AQD Highlights 2005

Annual Report
SEAFDEC Aquaculture Department
Tigbauan, Iloilo, Philippines

Raising Rural Productivity through aquaculture

The AQD Chief reports

The SEAFDEC Aquaculture Department (AQD) implemented several programs aimed at generating and transferring technologies for responsible and sustainable aquaculture in the ASEAN-SEAFDEC Member Countries. The programs included research, technology verification and demonstration, training, and information dissemination. AQD convened five regional consultations in 2005 as part of the implementation of the SEAFDEC regional programs.

The many beneficiaries of AQD's programs recognize its efforts at providing technologies and information products and services. In particular, the technology demonstrations done in government hatcheries and farms through the Integrated Regional Aquaculture Program and the Mangrove-Friendly Aquaculture Program have been highly appreciated by the Member Countries.

Several AQD projects were done in collaboration with government agencies, universities, local governments, non-government organizations, and the private sector. Collaborative research was done with the European Union, the Japan International Research Center for Agricultural Sciences, and the Fisheries Research Agency of Japan. Professors from Philippine universities were invited to AQD as Visiting Scientists to conduct some research in immunology, seaweed strain improvement, and marine natural products such as polyunsaturated fatty acids. AQD hosted the Workshop on Education and Training for the Asia-Europe Meeting (ASEM) Aquaculture Platform and conducted training courses for UNESCO-MAB-SeaBRnet and BIMP-EAGA and a study tour for the Secretariat of the Pacific Community. The training course on Important Viral Diseases of Fishes and Shrimps was conducted by AQD with the Office International Epizooties Tokyo for the second year in a row.

AQD enhanced SEAFDEC visibility and communication in a variety of ways. AQD scientists participated in several international scientific conferences, symposiums, and experts' workshops in aquaculture and fish health management. AQD joined six fairs and exhibits in three countries. AQD produced and distributed several flyers and brochures, two regional codes, the annual report *AQD Highlights*, and the newsletter *AQD Matters*. The Library, website, Bookstore, and FishWorld continued to serve readers, students, information seekers, and visitors.

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SEAFDEC/AQD responds to Southeast Asia

AQD in the context of SEAFDEC

Programs of the Southeast Asian Fisheries Development Center in 2005

		Department(s) responsible
	Departmental Programs	
1.	Center-Wide Information Network	SEC
2.	Working Group on Regional Fisheries Policy	SEC
3.	Information and Communications Technology	TD
4.	**Broodstock Management and Seed Quality Improvement**	**AQD**
5.	**Responsible and Sustainable Aquaculture Technologies**	**AQD**
6.	**Collaborative Program with Philippine Agencies**	**AQD**
	Regional Programs under the ASEAN-SEAFDEC FCG Mechanism	
1.	**Regionalization of the Code of Conduct for Responsible Fisheries in Southeast Asia**	**SEC, AQD**
2.	**Promotion of Mangrove-Friendly Aquaculture in Southeast Asia**	**AQD**
3.	**Development of Fish Disease Surveillance System**	**AQD**
4.	**R&D on Stock Enhancement for Threatened Species under International Concern**	**AQD, MFRDMD**
5.	Assistance of Capacity-Building in the Region to Address International	SEC
6.	Management of Shark Fisheries and Utilization in Southeast Asia	SEC
7.	Information Collection for Sustainable Pelagic Fisheries in the South China Sea	MFRDMD
8.	Research and Analysis for Chemical Residues and Contamination in Fish, Fish Products, Fishing Grounds, and Fish Farms	MFRD
9.	Capacity Improvement of Fisheries Community for Fisheries Management and Alleviation of Poverty	TD
10.	Special 5-year Program on Sustainable Fisheries for Food Security in the ASEAN Region	
	• **Aquaculture for Rural Development**	**AQD**
	• **Supply of Good Quality Seeds**	**AQD**
	• Towards Decentralized Management for Sustainable Fisheries	SEC
	• Improvement of Fishery Statistical System and Mechanisms	SEC
	• Responsible Fishing Technologies and Practices	TD
	• Resource Enhancement	TD
	• Harvesting of Underexploited Resources	TD
	• Indicators for Sustainable Development and Management of Fisheries	MFRDMD
	• Information Gathering for Inland Capture Fisheries	MFRDMD
	• Maximizing the Utilization of Fish Catch	MFRD
	• Fish Quality and Safety Management Systems	MFRD

SEC Secretariat
TD Training Department
AQD Aquaculture Department
MFRD Marine Fisheries Research Department
MFRDMD Marine Fisheries Resources Development and Management Department

Research and Development

Aquaculture continues to be a significant producer of fish, crustaceans, mollusks, seaweeds, and other fishery products needed for food security, employment, and poverty alleviation in Southeast Asia. SEAFDEC/AQD's Departmental Programs gradually shifted from being discipline-based to being commodity-based. Each commodity program was implemented in terms of the continuum from research to commercialization.

AQD Departmental Programs

Program 1. Broodstock Management and Seed Quality Improvement
- Abalone production
- Mud crab production (with the European Commission)
- Shrimp domestication
- Marine fish seed production (with JIRCAS and ACIAR)

Program 2. Responsible Aquaculture Technologies
- Technology verification and commercialization
- Freshwater aquaculture for livelihood

Program 3. AQD Collaboration with Philippine Agencies
- Aquaculture biotechnology (with UPV, MSU, UEP, NFRDI, BFAR)
- Adoption and dissemination of milkfish technologies (with BFAR and World Fish Center)

Regional Programs under the ASEAN-SEAFDEC Fisheries Consultative Group Mechanism

Program 1. Regionalization of the Code of Conduct for Responsible Fisheries
Program 2. Promotion of Mangrove-Friendly Aquaculture
Program 3. Stock Enhancement for Threatened Species of International Concern
Program 4. Regional Fish Diseases Program: Development of Fish Disease Surveillance System
Program 5. Integrated Regional Aquaculture Program

Scientific research is the method of choice for filling in gaps in knowledge, information, and technologies for responsible aquaculture. AQD implemented a large number of research and technology verification projects (pages 6-7), as well as a wide variety of training, publications, and information dissemination projects.

Donkey-ear abalone Haliotis asinina

Tiger grouper Epinephelus fuscoguttatus

Start	% done	Projects	Leaders	Approved budgets (PhP) AQD	External agencies		Expenses (PhP)
		Abalone Production					
2005	75	Refinement of seed production techniques for abalone *Haliotis asinina*	SM Buen-Ursua	1,196,881			1,362,253
2005	50	Propagation and use of diatoms *Amphora* and *Navicula* for feeding abalone larvae	MR de la Peña	118,000			85,836
2005	15	Nursery of the abalone in land-based flow-through tanks and in open-water fixed bottom cages	SM Buen-Ursua	153,479			
2005	15	Participatory grow-out of abalone *Haliotis asinina* in cages at Manlot Island, Carles, Iloilo	SM Buen-Ursua	212,279	184,400	Rotary Club	63,949
		Mud Crab Production					
2002	100	Culture and management of *Scylla* Species: Seed production	ET Quinitio		381,421	EC-CMMS	493,545
2002	100	Culture and management of *Scylla* Species: Nursery	FDP Estepa		161,376	EC-CMMS	222,690
2003	100	Culture and management of *Scylla* Species: Geography and hydrography of Aklan mangroves	MJHL Lebata		-	EC-CMMS	-
2002	100	Culture and management of *Scylla* Species: Fisheries of *Scylla* species in Western Visayas	JH Primavera		1,096,943	EC-CMMS	707,388
2002	100	Culture and management of *Scylla* Species: Refinement of mangrove-mud crab pen systems	JH Primavera		308,737	EC-CMMS	420,261
2005	30	Refinement of broodstock management and seed production techniques for mud crab	ET Quinitio	1,151,097			1,209,210
2005	20	Cost-effective techniques for culture, harvest, and preservation of green microalgae for crab and fish seed production	MR de la Peña	218,000			117,886
		Shrimp Domestication					
2005	5	Improvement of maturation of pond-reared *Penaeus monodon* broodstock	ET Quinitio	250,000			29,779
2005	5	Refinement of broodstock management and larval rearing of *P. indicus* and *P. merguiensis*	FDP Estepa	218,900			129,059
		Marine Fish Seed Production					
2005	10	Refinement of techniques, pilot scale operation, and feasibility of marine fish seed production	DR Chavez	3,255,148			3,325,379
2004	50	Insulin-like growth factor II (IGF-II) as molecular markers for egg quality in fish and mud crab	J Bangcaya	483,008	402,989	ACIAR	857,470
2003	70	Pathogenesis and control of subclinical viral nervous necrosis in broodstock of grouper	I Kiryu		293,570	JIRCAS	283,658
2004	90	Reproductive and larval performance of rabbitfish *Siganus guttatus*	H Ogata/DR Chavez		1,253,534	JIRCAS	1,203,303
		Freshwater Aquaculture for Livelihood					
2005	5	Growth and survival of Asian catfish fry reared in net cages with and without supplemental feeding in Laguna de Bay	AD Evangelista	176,000			30,000
2005	new	Production of milkfish *Chanos chanos* fingerlings in modular lake-based in Laguna de Bay	MLC Aralar	274,472			2,646
		Technology Refinement and Dissemination					
2004	100	Poverty alleviation through aquaculture: increasing food and income through fish farming	NM Franco	350,000	243,954	AusAID	387,042
2004	50	Aquaculture Consultancy Project in Ngatpang State in Palau	JEA Basco		1,673,642	Palau	1,645,635
2004	100	Grow-out of *Penaeus monodon* by the SEAFDEC/AQD environment-friendly method	CMV Ganancial		778,721	Hautea	449,736
2005	100	Grow-out of *Penaeus indicus* by the SEAFDEC/AQD environment-friendly method	CMV Ganancial	1,651,979			482,212
2005	90	Seed production of shrimps	CMV Ganancial	129,401			323
2005	90	Seed production of SEAFDEC/AQD saline-tolerant tilapia *Oreochromis* spp.	CMV Ganancial	109,401			13,253
2005	90	Grow-out of milkfish and tilapia in brackishwater ponds	CMV Ganancial	233,851			22,037
2005	10	Modified-extensive shrimp farming with nursery pond component	CMV Ganancial	352,118			138,691
2005	30	Grow-out of humpback grouper *Cromileptes altivelis* in floating net cages	NRS Jamon	827,025			118,519
2005	30	Grow-out of humpback grouper *Cromileptes altivelis* in ponds	NRS Jamon	799,597			191,307
2005	25	Grow-out of grouper *Epinephelus* spp. in floating net cages	NRS Jamon	684,302			149,889
2005	90	Grow-out of grouper *Epinephelus* spp. in brackishwater ponds	NRS Jamon	490,806			73,012
2005	90	Grow-out of mud crab *Scylla serrata* in mangrove pens	NM Franco	419,246			177,419
2005	90	Grow-out of mud crab *Scylla serrata* in brackishwater ponds	NM Franco	100,220			90,721
2005	75	Commercialization of grow-out of mud crab *Scylla serrata* in ponds	NM Franco	672,793		Private Sector	25,671
2005	0	Commercialization of grow-out of mud crab *Scylla serrata* in mangrove pens	NM Franco	127,646		Private Sector	500
2005	0	Verification of grow-out technology for soft-shelled crab production in floating cages	NM Franco	211,699			35,076

