lampirong reared in an open area without cage (no feeding); treatment 2 = sandfish + imbao + lampirong beneath a fish cage right after harvesting milkfish *Chanos chanos* (no feeding); and treatment 3 = sandfish + imbao + lampirong beneath a fish cage rearing snapper *Lutjanus argentimaculatus* (with feeding). Temperature, salinity, pH, DO and sulfide were also monitored. No mortality was observed in sandfish in all treatments until day 7. On day 28, 100% mortality was observed in treatment 3, 25% in treatment 2 and 3% in treatment 1. On weeks 6 and 8, 100% mortality was observed in all treatments. For lampirong, mortality was first observed in treatment 3 after 48 h. No mortality was observed in other treatments until day 14. At week 6, all lampirong in treatment 3 died. Survival of lampirong in treatment 2 continued to drop slowly until week 14 and by week 16, mortality was 100%. Survival of lampirong in treatment 1, however, remained constant from weeks 8 to 22. In imbao, mortality was first observed in treatment 3, 24 hours after the experiment started. Survival was almost stable from the first week to week

12 where treatment 3 had the highest survival among all treatments. However, survival continued to drop afterwards. After 22 weeks of monitoring water parameters, temperature, salinity and D.O. did not significantly differ among treatments with means ranging 26-29°C, 28-36 ppt and 0-6.5 ppm, respectively. pH was significantly higher in treatment 2 at 8.14 compared with treatments 1 and 3 at 8.02 and 8.03, respectively. Sulfide was significantly higher in treatment 3 at 22  $\mu\text{moles l}^{-1}$  compared with treatments 1 and 2 at 1.4 and 1.2, respectively). An increasing trend in sulfide levels was also observed in treatment 3 but constantly low in the other treatments. Sulfide erratically decreased from day 125 due to the movement of cages and the changes in stocks and feeding regimes.

To evaluate growth and survival of sandfish juveniles at different salinity and substrate quality, four types were tested: silty mud (similar to that found in mangrove areas and brackishwater ponds), sandy mud (characteristic of areas where the seagrass *Halodule* thrive), coarse sand (characteristic of a barren sandflat), coral-shell rubble (characteristic of areas where the seagrass *Thalassia* are abundant), and wooden plate with attached algae/diatoms (characteristic of a nursery rearing tank). The experiment on substrate preference also confirmed the daily burrowing and surfacing schedule of sandfish juveniles.

Sandfish and seabass / milkfish polyculture set-up at AQD's Igang Marine Station



Almost all (92-97%) juveniles (4-10 g) tended to burrow in the substrate from 03:00–09:00, and peak feeding hours (>98%) were observed from 18:00 to 03:00 of the next day. Juveniles generally preferred to burrow in sandy-muddy substrates.

Using results from previous experiments on substrate preference of sandfish juveniles, field experiments were conducted in these sites: (1) sandy-muddy substrate at a coastal mudflat in Brgy. Igang; (2) coral-shell rubble at IMS; (3) silty-mud at DBS pond; (4) sandy-mud at same DBS pond, and (5) a control without substrate in TMS tanks. Results confirmed that sandy-muddy substrate has the best potential for sandfish culture and that ponds with sandy-mud have significantly better potential than silty-mud.

The salinity tolerance of sandfish juveniles (8 g) was determined using three levels (15, 20, 25 ppt) with 30 ppt (ambient) serving as control. Twelve sandfish juveniles were stocked in each experimental tub (0.4 m<sup>2</sup> base area) after 48-hour conditioning to ambient salinity. Noticeably, sandfish in 15 ppt showed the most behavioral changes. They remained burrowed and majority only surfaced after 24 h. After 40 h, four individuals eviscerated, while majority responded very weakly when prodded or remained upside-down, indicating stress. Other treatments (20, 25 and control) showed no observable difference in behavior. This indicated that salinity threshold for sandfish is between 15 to 20 ppt.

A 10-week growth trial run of sandfish juveniles was conducted to compare performance in ponds (at DBS) or open sea pens (in IMS). Two 45 m<sup>2</sup> pens were constructed and stocked (35 g m<sup>-2</sup>) with 200 sandfish juveniles (8 g). Accelerated growth (0.27 g d<sup>-1</sup>) was observed in DBS in the first two weeks but then this consistently shrunk until week 10. In contrast, IMS stocks gradually increased in weight (0.3-0.11 g d<sup>-1</sup>) until week 6 before shrinking slowly until week 10. This indicated that natural food in ponds were readily available but were soon consumed by sandfish, while natural

food in the open sea pen can sustain sandfish population longer (6 weeks).

To determine optimal stocking density of sandfish for pond culture, four densities were tested: 50, 100, 200 and 300 g m<sup>-2</sup>. Densities of sandfish at 200 and 300 g m<sup>-2</sup> showed pronounced decline in growth after the first week; sandfish stocked at 100 and 50 g m<sup>-2</sup> showed better overall growth but still showed declining growth after the third week. These indicated that stocking density of more than 200 g m<sup>-2</sup> is not ideal for culture when sandfish depended on natural food alone.

The studies to determine appropriate fish:sandfish ratio and size at stocking using snapper (*Lutjanus argentimaculatus*) were successfully completed. Although the growth, survival and condition of sandfish were good, the stocking density for snapper was too low, resulting in aggressive territorial behavior and causing injuries and eventual mortality, and a wide disparity of size among surviving fish. Sandfish and snapper polyculture seemed possible with the right fish stocking density and routine size-grading.

Polyculture of sandfish with seabass in pens was tried in IMS. About 100 seabass and/or 80 sandfish were stocked in these treatments: (1) seabass only, (2) sandfish only, and (3) seabass & sandfish. After one month of culture, all sandfish in one pen died probably due to the numerous large shrimp found inside the pen. A preliminary study last year showed that shrimp are



[CLOCKWISE] Stocking of 214 giant clam juveniles in Cataan marine protected area in San Joaquin, Antique, west central Philippines; preparation for installing clam nursery cages; and measuring corals at Cataan

PHOTOS by J. ALTAMIRANO

not compatible with sandfish as they walk all over the sandfish, picking at them constantly which irritates them and cause them to eviscerate and die. By the second month, all sandfish in the second pen were lost as well, and by the end of the 4-month study, no sandfish survived perhaps due to poor sediment quality.

The second production run used 5-6 inch milkfish (*Chanos chanos*). For this run, the bottom of the pens was raised to be above the mud, and after one month of culture, survival of sandfish has been much better than the first run. Milkfish growth and survival were also high.

To enhance the hatchery/nursery techniques for sandfish, sites with sustainable sources of sandfish breeders were surveyed. For the moment, AQD focused its broodstock assessment and collection in areas where current and anticipated sandfish projects will be done. These included: (1) south Guimaras (Igang and Lawi); (2) Ajuy, Iloilo; and (3) Sagay, Negros. Genetic characterization of wild sandfish populations from various locations will be done next.

The current practice in AQD's sandfish hatchery is to induce spawning

by temperature shock, in other words, introducing warmer water (3°C higher than ambient) to spawning tanks. Because this was not always successful, a series of techniques that included desiccation and food shock were attempted. A single healthy female (>250 g) may be able to release up to 4 million eggs.

Optimal methods for rearing sandfish juveniles continued to be identified since hatchery survival remained at a low 0.8% until first-stage juvenile (3-10 mm body length). This year, rearing water was made to pass through water filters and UV to keep it clean. However, copepod blooms and infestation of blood worms still occurred in tanks.

For nursery operations, hapas in pond (at DBS) yielded low survival (26%) of sandfish after two weeks, whereas floating hapas (in IMS) showed high survival (93%). A second 8-week run showed growth rate of sandfish at 0.14g d<sup>-1</sup> with 15% survival in pond hapas compared to 0.06 g d<sup>-1</sup> with 74% survival in floating hapas.

### Stock enhancement

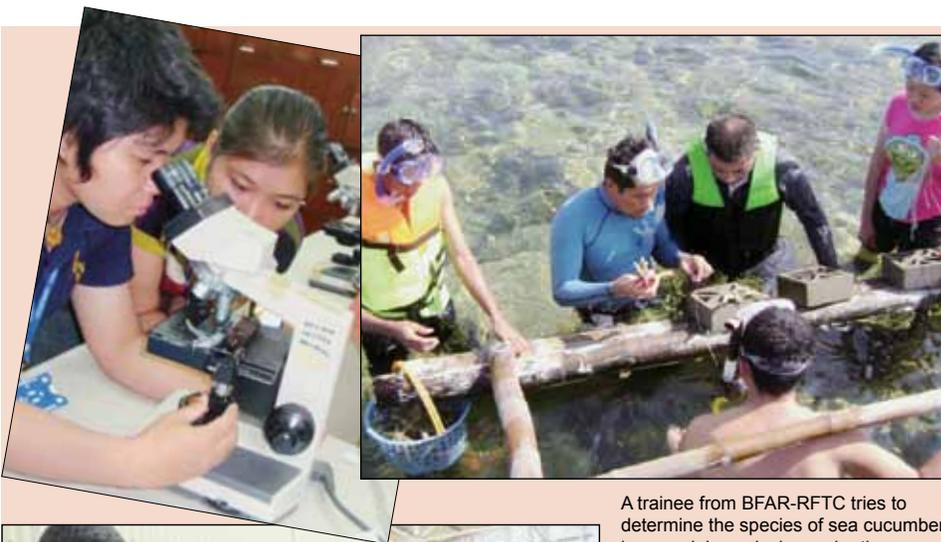
For the stock enhancement of giant clam (*Tridacna* species) in San Joaquin, Iloilo, west central Philippines, three MPAs or marine protected areas namely Tiolas, Cataan, and Lawigan-Igcadlum were assessed for natural populations of clams. All sites had wild clams -- mostly *T. squamosa*, *T. maxima* -- with Cataan having more clams (more than 20) and chosen as the best site to establish a clam ocean nursery. The local people had noted in interviews that large *T. gigas* had been harvested from the area.

For the ocean nursery, four cages (1 x 2 m) were fabricated and deployed in Cataan one week prior to stocking clam juveniles. A total of 214 clams (*T. gigas*, 9-12 cm shell length, SL) from the Bolinao Marine Laboratory of the UP Marine Science Institute were stocked on 26 April. Six clams (3%) died within two weeks attributed to transport and acclimation stress. Another six died after

7 months caused by strong waves of the northeast monsoon. Growth rate of the clams averaged 8.3 mm month<sup>-1</sup> which was similar to wild clams. Monitoring of growth and survival will continue until next year.

In September, 16 bigger clams (>18cm SL) were removed from the cages to reduce overcrowding. Four clams each were deployed at four depths (3, 5, 10 and 15 m) to determine optimum depth for survival and growth. Results after two months showed comparable growth in all depths. This suggested that clams can be deployed up to 15 m, reducing the risk of poaching by free-diving fishers.

Another trial release of 30 clams was done at a reef near the cages. But seven clams had their hard shells torn apart probably by big parrotfish and turtles that may have reoccupied the two-year old protected area. Rearranging the clams (on or between corals or coral rubble) to hide them better seemed to have solved the predation problem.



A trainee from BFAR-RFTC tries to determine the species of sea cucumber by examining spicules under the microscope (above left); trainees of the resource enhancement course do their transect assessment of a coral reef (above)



AQD's sandfish hatchery (above left) in 2011 produced 47,248 juveniles (1-10 mm in size, about 30-45 days old); the juveniles were mostly used for the studies in the aquatic ecology program. Sandfish pens at AQD's Igang Marine Station (right)



Photo by J ZARATE

## Technology extension for aquatic ecology

AQD conducted three courses:

(1) *Seed production and grow-out of sandfish (Holothuria scabra)* which was funded by BFAR-RFTC and held 04-17 May with 23 participants (19 RFTC staff and 4 privately-sponsored including an Australian national)

(2) *Mangrove conservation, rehabilitation and management* organized in collaboration with ZSL (Zoological Society of London) and conducted 25 May – 4 June with 26 participants from the Philippines (24), Micronesia (1) and Vietnam (1).

(3) *Community-based resource enhancement* which AQD offered for the first time. Funded by GOJ-TF, this was conducted 12-20 July with five participants from Cambodia, Myanmar, Philippines (2), and Sudan.

AQD also extended sandfish technology through a presentation of *Environment-friendly technologies: sandfish and grow-out* at the World Trade Center - Manila on 8 October. In addition, basic training on ocular monitoring of ocean nursery cages of giant clam had been given to a marine protected area operations manager in San Joaquin, Iloilo, Philippines.