Start	% done	Projects	Leaders	Approved budgets (PhP) AQD	Approved budgets (PhP) External agencies		Expenses (PhP)
		Collaboration with Philippine Agencies: Aquaculture Biotechnology					
2004	42	Evaluation of nutritional and microbial derivatives as immunostimulants in grouper	EC Amar	100,000		UPV	1,644
2005	20	Polyunsaturated fatty acids as useful compounds in aquaculture and human nutrition	JM Oclarit	346,019		MSU	345,694
2005	20	Strain improvement of farmed carrageenan-producing marine macroalgae	RC Salvador	146,600		NFRDI	207,325
2005	75	Phytic acid levels in non-conventional feedstuff in various processed forms	RGG Ledesma		242,597	NFRDI	3,675
2005	75	Growth performance of GET-EXCEL tilapia fed diets with azomite as mineral mix	RGG Ledesma		612,170	NFRDI	23,058
		SEAFDEC-BFAR-WorldFish Collaboration					
2004	100	Dissemination and adoption of milkfish aquaculture technology in the Philippines	WG Yap		733,449	World Fish	716,391
		SEAFDEC-FRA Collaboration					
2004	10	Characteristics of koi herpesvirus isolates from Asia	GL Po		730,893	FRA, Japan	561,956
		Mangrove-Friendly Shrimp Farming					
2004	100	Beneficial mangrove-friendly shrimp aquaculture practices: assessment of investment, income, and environmental benefits (Thailand experience)	S Ekmaharaj		250,000	GOJ-TF	250,000
2004	100	Economic valuation of environment-friendly shrimp farming in mangrove areas (Philippine experience)	G Samonte-Tan		250,000	GOJ-TF	199,488
2004	100	Mangrove friendly shrimp culture in Malaysia	DD Baliao			GOJ-TF	
2004	100	Mangrove friendly shrimp culture in Myanmar	DD Baliao		150,000	GOJ-TF	113,506
		Stock Enhancement for Threatened Species of International Concern					
2005	10	Population dynamics, breeding, and seed production of sea horses	RJ Maliao	174,961			173,625
2005	10	Abalone fishery in Western Visayas and refinement of seeding strategies for stock enhancement	RJ Maliao	88,500			60,403
2005	new	Behavioral conditioning of the abalone *Haliotis asinina* for stock enhancement	SM Buen-Ursua		193,694	GOJ-TF	-
		Regional Fish Diseases Program: Development of Fish Disease Surveillance System					
2004	30	Surveillance of emerging fish viral pathogens in Southeast Asian countries	GL Po		945,450	GOJ-TF	739,552
2004	20	Monitoring and surveillance of transboundary pathogens in farmed shrimps and prawns	CL Pitogo		703,300	GOJ-TF	525,708
2004	20	Optimization and standardization of PCR protocols of important viral diseases of farmed and wild shrimps in the Philippines	LD de la Peña		270,500	GOJ-TF	405,862
2004	25	Viral nervous necrosis in wild and farmed fish in the Philippines	LD de la Peña		297,550	GOJ-TF	181,681
2004	40	Immunostimulation strategies against white spot syndrome virus	EC Amar		216,400	GOJ-TF	268,501
2004	65	Control of luminous bacterial disease of tiger shrimp with fish and other aquaculture species	EA Tendencia		216,420	GOJ-TF	291,103
2005	new	Regional survey of pesticide residues in fish and fish products and their environment	EA Tendencia		79,500	GOJ-TF	-
2005	new	Study on the withdrawal period of antibiotics used in aquaculture shrimps and fish	EA Tendencia		26,500	GOJ-TF	-
2005	new	Survey of chloramphenicol and nitrofuran in Southeast Asian fish and fish products	EA Tendencia		79,500	GOJ-TF	-
		ASEAN-SEAFDEC Integrated Regional Aquaculture Program					
2004	80	Morphometric characterization of *Macrobrachium rosenbergii* and related species in the Philippines	MR Eguia/ MLC Aralar		240,026	ASEAN	84,857
2003	80	Selective breeding for genetic improvement of *Macrobrachium rosenbergii* in Thailand	P Sodsuk		250,000	ASEAN	250,000
2003	100	Evaluation of growth rate of GI Macro II strain in different locations in Indonesia	E Nugroho		250,000	ASEAN	250,000

EC-CMMS European Commission—Culture and management of the mud crabs *Scylla* spp., ACIAR Australian Center for International Agricultural Research, AusAID Australian Agency for International Development, UPV University of the Philippines Visayas, FRA Fisheries Research Agency, JIRCAS Japan International Research Center for Agricultural Sciences, GOJ-TF Government of Japan Trust Fund, ASEAN Association of Southeast Asian Nations

Abalone Production

Abalone broodstock

Abalone is a high-value commodity with good local market and high export potential. It can be sold live at an ex-farm price of P300/kg. Blanched and blast frozen, it can be exported at US$12/kg. Major markets for abalone include Hongkong, China, and Korea. In tropical southeast Asia, the abalone of interest to aquaculture is the donkey-ear *Haliotis asinina*. Abalone can be grown in floating cages suspended from buoys or rafts, or in pens set at the bottom of shallow bays and coves with clean sea water.

AQD's Abalone Program went full-swing in 2005 with the following projects:

- Refinement of seed production technology for abalone *Haliotis asinina*
- Propagation and use of diatoms *Amphora* and *Navicula* for feeding abalone larvae
- Nursery of the abalone in land-based flow-through tanks and in open-water fixed bottom cages
- Participatory farming of abalone in bottom cages
- Grow-out of abalone in floating cages
- Training course: Hatchery and Grow-out of Abalone, 14-29 November 2005
- On-the-job Training in abalone hatchery

Refinement of seed production technology for abalone

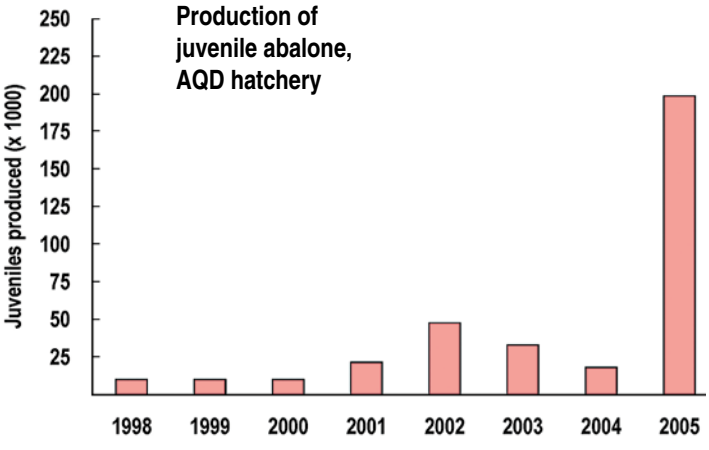
A total of 198,567 early juveniles (<1 cm in shell length) were produced in 2005. The marked increase was due to a steady supply of abalone broodstocks; more settlement plates and tanks made available to the larvae; feeding the larvae high densities of the benthic diatoms *Amphora* and *Navicula* during the first 5-10 days of rearing; continuous feeding with mixed diatoms until early juveniles reached 0.5 cm; and feeding with sufficient seaweed *Gracilaria* until the juveniles reached 2 cm. The AQD hatchery had about 620 breeder abalones in 2005.

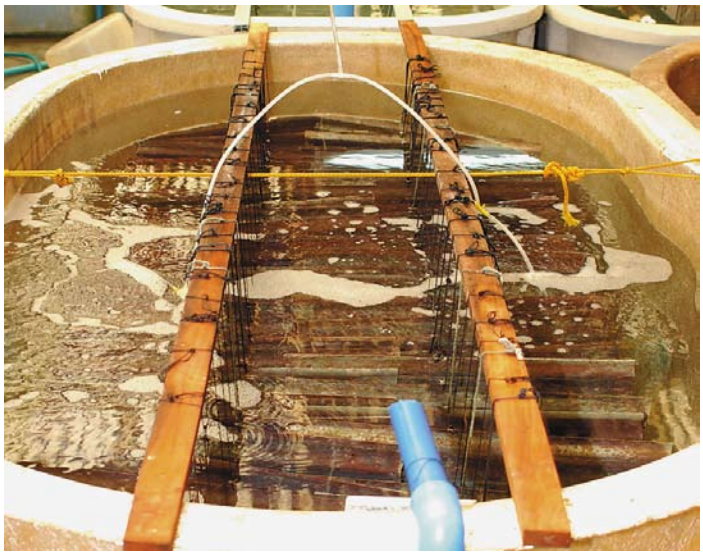
Abalone broodstocks, AQD hatchery in 2005

Broodstock source	Generation	Males	Females	Total
Concepcion 2005	Wild	63	157	220
Igang (old) 2005	Hatchery-bred F1-F2	10	32	42
Igang (new) 2005	Hatchery-bred F1	33	188	221
Panagatan Cays, Concepcion, 1990s	Hatchery-bred Fx	48	89	137
Total		154	466	620

Use of the benthic diatoms *Amphora* and *Navicula* for feeding abalone larvae

Replicate groups of abalone larvae were given equal biomass of either *Amphora*, *Navicula*, both species, or mixed diatoms, and the settlement rates were determined on days 5, 10, and 15. In the first run, highest settlement (2.9% on day 15) was attained among larvae fed both *Amphora* and *Navicula*, but was not significantly different from the other treatments. Higher settlement was recorded on plates with crustose coralline algae than without. A total of 8,810 juveniles were harvested from run 1 after 90 days. In the second run, larvae fed mixed diatoms had the highest settlement (2.5% on day 10, 4.4% on day 20) on plates without crustose coralline algae but not significantly different from the other treatments. Survival of juveniles was also highest on a diet of mixed diatoms (given at high density and frequency) and 19,714 were harvested from run 2 after 90 days.





Settlement plates for abalone larvae

Trainees at work at the abalone hatchery, November 2005

Nursery of the abalone in land-based flow-through tanks and in open-water fixed bottom cages

Some 3,600 early juvenile abalones (average weight <0.1 g, shell length 0.8 cm) were transported to Manlot, Carles, Iloilo on 22 Aug 2005. After four months, they grew to 4.4 g and 2.7 cm. In contrast, the same batch of early juveniles reared in flow-through concrete tanks at the AQD hatchery grew to only to 2.6 g and 2.2 cm. The better growth of early juveniles in open-water bottom cages may be due to the microalgae present that served as food besides the seaweeds.

Grow-out in floating cages at Igang Marine Station

AQD maintains 27 round net cages for abalone—4 cages for nursery and 23 cages for grow-out. These cages are hung from floating rafts and fed *Gracilaria*.

Grow-out in floating cages in Escalante, Negros Occidental

Some 20,600 juvenile abalones were transported to Escalante on 10 Nov 2005, a trip that took 8 hours and caused 3.5%mortality over the next 48 hours. The abalones are kept in floating plastic boxes with fine-mesh net and fed *Gracilaria*.

Floating cage for abalone at AQD's Igang Marine Station

Juvenile abalone packed in oxygenated bags were given to MaBaKAs cooperators by Speaker Jose De Venecia, Jr. and Iloilo First District Congresswoman Janette Garin on 15 July 2005

On-farm research on abalone

AQD forged ties with private cooperators to study the economics of abalone growout in actual farm situations. The cooperators involved are MaBaKAs of Manlot Island, Carles, Iloilo and the Cruz Aquafarm in Tando, Nueva Valencia, Guimaras. MaBaKAs is the Manlot Bantay Katunggan Association, which consists of fisher families in Manlot Island. The group's abalone farm is being assisted financially by the Rotary Club of Lapaz, Iloilo City. Aside from providing the abalone seedstock, AQD also trained in June 2005 the members of MaBaKAs and the workers of Cruz Aquafarm in abalone farm management and monitoring. A ceremonial turnover of abalone seedstock from AQD to the private sector took place on 15 July at AQD Tigbauan.

Grow-out of abalone in fixed bottom cages

Some 5,000 juvenile abalones (4 g, 2.6 cm) were transported to Manlot Island, Carles, Iloilo, on 22 Aug 2005 and stocked in fixed bottom cages with the seaweed *Gracilaria* as food. After four months, the abalones grew to 15 g and 3.7 cm. They probably also grazed on the microalgae growing on rocks placed inside the cages as shelters. Some problems were noted. Some MaBaKas members showed poor attitude and lack of skills. Strong waves due to the northeast monsoon deformed the cage frames, tore the nets, and rolled the rocks inside. Some abalones escaped, were crushed to death, or exposed to predators (crabs, fishes, gastropods, mantis shrimps, octopus, starfish). It was essential to monitor the cage daily to check and repair the damage, get rid of predators, and search for missing abalones. Over a week, 51 abalones were recovered 2-5 meters away from the cage.