# Small-holder freshwater aquaculture program

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

## Giant freshwater prawn

Broodstock management schemes were tested to improve the reproductive performance of domesticated giant freshwater prawn (*Macrobrachium rosenbergii*) and the growth of their progenies. Spawning sets composed of specific crosses between similarly aged stocks from Old Calumpit (OC F6) and New Calumpit (NC F2) were placed separately in 2 x 2 x 1 m concrete tanks at 1male: 4females per tank. The following crosses were made -- treatment 1: OCxOC, treatment 2: OCxNC, treatment 3: NCxOC and treatment 4: NCxNC. The breeding scheme, which involved the use of females from one line crossed with males of another line and vice versa, was tested as a method that could minimise any adverse effects of long-term domestication in prawn broodstock. Monthly broodstock performance data (number of berried females, average number of hatchlings, number of broodstock mortalities, average postlarval survival or seed yield and the number of days to PL metamorphosis) are being collected and monitored. The cross that will show the best performance in terms of seedstock production and subsequent growth in tested progenies shall be noted. To date, reproductive efficiency data has already been collected from ten monthly samplings.

Growth trials comparing progenies from all four crosses were conducted in tanks and cages from June to November. It was noted that specific growth rate (SGR) and survival are generally better in progenies from either the OCxNC and NCxOC crosses in both the tank and cage trials. Moreover, the ANCOVA or analysis of covariance on specific growth rate using survival as a covariate showed that SGR differed significantly amongst the progenies mainly in the cage trial.

Another study aims to improve prawn growth and reproduction through nutritional approaches, that is, by the development and adoption of efficient and low-pollution feeds. A second trial was made to determine the effect of partial fishmeal protein replacement with cowpea meal protein in prawn PL and juvenile diets. Prawn PL (0.032 g) stocked at 15 pcs m<sup>-2</sup> in lake

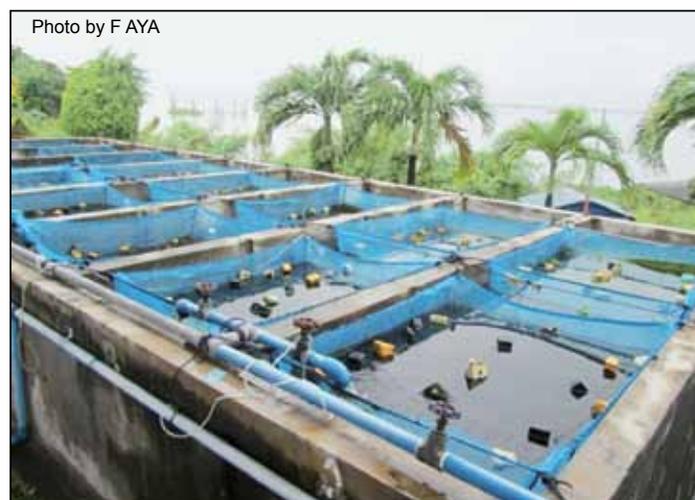


Photo by F AYA



Photo by MLC ARALAR

Land-based nursery for giant freshwater prawn (top); net substrate for a cage study, also for prawn

based 2 x 2 x 1.5 m cages were fed four isonitrogenous diets (27% crude protein) with different levels of protein substitution (0% or control, 15, 30 and 45%). After 29 days of culture, the maximum average body weight varied from 0.65 to 0.76 g and survival was 78-85%.

In another experiment, four isonitrogenous diets (0, 10, 20, and 30%) containing 38% crude protein were offered to 1 male and 4 female broodstock each at 3% of the body weight. Nutrient concentrations in the rearing tanks were found to be generally higher in prawns fed the fishmeal-based or 0% diet (PO<sub>4</sub>-P: 1.50 mg l<sup>-1</sup>; TAN: 0.19 mg l<sup>-1</sup>; NO<sub>3</sub>-N: 1.90 mg l<sup>-1</sup>; NO<sub>2</sub>-N: 1.71 mg l<sup>-1</sup>) than the other diet treatments (PO<sub>4</sub>-P: 1.43-1.56 mg l<sup>-1</sup>; TAN: 0.16-0.19 mg l<sup>-1</sup>; NO<sub>3</sub>-N: 1.57-1.69 mg l<sup>-1</sup>; NO<sub>2</sub>-N: 1.38-1.53 mg l<sup>-1</sup>). The reproductive performance of *M. rosenbergii* showed that broodstock fed 20% cowpea meal-based diet produced better results in terms of number of berried females, weight of eggs/female, and larval survival. The highest average number of hatchlings and shorter time for larvae to metamorphose to postlarvae was observed in 0% and 10% diet treatments, respectively.

Seedstock production for selected freshwater aquaculture species started in early 2011 and included the production of prawn juveniles. *M. rosenbergii* postlarvae

Larval rearing set-up for giant freshwater prawn at AQD's Binangonan Freshwater Station



Photo by F AYA

(PL15) were stocked in tanks and lake-based hapa net cages for secondary nursery rearing to juvenile stage. A rearing trial using different stocking densities (100, 200 and 300 pcs m<sup>-2</sup>) in 2.5 x 1 x 1 m netcages determined the ideal stocking density for nursing prawn. Results showed that after 29 days, no significant difference in mean weight (0.18-0.2 g), survival (74-76%), and feed conversion ratio (FCR, 0.60-0.69) was noted among treatments. As the secondary nursery period progressed further, significant differences in mean weight and FCR were observed. Based on the results, it is suggested that stocking densities of 300 postlarvae per m<sup>2</sup> can be used for the first month of rearing and subsequent reduction in stocking densities should be done to obtain larger juveniles.

PL20 (0.07 g) were stocked in 1 x 1 m hapa net cages in tanks with total substrate area of 6 m<sup>2</sup> per cage at 200, 400 and 600 pcs to determine if increased substrate will allow for higher survival at high stocking densities in the secondary nursery. The abundant substrate allowed for better survival even at double the stocking density used in the first run.

Different grow-out management strategies to improve cage-based production of market-sized giant freshwater prawn were evaluated. When smaller (1 x 1 x 1 m) cages with substrate areas of 0, 40, 80 and 100% of cage bottom were used, results showed that only the feed conversion ratio was significantly better for prawn grown in cages with the highest substrate area. However, survival and yield were not significantly different among treatments.

Another trial using bigger cages (16 units of 4 x 4 x 1 m hapa net) and bigger substrate area was conducted. Mean prawn size at stocking was 0.23 g. The following treatments with four replicates were used: HS16 (with 16 m<sup>2</sup> additional substrate), HS 32 (with

32 m<sup>2</sup>), NS (no substrate) and NSH (no substrate and half of the stocking density of the other 3 treatments). The 16 m<sup>2</sup> and 32 m<sup>2</sup> substrate area are equivalent to 100% and 200% of the cage bottom area, respectively. After 189 days, no significant difference in mean final weight and growth rates was observed in the S16, S32, and NSH though these were all higher than NS. Feed conversion ratio was also significantly higher in S16 and S32 compared to NS and NSH. No difference in survival in all treatments was observed. Provision of substrate improves prawn production in lake-based cages making higher stocking densities possible. However, increasing the substrate area from 100% to 200% did not improve production significantly.

To improve growth and other production traits, the claws of male prawn were ablated from the ischium of the cheliped on the second month of culture. However no significant difference in growth, growth rate, survival, FCR, and yield was observed between ablated and unablated prawns.

## Tilapia

To identify which among the currently available species/strains of tilapia are suitable for brackishwater culture, studies were conducted in tanks and ponds to compare traits such as growth, survival, and fillet yield. Results of two consecutive four-month experiments showed that both the red and Nile tilapia species generally had better growth (average weight gain = 15 g for Nile tilapia for the first run; 6.4 g for red tilapias for the second run) and morphometric traits than the Mozambique tilapia stocks. Mozambique tilapias, known to be the most saline tolerant, had the highest survival in brackishwater (100% and 90% for runs 1 and 2, respectively). Similar trends were observed when the same species were reared in cages within a brackishwater pond.

Recently, two stocks of the BEST strain tilapia from BFAR (Philippine Bureau of Fisheries & Aquatic Resources) were procured and will be used in growth comparison trials.

Co-culture of tilapia and giant freshwater prawn using SEAFDEC-formulated diets are being verified in 5 x 5 x 2.5m cages in a freshwater reservoir in Dingle, Iloilo. Freshwater prawn (average body weight, ABW: 6.7 g) and Nile tilapia (ABW = 3 g) were reared in a polyculture system by feeding them the test diet (SEAFDEC-formulated) and a commercial feed. Six netcages were stocked with prawn PLs and tilapia at 15 pieces m<sup>-3</sup>, respectively. After 109 days of culture, tilapia was harvested while the prawn was harvested a week later. Results showed that tilapia stocks fed the SEAFDEC diet (1.7 g day<sup>-1</sup>) grew better than those fed the commercial diet (1.56 g day<sup>-1</sup>). Survival was similar, about 87% for both diets. For prawns, feeding SEAFDEC or commercial diet was not significantly different (0.15 vs. 0.14 g day<sup>-1</sup> growth rate). Survival for prawn was higher in SEAFDEC diet at 64% compared with 60% for the commercial diet.

### Indigenous freshwater species

Domestication and evaluation of the culture potential of an indigenous freshwater prawn species known as *Macrobrachium lar* is being conducted with funds from AQD and the National Research Council of the Philippines. *M. lar* samples were collected from Pilar, Sorsogon and brought to AQD. Newly hatched larvae from wild-sourced berried females were reared in 6, 12, 18 and 24 ppt brackishwater to determine the ideal salinity for larval rearing. Poor survival was noted in all salinities although larvae reared in 24 ppt were noted to have survived until the zoea IV stage.

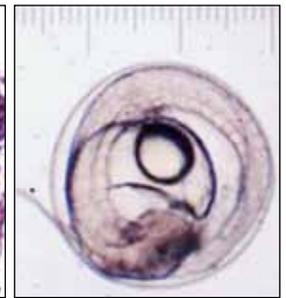
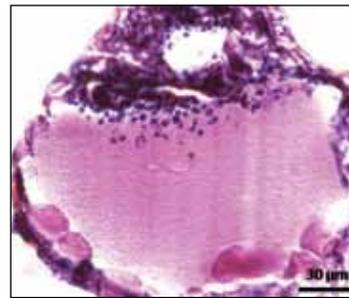
In a separate experiment, larvae reared in 30 ppt using a commercial salt formulation (Biomix) survived for 3 days while those reared in CAUNESP (Centro Aquicultura de Universidade Estadual Paulista, Brazil) formulation reached PL after 48 days of rearing. Only two individuals survived to PL stage.

Meanwhile, mean production of 502 pieces of stage I zoea g<sup>-1</sup> female was observed from existing *M. lar* broodstock. In the hatchery, it took 39-50 days before

postlarvae were obtained from two batches of hatchlings. However, PL survival was very low at 0.1-0.025%.

The breeding and larval rearing methods for several locally important fish species that have aquaculture potential are currently being studied for purposes of propagation. Studies on the artificial spawning and larval rearing of the silver therapon, *Leiopotherapon plumbeus* (Kner 1864) have been conducted. Broodstock (1female:2 males) were induced to spawn in tanks using 50 IU hCG g<sup>-1</sup> body weight. Fertilized eggs were reared in 1-liter beakers or 10-liter aquaria at 27°C. At hatching, silver therapon larvae measured 2.3 mm total length. Histological sections of larvae showed that yolk is completely resorbed two days after hatching. Mouth gape size at first feeding was 160 µm. Ciliated protozoans and microalgae have been given as larval food, but therapon larvae did not thrive on them.

The reproductive biology of the climbing perch, *Anabas testudineus*, was likewise studied. Mean ovarian gonadosomatic index (GSI) in the climbing perch was noted to peak from March (9%) until May (11%) and again increased in July (8%) through August (6%).



[FROM THE TOP] Larval rearing set-up for silver therapon; histological section of newly hatched therapon larvae showing yolk sac; therapon embryo 20 hours post-fertilization; newly-hatched therapon larvae; and adult therapon

Photos by F AYA

Mean testicular GSI was two- to three- fold lower than the ovarian GSI. Testicular GSI values were noted to fluctuate as an increase was observed in June (2%), declined briefly in July (0.6%) and then peaked in August (5%). Mean oocyte size was notably large in May until July (521-564 µm). The oocyte size composition of the posterior, middle and anterior regions of the vitellogenic ovary revealed a single clutch of ovaries (diameter: 351-450 µm), suggesting group synchronous development of the oocytes.

# Technology extension for freshwater aquaculture

AQD organized five courses in 2011:

(1) *Community-based freshwater aquaculture for remote rural areas of Southeast Asia* which was funded by GOJ-TF. Conducted 22 November –1 December at AQD's Tigbauan Main Station in Iloilo, had 10 participants coming from Cambodia (1), Indonesia (1), Lao PDR (1), Malaysia (1), Myanmar (1), Thailand (1), Philippines (2), China (1), and a student intern from Spain. Of the 10 participants, eight had GOJ-TF fellowships.

(2) *Freshwater prawn hatchery and grow-out operations* which had three sessions conducted at AQD's Binangonan Freshwater Station (BFS) in Rizal. The first, 21 March-1 April, had seven participants from four countries (Cambodia, Indonesia, Malaysia, Philippines) and was GOJ-TF supported. The second session, 22-26 August, had four private sector and LGU participants from the Philippines. The third, 7-11 November, was funded by the WorldFish Center and had 16 participants.