Mud Crab Production

The mud crabs *Scylla serrata* and related species now support a fast-growing demand in domestic and foreign markets, and more of them must now be sourced from aquaculture. AQD's Mud Crab Program included the research projects of the European Commission and related studies and training courses:

- Culture and management of *Scylla* species: Seed production
- Culture and management of *Scylla* species: Nursery
- Culture and management of *Scylla* Species: Fisheries in Western Visayas
- Culture and management of *Scylla* Species: Refinement of mangrove–mud crab pen systems
- Culture and management of *Scylla* Species: Geography and hydrography of Ibajay and Kalibo mangroves
- Refinement of broodstock management and seed production techniques for mud crab
- Cost-effective culture, harvesting, and preservation of green microalgae for crab and fish hatchery
- Training course: Crab Seed Production, 14 Sep–14 Oct 2005
- On-the-job training in mud crab hatchery

One major accomplishment in 2005 was the refinement of techniques for mud crab broodstock and hatchery. To provide good food to mud crab broodstock and juveniles, marine annelids are necessary—these may be mass produced using available technologies. Only mature (not berried) females from the wild or spawners in captivity are used for hatchery runs—to ensure that the egg mass is not badly contaminated. To establish a biosecure (virus-free) crab broodstock and hatchery, the spawners are grown from juveniles in captivity. To maintain good sanitation, the broodstock facility are provided efficient filters. Microbially aged water and concentrated algae are used instead of commercial probiotics. Commercialization of the mud crab hatchery technology is being fast-tracked to supply the demand of crab farmers. Two private hatcheries now work closely with AQD.

Scylla crablets (1 cm carapace width) produced at the AQD hatchery

Refinement of broodstock and hatchery management

Four water management schemes were tested for effects on mud crab larvae:

- T1 – daily water change, green algae *Nannochlorum* maintained at 50 x 10^3 cells/ml
- T2 – water change every 5 days, algae 50 x10^3 cells/ml
- T3 – water change every 5 days, algae 100 x10^3 cells/ml
- T4 – recirculating water at zoea 2, algae 50 x 10^3 cells/ml

Survival from zoea 1 to megalopa 4-5 was 6.7% in T3, 5.3% in T2, 3.3% in T4 and 1.6% in T1. The water management schemes did not significantly affect the bacterial flora of the rearing water, but the bacterial populations of the zoeae in T2, T3, and T4 were about one-tenth that in T1. Furthermore, the population of presumptive vibrios was less in T2, T3, and T4 than T1. These results suggest that daily water change in crab larval rearing may not be beneficial to the larvae. T3 gave the best results overall.

Another experiment tested T3 and two other treatments:

- T5 – water change only once during the culture period, algae 100 x10^3 cells/ml
- T6 – with probiotic (CP Biodream), water change every 5 days, algae 100 x10^3 cells/ml

After 20 days, survival of megalopae was higher in T3 (11.5%) than in T5 (7.96%) and T6 (5.71%). However, development through megalopa was fastest in T6. In the second run, another treatment was added:

- T7 – with probiotic, water change every 10 days, algae 100 x 10^3 cells/ml

Problems with broodstocks spawners from the wild and from ponds delayed the hatchery production. Still, in 2005, the crab hatchery produced 50,538 crablets (0.5-2 cm carapace width) of king crab *S. serrata* and 5,109 crablets (1-1.5 cm) of *S. olivacea*. Many crablets were used for experiments and only the excess were sold. The crablets were sold at lower than the prevailing market price under an agreement that the buyers will provide AQD information on the performance of the crabs in grow-out and also later give AQD broodstock for free.

Cost-effective culture, harvesting, and preservation of green microalgae for crab and fish seed production

Two freshwater microalgae, *Chlorella vulgaris* and *C. sorokiniana*, and two seawater microalgae, *Nannochlorum* sp. and *Chlorella* sp., were propagated by batch culture and concentrated by electrolytic and chemical (1 N NaOH) flocculation techniques. Freshwater microalgae are more stable in culture than the seawater species. The flocculated algae were fed to rotifers, but rotifer populations did not increase, perhaps due to the difficulty in digesting the microalgae or due to stress since rotifers were starved 24 hours before the experiment. The freshwater species *C. vulgaris* resulted in better survival of the rotifers.

Rearing tanks for mud crab larvae at the AQD hatchery

Trainees at the Crab Hatchery, September 2005

AQD technology for mud crab farming in Zamboanga Sibugay

AQD researchers visited a mud crab pen project in Alicia, Zamboanga Sibugay on 14-15 March 2005. Alicia is a coastal municipality along the 4,500 ha Tantanang Bay, which is shared by 16 villages, 75% of whose population depends on the bay (fish, shells, seaweeds) for livelihood. The federation NAGMMATABA (Nagkahiusang Mangingisda ug Mag-uuma sa Tantanang Bay) was organized in 1998 by the Alicia municipal government to curb illegal fishing and protect the environment. At present, NAGMMATABA has 10 community-based organizations or cooperatives, two with Muslim members; half of 385 members are fishers.

Alicia Fishery Technician Cristituto Batonghinog was among the Mindanao participants during the 1999 training course on Marine Fish Cage Culture at SEAFDEC/AQD. The same year, Cristituto was awarded an AQD fellowship to join the training course on Sustainable Aquaculture and Coastal Resource Management. He had the chance to observe SEAFDEC/AQD's experimental crab pens in the mangroves of Ibajay, Aklan. His training provided the inputs for a project proposal on mud crab farming in mangrove pens that was submitted to various funding agencies. In 2003, the provincial government obtained a grant from the Department of Science and Technology and the pens were operational the next year.

Cristituto Batonghinog and one of the mudcrab-mangrove pens in Alicia, Zamboanga Sibugay, March 2005

AQD works with the European Union

2005 was the last year of the European Commission Project on Culture and Management of *Scylla* spp., a 4-year collaboration among two European and two Southeast Asian partner institutions: the University of Wales-Bangor in the UK, the University of Gent in Belgium, Can Tho University in Vietnam, and the SEAFDEC Aquaculture Department in the Philippines. Lewis Le Vay of the University of Wales-Bangor was the Project Coordinator and Jurgenne Primavera of SEAFDEC/AQD was the Project Leader for the Philippines. The AQD mud crab team also included ET Quinitio, FP Estepa, CR Lavilla-Pitogo, ME Rodriguez, JH Lebata, J de Pedro, D Catedral, J Biñas, Q Ganon, L Gustilo, V Alava, and G Samonte-Tan. Several European students did parts of their theses with the *Scylla* Project at AQD and in Vietnam.

The *Scylla* Project was funded by the European Union, whose overarching principle of development cooperation is to support and develop sustainable benefits for stakeholders in developing countries without contributing to degradation of the natural environment. The *Scylla* Project supported conservation and protection of fisheries resources and biodiversity through development of farming technologies for mud crabs in coastal waters, and through mud crab stock enhancement integrated with mangrove conservation and rehabilitation. One set of studies sought to improve the reliability and economic viability of mud crab hatchery and nursery systems. Another set of studies dealt with the fisheries biology of *Scylla* species, crab-silviculture systems, and stock enhancement—tagging and release of hatchery-reared juveniles into mangrove habitats.

An International Workshop on Culture, Fisheries, and Stock Enhancement of Portunid Crabs was held in Iloilo City, Philippines on 20-22 January 2005 and was attended by 57 participants from 11 countries. Dr. Cornelia Nauen, the European Commission's Principal Scientific Officer for International Scientific Cooperation and Research graced the workshop. Dr. Patrick Sorgeloos, AQD's friend over the years, chaired one of the sessions and was honored with Dr. Nauen at a dinner hosted by AQD Chief RR Platon.

The Project members also met for a research evaluation workshop in Nha Trang, Vietnam in November 2005. A report on AQD's research results appeared in the July-September 2005 issue of the *SEAFDEC Newsletter*.

Participants of the International Workshop on Culture, Fisheries, and Stock Enhancement of Portunid Crabs, Iloilo City, Philippines, 20-22 Jan 2005

Reproduction in females fed diets with various lipid levels

Adult *Scylla serrata* were fed diets with 10, 12, or 14% lipid (as % dry weight, with squid oil and soybean lecithin as lipid sources) with or without natural food (mussel, squid, or fish). The period from ablation to spawning (32-56 days) and the period from spawning to hatching (10-14 days) did not vary significantly among treatments. The number of females whose eggs hatched to zoeae was higher in crabs fed natural food with and without the dry diets than in those fed dry diets only. Repeated spawning occurred in all crabs except those fed dry diets with 10% and 14% lipid.

Lipids in the ovaries, hepatopancreas, and muscles of broodstock and newly hatched zoeae increased with dietary lipid level, and were higher in crabs fed the dry diets plus natural food. Higher dietary lipid levels enhanced the levels of free fatty acids, triacylglycerols, cholesterol + diacylglycerides, phosphatidyl choline, and phosphatidylethanolamine + phosphatidylanisole levels in zoeae, and all were higher in crabs fed dry diets plus natural food. Blackened (melanized) ovaries were seen in broodstocks fed dry diets without natural food. The lipid classes and essential fatty acids in zoeae improved after the broodstock were fed both natural food and dry diets with 10-14% lipid.

Normal ovarian tissue

Melanized ovarian tissue

Heavily melanized ovarian tissue

Microbial populations in mud crab eggs and larvae

Spawned eggs and larvae of *Scylla serrata* and *S. tranquebarica* were examined to determine buildup of bacteria, fungi, protozoans, and other fouling organisms. The microbial pathogens and abnormal manifestations observed in broodstock and larvae were fungi, filamentous bacteria, protozoans (sessile and motile), and shell disease. Infestations in larvae were clearly due to infected eggs. To minimize microbial populations in the hatchery, spawners are disinfected with formalin and newly hatched larvae are carefully rinsed before stocking in rearing tanks.

Activity of probiotic bacteria strain C1 on mud crab larvae

A probiotic bacteria designated as strain C1 was found closely associated with the green microalga *Nannochlorum*. C1 was tested on *Scylla serrata* zoeae over a 16-day period by feeding them the rotifer *Brachionus* and brine shrimp *Artemia* that had incorporated the probiotic through immersion in 10^7 cfu/ml of C1 one hour before feeding. Zoeae were fed *Brachionus* at a density of 10-15 ind/ml starting on day 0 of the experiment, and *Artemia* at 1-5 ind/ml starting at late zoea 2. Half of the experimental setup used rearing water treated with antibiotic and fungicide, and the other half had no antibiotic or fungicide added. Bacterial count was done on the rearing water every other day, and the bacteria associated with zoeae were determined at every molting. Survival was determined daily.

No fungal infection was observed in all treatments. At day 10, the survival was not significantly different among treatments. At day 11, however, significantly higher survival was recorded in treatments with antibiotic than in treatments with C1. Thus, the beneficial activity of C1 did not surpass that of antibiotic. For probiotic bacterial strain C1 to positively influence the survival and bacterial flora of crab larval rearing systems, other means of application (through colonized surfaces in rearing tanks, or biofiltration systems) are necessary to augment application through natural food.

Counts of total bacteria and *Vibrio* spp. associated with zoeae were higher in those treated with C1 than in those without it. However, in the rearing water, both total bacteria and *Vibrio* spp. increased. In treatments where both probiotic bacteria and antibiotic were applied, the probiotic bacterial population in the rearing water was reduced by two orders of magnitude. However, a relatively stable probiotic bacterial population remained associated with the larvae starting at zoea 3 despite the antibiotic.

Fungal infection and control

Crabs have serious problems with fungi due to the long period of egg incubation within the abdominal flap making them susceptible to fungal colonization. Rapid fungal zoospore production ensures the continuous spread of infection over the egg mass and to the zoeae. Fungal infection in incubating eggs was recorded in 79% of berried females from day 3 post-spawning. Fungi isolated from mud crab eggs and larvae are either *Lagenidium*-like vesicle formers and *Sirolpidium*-like non-vesicle formers. Comparative tests were done on the effect of biocontrol bacteria and formalin on vesicle formation and spore release of *Lagenidium* sp. and *Sirolpidium* sp. Bacteria inhibited both processes after 48 h, but 10 ppm formalin did so after 18 h. Short-term (30 min to 2 h) exposure of hyphae to various salinities (0–30 ppt) did not affect viability, but 0–8 ppt inhibited sporulation and release. The motility of released spores was not affected by biocontrol bacteria, but was completely inhibited by 10 ppm formalin and 15 ppt salinity. Thus, fungal infection may be controlled by means of low salinity or low doses of formalin.

White spot syndrome virus (WSSV) in mud crabs

Different stages of *Scylla serrata* showed a low incidence of WSSV infection by one-step polymerase chain reaction (PCR) test, but high incidence by the nested PCR method. By definition based on shrimps, samples are considered diseased due to WSSV if they test positive by one step PCR. The absence of mud crab samples that tested WSSV-positive by one-step PCR indicates that mud crabs are not susceptible to WSSV but are carriers of the disease.