(3) *Tilapia hatchery and grow-out operations* which was held 15-19 August at BFS for a private sector participant

(4) *Selected topics on fish breeding*, which was funded by Meralco Foundation (MFI) and held 21-23 January at BFS with 31 student-participants

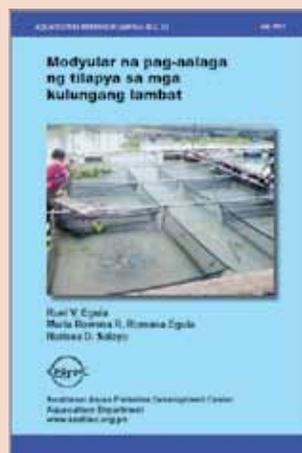
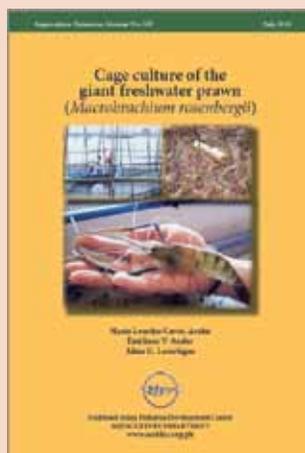
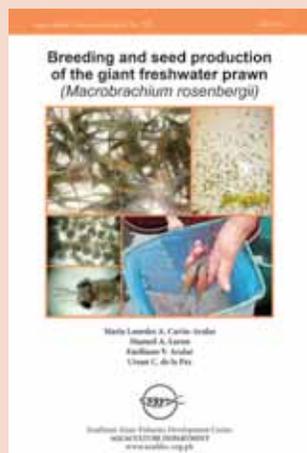
(5) *Fish culture management*, also funded by MFI and held 21-23 February at BFS for 31 student-participants



[TOP] Stocking of giant freshwater prawn in LMPC (Lunsad multi-purpose cooperative) cages in Binangonan, Rizal which was accompanied by a training on prawn culture. AQD also assists LMPC in their monthly on-farm monitoring [LEFT] A lecture on prawn biology as part of the hatchery & grow-out course

## AQD published two manuals on giant freshwater prawn and a manual on tilapia modular cage culture

- (1) *Breeding and seed production of giant freshwater prawn (Macrobrachium rosenbergii)* by MLA Cuvin-Aralar, MA Laron, EV Aralar, UC de la Paz
- (2) *Cage culture of giant freshwater prawn (Macrobrachium rosenbergii)* by MLA Cuvin-Aralar, EV Aralar, AG Lazartigue
- (3) *Modyular na pag-aalaga ng tilapia sa mga kulungang lambat* [in Filipino] by RV Eguia, MRR Romana-Eguia, ND Salayo



Photos by JD DEAUNA

[RIGHT] Trainees at their practical sessions, counting the number of prawn postlarvae, and trying their hand at making a net for cages

## AQD @Lakecon 2011

AQD cooperated with PCAMRD (Philippine Council for Aquatic & Marine Research Development) in the organization of the *Second national congress on Philippine lakes*. With AQD chairing the technical secretariat, the congress was held 27-29 April in Los Banos, Laguna.

Tilapia tanks at AQD's Binangonan Freshwater Station which is right by Laguna de Bay



Fish cages in the Philippines' largest freshwater body Laguna de Bay, northern Philippines

## Techno-demonstration

As research by-products, AQD was able to produce (1) giant freshwater prawn postlarvae valued at Php270,675 (US\$ 6,295); (2) Nile and red tilapia swim-up fry or fingerlings that were sold for Php542,154 (US\$12,608); (3) bighead carp fry / fingerlings sold for Php114,545 (US\$2,663).



Larval rearing area for freshwater prawn (above left) and hatching tanks for bighead carp



[BELOW] In the GOJ-TF funded course on community-based aquaculture, a trainee from China interviews a resident to make a 24-hour activity map (left top); trainees and their mentor discuss livelihood opportunities for a riverside village in Dumarao, Capiz (left bottom).

A fisher in the Dumarao, site of AQD's training on community aquaculture



# Sustainable aquaculture

The Government of Japan Trust Fund (GOJ-TF) is implementing four projects under the ASEAN-SEAFDEC Fisheries Consultative Group (FCG) Mechanism. Year 2011 is the second year of the 5-year project cycle.

The first project, **Promotion of sustainable and region-oriented aquaculture practices**, aims to promote sustainable aquaculture practices in Southeast Asia and help countries secure a stable supply of aquaculture products for consumption or for export. 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 & demonstration.

The following were major outcomes in the sustainable aquaculture project in 2011:

- The exposure of mud crab *Scylla serrata* zoea 1 in 30 and 40 ppm formalin solutions for 3 hours proved to be a good method for batch quality assessment. Since dose-dependent cumulative mortality was confirmed by injection of luminous bacteria *Vibrio harveyi* in the range of 0-10<sup>8</sup> colony forming unit or CFU ml<sup>-1</sup> to crab juveniles, the challenge test using *V. harveyi* could also be an effective method for quality assessment.
- The challenge test using *V. harveyi* for black tiger shrimp *Penaeus monodon* juvenile (2-3g) gave a computed median lethal dose of 4.2 x 10<sup>5</sup> CFU shrimp<sup>-1</sup>, showing that this test could be effective for quality assessment of both shrimp and mud crab.
- A broodstock management scheme -- comprising of (a) reciprocal mating where males from line one will be paired off with females from the other line and *vice versa*; and (b) frequent

broodstock replenishment -- was used to improve or minimize the impact of inbreeding on the giant freshwater prawn *Macrobrachium rosenbergii* hatchery stocks. Validation of the scheme is on-going.

- Culture conditions for seaweed *Kappaphycus* sp. in the laboratory were optimized. Explants from tissue cultured seaweeds and spores were grown in the laboratory, tanks, cages (multi-step culture method).  
In the laboratory, propagules were cultured under these conditions: 25°C, continuous aeration, 50-100 um m<sup>-2</sup> sec<sup>-1</sup> light, LD12:12 photoperiod, 30-34 ppt salinity, sodium nitrate (10 ppm) as the culture medium in sterile UV-treated seawater.  
In cages, propagules were tied in lines, and cleaned daily to reduce epiphytes and "ice-ice". The cage sites were in (1) Panubolon, Nueva Valencia, Guimaras with its 2,500 m<sup>2</sup> area requiring 5,000 propagules; and (2) Igang, Guimaras which needed

6,000 seaweed seedlings to be grown until 15 January 2012.

- Preliminary experiments using hCG injections to spawn the pompano (1000, 500, 250 and 100 IU) showed that the highest fertilization rate was obtained in 500 IU.
- To determine the optimum salinity requirement for larval rearing of pompano (newly hatched larvae to day 5), different salinities were tested (5, 10, 15, 20, 25, 30 ppt). High survival rates were observed in 25 and 30 ppt.
- Feeding experiments investigating the effect of partial fishmeal replacement with cowpea meal (i.e. 0, 15, 30, and 45%) in diets of *M. rosenbergii* in grow-out culture showed that no significant difference was found among treatments. However, prawn fed 45% cowpea meal-based diet showed the best performance for all the parameters evaluated (i.e. mean final weight, %weight gain, SGR and survival rate).

- The proximate analyses of fish meal samples obtained from Palawan, western Philippines, showed high proportions of crude protein (>50%) and ash content (>35%) with crude fat levels of less than 4%. Samples from Myanmar showed a variety of feed ingredients of plant origin, including steamed and full-fat soybean meals and also cakes (where crude fat had been removed or extracted) of peanut, sesame and ground nut. These ingredients from Myanmar were high in crude protein & crude fat, and were not commonly found in the Philippines.
- Tank experiments confirmed low temperature and low salinity as risk factors for white spot syndrome virus (WSSV). Viral load in WSSV experimentally infected shrimp *Penaeus monodon* cultured in small tanks with tilapia decreased from  $10^1$  to  $10^0$  WSSV  $\text{mg}^{-1}$  sample, while those in control increased to  $10^5$ .
- Cooperators in Dumarao, representing an inland freshwater fishery, responded (to interview) that aquaculture provided opportunity for them to use their submerged farmlands. They ranked tilapia culture second (30%) to farming (50%) as the most important household occupational activity that contributes to their household income and food security.

## Technology extension and demonstration

### GOJ-TF funded six courses

[see also commodity programs]

- (1) *Giant freshwater prawn production* (21 March -1 April, 7 participants)
- (2) Distance learning course on *Principles of Aquaculture Nutrition* (AquaNutrition Online) (21 March - 22 July 2011, 10 participants)
- (3) *Marine fish hatchery* (20 June–26 July, 10 participants)
- (4) *Abalone hatchery and grow-out* (7-27 July, 9 participants)
- (5) Regional dissemination of mud crab farming program (26 Sep - 01 October, 6 participants and 11 observers)
- (6) *Community-based freshwater aquaculture for remote areas of Southeast Asia* (22 November-1 December, 10 participants)

AQD Deputy Chief Dr. Teruo Azuma (leftmost) moderates the presentations at the mid-year 2011 review of programs funded by GOJ-TF. The review was held 3-5 August at AQD's Tigbauan Main Station in Iloilo. The annual progress and planning meeting was held in early 2012



# Resource enhancement

The second GOJ-TF project under the ASEAN-SEAFDEC FCG mechanism is **Resource enhancement of internationally threatened and over-exploited species in Southeast Asia**. The project aims to: (1) establish resource enhancement strategies of CITES species and regionally over-exploited species; (2) establish stable seed production technologies appropriate for release, with genetic consideration; and (3) develop a sustainable utilization and exploitation of coastal resources through community-based management.

Major outcomes:

- Growth of seahorse *Hippocampus comes* reared in illuminated sea cages were compared among different stocking density groups (15, 25 and 50 m<sup>-2</sup>). There was no significant difference in daily growth rate (DGR) in terms of stretched height (0.28-0.39 mm day<sup>-1</sup>) and body weight (8.22-11.91 mg day<sup>-1</sup>) among groups, although the highest and lowest DGRs were observed in seahorse grown at densities of 25 and 50 m<sup>-2</sup>, respectively.
- Through consultation with Indonesia's Research Institute for Mariculture, Gondol in Bali, information on broodstock maintenance and larval rearing of Napoleon wrasse was generated.
- Broodstock of sandfish *Holothuria scabra* were obtained from the study site (Molocaboc, Sagay, northern Negros) and were brought to AQD's sandfish hatchery for spawning induction and juvenile production. Two larval batches were produced and reared to juvenile stage (>5 mm length). In collaboration with the local resource management council, a floating ocean nursery and broodstock pen were established in Molocaboc Daku. A total of 3,470 juveniles (0.02-1.2 g) were transferred to the ocean nursery in June, July and October. Growth was good

with weight gain of 0.4 to 2 g (1 month nursery) to 10 g (4 months nursery) in the hapas. Survival was moderate (55%) between June to July, while poor (9%) from July to September due to inclement weather. In October, 147 juveniles were transferred from hapas to a monitoring pen where they grew from 10 to 47 g in 1.5 months with 26% retrieval.

- From January onwards, a total of 90 abalone *Haliotis asinina* was collected from all 10 transects in Sagay. Of these, 66% were wild, 1% wild recaptures, 1% hatchery released recaptures from July 2008 batch release (HR1), and 32% hatchery released recaptures from August 2010 release (HR2). Wild abalone were recaptured up to a maximum of 278 days post-release; 1,071 days post release for HR1 and 442 days post release for HR2. All recaptured abalone were caught from the transects where they were originally released. Monthly abalone collection as significantly highest in the transect with the highest percentage cover of dead branching corals with encrusting algae. This parallels the findings in previous years.
- From January to October, a total of 9,137 crabs (1.6 tons) had been identified, measured and weighed in the study site in northern Iloilo. Of

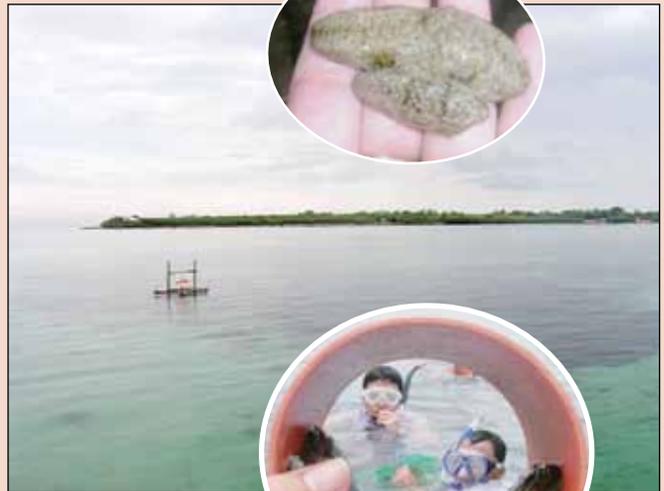
these, 76% was *Scylla olivacea*, 24% *S. tranquebarica*, and 0.11% *S. serrata*. Individual daily yield ranged 0.09-7.18 kg. Individual catch per unit effort (CPUE) in terms of quantity (crab gear<sup>-1</sup> day<sup>-1</sup>) ranged 0.02-1.38 while in terms of biomass (g gear<sup>-1</sup> day<sup>-1</sup>) this ranged 2.25-214. CPUE in terms of quantity and biomass were significantly higher using bamboo traps than in crab pots. Daily yield was also significantly higher in traps than in pots. Catchability of *S. olivacea* was positively correlated with soaking time, number of gears deployed, and moon phase while *S. tranquebarica* had significantly negative correlation with all these three factors.

- The community-based resource enhancement activity in the demo-site in Brgy Molocaboc (Sagay) aims to improve awareness and participation of stakeholders. Drafting of guidelines and schedule for managing and "guarding" the abalone and sea cucumber demo-site were done in April. The tagged and released abalone included: 514, 460 and 1040 individuals in June, September, and December 2011, respectively. The release was participated in by Sagay Marine Reserve (SMR) staff, Molocaboc local government unit (LGU) staff, AQD researchers, resource management council officers, the fishers, men and women of Molocaboc.

## Technology extension and demonstration

GOJ-TF funded the international training course on *Community-based resource enhancement* that was offered by AQD for the first time and conducted from 12 to 20 July with 5 participants. Lectures and practicals included not only seed production but also marine ecosystems & coastal resource management; habitat resources management / enhancement / restoration, site assessment; stock enhancement in ecosystems of mangroves, seagrass, seaweeds and coral reefs; community-based strategies and governance; socio-bio-economic strategy and education & information dissemination.

Floating ocean nursery and broodstock pens for sandfish (inset) are maintained with the assistance of the community in Molocaboc, Sagay



PHOTOS by ND SALAYO

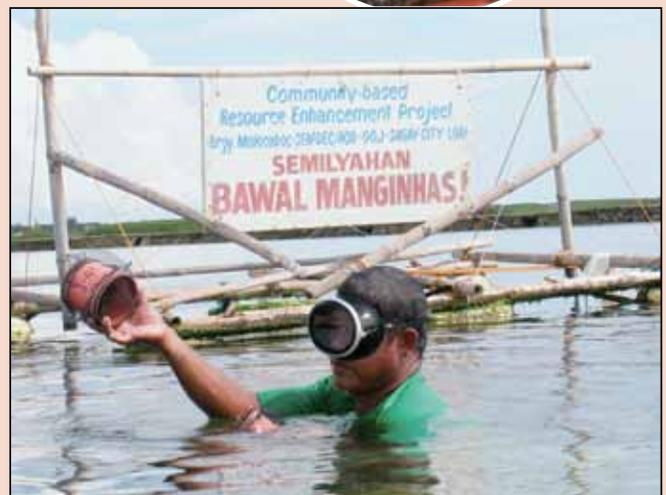


Signing of an agreement with the Sagay LGU and local management council for the resource enhancement project

Information campaign conducted 27-28 September by AQD researchers for 10 *sitios* of Brgy. Molocaboc to enhance compliance to an ordinance prohibiting the harvest of less than 6 cm abalone



A signage reminds villagers of "no fishing" in the resource enhancement project site



Hatchery-bred tagged abalone juveniles in pipes dispersed by community members / leaders and AQD researchers

# Fish health management

The third GOJ-TF project under the ASEAN-SEAFDEC Fisheries Consultative Group mechanism is ***Accelerating awareness and capacity-building in fish health management in Southeast Asia***.

This aims to (1) accelerate the delivery of information and awareness-building among fishfarmers and (2) develop aquatic animal health management techniques to help ensure a stable supply of safe aquaculture products in Southeast Asia. Two activities make up this project: industry-wide capacity building and innovative research studies.

## Major outcomes:

- A survey in four regions of Luzon, Philippines confirmed the lack of proper awareness of fish health management concepts as well as environmental and food safety issues among small-scale fishfarmers. The survey also highlighted the need for hands-on training to build technical capacities of fishfarmers on fish health.

In 2011, an on-site training course on *Freshwater fish health management* with emphasis on detection & identification of fish-borne zoonotic parasites was conducted in Lao PDR.

- A survey on fish-borne zoonotic trematodes (FZTs) metacercariae in farmed fish were carried out in the Philippines and Lao PDR. Tissue filtrates of tilapia from the Philippines were negative for FZTs.

For the Vientiane municipality in Lao PDR, a total of 120 fish samples comprising six species [*Puntius gonionotus*, n=30; *Tilapia niloticus*, n=35; *Cyprinus carpio*, n=24; *Clarias* spp., n=18; *Hypophthalmichthys molitrix*, n=5; *Ctenopharyngodon idellus*, n=8] from four fish farms

(Muang Song Farm, Patong Village, Viangvieng Village, Sapengmuck Village) and Thaheua Market (local market) were analyzed. An unidentified FZT metacercaria was present in 2.5% of *P. gonionotus* samples from the local market. On the contrary, none was found in all samples obtained from fishfarms.

- As part of the optimization of q-PCR methods, the recovery of plasmids containing DNA viruses like WSSV, iridovirus and KHV that will serve as positive controls had been completed while preparation of plasmids with inserts of the RNA viruses is on-going. WSSV isolate was already tissue-passed thrice and the infected tissue material is ready for the preliminary infection experiment to determine the threshold level of the virus and the susceptibility of different shrimp species.
- Neutralizing antibody titers in the sera of seabass taken 2, 4, and 6 months after the post-3rd booster vaccination (Vac) ranged from 1:7764 ~1:20480, 1: 6442 ~ 1:10240, and 1: 3162 ~ 6310, respectively, while unvaccinated (UVac) sea bass pre-broodstocks have

neutralizing antibodies <1:40. Although spawned eggs from matured Vac fish injected with LHRH were negative for betanodavirus detection, eggs from UVac fish were found positive. In contrast, maternal neutralizing antibody titers were 1:192 and <1:40 in the eggs of Vac and UVac fish, respectively. To test the protective effect of the maternal antibodies present in Vac larvae, newly-hatched larvae were challenged with  $10^6$  TCID<sub>50</sub> ml<sup>-1</sup> of betanodavirus. No significant differences in mortality were noted in virus-challenged Vac and UVac larvae.

- Different concentrations of seaweed (*Ulva pertusa*) extracts dissolved in sterile normal saline solution (SNSS) were tested for antibacterial activity. These concentrations ranged from 100 mg to 3.1 mg, and were tested against *Escherichia coli* (ATCC 25922), *Staphylococcus aureus* (ATCC 25923), *Pseudomonas aeruginosa* (ATCC 27853), *Vibrio alginolyticus* (isolated from eye of diseased pompano), and *Vibrio harveyi* (isolated from kidney of diseased sea bass). Aqueous extract at 100 mg showed maximum inhibition (31 mm) against *S. aureus*, higher than

the antibacterial activity (28 mm) of the control (Amoxicillin). Growth of *S. aureus* was otherwise inhibited when exposed to 50 mg (27 mm), 25 mg (24 mm), 12.5 mg (20 mm), 6.3 mg (12 mm), and 3.1 mg (4 mm). Similarly, *V. alginolyticus* showed inhibition zones of 32 mm and 29 mm when exposed to 100 mg and 50 mg of aqueous extracts, respectively.

- After a 2010 trial showed improved survival in shrimp after treatment with formalin-inactivated WSSV vaccine, tank trials were further conducted to test different delivery

vehicles for a recombinant sub-unit vaccine. Laboratory-scale quantities of the recombinant vaccine were first produced for use in various vaccine+carrier complexes, i.e. transformed BL21 *E. coli* cells. These cells, upon induction with IPTG, were able to produce the recombinant VP28 protein. A preliminary test run showed that the vaccine without carrier could confer protection, but the delivery modes needed optimization.

- Abalone reared in cages and those from the wild were examined for the presence of parasites and shell diseases.

About 80% and 50%, respectively, were found to have brown blisters on the internal surface of their shells. Shells were fouled by burrowing polychaetes, such as *Serpulidae* (49 and 58%, respectively, of cultured and wild stocks), *Spionidae* (55 and 20%) and *Dorveillidae* (76 and 30%). Prevalences of 5 and 3% for rickettsial-like organisms, 40 and 6% for ciliates, 15 and 8% for metacestodes, and 13 and 5% for gregarine-like organisms (*Nematopsis sp.*) were also noted in cultured and wild abalone, respectively.



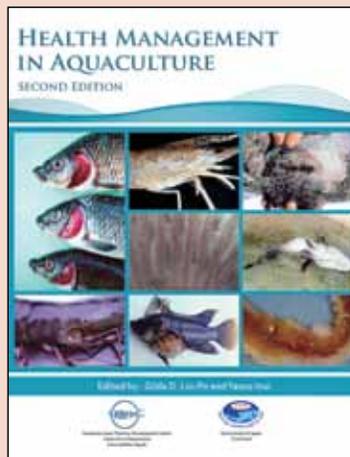
## Technology extension and demonstration

GOJ-TF funded the *On-site basic training on freshwater fish health management* implemented 11-14 October in Lao PDR in collaboration with Lao PDR's Department of Livestock and Fisheries (DLF). Ten staff of the DLF and 10 observers from private farms attended.

The training aimed to enhance knowledge and skills of extensionists, and emphasized the detection & identification of fish-borne zoonotic parasites. Lectures and practical exercises included (a) signs and epizootologies of economically-important freshwater fish diseases; (b) evaluation of fish epizooties; (c) submission of diseased fish samples for diagnosis; and (d) basic laboratory skills for detection of pathogens

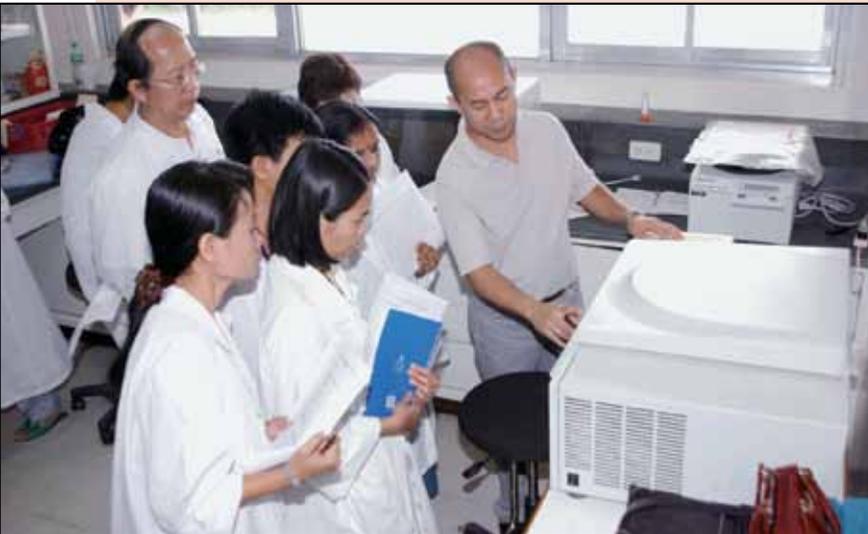


The training in Lao PDR



Funded by GOJ-TF, the second edition of the textbook *Health management in aquaculture* edited by Dr. Gilda Lio-Po, Dr. Yasuo Inui and published by AQD came out in 2011

**Biotech or LFAAT (Laboratory Facilities for Advanced Aquaculture Technologies):** A grant-in-aid from the Government of Japan to the Philippine Government through DA-BFAR, the biotech consists of four laboratories -- molecular microbiology; molecular endocrinology and genetics; algal production; and fish feed technology. In 2011, LFAAT processed 1,321 samples for proximate analysis and fatty acid profile; 2,265 water samples for pH, phosphates, nitrate, nitrite, ammonia, ammonium, dissolved oxygen, chlorophyll, among others; 831 soil samples for organic matter, carbon nitrogen sulfur analysis, available iron sulfur phosphorus, pH; 349 samples for microbial analysis; 87 samples for electron microscopy. All these earned the lab Php1,218,234 in income for 2011.



Pathogen detection using polymerase chain reaction (PCR)

**Fish health diagnostic services:** AQD provides disease diagnostic services to stakeholders of the aquaculture industry. In 2011, the fish health laboratory examined 302 cases which came from the private sector (66%) and AQD studies (34%). Of the cases, 54% was shrimp, 22% fish, 11% crab and other crustaceans, and the rest were molluscs / mice kidney / water.

Some of the samples were found positive for the viruses WSSV, IHNV, TSV and VNN as detected by PCR. Bacteria and parasites were also isolated and counted; while 1,843 histological slides were made for research and disease diagnosis. The laboratory earned an income of Php629,837 for its services in 2011.