Since high mortality of wild crabs has been reported during the cold months (December–February), an experiment was done to determine temperature effects on WSSV infection rate. Crab juveniles were maintained at 20–22°C and at 27–29°C for 36 days. Survival was 97% at both temperature regimes, but crabs exposed at 20–22°C consistently tested WSSV-positive starting on day 15 and crabs at 27–29°C tested positive only after 25 days. About 37% of the crabs molted at 27–29°C, and only 17% at 20–22°C. Thus, mud crabs are tolerant to WSSV and temperature is not the only factor that causes mortality.

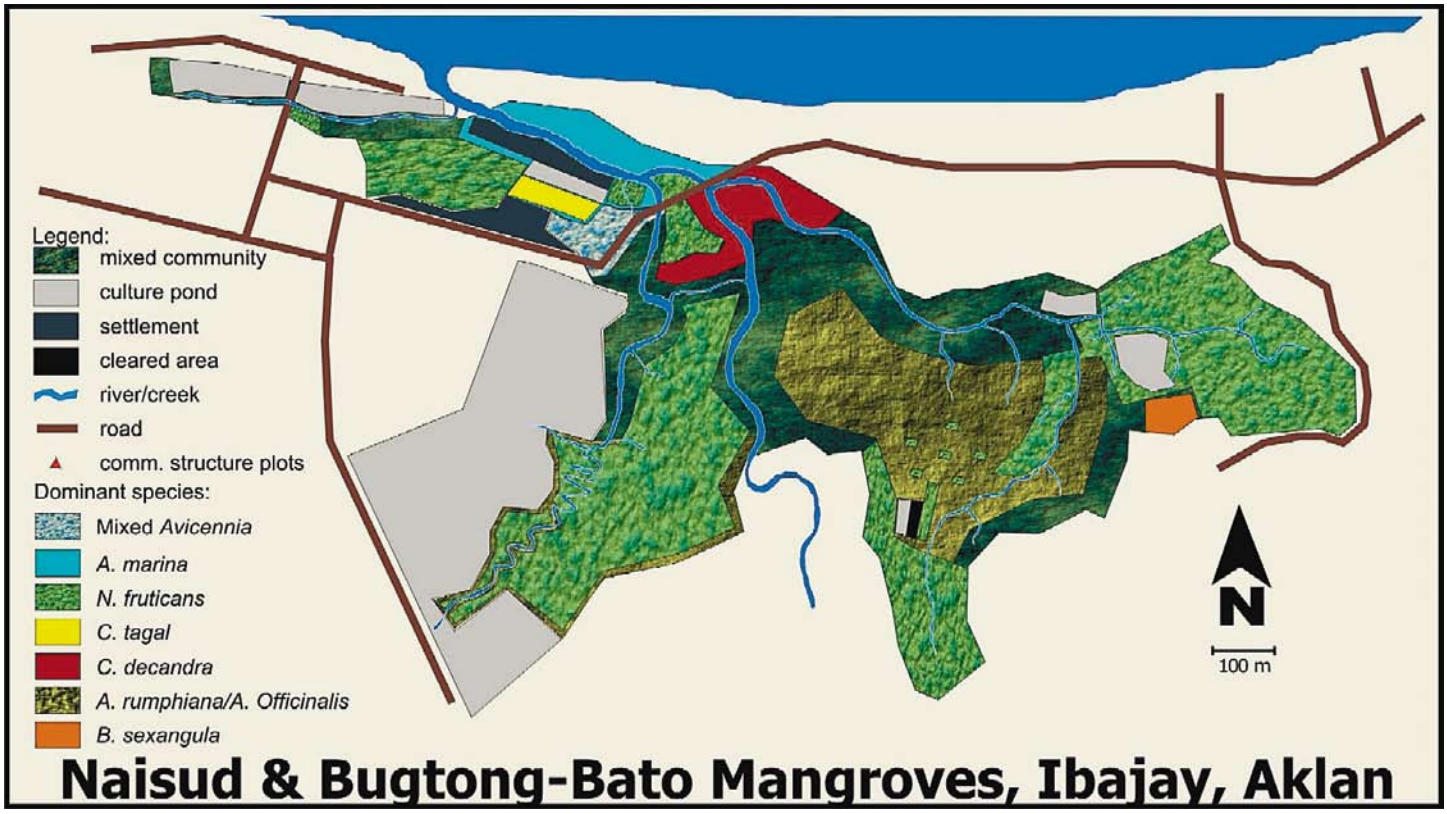
Extended crab nursery in net cages and ponds

Scylla serrata (2–5 grams, 1–3 cm in internal carapace width) were nursed one month further in earthen ponds or in net cages inside ponds at stocking densities of 1, 3, and 5/m^2. Growth and survival were not significantly different among the densities tested. Survival was higher in net cages (77 ± 7%) than in ponds (40 ± 4%), but growth was higher in earthen ponds. The harvested crabs were 10–16 grams and 3.8–4.3 cm and within the size range preferred by farmers for stocking in grow-out ponds.

Wild versus hatchery-reared crabs in grow-out

Wild, hatchery-sourced, and mixed wild and hatchery-sourced juvenile crabs (3.7–4.6 cm in carapace width in the first run, and 2.7–3.9 cm in second run) were stocked at 0.4/m^2 in 200 m^2 ponds. After three months, survival (21-23%) was not significantly different among the three groups, but wild-sourced juveniles were significantly larger and more aggressive.

Preparing a nursery pond for mud crab



Map of the Naisud–Bugtong Bato mangroves where stock enhancement procedures and techniques were worked out for mud crabs

Geography and hydrology of Ibajay mangroves

Several Filipino and European graduate students conducted research to characterize the Naisud–Bugtong Bato mangroves in Ibajay, Aklan. Mangrove community structure was analyzed in 47 quadrats (10 m x 10 m) on both sides of Naisud River. The Naisud–Bugtong Bato mangroves has 27 of the 34 species of mangroves documented in Panay; *Bruguiera parviflora* was found for the first time during a sampling trip in June 2005. The elevation of the river bottom was determined at different points. The main branch of the river was found to be basin-like at 1–1.5 km from the mouth. Tidal levels were measured at 12 stations during the highest high tide of the year on 23 July 2005; the highest tide was 2.3 m in water depth. A map was generated of the Naisud–Bugtong Bato mangroves—it shows settlement areas, pond areas, and mangrove areas dominated by particular species such as *Avicennia* and *Ceriops*. One-third of the mangrove areas a decade ago is now *Nypa* plantation.

Stock enhancement of mud crabs in Ibajay, Aklan

A total of 5,601 mud crabs were coded with microwire tags and released in batches between May 2004 and September 2005. These included 14 batches of wild *Scylla olivacea* (n=1,789) and several batches of hatchery-reared crabs, which were released unconditioned from the hatchery or conditioned for 1-2 months in ponds before release. Unconditioned *S. serrata* (n=1,832) were released in seven batches, and *S. tranquebarica* (n=94) in one batch. Conditioned *S. serrata* (n=1,206) were released in five batches, *S. olivacea* (n=441) in two batches, and *S. tranquebarica* (n=239) in one batch. Recapture of tagged *S. olivacea* was 54% among wild crabs and 29% among hatchery-reared crabs. For both *S. serrata* and *S. tranquebarica*, recapture rates were higher among conditioned crabs (39% and 47%) than unconditioned crabs (12% and 1%). Overall, the recapture rates reflected high survival and low dispersal of crabs and capacity of the Ibajay mangroves to hold higher crab populations.

Mud crab farming in mangrove pens

Wild juveniles of *Scylla serrata* (average size 23 grams and 5 cm) were stocked at 79-80 per mangrove pen and fed different diets. Crabs fed fish plus formulated diet grew best. In a separate experiment, *S. serrata* juveniles (26 g, 5 cm) from the hatchery were stocked in two batches at 81-83 per mangrove pen (area 167 m^2) in Napti, Batan and grown for three months. These hatchery-sourced crabs grew slower and survived less than the wild crabs in an earlier run. Thus hatchery-sourced crabs must first be reared in nursery ponds before grow-out in mangrove pens. To prevent escape of juvenile crabs, canals to retain water during low tide should be built at the center of the pen, rather than along the perimeter nets.

Shrimp Domestication

Hatchery-reared postlarvae of Penaeus indicus

This new program intends to produce pond-reared broodstocks of *Penaeus monodon* and *P. indicus* selected for desirable characteristics, particularly disease resistance. Along the way, a protocol will be developed for producing spawners that are free of white spot syndrome virus (WSSV). Two research studies were conducted in 2005.

Improvement of maturation of pond-reared *Penaeus monodon* broodstock

Market-size *Penaeus monodon* (30-50 g body weight) were obtained from ponds in Sta. Clara, Banago, Bacolod City and grown to broodstock size (80-100 g). The 28 males were 34.6 g and 3.8 cm in carapace length and the 32 females were 46.5 g and 4.4 cm. Randomly sampled shrimps were analyzed and found to be negative for white spot syndrome virus and taura syndrome virus. Males were stocked separately from females in 40-ton outdoor concrete tanks with sand bottom. After 38 days, the population decreased to 23 males (42.2 g, 4.1 cm) and 28 females (52.7 g, 4.5 cm). These shrimps will later be allowed to mate with other families.

Refinement of broodstock management and larval rearing of *Penaeus indicus* and *P. merguiensis*

Spawners (6.8 to 16.8 grams body weight) of *Penaeus indicus* were obtained from the wild in Himamaylan, Negros Occidental. All 17 of them spawned, but only eight produced viable eggs. A spawner produced from 8,000 to 20,000 nauplii. Nauplii from one spawner were divided into two groups—one was reared with 2 ppm oxytetracycline added and the other with 1 ppm Biodream probiotic. Faster growth was observed in larvae reared with oxytetracycline. Postlarvae from different females were stocked separately in 10-ton concrete tanks.

Six *Penaeus merguiensis* spawners were obtained from the wild in Negros Occidental. From the spawn were produced 1,500 PL40 (40 mg body weight) and stocked in a 40-ton outdoor concrete tank with sand bottom. The shrimps grew to 200 mg in one month and to 2.74 grams after two months. These shrimps will be raised as broodstock and will be mated with other families as the start of the breeding program. Spawners of *P. merguiensis* are quite difficult to find in the wild and captive broodstocks are necessary for research and hatchery work.

Shrimp broodstock facility breaks ground

Speaker Jose de Venecia graced the groundbreaking ceremony on 15 July for a biosecure shrimp broodstock facility next to the enclosed wet laboratories at Tigbauan Main Station. The new facility will have a net water area of 10,000 m^2 and consist of one grow-out pond and eight compartments that can hold eight separate shrimp family lines.

AQD has embarked on an R&D program to completely domesticate the sugpo or tiger shrimp *Penaeus monodon* in order to be able to produce healthy postlarvae as needed. Although advanced grow-out technologies are available for the tiger shrimp, hatcheries still depend on broodstock from the wild. Wild spawners are now harder to find, more expensive, and often harbor diseases that cause heavy or even total mortality of farmed shrimps. AQD hopes to solve this shortage of healthy broodstock.

The new shrimp domestication program was explained to Speaker Jose De Venecia by AQD Chief RR Platon, Research Division Head WG Yap, and Program Leader ET Quinitio. Speaker De Venecia pledged P10 Million for the construction of the new shrimp broodstock facility.

AQD breaks ground for the shrimp broodstock facility, 15 July

Marine Fish Seed Production

Fish hatcheries are very important for sustainable aquaculture, and production of quality seedstock has always been an anchor program of AQD. Work at the marine fish hatchery produced seedstock of various species for verification studies at AQD and for grow-out by the private sector. Two research projects were conducted by scientists from the Japan International Research Center for Agricultural Sciences (JIRCAS).

- Insulin-like growth factor II (IGF-II) as molecular markers for egg quality in fish and mud crab
- Technology refinement and pilot scale operation of multi-species marine fish hatchery
- Reproductive and larval performance of rabbitfish
- Pathogenesis and control of subclinical infection of viral nervous necrosis in broodstock of grouper
- Training course: Marine Fish Hatchery and Nursery, 4 May – 16 Jun 2005
- On-the-job training in marine fish hatchery

Insulin-like growth factor II (IGF-II) as molecular markers for egg quality in fish and mud crab

From February to December 2005, there were 23 spawnings grouper, 27 of milkfish, and 37 of rabbitfish. Nine batches of grouper, 15 batches of milkfish, and 16 batches of rabbitfish were processed for RNA extraction, DNAse treatment, and first strand cDNA synthesis. A batch consisted of sinking eggs, fertilized eggs (early embryos), late (C-shaped) embryos, and hatched larvae. Of the fertilized eggs, 39-97% of grouper eggs were 'good eggs' and reached the C-embryo stage. So did 74-99% of milkfish and 70-99% of rabbitfish eggs. Of the 'good eggs', 52-99% hatched in grouper, 58-99% in milkfish, and 28-99% in rabbitfish. In addition, mud crab eggs were collected from nine Scylla olivacea and seven *Scylla serrata* 3-4 days after spawning. One sample of day 0 crab zoeae was also obtained. IGF-II forward and reverse primers for quantitative polymerase chain reaction were designed based on the homologous nucleotide sequences of rabbitfish and grouper.

Smaller rearing tanks resulted in higher survival of milkfish larvae

AQD Marine Fish Hatchery

Tiger grouper *Epinephelus fuscoguttatus*

Natural spawning occurred during the new moon in January, June, July, September, November, and December. Highest egg collection was in July (30 million). A total of 137 million eggs were spawned and 93 million were good eggs. Eggs and newly hatched larvae were sold to the ISDA Hatchery in Botong, Oton and ECG Aquaculture Enterprises in New Washington, Aklan. Demand for tiger grouper seed increased this year. Further testing and refinement were made on hatching and incubation techniques, larval rearing protocol, egg and larval shipment, and transport of early juveniles (called 'tiny' in the industry). Nursery techniques for 'tiny' in brackishwater ponds are now being developed.

Milkfish *Chanos chanos*

Production of milkfish eggs at the Integrated Fish Broodstock Hatchery Complex was only 66 million this year. However, due to higher survival of larvae in tarpaulin tanks (40-68% at day 21), fry production increased. The selling price was pegged at P250 per 1000 fry. Total sales of milkfish larvae and fry was P497,410.

Sea bass *Lates calcarifer*

Lack of males hampered sea bass seed production. Successful induced spawning was done twice in June and July. A total of 700,000 good eggs produced 451,000 normal larvae. After day 15-20, some 412,000 postlarvae were sold to nursery operators.

Orange-spotted grouper *Epinephelus coioides*

The broodstocks spawned five times this year, but egg production was low, the percentage of bad eggs was high, hatching was low, and the hatchery-reared juveniles were turned over to Fish Health for further studies on viral nervous necrosis.

Orange-spotted rabbitfish *Siganus guttatus*

Market for this species is being developed. Salinity tolerance test showed that this species can survive at salinities from sea water down to 5 ppt. Juveniles shipped to Negros had 99% survival upon arrival.

Production/Income:

Total sales of marine fish seed stock in 2005 was P809,365.

SEAFDEC-JIRCAS Collaboration

The Japan International Research Center for Agricultural Sciences, based in Tsukuba City, collaborated with SEAFDEC on the project, *Studies on sustainable production systems of aquatic animals in brackish mangrove areas*. JIRCAS' Dr. Hiroshi Ogata and Dr. Ikunari Kiryu worked at AQD in Iloilo, Philippines, to determine the effects of essential fatty acids on tropical marine fishes, and to understand viral nervous necrosis in groupers.

Through JIRCAS' Counterpart Researcher Invitation Program, AQD's Denny Chavez and Esteban Garibay worked with Dr. Ogata in Tsukuba several times in 2005 to determine the fatty acid composition of plankton and tropical marine fish. Under the Administrators' Study Tour Program, AQD Chief RR Platon and Training and Information Head TU Bagarinao visited Japan from 13 to 20 March, and learned, among other things, that the Japanese government seeks to develop a *Penaeus vannamei* farming industry to boost the local shrimp supply from the indigenous kuruma shrimp *P. japonicus*.

AQD's DR Chavez with JIRCAS President Mutsuo Iwamoto, Dr. Koji Nakamura, and Dr.Hiroshi Ogata in Tsukuba

JIRCAS' distinctive red buildings in Tsukuba, March 2005

Fatty acid composition of zooplankton used in marine hatcheries in the Philippines

Rotifers grown with *Nannochlorum* were harvested and fed the artificial diet Culture Selco (INVE, Belgium). After 24 hours, the rotifers were enriched with DHA Protein Selco (INVE, Belgium) plus 0, 1, 2.5, and 5% arachidonic acid, according to the standard enrichment protocol used at AQD. Samples of mixed zooplankton with and without detritus were collected by plankton sampler from the mangrove area near AQD's Dumangas Brackishwater Station. Samples of the cladoceran *Moina* were collected from a freshwater pool, and copepods from a brackishwater nursery pond in Oton, Iloilo. The samples were freeze-dried, stored at –80°C and analyzed for long-chain eicosapentanoic acid (EPA, 20:5w3), docosahexaenoic acid (DHA, 22:6w3), and more recently, arachidonic acid (ArA, 20:4w6).

Rotifers fed with *Nannochlorum* had high ArA and EPA but no DHA. DHA increased upon feeding with Culture Selco and enrichment with DHA Protein Selco. ArA and EPA in rotifers fed Culture Selco were higher than in those fed DHA Protein Selco. Zooplankton from mangrove areas contained DHA, but detritus did not. Copepods from brackishwater ponds and *Moina* from freshwater pools both contained ArA and EPA at higher percentages than DHA. Copepods and *Moina* also had higher ArA and EPA levels, but lower DHA/EPA and DHA/ArA ratios than the mixed zooplankton.

H Furuita and ES Garibay work together at the National Research Institute for Aquaculture in Mie, Japan

Dr. Okuzawa, Dr. Kiryu, and ES Garibay show AQD's hatcheries to Dr. Nguyen Thanh Phuong, Dean of the College of Aquaculture and Fisheries, Can Tho University, Vietnam, Dr. Satoru Miyata, JIRCAS Southeast Asia Representative, Dr. Nobuaki Arai, Associate Professor at Kyoto University

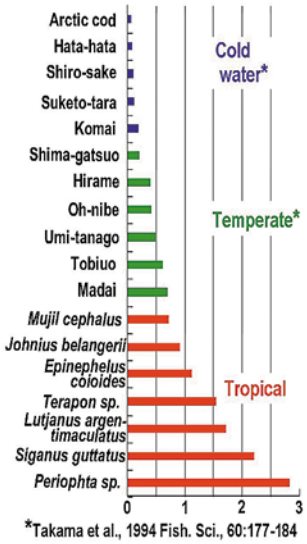
Arachidonic acid improves seed production for tropical marine fishes

HY Ogata, DR Chavez, ES Garibay, A Suloma, H Furuita, AC Emata

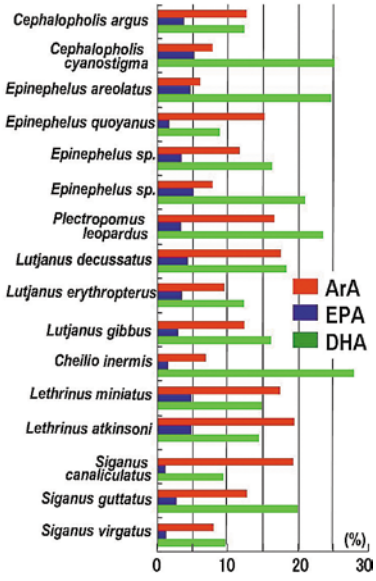
Aquaculture contributes significantly to food production, incomes, and jobs in coastal communities in Southeast Asia. A persistent constraint in aquaculture development is the supply of good-quality seed (called 'fry' in the industry) in quantity at the right time. The fry of tropical marine fishes used in aquaculture still come mostly from the wild. Hatcheries are expected to provide a stable fry supply for farmers, but seed production is often highly variable due to poor fecundity and low survival. During the period 2002–2005, SEAFDEC/AQD and JIRCAS (Japan International Research Center for Agricultural Sciences) Fisheries Division have collaborated on studies aimed at developing advanced diets to improve the quality and production of eggs, larvae, and seedstock for tropical marine fishes.

ArA is a major fatty acid in tropical marine fishes

The mass production of marine fish fry used in aquaculture and aquaranching has progressed remarkably due to the discovery of the dietary importance to marine fish of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) and the establishment of technologies for EPA/DHA-enriched feeds. Most studies on essential fatty acids in relation to fry production have been focused on EPA and DHA and little attention has been paid to arachidonic acid (ArA). ArA is found in only small quantities in cold-water and temperate-water fish and has been presumed to be unimportant It was a pleasant surprise to find intermediate or high ArA and relatively low EPA in the ovaries, eggs, and fry of mangrove red snapper *Lutjanus argentimaculatus*.



ArA/EPA ratios in the muscle of coldwater, temperate, and tropical fishes



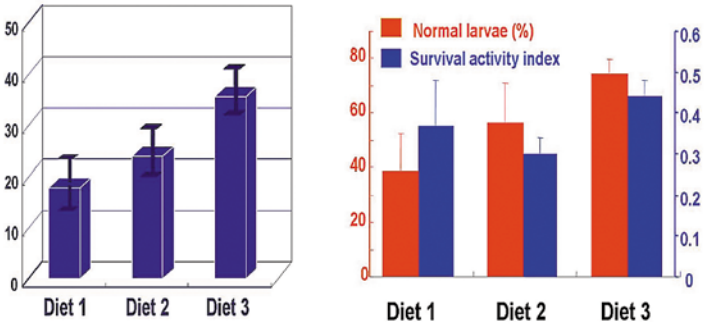
ArA, EPA, and DHA (as % total fatty acids) in the ovaries of coral reef fishes

Later sampling showed similarly high levels of ArA in muscle, liver, ovary, and testes of other tropical marine fishes from mangrove areas or coral reefs in the Philippines, Malaysia, and Ishigaki, Japan. Thus, ArA is a major fatty acid widely distributed in tropical marine fishes and likely important to reproduction and larval survival and growth.

The potential value of ArA has not been applied to fry production technologies for tropical and subtropical fishes. We studied the effects of dietary ArA on reproductive and larval performance in mangrove red snapper (a carnivore) and in the orange-spotted rabbitfish *Siganus guttatus* (a herbivore). We conclude that adding arachidonic acid to broodstock diets or larval feeds improves seed production tremendously. Improved hatchery production of seedstock can help aquaculture take off in the developing tropical countries.

Feeding broodstocks ArA-enriched diets

From March to October 2003, mangrove red snapper broodstock were fed one of three diets supplemented with either 6% soybean oil (diet 1), 2% soybean oil + 4% squid oil (diet 2), or 2% soybean oil + 3.5% tuna oil + 0.5% ArA (diet 3). Total egg production (9.3 million) and total number of spawns (11) were highest in broodstock fed diet 3. Diet 1 produced 2.4 million eggs in six spawns, whereas diet 2 resulted in 3.6 million eggs in eight spawns. Mean egg viability, hatching rate, egg diameter, total length of newly hatched larvae, and survival were similar among the diets. However, diet 3 increased the percentage of normal larvae and the cumulative survival to more than twice those in diets 1 and 2. The results clearly showed the importance of dietary ArA to reproduction of mangrove red snapper.



Percent normal larvae, survival index, and cumulative % survival of larvae from broodstock of mangrove red snapper fed three diets (diet 3 had 0.5% ArA)

From July to December 2004, rabbitfish broodstock were given diets supplemented with 0.75%, 1.5% or no ArA. The diet with 0.75% ArA increased the egg production and normal larvae, but that with 1.5% ArA aborted embryo development. From March 2005 to January 2006, another feeding test was conducted using diets with fish meal, soybean meal, *Acetes*, and squid meal as the protein sources and wheat flour and corn starch as the carbohydrate sources. The basal diet had 1% soybean oil + 6% squid oil + 4% cod oil (diet 1). The soybean oil was replaced with 0.3% ArA in diet 2 or 0.6% ArA in diet 3.