**Special training:** AQD offered two special training upon the request of stakeholders: (1) *Fish health management* for two Filipinos 22-23 March; and (2) *Fish parasite detection and identification* for a Sudan national 15 August–28 September by the Red Sea University, Sudan.



**Food safety** GOJ-TF sponsored the international seminar on *Food safety in aquaculture* that was held 22 January at AQD's Tigbauan Main Station, Iloilo. Participants were from Cambodia, Malaysia, Myanmar, Thailand, Singapore and Philippines.

The following topics were discussed: (1) issues, problems, future outlook of food safety in aquaculture in Southeast Asia; (2) good aquaculture practices: current knowledge and future priorities; (3) fish health, nutrition and food safety in aquaculture; (4) hazard analysis critical control point (HACCP); (5) technological tools for biological, chemical and physical evaluations; (6) food safety management systems, policy and regulations; (7) food safety program in aquaculture: training and information needs and strategies

# Food safety

The fourth GOJ-TF project under the ASEAN-SEAFDEC Fisheries Consultative Group mechanism is ***Food safety of aquaculture products in Southeast Asia***. This project aims to: (1) contribute to the guidelines on the production of safe aquaculture products from Southeast Asia; (2) determine the presence and levels of commonly used chemicals in aquaculture and aquaculture products such as fish and shrimps; (3) investigate the status of antibiotics and chemical use in aquaculture in the region; and (4) compile and disseminate SEAFDEC guidelines on the use of antibiotics and chemicals in aquaculture. This project has these activities: withdrawal period of antibiotics in some tropical cultured species; surveillance of chemical contaminants in aquaculture products and feeds; and investigation of antibiotics / chemicals usage and regulations in aquaculture.

## Major outcomes:

- In hybrid red tilapia, the withdrawal period of oxytetracycline (OTC) administered at a dose of  $75\text{mg kg}^{-1}$  fish per day was found to be 26 days while that of oxolinic acid (OXA) given at a dose of  $30\text{ mg/kg}$  fish per day, was 17 days. Body weight of test animals was 120 g and the medicated diet feeding for each treatment was 10 days. The experiment was conducted using freshwater and tank water temperature was  $29^{\circ}\text{C}$ .
- Residues of commonly used antibiotics, OTC and OXA, and organochlorine pesticides (OCPs) were examined in samples of aquaculture products such milkfish, grouper, snapper, sea bass, rabbit fish, black tiger shrimp and tilapia obtained in the Philippines. One sample out of 40 analyzed so far was positive for OTC, with a residue level of 0.04046

ppm. Five samples out of 52 analyzed were positive for OXA, with residue levels ranging from 0.005 to 0.02 ppm. Four OCPs were detected in 6 out of 14 samples analyzed with levels ranging from 0.001 to 0.027 ppm. Methoxychlor was detected in three out of six samples found positive for OCPs. Exposure limit levels in OCPs were in the range below the PEL (Permissible Exposure Limits) values. For methoxychlor the PEL value is 0.71 ppm TWA (8-hr time

weighted average), while for OTC it is 0.025 ppm TWA. There is no PEL established yet for OXA.

- DOF Malaysia has come up with the draft *ASEAN guidelines for chemical use in the ASEAN region* now being circulated among member countries. To avoid duplicating efforts, GOJ-TF will focus on guidelines for cultured products.



Injection of sample for detection of antibiotic residues in fish using the HPLC (high performance liquid chromatograph)

# Special projects

Funded by JIRCAS (Japan International Research Center for Agricultural Sciences), a study on shrimp-sandfish polyculture was completed while a 5-year project on developing environment-friendly aquaculture began its first year. Both complemented AQD's aquatic ecology program.

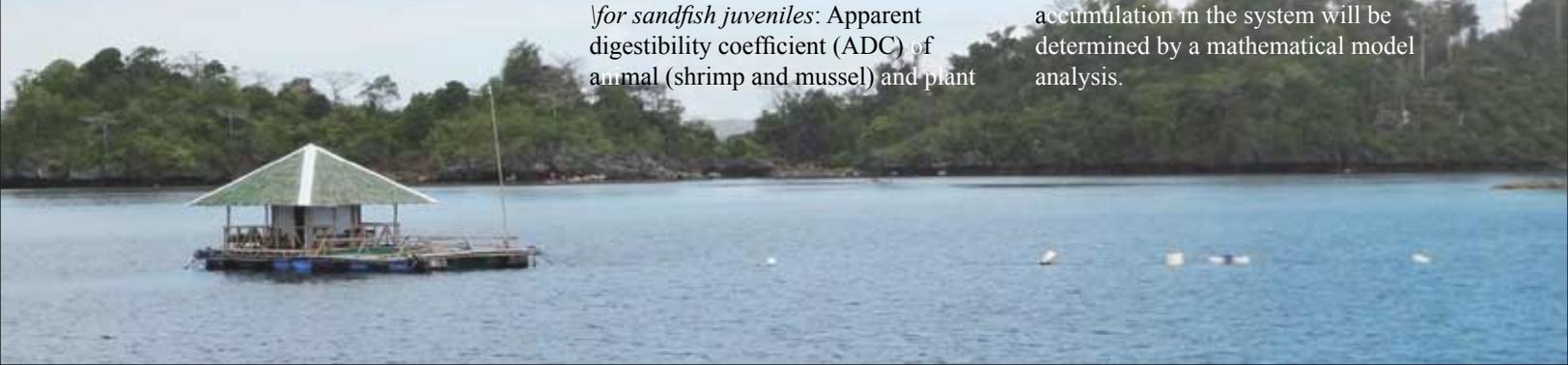
Tiger shrimp and sandfish polyculture set-up



PHOTOS by S. WATANABE

Pond trial of seabass, sandfish, oyster and seaweed polyculture at AQD's Dumangas Brackishwater Station

Water and sediment quality are monitored around a milkfish cage at AQD's Igang Marine Station



A study on the polyculture system of tiger prawn *Penaeus monodon* and sandfish *Holothuria scabra* was completed in March, the end of Japan's fiscal year. Growth rate of sandfish juveniles cultured with black tiger shrimp in a concrete tank without supplemental feeding (i.e. only shrimp feed was used) was 0.37 or 0.25 g d<sup>-1</sup>, which was comparable to previously reported growth rates. Neither growth rate nor survival rate of the shrimp was significantly affected by the presence of sandfish. Dissolved inorganic nitrogen levels, DO level, pH and salinity of the rearing water were not affected by the presence of sandfish. The presence of sandfish did not affect the organic matter (OM) content in the sediment. The mean oxidation reduction potential (ORP) of sediment pore water was significantly higher in a tank with sandfish (-137) than in a tank without sandfish (-280). The mean acid volatile sulfur (AVS) was significantly higher in a tank with sandfish (0.15 mg g<sup>-1</sup>) than in a tank without sandfish (0.095). Thus, while sandfish may cause bio-deposition of sulfur to the sediment, they may serve to maintain the sediment quality in better condition.

Towards the development and extension of integrated multi-trophic aquaculture (IMTA) techniques to improve people's livelihood, three studies were conducted:

(1) *Apparent digestibility of diets for sandfish juveniles*: Apparent digestibility coefficient (ADC) of animal (shrimp and mussel) and plant

(diatom and seaweed) sources of nutrients (protein, carbohydrate and organic matter) were determined. Nutrients from animal source have higher ADC compared with the nutrients from plants. This indicated that nutrients from animals can be better assimilated by sea cucumber and thus might lead to better growth.

(2) *Preliminary IMTA trial in DBS ponds*: Pond polyculture trial of Asian seabass (*Lates calcarifer*), oyster (*Crassostrea iredalei*), sandfish (*Holothuria scabra*) and seaweed (*Gracilaria heteroclada*) was conducted at DBS. In terms of energy budget, the polyculture with feeding only the seabass was feasible. However, the seabass tended to bite the seaweed and get tangled by the straw holding the seaweed. Inorganic nutrient provision to the seaweed was not determined due to the disturbance by seabass; however, phytoplankton production seemed to be high enough to support the growth of the oyster. Sandfish mortality tended to be higher in sediment with higher silt content.

(3) *Environmental monitoring of area adjacent to a milkfish cage in IMS*: In order to quantify the organic load by cage culture of milkfish to adjacent area, periodical monitoring of water current, dissolved oxygen, chlorophyll *a*, inorganic nitrogen and phosphorus in the water column, carbon and nitrogen content, acid volatile sulfur and organic matter content in the sediment, and <sup>13</sup>C and <sup>15</sup>N of the sediment organic matter are being conducted. Nutrient flow and accumulation in the system will be determined by a mathematical model analysis.

# Aquabusiness for entrepreneurs

Through ABOT AquaNegosyo (Agree-Build-Operate-Transfer AquaBusiness), AQD extends technical assistance to entrepreneurs willing to invest in fish hatcheries and fishfarms. The ABOT mechanism received 13 inquiries from the Philippines and two from Timor Leste and Malaysia. Client list in 2011:

Client	Project or services rendered / assigned AQD technical expert	Location of farm (time frame or year undertaken)
Mr. Alain Alafriz	Site assessment for hatchery, pond development by M Jopson, Z Suriaga, A Gaitan	Batangas (2010 – 2011)
Mr. Juan Nepomuceno	Milkfish stock monitoring by G Jamerlan	Sorsogon (starting 2008)
Mr. Emil Pepito	Site assessment of family-owned farm by RV Eguia	Liloan, Cebu (January 2011)
Ms. Aida Mago	Site assessment of family-owned farm and consultation on shrimp, mud crab and milkfish by Dr. E Qunitio	Vinzon, Camarines Sur
ACDI/VOCA (Mr. Robert Rosengren and Mr. Henry Merto)	Site assessment, technical training, feasibility study preparation for a mud crab culture and fattening project by Dr. E Qunitio	Five districts in Timor-Leste (August-September 2011)
GAIA Mariculture (Dr. Mathilde Richer de Forges)	<i>Integrated multi-trophic aquaculture (IMTA) project</i> Site assessment; IMTA project implementation using seaweeds, abalone and sandfish; establishment of hatcheries to support IMTA project by MR Luhan, V Encena II, J Altamirano	Ronda, Cebu (starting September 2011)
DIAGSCORP (Mr. Luis Gonzales and Mr. Cris Gonzaga)	Site assessment of ponds (multi-species farming; seabass, grouper, mud crab, tiger shrimp) by F Estepa, D Baliao, J Ladja	Bacay, Dumangas, Iloilo (16 September 2011)
NORMINMAR (Mr. Vicente Manzano Jr)	Site assessment of aquaculture facilities (multi-species high-value fish, nursery ponds and grow-out cages) by O Reyes, J Ladja, E Coniza	Talisayan and Balingasag, Misamis Oriental (1-3 December 2011)

## Small-scale fish farmer

Mr. Emil Pepito is an overseas Filipino worker (OFW) who sought assistance from AQD to assess an undeveloped 25-ha water-logged area surrounding his family farm in Liloan, Cebu. After preliminary site assessment, AQD proposed the development of 1,500 m<sup>2</sup> for tilapia culture as a test run.

Most of the inquiries for ABOT assistance come from small-scale investors like Mr. Pepito who essentially request technical assistance from site assessment to feasibility study preparation.

## Market-size fish from AQD

As by-products of its research, verification & demonstration studies, AQD produced and sold market-size fish. In 2011, these included:

	Pond production (kg)	Cage production (kg)	Total production (kg)	Total value In Php (US\$)
Milkfish	2,253	7,067	9,320	990,976 (23,045)
Snapper	1,964	146	2,110	428,149 ( 9,956)
Tilapia	1,913	-	1,913	166,815 ( 3,879)
Siganid	967	37	1,004	132,889 ( 3,090)
Pompano	218	315	533	93,563 ( 2,175)
Seabass	374	-	374	46,175 ( 1,073)
Grouper	0.85	86	87	15,487 ( 360)

Pompano harvest at DBS



# Aquabusiness for communities

AQD's *Institutional capacity development on sustainable aquaculture* (ICDSA) mechanism was launched in mid-2006 to empower stakeholders (local government units, fisherfolk organizations, and schools, NGOs, among others) to become efficient resource managers and prudent resource users. The major strategy is to build stakeholder capacities on participatory, inter-disciplinary and community-based strategies in the transfer and adoption of scientifically tested and appropriate aquaculture and resource management techniques.

The Petron-supported ICDSA project on *Milkfish cage culture as a livelihood option for Guimaras fisherfolk* was a learning experience for researchers, development workers, and the fishing communities. Milkfish cage culture technology was found to be a viable technology based on the test trials conducted AQD's Igang Marine Station with trained fish farmers. In phase 2, which began in 2009 and ended in 2011, one fish cage each in the sites of the five fisherfolk organizations (FOs) were constructed and 125 fishers attended the season-long training courses conducted in four barangays. The total production of the five FOs was 34.4 tons valued at Php3,550,867. The five FOs realized a net income of Php122, 857.