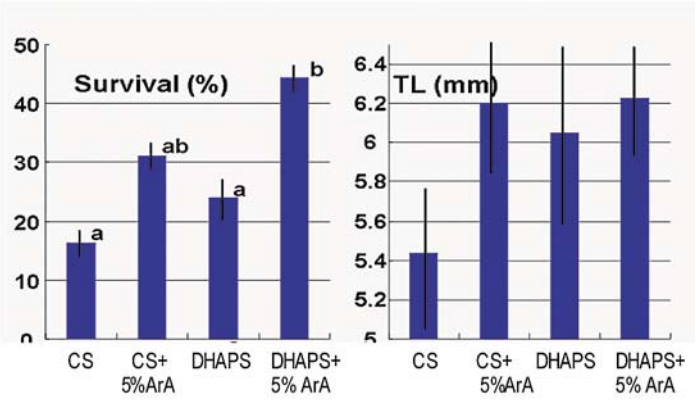
The broodstock (six pairs) spawned 13 times on diet 1, five pairs spawned 14 times on diet 2, and six pairs spawned 17 times on diet 3. The total hatched larvae were 3.8 million on diet 1, 4.4 million on diet 2, and 4.6 million on diet 3. The percentage normal larvae did not differ among diets. Given the results for snapper and rabbitfish, the optimum ArA level may be between 0.5% and 0.7% of the dry weight of the broodstock diet.

Feeding larvae ArA-enriched rotifers and brine shrimp

Rotifers *Brachionus* sp. were fed the diet DHAPS (Protein Selco high in DHA) with graded levels of ArA (0—20%). ArA levels increased in both rotifers and culture media. Surprisingly, EPA and DHA levels in the rotifers decreased as the amount of ArA increased—this result suggests that ArA depresses the absorption or accumulation of EPA and DHA in rotifers. Thus, the optimum level of ArA supplementation is 5% in DHAPS.

Larval rearing tests were conducted to investigate the effects of ArA-enriched rotifers (3 trials) and *Artemia* (2 trials) on survival and growth of rabbitfish larvae. Enrichment was done for four treatments: Culture Selco (CS, which is low in DHA), CS + 5% ArA, DHAPS, and DHAPS + 5% ArA. Larvae fed rotifers or *Artemia* enriched with DHAPS+5% ArA always showed the best survival. Growth was not different among the enrichment treatments.

Fatty acid analysis indicated that DHA and ArA must be added to larval diets at the same time to make the DHA/ArA ratio optimum for the larvae.



DHAPS + 5% ArA improves survival of rabbitfish larvae to day 17

Dr. I. Kiryu speaks at a JIRCAS Workshop about his research at AQD

Pathogenesis and control of viral nervous necrosis in broodstock of grouper

I Kiryu

An experiment examined the distribution of the viral nervous necrosis betanodavirus in orange-spotted grouper *Epinephelus coioides* with no clinical signs. More fish were examined for virus distribution in the tissues: 22 wild juveniles were each sampled for five different organs. Seven fish about 1 gram in body weight were obtained from a supplier in Roxas City and 15 fish (5-20 grams) from Alabel, Sarangani. Two of seven fish from Roxas City and 1 of 15 fish from Alabel were positive for VNN by polymerase chain reaction assay. The highest detection rate of the virus among the organs was in the brain. However, the virus gene was also amplified from organs other than the central nervous system. These results this year support the conclusion last year—the virus is latent in the CNS of subclinically infected fish and when the fish immune system is weakened, the latent virus is released to the peripheral organs including the gonads. This mechanism can lead to vertical transmission of infection. For hatchery operations, it is essential to use broodstocks free of betanodavirus. To screen the broodstocks, non-destructive sampling of the gills can be done.

Another experiment sought to establish and evaluate a DNA vaccine for prevention against VNN. The DNA vaccine construct was prepared as follows: the open reading frame of the betanodavirus RNA 2 which is thought to produce the capsule of the virus was inserted into the plasmid of cytomegalovirus. For comparison, the gene encoding the infectious hematopoeitic necrosis virus (IHNV) G protein was prepared the same way as that of the betanodavirus. It is known that the IHNV vaccine stimulates a nonspecific immune response in fish. This IHNV vaccine is thought to be effective for VNN. For the vaccination experiment, four groups of 14-17 groupers (5–20 grams each) were injected intramuscularly with: betanodavirus DNA vaccine, IHNV G protein DNA vaccine, combination of both DNA vaccines, or phosphate buffered saline. The betanodavirus challenge test was carried out one month after vaccination, and the efficacy of the vaccine was estimated by fish survival. The results of the experiment showed the efficacy of the betanodavirus DNA vaccine.

Harvest of juvenile tiger grouper from the AQD hatchery

AQD conducted the 21st Training Course on Marine Fish Hatchery from 4 May to 17 June 2005 for 15 hatchery owners, managers, technicians, and extension workers from Philippines, Saudi Arabia, Iran, Singapore, and Sri Lanka. The course included mostly actual hatchery work, but also lectures, laboratory sessions, and field trips. The trainees were provided the technical knowledge and skills to spawn and rear the larvae of marine fishes, including milkfish, seabass, grouper, snapper, and rabbitfish. They learned how to produce natural food organisms for the fish larvae, and to monitor water quality and fish health. They also had special lectures by Japanese scientists.

MarFish trainees discuss hatchery procedures and assignments, June 2005

SEAFDEC/AQD collaborates with PBSP

The Philippine Business for Social Progress (PBSP) Samar Field Office maintains cages for several species of marine fishes in Maqueda Bay. All the broodstocks spawned this year except the orange-spotted grouper, pompano, and trevally. Seabass juveniles were produced and handed over to other PBSP-supported projects in Maqueda Bay.

In 2005, PBSP donated fish broodstocks to AQD: two male sea bass and 4 male and 4 female red snappers. However, 2 male snappers died upon arrival at AQD after 15 hours of transport. PBSP Director for Operations, Leo Dionisio Hilado signified the intention to donate more broodstock to AQD. In exchange for the broodstock, AQD shipped milkfish and rabbitfish seedstock (test transport) to Samar Field Office.

PBSP's fish cages in Maqueda Bay, Samar

PBSP's fish hatchery

Technology Verification and Commercialization

AQD personnel at the Dumangas Brackishwater Station and Igang Marine Station conducted several projects to demonstrate the technical and economic feasibility of aquaculture technologies for a variety of commodities.

- Hatchery of shrimps and salt-tolerant red tilapia
- Grow-out of *Penaeus indicus* and *P. monodon* by the environment-friendly method
- Commercialization of grow-out of mud crab *Scylla serrata* in ponds and mangrove pens
- Grow-out of humpback grouper *Cromileptes altivelis* in ponds and cages
- Grow-out of groupers *Epinephelus* spp. in ponds and cages
- Poverty alleviation through aquaculture: increasing food and income through small-scale fish farming (AusAID project implemented by AQD in Carles, Iloilo, Philippines)
- Aquaculture consultancy project in Ngatpang State, Palau
- Training course: Environment-Friendly Shrimp Farming, for 3 Saudi nationals, 19 Jul–15 Aug 2005
- On-the-job training in shrimp farming in ponds
- On-the-job training in fish farming in cages

Grow-out of tiger shrimp by the SEAFDEC/AQD environment-friendly method

A 0.88 ha pond was stocked with tiger shrimp *Penaeus monodon* at 25 postlarvae/m^2 on 15 July 2005 to test a commercial probiotic. Water quality was monitored daily and maintained at ranges of 3.4-5.2 mg/l dissolved oxygen, 17-21 ppt salinity, 120-130 cm water depth, 35-50 cm water transparency, and 28-33°C water temperature. Ammonia, nitrite, nitrate, luminous bacteria, and phytoplankton were also monitored and kept at safe levels. After 109 days, a total of 3,014 kg of shrimps was harvested. Average body weight was 19 grams and survival was 72%. Total sales was P578,721 at the average price of P192/kg. The farm gate price was low because the harvested stocks had to be transported to processors and buyers in Manila and Bohol. Some of the harvest was sold to AQD staff.

Grow-out of white shrimp by the SEAFDEC/AQD environment-friendly method

A 0.8 ha pond was stocked on 15 July 2005 with white shrimp *Penaeus indicus* larvae (PL16) produced at the TVCD hatchery at Tigbauan Main Station. The environment-friendly method of farming *P. monodon* was used. Water depth was kept at 110-130 cm, transparency at 35-50 cm, salinity at 17-21 ppt, water temperature at 28-32°C, and dissolved oxygen at 3.4-5.2 mg/l. The average body weight was 9 grams after 75 days and survival was 80%. Partial harvests were done by the *bitinan* and *pasulang* methods whenever there was demand and the market price was high.

Saudis train at AQD

Three technicians from the National Prawn Company (NPC) in Al Lith, Kingdom of Saudi Arabia came to AQD for a special training course on Environment-Friendly Shrimp Farming from 19 July to 16 August 2005. The NPC is the largest shrimp- producing company in the Middle East. Its rapid expansion has increased the need for more Saudis to be involved in the NPC work force. The NPC recognized AQD's capability to fill the gap in the training of technicians, focusing on the basic science of aquaculture.

The Saudis expressed appreciation for the lectures and laboratory sessions they had, but explained that the NPC farm is so advanced in terms of facilities, technologies, inputs, and harvests that they found it hard to relate to the pilot-scale farm at AQD Dumangas. AQD Chief RR Platon explained that AQD's shrimp farming technologies are scaled down to suit the financial and institutional capabilities of developing countries in southeast Asia.

The three Saudis learn microbiological techniques, among other skills

Commercial production of shrimp postlarvae

Penaeus monodon and *P. indicus* postlarvae were produced in six 10-ton tanks in the TVCD hatchery at Tigbauan Main Station. The postlarvae were used for commercial-scale grow-out at the Dumangas Brackishwater Station and the excess were sold to the private sector.

Grow-out of mud crab in brackishwater ponds

Crablets of *Scylla serrata* (average weight 25 grams) were sourced from the wild in Capiz and stocked on 22 June 2005 in a 1,300 m^2 pond enclosed by nets at DBS. Stocking density was 1/m^2. Stocks were fed with chopped 'trash' fish, water snakes, and animal entrails and hides at amounts adjusted bimonthly according to crab biomass. Water quality was monitored daily. Average crab weights were 80 grams after 15 days, 137 g after 30 d, 251 g after 60 d, 305 g after 90 d, and 564 g after 120 d. Partial harvests started on the second week of October and crabs were sold to buyers from Roxas City and Dumangas. From 31.7 kg of crabs partially harvested, sales was P6,117 by 31 December.

Commercialization of grow-out of mud crab in ponds

Two grow-out ponds in Capiz with areas of 3982 m^2 and 2043 m^2 were stocked on 27 Jun 2005 with crablets of *Scylla serrata* at 1/m^2. Water depth ranged 70-100 cm, transparency 40-45 cm, and salinity range 7-25 ppt. Crabs were fed 'trash' fish. Stocks were sampled monthly. After 105 days, the crabs in the two ponds weighed 455 grams on average and survival was 70%. Harvest by *bintol* and *pasulang* method was done during spring tide periods when demand and price were good. A total of 691 kg was harvested from the two compartments and the gross sales was P182,000 (net income P20,406).

Grow-out of mud crab in mangrove pens

Six net pens each 288 m^2 in area and one with an area of 1,582 m^2 were set up in the mangroves at the periphery of DBS. The pens were stocked with mud crabs *Scylla serrata* at 1/m^2 in July, September and October 2005. The crabs were fed 'trash' fish and water snakes at 10% of the body weight daily, adjusted bimonthly. Water depth, salinity, and transparency were monitored regularly. Average body weight was 71 grams after 15 days, 101 g after 30 d, 197 g after 60 d, 309 g after 90 d, 324 g after 120 d, and 382 g after 150 d. Partial harvesting was done regularly. Total sales as of 31 December was P7,370 from 27.7 kg of crabs partially harvested.

Mud crab pens in ponds, Dumangas Brackishwater Station

Aquaculture consultancy in Palau

AQD forged a consultancy agreement with Ngatpang State, Palau and dispatched an 11-man aquaculture team on 3 August 2004 to verify seed availability in the wild, construct a 14-hectare modular milkfish pond system, construct fish cages, and operate the built facilities to demonstrate technical, environmental, and economic viability of different aquaculture technologies. A renewal of the AQD contract with Ngatpang State was signed on 27 June 2005.