AQD sociologist interviews a stakeholder in southern Mindanao where AQD and TSKI (Taytay sa Kauswagan Inc) are giving technical assistance to the *Sustainable mariculture investment program* of DBP (Development Bank of the Philippines). Consultation-interviews had been done 27 June-2 July and 8-13 August in Panabo City, and Sta. Cruz and Digos (Davao del Sur)



AQD makes a gift of its 25 publications to the library of Nueva Valencia, the municipality where AQD has a milkfish livelihood project funded by Petron Foundation Inc. AQD researchers are resource persons to the municipality's *Coastal resource management planning workshop* held 8-10 June

Although technological skills are critical in mariculture production, it is not a guarantee for a successful mariculture livelihood for small-scale fisherfolk. From the experience of the project, it is equally important for the fishers to undergo values formation, organizational development, and entrepreneurial skills development. It is for this reason that the *Taytay sa Kauswagan Inc* was tapped as partner to build the capacity of the members of the five FOs on organizational and entrepreneurial development.

The Dumarao freshwater aquaculture project (Capiz) attracted interest not only from the originally targeted rural folk but also private investors. Tilapia culture is now practiced as a viable enterprise in the locality. The socioeconomic impact assessment is being finalized.

Policy intervention in the form of a municipal ordinance is necessary to control the proliferation of cages on Dumarao river. The growth of water hyacinth is caused by the feeds, among other things, and it had choked the cages during summer time.

While the ACIAR-supported ICDSA projects in Northern Samar on mud crab culture and in Misamis Occidental on grouper culture have been completed, a project in the pipeline is mariculture in Romblon in partnership with Romblon Agricultural Improvement for Sustainable Economic Development (RAISED) with funding from Winrock International.

# Training

AQD successfully conducted 26 training courses with 328 total number of participants in 2011. Two courses were offered for the first time: (1) *Community-based resource enhancement* that was held 12-20 July with GOJ-TF funding and (2) *Capacity building on information dissemination & data management* held 12-20 December in collaboration with the SEAFDEC Secretariat.

Course, funding or requesting party, date, venue	Total participants (male + female), age range	Countries represented by participants
<b>REGULAR COURSE OFFERING</b>		
<b>Basic principles of aquaculture nutrition (AquaNutrition On-line)</b> <i>A distance learning course funded by GOJ-TF</i> 21 March-22 July	10 (6 M + 4 F), 23-42 years old	Indonesia (2), Myanmar (1), Thailand (1), Brunei Darussalam (1), Cambodia (1), Guyana (1), Malaysia (1), Philippines (2)
<b>Marine fish hatchery</b> <i>Funded by GOJ-TF</i> 20 June-26 July; AQD's Tigbauan Main Station	10 (9 M + 1 F), 20-61 years old	Cambodia (1), China (2), India (1), Singapore (3), Sri Lanka (1), and Philippines (2)
<b>Crab hatchery and grow-out</b> <i>Funded by BFAR-RFTC</i> 27 June-19 July; AQD's Tigbauan Main Station	25 (19 M + 6 F), 20-59 years old	Korea (1), Vietnam (1), Philippines (23)
<b>Abalone hatchery and grow-out</b> <i>Funded by GOJ-TF</i> 7-27 July; AQD's Tigbauan Main Station	9 (7 M + 2 F), 28-55 years old	Cambodia (1), Thailand (1), Philippines (7)
<b>Community-based freshwater aquaculture for remote rural areas of Southeast Asia</b> <i>With funding support from GOJ-TF</i> 22 November-1 December; AQD's Tigbauan Main Station	10 (6 M + 4 F), 26-56 years old	Cambodia (1), Indonesia (1), Lao PDR (1), Malaysia (1), Myanmar (1), Thailand (1), China (1), Spain (1), Philippines (2)
<b>COLLABORATIVE / ONSITE TRAINING</b>		
<b>Abalone hatchery and grow-out</b> <i>Funded by BFAR-RFTC</i> 29 March – 18 April; AQD's Tigbauan Main Station	21 (17 M + 4 F), 18-58 years old	Philippines
<b>Seaweed farming (<i>Kappaphycus</i>)</b> <i>Funded by BFAR-RFTC</i> 26 April-10 May; AQD's Tigbauan Main Station	21 (13 M + 8 F), 23-59 years old	Philippines
<b>Seed production and grow-out of sandfish (<i>Holothuria scabra</i>)</b> <i>Funded by BFAR-RFTC</i> 4-17 May; AQD's Tigbauan Main Station	23 (7 M + 2 F), 28-55 years old	Australia (1), Philippines (22)
<b>Marine fish hatchery</b> <i>Funded by BFAR-RFTC</i> 19 May-24 June; AQD's Tigbauan Main Station	21 (15 M + 6 F), 22-53 years old	Iran (1), Philippines (20)
<b>Community-based resource enhancement</b> <i>Funded by GOJ-TF</i> 12-20 July; AQD's Tigbauan Main Station	5 (4 M + 1 F), 31-43 years old	Cambodia (1), Myanmar (1), Sudan (1), Philippines (2)
<b>Mangrove conservation, rehabilitation and management</b> <i>In collaboration with Zoological Society of London</i> 25 May- 4 June; AQD's Tigbauan Main Station	26 (12 M + 14 F), 21-58 years old	Vietnam (1), Micronesia (1), Philippines (24)

<b>Mudcrab culture</b> <i>Funded by GOJ-TF in collaboration with DOF-Myanmar</i> 26 September-1 October; Chaung Tha, Myanmar	6 official participants (4 M + 2 F; 27-55 years old)  11 observers from DOF-Myanmar	Brunei (3), Cambodia (1), Myanmar (1), Thailand (1)
<b>Freshwater fish health management</b> <i>Funded by GOJ-TF and in collaboration with the Department of Fisheries and Livestock – Lao PDR</i> 11-14 October; Namxouang Aquaculture Development Center, Lao PDR	20 official participants (7 M + 3 F)  10 observers (9 M + 1 F)	Lao PDR
<b>Capacity building on information dissemination and data management</b> <i>Funded by GOJ-TF and in collaboration with SEAFDEC Secretariat</i> 12-20 December; AQD's Tigbauan Main Station	7 (1 M + 6 F), 23-44 years old	Thailand (4), Malaysia (1), Philippines (2)
<b>CLIENT-DRIVEN TRAINING</b>		
<b>Selected topics on fish breeding</b> <i>At the request of Meralco Foundation Inc</i> 21-23 January; AQD's Binangonan Freshwater Station	31 (19 M + 12 F) 16-26 years old	Philippines
<b>Freshwater prawn hatchery and grow-out operations</b> Three sessions requested by the Government of Japan for 7 participants (21 March-1 April) ; private sector for 4 participants (22-26 August); and WorldFish Centre for 16 participants (7-11 November). All three sessions were conducted at AQD's Binangonan Freshwater Station	27 (22 M + 5 F); 24-55 years old	Malaysia (1), Cambodia (1), Indonesia (1), Philippines (24)
<b>Fish health management</b> <i>At the request of the private sector</i> 22-23 March; AQD's Tigbauan Main Station	2 (1 M + 1 F), 26 and 53 years old	Philippines
<b>Culture of microalgae</b> <i>At the request of the private sector</i> 9 May-10 June; AQD's Tigbauan Main Station	1 male, 22 years old	Philippines
<b>Aquaculture practices</b> <i>At the request of Maldives Food and Drug Authority and funded by Food and Agriculture Organization (FAO)</i> 24-30 May; AQD's Tigbauan Main Station	3 (1 M + 2 F), 27-32 years old	Maldives
<b>Natural food culture</b> <i>At the request of the private sector</i> 7-26 July; AQD's Tigbauan Main Station	1 male, 22 years old	Philippines
<b>Tilapia hatchery and grow-out operations</b> <i>At the request of the private sector</i> 15-19 August; AQD's Binangonan Freshwater Station	3 males 52-58 years old	Philippines (2), Malaysia (1)
<b>Fish parasite detection and identification</b> <i>At the request of the Red Sea University</i> 15 August-28 September; AQD's Tigbauan Main Station	1 male, 37 years old	Sudan
<b>Marine fish hatchery</b> <i>At the request of the private sector</i> 14-30 September; AQD's Tigbauan Main Station	1 male, 53 years old	Philippines
<b>Milkfish farming</b> <i>At the request of FAO-Kiribati</i> 26 September-10 October; 's AQD Tigbauan Main Station	3 (2 M + 1 F), 21-41 years old	Kiribati (2), Philippines (1)
<b>Capacity building on good aquaculture practices</b> <i>At the request of SEAFISH (South East Asia Fish for Justice Network)</i> 11-15 October; AQD's Tigbauan Main Station	19 (11 M + 8 F) 26-60 years old	Cambodia (2), Indonesia (4), Myanmar (2), Vietnam (2), Philippines (9)
<b>Pond / cage culture of selected marine species</b> <i>At the request of the private sector</i> 5-15 December; AQD's Tigbauan Main Station	2 males, 51 and 58 years old	USA (1), Philippines (1)

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

<b>Internship</b> at AQD hatcheries, laboratories and stations	37 (31 M + 6 F), 18-60 years old	Vietnam (1) , China (2), Sweden (1), Spain (1), USA (1), Philippines (27)
<b>Student on-the-job training</b> (OJT), a requirement in the academic curriculum	217 (97 M + 120 F), 17-27 years old	Philippines (217 students from 23 schools / universities)
<b>Observation / study tours</b>	142 total people in 16 groups	China (3), Japan (22), France (2), Micronesia (3), Sweden (1), UK (2), Germany (1), Guyana (1), Philippines (107)

Of special note are the internships of veterinary medicine students of Capiz State University (2-16 November) and Aklan State University (24 October to 10 February 2012) on fish health laboratory work. After graduation from college, the students will seek Philippine government license as veterinarians



Log-in page of AquaNutrition

## Non-commodity / non-program courses

(1) *AquaNutrition Online* is an internet course that provides the e-learners with knowledge and skills in aquaculture nutrition and feeding with emphasis on tropical species like milkfish, tilapia, tiger shrimp. Also included are aspects of feeds & feeding related to the conservation of the aquatic environment

(2) *Good aquaculture practices* provides a better understanding of the science of aquaculture and its socioeconomic and environmental impacts

A trainee monitors shrimp larval condition; trainees visit abalone hatchery

(3) *Capacity building on information dissemination and data management* provides participants with skills in information dissemination (writing, editing, designing publications and websites) and putting up organization-wide databases and institutional repositories

Trainees gather news from a field visit to IMS; and visit the rice bank of the International Rice Research Institute in Laguna



# Information dissemination

AQD published three manuals, one textbook, one proceedings volume; the annual report for 2010 and four flyers with e-versions downloadable from the website [www.seafdec.org.ph](http://www.seafdec.org.ph). AQD also launched its institutional repository - [repository.seafdec.org.ph](http://repository.seafdec.org.ph) - in July and re-designed its website in August.

AQD organized the Philippine phase of the 2011 ASEAN-SEAFDEC children's drawing contest, hosted media groups, joined five fairs & exhibits, and received more than 25,000 visitors to FishWorld and its four stations.

## Publications

*Sustainable aquaculture development for food security in Southeast Asia towards 2020*, a 169-page proceedings of the *Regional technical consultation on sustainable aquaculture* held 17-19 March 2011 in Bangkok, Thailand. Edited by B Acosta, RM Coloso, EG de Jesus-Ayson, JD Toledo

*SEAFDEC/AQD Highlights 2010*, a 52-page report of AQD's research & development activities

*Tigbauan Main Station* and *Igang Marine Station*, 2-3 fold flyers on AQD's two stations in Iloilo and Guimaras

*AQD Matters*, a newsletter circulated to more than 800 employees and friends of AQD. Released were nine issues

*Our Vision, Our Mission, Our Objectives*, a large-format tarpaulin poster. Other tarps were also produced for the exhibits

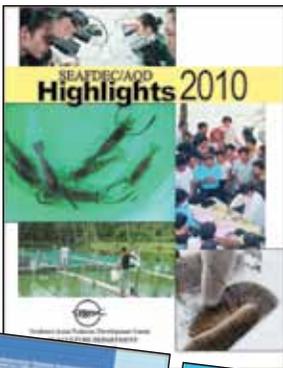
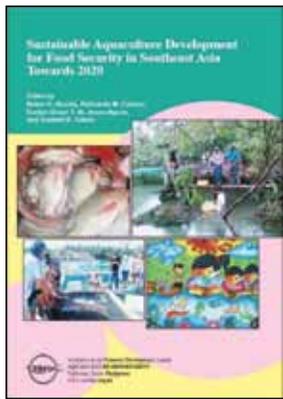
## AQD website

The AQD website [www.seafdec.org.ph](http://www.seafdec.org.ph) had 53,334 unique visitors in 2011 with 9,892 links from other websites. A new design was unveiled in August.