Grouper farming in cages

The grouper stocks in three floating cages were sampled on 19 May and found to have average body weights of 462 grams, 288 grams, and 284 grams after 132 days of grow-out. These groupers were fed 'trash' fish every other day at 5% of body weight. The younger groupers in a fourth cage were fed at 8% of body weight per day and weighed 88 grams after 62 days of grow-out. Several restaurant owners from Koror have visited the cages and have expressed interest to buy the groupers larger than 450 grams. The groupers were harvested when the Governor of Ngatpang visited. The selling price of the live groupers was $5 for 450-gram fish. Dead groupers sold for $1.50 for the same size. Partial harvesting and marketing has been going on upon request. Five sets of aquaria were transported from the Philippines and used to display live grouper in selected hotels in Koror.

Mud crab farming in mangrove pens

On 16 April 2005, a stock of 2,048 *Scylla serrata* crablets (about 4 cm in carapace length) were imported from the Philippines into Ngatpang. Of these crablets, 314 died during transport, 500 were stocked in one compartment (area 500 m^2) of the Ngatpang State Mangrove Pen Project, and the other 1,234 were stocked in three compartments of a privately owned crab pen in Old Ngatpang. The crablets were weak upon arrival in Ngatpang, probably due to improper packing for the plane ride from the Philippines to Koror. Of the 500 crablets stocked in the State-owned crab pen, 131 died. The crablets that recovered from the transport stress consumed about 1 kg of 'trash' fish daily. The crabs were partially harvested over several months, and some were served during Ngatpang State occasions. The mud crab pens in the mangroves have been turned over to Ngatpang State for operation and management.

Fish pond construction

Gate construction was started on 16 May when a used Yanmar engine (8 hp) was provided by the Mariculture Demonstration Center for use by the AQD team. The main gate was finished by the second week of June and the secondary gate was built. Backfilling of soil in the partition dike of the sedimentation pond was delayed due to frequent rains in Ngatpang. Pond inputs purchased in the Philippines were transported by van on 8 Dec 2005. Upon arrival of inputs, the ponds will be prepared for grow-out of milkfish.

Seed production of SEAFDEC/AQD saline-tolerant tilapia
About 800 breeders of the SEAFDEC/AQD saline-tolerant tilapia *Oreochromis* spp. (black and red) were brought in five years ago from Binangonan Freshwater Station. Six 12-ton circular tarpaulin tanks at the TVCD Hatchery at TMS have been continuously used for seed production. The seedstocks have been used as biomanipulators in commercial shrimp farming at DBS and some private farms. A total of 25,000 juvenile tilapia were produced in 2005.

Grow-out of milkfish in brackishwater ponds
At Dumangas Brackishwater Station, milkfish production runs were done in four 1,000 m^2 nursery ponds, one 5000 m^2 transition pond, two 8000 m^2 and one 6900 m^2 grow-out ponds. Hatchery-reared milkfish fry from TMS were stocked in the ponds in June 2005. From 315 kg of milkfish harvested on 21-25 October, total sales was P16,673.

Grow-out of grouper *Epinephelus* spp. in ponds
At Dumangas Brackishwater Station, a pond with an area of 9,027 m^2 was prepared to grow natural food. Tilapia larvae were stocked to grow and serve as food for the grouper seedstock to be released. Inside the pond were installed 24 net cages (1 x 1 x 1.5 m) and two net cages (5 x 5 x 1.5 m) for size-grading of stocks. Juvenile grouper (1 cm long, called 'tiny') purchased from Mindoro were stocked in the nursery nets at 0.5/m^2 on 10 October 2005. They were fed *Acetes* shrimps. The seedstock was released from the nursery nets after 15 days when they were already 2.5 cm long. Water quality in the grow-out pond was carefully monitored. The groupers were fed 'trash' fish in addition to the live tilapia. Stock sampling was done every 15 days. After 91 days of grow-out, the average weight of the groupers was 376 grams, total biomass was 130.4 kg, and survival was 70%.

Grow-out of humpback grouper in ponds
At Dumangas Brackishwater Station, two 520 m^2 ponds were prepared for grow-out of the coral trout *Plectropomus leopardus* but seed was not available. Seedstock of the humpback grouper *Cromileptes altivelis* was ordered from Gondol Brackishwater Aquaculture Center, Indonesia, through the AquaSur Hatchery. For sorting and grading of the grouper seedstock, four nursery nets (5 x 5 x 1.5 m) were installed inside the pond by means of bamboo framework with catwalk. Tilapia larvae were stocked in the pond to serve as initial and supplemental natural food for the humpback grouper.

Grow-out of humpback grouper in floating net cages
At Igang Marine Station, two floating cages (5 x 5 x 3.5 m) were prepared for grow-out of the humpback grouper *Cromileptes altivelis* ordered from Gondol, Indonesia, and nursed in the DBS ponds.

Nursery of groupers in floating net cages
At Igang Marine Station, two floating cages (5 x 5 x 3 m) were used as nursery and size-grading facility for grouper *Epinephelus* seed (juveniles 1 cm long, called 'tiny') stocked in batches from 10 August to 6 September 2005. About 8,000 grouper seed from the wild (purchased in Capiz) and 568 hatchery-reared seed from TMS were stocked in the nursery cage at 75/m^2. A 25-watt light bulb was installed above each cage and switched on at night to attract natural food (copepods, mysids, and fish larvae). The fish were fed to satiation 5x daily between 0600 h and 1800 h. Feeding was reduced to 12% of biomass daily after 1.5 months and down to 5% a day. The fish were grown to 50 grams then transferred to grow-out cages.


Stocking grouper in floating cages in Palau


Grow-out cages for grouper with nursery cages on the side, Igang Station

AQD validates grouper farming with *Land Bank*

A Memorandum of Agreement was signed on 9 August 2005 among SEAFDEC/AQD, Land Bank of the Philippines, University of the Philippines, and the Iloilo State College of Fisheries for the delivery of technologies to farmers and fishers through the Technology Promotion Center Region VI. AQD's third techno-validation proposal, *Culture of Grouper in Floating Net Cages*, was presented on 14 September 2005 before Land Bank's Program Technical Team and was approved for funding. The proposed investment was P296,231. Validation was conducted in six floating net cages (5 x 5 x 3.5 m) off Sitio Baybay, Alegria, Sibunag, Guimaras. Three cooperators from the locality were selected by the Municipal Agriculturist and Municipal Administrator. Each cooperator was given two net cages to operate and manage. AQD provides the technology package and technical support for the project. Earlier, two other technologies were successfully validated by AQD with funding from Land Bank—grouper farming in ponds in 2000, and the modified extensive method of shrimp farming in 2003.

AQD turns over grouper cages to MACABATA

The Australian Agency for International Development initially funded the project Poverty alleviation through aquaculture: increasing food and income through small-scale fish farming for a beneficiary fisher association (MACABATA-ARM: Manlot-Cabilao-Bancal-Tarong Association for the Rehabilitation of Mangroves, Inc.) comprising eight fishing barangays in Carles, Iloilo, Philippines.

After site suitability was assessed, 20 fish cages (5 x 5 x 3 m) were set up off Manlot Island in October 2004 and stocked with 5-10 gram juvenile groupers (from Cagay, Capiz) in December 2004. Each barangay was allotted two fish cages to operate. To transfer the grouper cage farming technology to the association, two trainees from each barangay worked day to day at the cages under the guidance of the AQD technician. The beneficiaries were trained in the production technology, including sourcing of quality seedstock and marketing.

After March 2005, AQD continued the project after AusAID. AQD shouldered all expenses and helped the barangays run the farm until the stocks were harvested on 21-25 Sep 2005. The total harvest was 1,278 kg and gross sales was P378,905. Survival was 47% and food conversion was 5.4 kg 'trash' fish to 1 kg grouper. All the income from the sale of the groupers, less the operating expenses advanced by AQD, was given to MACABATA—a balance of P221,707, enough to finance succeeding operations. On 25 September, AQD turned over to the beneficiaries 20 floating cages in good condition, complete with mooring system and caretaker's hut.

Floating cages for fish farming at Igang Marine Station

Freshwater Aquaculture for Livelihood

AQD personnel at the Binangonan Freshwater Station carried out research projects and intensified work to disseminate information and transfer technologies for freshwater aquaculture. Training was done in a variety of formats for different beneficiaries, mostly small-scale fish farmers.

- Growth and survival of Asian catfish fry in net cages with and without feeding in Laguna de Bay
- Farmers' Training in Integrated Fish Farming and Freshwater Aquaculture (with ABCDEF Inc. and Meralco Foundation Inc.), 6 sessions
- Training course: Freshwater Aquaculture, for TESDA Trainors, 18 May – 4 Jun 2005
- Training in Freshwater Aquaculture for Vigan fish farmers, 26-27 Jul 2005
- Training course on Tilapia Hatchery and Grow-out, 1-10 Aug
- Training course: Freshwater Aquaculture, 17 Aug – 6 Sep
- Training Modules on Tilapia/Carp/Catfish Breeding and Farming, 4 sessions
- On-the-job training in freshwater aquaculture for students

AQD Scientist ML Cuvin-Aralar of the Binangonan Freshwater Station attended the 10th Living Lakes Conference in Tagaytay City from 15 to 19 May 2005. The Conference theme was The lake and its people: responsible stewardship by lake communities and sustainable development of densely populated lake regions. The Living Lakes Network is an international partnership whose mission is to enhance the protection, restoration and rehabilitation of lakes, wetlands and other freshwater bodies of the world. In 2001, Laguna de Bay was accepted into the prestigious International Living Lakes Network as the 18th Partner (total now 24 Partners).

President Gloria Macapagal-Arroyo attends the 10th Living Lakes Conference in Tagaytay, May 2005

AQD to assist Gawad Kabuhayan

The SEAFDEC Aquaculture Department signed a Memorandum of Agreement with the Couples for Christ-Eastern Rizal on 7 November 2005 to implement the CFC-Eastern Rizal Aquaculture Project under the Gawad Kabuhayan Program. Under the MOA, AQD will assist CFC in skills training and technical support for aquaculture livelihood projects in beneficiary communities. In turn, CFC will help in the dissemination of AQD aquaculture technologies to other communities where other CFC chapters operate. CFC is a private organization that seeks to build renewed and empowered communities in depressed areas. Part of the strategy of CFC in community building is the Gawad Kabuhayan program, which includes aquaculture livelihoods in selected communities.

AQD Chief Rolando Platon and CFC-Eastern Rizal Provincial Area Director Rey Tan sign the MOA

The hatchery and farm of Meralco Foundation and ABCDEFI in Jalajala

Training courses in freshwater aquaculture

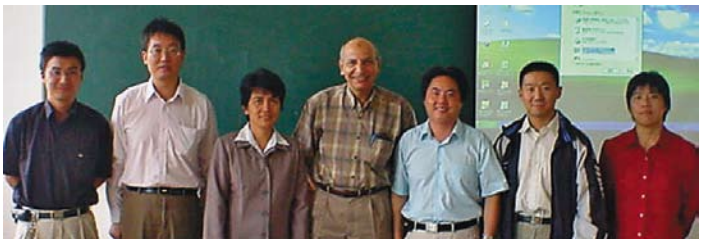
The Binangonan Freshwater Station and the Aquaculture-Based Countryside Development Enterprises Foundation Inc. (ABCDEFI) continued to assist Municipal Agricultural Officers and other local government officials in implementing aquaculture-based livelihood activities. The BFS-ABCDEF training team conducted on-site training for fish farmers who will be involved in the fishfarming clusters. In 2005, six training sessions on Integrated FishFarming and Freshwater Aquaculture were carried out: in Siniloan, Laguna on 27-28 January; in Jalajala, Rizal on 31 January – 1 February; in Sta. Cruz, Laguna on 10-11 February; in Angono, Rizal on 24-25 February; in Morong, Rizal on 31 March -1 April; and in Cabuyao, Laguna on 26-27 April. Funds for these training sessions were provided for by Senator Ramon Magsaysay Jr. through the Department of Science and Technology. Since the program started in 2004, some 244 farmers and 82 MAOs have been trained.

For the second year in a row, BFS conducted the Industry Immersion Training on Freshwater Aquaculture for technical and vocational education trainors, particularly fisheries instructors, at schools accredited by the Technical Education and Skills Development Authority (TESDA). Eight fisheries instructors from Pangasinan, La Union, and Camarines Sur attended the training from 18 May to 4 June. A special training course on freshwater aquaculture was also held from 18 August to 5 September for three participants from Ecuador, Chile, and the Philippines.