AQD continued to be on social networking sites: Facebook (account name: Devcom Section) with 60 posts; Flickr (seafdecaqd) with more than 20,000 photo views; and YouTube with more than 89,000 video views.

## Mass media

AQD hosted four mass media groups for a total of 14 days when these groups interviewed researchers and filmed R&D activities in show-and-tell. AQD also wrote two press releases, and media appearances totalled 63 in 2011, including in television, websites, and articles in print like *Global Aquaculture Advocate* (January issue) and a series in *Malaya Business Insight*.

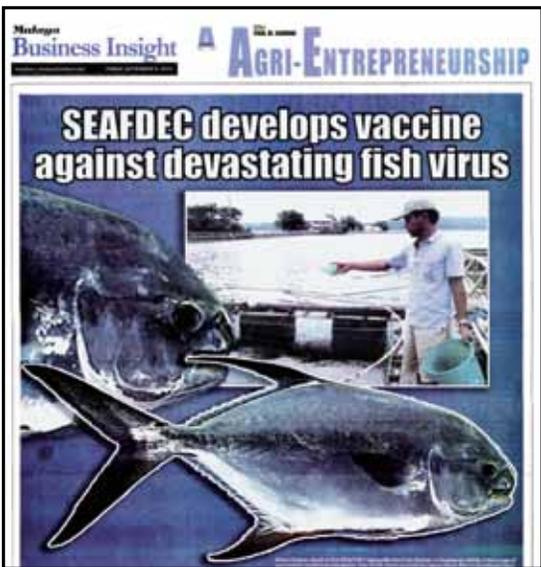


## Drawing contest for Filipino children

To ensure that Filipino children's vision of food security in Southeast Asia was given consideration, AQD placed a call for children 14 years or younger to submit artwork on the theme *Fisheries for food security: adaptation to climate change*. The same call was also made in the other 10 member-countries of SEAFDEC, and four winning entries from each country were brought to Bangkok in June for exhibition at the 2011 ASEAN-SEAFDEC conference. AQD received 103 drawings from 41 schools nationwide and these were exhibited 22 February-4 March at TMS and 24-26 March in Iloilo City. Judging was done by the AQD community and professional artists. [See also the back cover of this report.]



Photo by J ZARATE



## Fairs & exhibits

AQD joined the Philippines' largest expo in agriculture -- *AgriLink / FoodLink / AquaLink 2011* -- held 6-8 October at the World Trade Center, Pasay City (bottom right). AQD joined four other fairs: (1) *2011 AquaTech Expo & Convention* in Clark, Pampanga; 23-25 March; (2) *1st Vis-Min Davao Agri-Aqua Expo 2011* in Davao City, 11-13 August; (3) *1st Regional Organic Agri Research Fair & Exhibit* in Iloilo City; 14-18 November; and (4) *Pantat (Catfish) Festival*, in Zarraga, Iloilo; 18-20 December

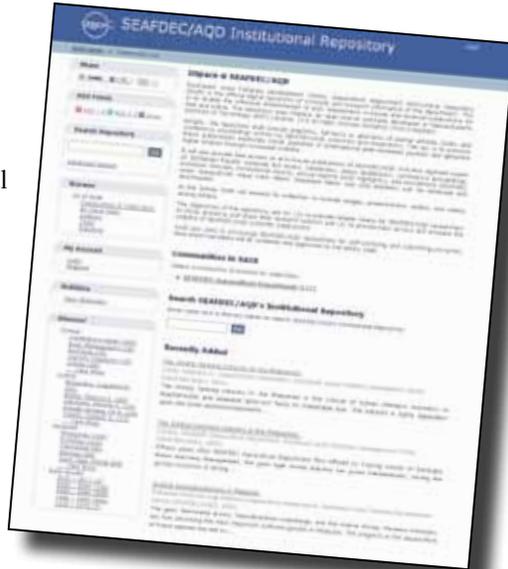


## Institutional repository

AQD unveiled its institutional repository in July which is accessible at *repository.seafdec.org.ph*. With 421 titles on offer, 39,161 downloads were made by AQD stakeholders in 2011.

The AQD Library continued to add aquaculture materials to its collection, an average of 7% new materials each year (2002-2011) or 2,779 copies on average. The global web searchers of AQD's OPAC or online public access catalogue (*opac.seafdec.org.ph/wx*) averaged 19,836 yearly in 2002-2011. The top search topics were mudcrab, shrimp, milkfish, tilapia, grouper, seabass, mangroves, tiger shrimp, seaweeds, and abalone. AQD mostly hosted visiting researchers, AQD trainees and students (around 5,000 a year on average) as library walk-ins.

The AQD Library is a member of four network libraries including IAMSILIC (International Association of Aquatic and Marine Science Libraries and Information Centers) and has 320 exchanges or mailouts with institutions and individuals.



## AQD visitors

AQD received a total of 25,374 visitors, mostly students (75%), officers of international / regional organizations (0.8%), among others. Some scientists and experts gave research seminars at AQD:

- Dr. Heather Koldewey**, Zoological Society of London / UK: *Project Seahorse: Using flagship species for marine conservation*, 18 January
- Dr. Mitsuru Ototake**, Fisheries Research Agency / Japan: *Current status of KHV in Japan: Epidemiology, preventive measures*, 18 January
- Dr. Fahrul Huyop**, Universiti Teknologi Malaysia / Malaysia: *Microbial pollutant degraders - past, present and future*, 3 February
- Capt. Gert Heyns**, Coast Guard Auxiliary Western Visayas Squadron 605 / Philippines: *Lectures on scuba diving*, 7 February, 20 May, 25 May and 10 June
- Dr. Keita Furukawa**, National Institute for Land and Infrastructure Management / Japan: *Integration of coastal management (ICM) for wetlands*, 8 March
- Ms. Eileen Ragudo and Ms. Ma. Felisa Cenar**, MERCK / Philippines: *Safe handling of all reagents as an environmental support*, 23 March
- Dr. Marie Antonette Juinio-Menez**, University of the Philippines: *Opportunities and challenges of sandfish sea-ranching in the Philippines*, 11 May
- Dr. Leilanie Osano Suerte**, Mines and Geosciences Bureau Region 6 / Philippines: *Geologic hazards (landslides, floods and earthquakes)- how vulnerable is Panay Island*, 19 May
- Dr. Fernando Siringan**, University of the Philippines Diliman / Philippines: *Submarine groundwater discharge at the reef flat of Santiago Island, Bolinao, Philippines*, 3 June
- Dr. Raul Suarez**, University of California / USA: (1) *Metabolic scaling: a many splendored thing*, 22 June; (2) *The sugar oxidation cascade in nectarivorous vertebrates*, 28 June; (3) *Metabolic scaling in Panamanian orchid bees*, 6 July; and (4) *Deforestation, kaingin and Philippine biodiversity*, 13 July
- Dr. Benjamin Thompson**, Imperial College / London: *Investigating the blue carbon potential of mangroves: a case study from Panay Island, the Philippines*, 27 June
- Dr. Avigdor Abelson**, Tel-Aviv University / Israel: *Coral reef restoration: the unbearable lightness of a fast gallop on a smooth wrong way*, 4 October
- Dr. Masaki Kodama**, Fisheries Research Agency / Japan: *Nitrogen dynamics in shrimp pond and environmental improvement ability of sandfish*, 13 October
- Dr. Rosario Monsalud**, University of the Philippine Los Baños / Philippines: *Long-term ex-situ conservation and quality control of microbial resources for sustainable utilization*, 19 October
- Dr. Jurgenne Primavera**, PEW Fellow and Scientist Emerita of SEAFDEC/AQD / Philippines: *Climate change mitigation: The needs for science-based reforestation, with emphasis on native flora*, 17 November
- Dr. Lucille Abad**, Philippine Nuclear Research Institute / Philippines: *Radiation processing of polymer applications*, 22 November
- Dr. Dustin Kemp**, University of Georgia / USA: *Coral-dinoflagellate symbiosis and environmental challenges that modern coral reefs have to endure*, 25 November

## FishWorld

As AQD's museum-aquarium and visitor center dedicated to science and environment education for the general public, FishWorld continued to teach about aquatic ecosystems and biodiversity, aquaculture, fisheries, and the aquatic sciences.



In 2011, FishWorld mentored 38 high school students; conducted nine sci-art contests among 186 students and 121 coaches from 16 elementary schools and ten high schools; and worked on endangered megafauna (19 sea turtles, one dwarf sperm whale, one dugong, one whale shark and two sunfish).

A whale shark entrapped in a fish corral was released on 25 January with the help of local fish wardens



## AQD papers in science journals and proceedings



The **2011 Elvira O. Tan Memorial Award** was won by **AQD scientist Dr. Emilia Quinitio**. Her paper *Domestication of the mud crab *Scylla serrata** was adjudged as the **Best published paper in inland fisheries**. Her co-authors were Ms. Joana Joy de la Cruz, Dr. Maria Rowena Eguia, Dr. Fe Dolores Estepa, Mr. Gaudioso Pates, and Dr. Celia Lavilla-Pitogo. The award was given by the (Philippine) Department of Science & Technology (DOST) on 29 July in Laguna



The **Best Research Award for Young Scientist** (second place) was won by **AQD researcher Mr. Joseph Leopoldo Laranja Jr.** His paper *Effects of dietary L-tryptophan on the antagonistic behavior, growth and survival of juvenile mudcrab *Scylla serrata** was selected in the agricultural research category. Dr. Emilia Quinitio, Dr. Mae Catacutan, and Dr. Relicardo Coloso co-authored the paper. MERCK Philippines Inc and DOST gave the award on 13 May in Manila

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

- Asian Pacific Aquaculture Conference and Giant Prawn 2011** (17-20 January; Kochi, Kerala State, India) organized by Asian Pacific Aquaculture Conference Chapter of the World Aquaculture Society
- 9<sup>th</sup> Session of FAO Committee on Fisheries (COFI)** (30 January-02 February; Rome, Italy) organized by Food and Agriculture Organization
- Aqua Aquaria 2011 Conference** (6-8 February; Tamil Nadu, India) organized by Marine Products Export Development Authority (MPEDA), Government of India
- 9<sup>th</sup> Asian Fisheries Forum** (21-25 April; Shanghai, China) organized by Asian Fisheries Society
- 22<sup>nd</sup> NACA Governing Council Meeting** (9-12 May; India) organized by NACA
- World Aquaculture Society Conference** (6-10 June; Natal, Rio Grande do Norte, Brazil) organized by World Aquaculture Society
- 4<sup>th</sup> Congress of the International Society of Applied Phycology** (19-24 June; Halifax, Canada) organized by International Society of Applied Phycology
- 2011 Aquaculture Stakeholders Strategic Planning Meeting** (24-26 August; Kona, Hawaii) organized by United Soybean Board (USB) and US Soybean Export Council (USSEC)
- Short-term research & training on Advanced Program to Foster Young and Female Researchers from the Southeast Asia in Sustainable Fisheries Sciences** (22 August-26 September & 31 August-05 October; Hokkaido University, Japan) organized by Faculty of Fisheries Sciences, Hokkaido University
- Short-term training program- Internship Program for Young Researchers in Indo-China in the Field of Life Sciences** (15 September- 31 October; University of Tsukuba, Ibaraki,

AQD Chief Dr. JD Toledo signs an agreement with a media news group (FARM Inc) to promote AQD's aquaculture technologies through the television program *Mag-Agri Tayo* on NBN-4



## CONTINUED

Japan) organized by University of Tsukuba / JENESYS

**JSPS Asia and Africa Science Platform Program**  
**--Establishment of Research and Educational Network for Science of Sustainable Fisheries in Southeast Asian Marine Community** (3-27 October; Hokkaido University, Japan) organized by Hokkaido University

**FAO/SPC Regional Scoping Workshop: Development of a Pacific Aquaculture Regional Cooperative Programme** (11-14 October; Nadi, Fiji) organized by Food and Agriculture Organization

**10th Regional Fish Health Advisory Group Meeting** (19-20 November; Mangalore, India) organized by Network of Aquaculture Centers in Asia Pacific; Karnataka Veterinary, Animal & Fisheries Sciences University

**8th Symposium on Disease in Asian Aquaculture (DAA8)** (21-25 November; Mangalore, India) organized by Fish Health Section of the Asian Fisheries Society; Karnataka Veterinary, Animal and Fisheries Sciences

## New agreements

*Commonwealth of Australia represented by ACIAR (Australia):* Carry-out research on improved seaweed culture and post-harvest waste utilization in Southeast Asia (30 May 2011 - 31 May 2015)

*ACDI/VOCA (Washington DC):* Conduct training and provide technical assistance on mud crab (19 Aug 2011 - 30 Sept 2011)

*Japan International Research Center for Agricultural Sciences (Tsukuba, Japan):* Provide technical assistance and permit use of facilities as well as counterpart scientists for the conduct of research. Provide accommodation and assistance to JIRCAS scientists (14 July 2011 - March 2016)

*Freshwater Fisheries Research Center, Chinese Academy of Fishery Sciences (Wuxi, China):* Provide technical support through exchange of staff, research collaborations and conduct of training (1 July 2011 - 1 July 2013)

*Nagasaki University School of Dentistry (Nagasaki, Japan):* Conduct extraction of collagen (5 Jan 2011 - 5 Jan 2013)

*Universiti Teknologi Malaysia:* Provide technical support through exchange of staff, research collaborations and conduct of training (Dec 2011 - Dec 2014)

*Bureau of Fisheries and Aquatic Resources - Philippines (BFAR):* Conduct series of training for BFAR Regional Fisheries Training Centers (starting 15 March 2011)

*Bureau of Fisheries and Aquatic Resources Regional Office No. 5 - Philippines (BFAR-R5):* Train beneficiaries on marine fish hatchery & nursery; provide technical and administrative assistance (starting 12 April 2011)

*Bureau of Fisheries and Aquatic Resources Regional Office No. 11 - Philippines (BFAR-R11):* Train beneficiaries on marine fish hatchery; provide technical and administrative assistance

*Provincial Government of Pangasinan (Philippines):* Provide technical and training support. Prepare project proposal and undertake research suitable for the project of the Province (Feb 2011 - Feb 2016)

*Protected Area Management Board-Sagay Marine Reserve (Philippines):*

Undertake research on stock enhancement and socio-economic aspects in the Sagay Marine Reserve. Provide trainings and information dissemination relevant to the project (26 Jan 2011 - 26 Jan 2015)

*Foundation for Agriculture-Related Missions (FARM) Inc. (Philippines):* Provide topics/technologies and make available resources for filming (starting 17 Sept 2011)

*Surigao Del Norte College of Agriculture and Technology (Philippines):* Provide technical support through exchange of staff, research collaborations and conduct of training (6 Jan 2011 - 6 Jan 2016)

*Aklan State University (Philippines):* Provide technical support through exchange of staff, research collaborations and conduct of training (21 Oct 2011 - 21 Oct 2016)

*University of the Philippines Visayas:* Permit use of facilities for the conduct of student research on (1) tiger shrimp *Penaeus monodon* (24 Feb 2011 - 24 May 2011) and (2) snubnose pompano *Trachinotus blochii* (3 Nov 2011 - 3 April 2012 and 8 Nov 2011 - 8 March 2012)

*University of the Philippines Visayas:* Carry-out research on integrated and sustainable development program for the shrimp industry (1 June 2011 - 31 May 2014)

*University of the Philippines Diliman:* Permit the use of facilities and staff for the conduct of a student research on fish oral vaccines (7 Dec 2011 - 7 Dec 2012)

*Lunsad Multi-Purpose Cooperative (Philippines):* Assist in the strengthening of training and extension capabilities (2 March 2011 - 2 March 2014)

*San Miguel Corporation (Philippines):* Carry-out research on the comparison of performance of formulated diets used for grow-out culture of *Penaeus monodon* and *P. vannamei* (15 March 2011 - 15 March 2012)

*Meralco Foundation Inc (MFI):* Provide training to agriculture entrepreneurship students and technical assistance for MFI's on-farm demonstration aquaculture projects

*Mr. David B. Villaluz (Philippines):* Provide technology and technical assistance on net cage culture of tilapia (7 June 2011 - 15 Jan 2012)

## Statement on sources and application of funds

SOURCES OF FUNDS		APPLICATION OF FUNDS	
Government of the Philippines	Php 170 000 000	General / administrative & non-project expenses	Php 134,657,984
Government of Japan Trust Fund	13 232 521	AFD	38 401 108
Fish health	3 495 533	Management	11 226 480
Food safety	1 690 662	RD	53 095 764
Sustainable aquaculture	5 475 257	TVDD	20 505 105
Resource enhancement	2 571 069	TID	11 429 527
<b>External grants</b>	<b>19 942 105</b>	<b>Program / project expenses</b>	<b>29 911 948</b>
ACIAR - seaweed	1 491 686	RD	18 312 429
BFAR Region IV - milkfish hatchery	1 000 000	TVDD	8 705 262
BFAR Region V - Cam Sur hatchery	662 300	TID	2 894 257
BFAR Region VIII - hatchery in N Samar	1 178 143	<b>GOJ-TF</b>	<b>13 232 521</b>
BFAR Region XI - hatchery in Davao	1 593 797	Fish health	1 616 636
BFAR - RFTC - training of trainers	2 800 000	Food safety	1 276 433
BFAR - BIOTEC - Biotech laboratory	5 000 000	Sustainable aquaculture	4 702 695
DBP - technical assistant	849 883	Resource enhancement	1 967 928
DOST - NRCP - native Caridean prawns	106 900	GOJ committed funds / advances	3 668 829
Fats & Protein Research	259 979	<b>Externally funded projects</b>	<b>28 393 454</b>
ICLARM - sandfish	1 045 699	ABOT collaborative projects	457 903
JIRCAS - tiger prawn polyculture system	977 787	ACIAR - fisheries resource mgt	731 723
LMPC - tech development & training	41 000	ACIAR - seaweed culture	1 741 601
Marine Environment & Resources Foundation (MEARFI)	168 025	ASCOT - marine fish hatchery	38 510
NCSU - alternative feeding study	1 648 896	ASEAN Foundation - RTC	249 565
ICDSA - Rapu-rapu assessment	20 650	BFAR - biotech laboratory	7 495 043
San Miguel Foods - formulated diets	100 000	BFAR - multi-species hatchery	4 376 306
SEAFDEC Secretariat (PCM)	203 442	BFAR-RFTC - training of trainers	2 578 767
University of Wageningen	116 375	DBP - technical assistance	1 023 896
USB - soybean and soy protein study	602 543	Development of techniques	11 114
Worldfish - governance & sustainability	75 000	DOST-NRCP - domestication & evaluation	89 876
<b>Internally generated funds</b>	<b>27 077 468</b>	FAO - workshop on-farm feed	1 004 499
Income - RD	7 039 437	Fats & Protein Research	246 446
Income - TID	4 275 919	ICLARM - sandfish	1 118 487
Income - TVDD	6 559 061	ICDSA - Rapu-rapu project	112
Income - AFD	8 649 785	JIRCAS	1 450 674
Income - Management	553 266	MEARFI	182 427
Committed funds from prior year	66 201 627	NCSU - milkfish production	1 657 961
<b>Total sources of funds</b>	<b>Php 296 453 721</b>	Novus International - grouper study	41 643
		PETRON - milkfish cage culture	98 103
		PETRON - milkfish cage culture	1 655 570
		PETRON / Citi Foundation / TSKI	266 025
		RESCOPAR	117 828
		San Miguel Foods - formulated diets	1 538
		UNESCO - guidebook	20 300
		USB - soybean study	1 662 537
		WorldFish	75 000
		<b>Committed funds</b>	<b>90 257 814</b>
		Advances for on-going activities	1 685 030
		Capital outlay / repairs	88 572 784
		<b>Total application of funds</b>	<b>Php 296 453 721</b>

## AQD community notes

Every year, employees divide themselves into two teams for a friendly three-day sportsfest; it was Team Abalone vs. Team Sandfish in 2011



Employees and supervisors undergo seminars in 2011 on management policies and stress reduction, 26 January, 1 February, 17-18 May, and 11-13 July

AQD senior scientist Dr. Relicardo Coloso (below, left) delivered the 2011 Dean Domiciano K. Villaluz Memorial Lecture on *Feed formulation for healthy and wholesome aquaculture* on 7 July at AQD. It is to be noted that it was in Dr. Coloso's term as head (1992-1995) of Research Division (RD) that the DKV Lecture was conceptualized as RD's contribution to AQD's July anniversary celebration



AQD and Hokkaido University (Japan) jointly held the international seminar on *Environment-friendly aquaculture and stock enhancement* on 1 December at TMS

Afield is AQD's giant Christmas tree during the holidays



## AQD personnel distribution

As of 31 December 2011, AQD had a total personnel complement of 194 (regular employees, 116; fixed-term employees, 78)

### AQD officers in 2011

<i>AQD Chief</i>	Dr. Joebert Toledo
<i>Deputy Chief</i>	Dr. Teruo Azuma
<i>Head, RD</i>	Dr. Evelyn Grace Ayson / Dr. Relicardo Coloso
<i>Head, TVDD</i>	Dr. Ma. Rowena Eguia
<i>Head, TID</i>	Mr. Renato Agbayani
<i>Head, AFD</i>	Ms. Renee Valencia
<i>Head, BFS</i>	Engr. Emiliano Aralar
<i>Head, DBS</i>	Mr. Hanani Torilla
<i>Head, IMS</i>	Mr. Albert Gaitan
<i>Head, Manila Office</i>	Ms. Grace Garcia

### Program leaders

<i>Mollusc</i>	Ms. Milagros dela Peña
<i>Mudcrab &amp; shrimp</i>	Dr. Fe Dolores Estepa
<i>Marine fish</i>	Dr. Felix Ayson
<i>Seaweeds</i>	Ms. Ma. Rovilla Luhan
<i>Freshwater aquaculture</i>	Dr. Ma. Rowena Eguia
<i>Aquatic ecology</i>	Dr. Ma. Junemie Hazel Ramos
<i>Regional programs</i>	Dr. Teruo Azuma

### Section heads

[RD]	
<i>Breeding &amp; seed production</i>	Dr. Emilia Qunitio
<i>Fish health</i>	Dr. Edgar Amar
<i>Nutrition &amp; feed development</i>	Dr. Mae Catacutan
<i>Farming systems &amp; ecology</i>	Dr. Ma. Junemie Hazel Ramos / Dr. Jon Altamirano
<i>Socioeconomics</i>	Dr. Nerissa Salayo
[TVDD]	
<i>Demonstration &amp; packaging</i>	Ms. Jocelyn Ladja
<i>Technology verification</i>	Mr. Dan Baliao
[TID]	
<i>Training</i>	Ms. Kaylin Corre
<i>Development communication</i>	Ms. Milagros Castaños
<i>Library &amp; data banking services</i>	Ms. Luisa Pacino
[AFD]	
<i>Engineering</i>	Engr. Zaldy Suriaga
<i>Human resource management</i>	Ms. Renee Valencia
<i>Budget-cashiering</i>	Mr. Juan Garin Jr.
<i>Accounting</i>	Ms. Amelita Subosa

RD, Research Division

TVDD, Technology Verification & Demonstration Division

TID, Training & Information Division

AFD, Administration & Finance Division

BFS, Binangonan Freshwater Station

DBS, Dumangas Brackishwater Station

IMS, Igang Marine Station



**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.

Email: aqdchief@seafdec.org.ph

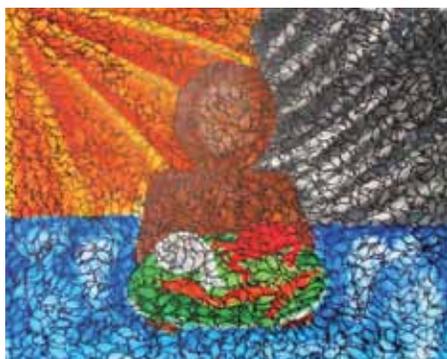
Tel. (63 33) 511-9170 to 71 Fax (63 33) 511-8709, 511-9070

**Winning children's artwork at the ASEAN-SEAFDEC drawing contest 2011 (Philippines)**

**Global fishing**

Acrylic

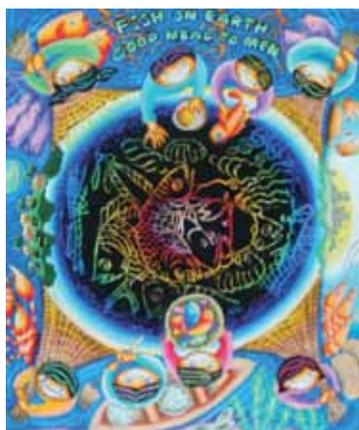
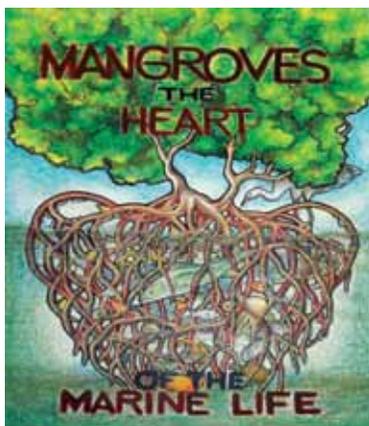
Ms. Aubrey Beatrice Carnaje, 10 yrs old



**Everything in nature is a web**

Oil pastel

Ms. Jann Martine Esperancilla, 13 yrs old



**Fish on earth, good meal to men**

Oil pastel

Ms. Laurice Anne Lima, 11 yrs old



**Protecting aquatic resources**

Oil pastel

Ms. Mariela Quipid, 12 yrs old