Vigan City Mayor Ferdinand Medina and 40 of his constituents visited Binangonan Freshwater Station in May 2005. They had already started several tilapia hatcheries in different barangays under a project funded by the Spanish aid agency *Cooperacion Española* and implemented by a Spanish non-government organization, *Accion Contra el Hambre*. Mayor Medina and his group wanted to find other commodities suited for freshwater aquaculture in Vigan. Thus was conducted the Freshwater Aquaculture Training for Vigan Fish Farmers on 27-28 July 2005.

Fish farmers consult with RV Eguia on ways to improve tilapia production

Aquaculture Training Modules allowed close individual instruction over a shorter period (5 days)



MRR Eguia with FFRC researchers and Dr Hussein Elgobashy of Egypt, in Wuxi, September 2005

MRR Eguia with officers of the Yangzhou fishery extension bureau

Prof Gong Yong Sheng visits Binangonan after attending the CrabSeed course

Prof. Dr. Xu Pao and Prof. Min Kuanhong of the Freshwater Fisheries Research Center visit the MFI-AQD booth during AgriLink 2005

AQD exchanges staff with FFRC Wuxi

As part of its long-standing collaboration with the Network of Aquaculture Centers in the Asia-Pacific (NACA), SEAFDEC/AQD initiated a staff exchange program with the Freshwater Fisheries Research Center (FFRC) in Wuxi, the NACA Lead Center in China. Under the AQD-FFRC program, Associate Professor Gong Yong Sheng of the FFRC joined the sixth training course in Crab Seed Production at AQD from 14 September to 13 October 2005. Prof. Gong went on a post-training tour of AQD's Binangonan Freshwater Station and the ABCDEFI's Jalajala farm. In Binangonan, Prof. Gong met his counterpart, AQD Scientist MRR Eguia, who visited FFRC from 25 September to 2 October, funded by the Integrated Regional Aquaculture Program. Together with Station Head MLC Aralar, they exchanged knowledge and ideas about genetic improvement and seed production of the giant freshwater prawn *Macrobrachium rosenbergii*.

Dr. Eguia visited FFRC to explore possible areas for collaborative research with SEAFDEC/AQD Binangonan, observe farming practices for freshwater prawn and ornamental fishes, to learn efficient methods for transfer of aquaculture technologies to small-scale fish farmers. On the first day, Dr. Eguia gave a seminar on AQD's research and training programs in freshwater aquaculture. Visiting Scientist Hussein Elgobashy talked about genetics research at the Central Laboratory for Aquaculture Research (Abbassa, Egypt) and three FFRC scientists talked about their research, including population genetics and hybridization work on *Macrobrachium rosenbergii* and other species, and the sex-determining mechanisms in the tilapia. FFRC has laboratories and resources for molecular genetics work—gene cloning, molecular marker analysis, etc.

The farm visits near Wuxi showed Dr. Eguia the technologies adopted in the commercial production of the freshwater prawn in ponds and the farm methods used in selective breeding and propagation of different varieties of ornamental fishes, especially goldfish. Interviews with young extension workers showed that much of their success is due to (a) adequate financial assistance and logistic support from the Chinese government; (b) qualified and well-trained fishery extension workers, mostly with BSc and MSc degrees in fisheries or aquaculture; (c) support provided by the private sector in the dissemination of technologies, and (d) active participation and cooperation of farmer cooperatives.

Dr. Eguia left for Manila on 2 October with FFRC Director Prof. Dr. Xu Pao, and External Affairs Officer Prof. Min Kuanhong who were visiting the Philippines upon the invitation of the Bureau of Fisheries and Aquatic Resources. They met again during AgriLink 2005.

AQD Collaboration with Philippine Agencies

SEAFDEC/AQD works closely with the Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture of the Philippines, particularly in the joint operation and maintenance of the Laboratory Facilities for Advanced Aquaculture Technologies (also known as the Biotech Labs), located at the AQD campus in Tigbauan but owned by the Government of the Philippines as a grant-in-aid from the Government of Japan through the Japan International Cooperation Agency.

Several research projects were conducted by non-AQD researchers at AQD's Laboratory Facilities for Advanced Aquaculture Technologies (a grant-aide from the Government of Japan to the Government of the Philippines). The first three projects listed below were carried out at AQD by professors of the University of Eastern Philippines, the Mindanao State University–Iligan Institute of Technology, and the University of the Philippines–Visayas. Two studies were conducted by the National Fisheries Research and Development Institute of the Department of Agriculture. Two training courses were conducted for NFRDI staff, partly to build capacity for quarantine and monitoring of viral diseases of imported stocks of *Penaeus vannamei*.

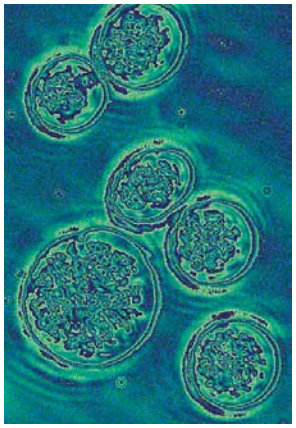
- Nutritional factors and microbial derivatives as immunostimulants in grouper
- Polyunsaturated fatty acids as useful compounds for aquaculture and human nutrition
- Strain improvement of farmed carrageenan-producing seaweeds
- Phytic acid levels in non-conventional feedstuff of plant origin in various processed forms
- Growth performance of GET-EXCEL tilapia using azomite as mineral mix in the feed formulation
- Training course: Detection of Shrimp Viruses by PCR Techniques, 15-19 Mar 2005
- Training course: Biotechnology Techniques and Instrumentation, 7-14 Aug 2005

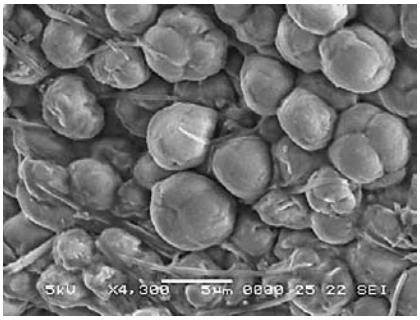
Nutritional factors and microbial derivatives as immunostimulants in grouper

Five groups of 40 tiger grouper *Epinephelus fuscoguttatus* (44 g) were stocked in five 250-liter tanks and fed either a control diet or diets with added onion, ginger, ß-glucan, and vitamin C. Weight gain and specific growth rates were significantly higher in groupers fed diets with ß-glucan and onion. Feed conversion ratio was significantly higher in groupers fed the onion, ginger, and vitamin C. Among the immunity indices, total immunoglobulin (total Ig) was significantly higher in all treatment groups than the control. Hematocrit, hemoglobin, lysozyme, and nitroblue tetrazolium reduction also increased slightly over the control. To prepare for the challenge tests, frozen (-80ºC) and lyophilized *Vibrio anguillarum* (Va1 and Va2) were grown in agar and broth media and passed three times in live 2-5 g groupers. Va2 showed good recovery and was used to inoculate 100 g groupers to see if the bacteria could induce lesions in the fish.

Polyunsaturated fatty acids (PUFA) for aquaculture and human nutrition

Strains of microscopic thraustochytrids were isolated from fallen mangrove leaves from localities in Mindoro, Guimaras, Panay, Caluya, Bohol, Palawan, Leyte, Mindanao, Sagisi, Samal and Camiguin. These strains were mass-cultured and analyzed for total lipids and fatty acid profiles. Gas chromatography showed that the isolates have high PUFA content, 35–54% of total fatty acids, mainly docosahexaenoic acid (DHA) at 24-41%. Genomic fingerprinting was done through RAPD-PCR technique to determine relatedness among isolates and mark strains with high biotechnological potential. PUFA-containing microbial symbionts of intertidal sponges were also isolated; these and other microorganisms were maintained in the laboratory for future fatty acid profiling.





Thraustochytrids, a rich source of DHA

Electronmicroscopy after cell culture

Strain improvement of farmed carrageenan-producing seaweeds

Fifteen cultivars of farmed *Kappaphycus alvarezii* and two of *Eucheuma denticulatum* were collected during the last cropping season of the year (October to December) from seaweed farms in Batangas (Mangrove Island and Gulod, Calatagan), Sorsogon (Peñafrancia, Pilar, and Bacon), Bohol (Sag Island and Bansan Island, Talibon), Antique (Caluya Island), Northern Samar (Capul Island and Lavezarez), Panguil Bay (Simbuco and Manga, Kolambugan), and Surigao (Manjagao, Sagisi Island). These cultivars were maintained at the Seaweed Wet Laboratory for carrageenan characterization and DNA fingerprinting to identify high-yielding and disease-resistant cultivars.

Phytic acid in plant feedstuff

Phytic acid levels were determined by spectrophotometry of 21 samples of seeds, leaves, and copra meal. Seeds had higher phytic acid than the leaves and copra meal. To remove the phytic acid, the seeds of mongo, soybean, corn, rice, green pea, and barley were immersed in 0.5 M HNO_3 and HCl. Phytic acid, protein, and available phosphorus in the samples were determined at 0, 2, 4, 8, 16 and 32 hours. Phytic acid in seeds was reduced to 24% after 4 h and not any further. Percent protein of the seed samples was not at all reduced by acid treatment. Acid immersion of seeds reduced the available phosphorus by 63%. Phytase enzymes should be tested on seeds to find ways to remove the phytic acid but retain the phosphorus.

Growth of GET-EXCEL tilapia fed diets with azomite as mineral mix

Six diets were formulated with azomite at 0, 0.1, 0.2, 0.4, 0.8, and 1.6% of dry weight and tested in an 18-tank system with recirculating water. The extruded pellets were fed to GET-EXCEL tilapia at 10% of wet body weight per day for 12 weeks. Average wet weight was highest in tilapia fed the diet without azomite, but there were no significant differences among treatments. Similar tests were conducted in concrete ponds and floating cages at the Binangonan Freshwater Station. Again, no significant weight differences were found among treatments.

NFRDI staff train at the Biotech Lab at AQD Tigbauan, August 2005

NIFTDC staff train at the Biotech Lab at AQD Tigbauan, March 2005

The Bureau of Fisheries and Aquatic Resources of the Department of Agriculture of the Philippines conducted quarantine procedures on imported stocks of *Penaeus vannamei* and wanted to closely monitor the stocks and the subsequent progenies for diseases, particularly viruses. SEAFDEC/AQD was requested to train BFAR personnel. Thus, a special hands-on training on Detection of Shrimp Viruses by PCR was conducted on 15–19 March 2005. Five laboratory personnel from the National Integrated Fisheries Technology Development Center joined the training. One day of lectures was followed by four days of laboratory sessions on polymerase chain reaction assay, sampling methodologies, and preservation of tissues for PCR analysis. Trainees learned DNA and RNA extraction and master mix preparation, 1-step PCR, nested PCR, reverse transcription PCR, and gel electrophoresis, staining and analysis. Combinations of these methods are used in the diagnosis of shrimp viruses such as WSSV, IHHNV, and TSV. The AQD resource persons were LD de la Peña, M Paner, and C Sombito.

The National Fisheries Research and Development Institute later conducted a training course on Biotechnology Techniques and Instrumentation at SEAFDEC/AQD on 8-14 August for 15 trainees—10 from NFRDI, two from UP-Visayas, and three from AQD (plus 4 observers). Dr. A Laurena from UP Los Baños lectured on polymerase chain reaction and related techniques, chromatography, bioinformatics, and DNA sequencing. He also conducted several laboratory sessions. Dr. A Serrano and Dr. C Caipang from UP-Visayas talked about molecular techniques in protein digestibility tests, and about recombinant proteins as fish vaccines. Dr. R Salvador from the University of Eastern Philippines lectured on biotech approaches in algal culture. AQD's Dr. MR Eguia taught about molecular genetic markers, and Dr. LD de la Peña about use of PCR in disease diagnosis. The practical sessions were held at the Laboratory for Advanced Aquaculture Technologies, with LD de la Peña, G Anuevo, F Pedroso, and T Billena as instructors.

AQD staff meet the officials from the embassy of Japan, 5 May 2005

SEAFDEC/AQD welcomed two officials from the Embassy of Japan on 5 May 2005—First Secretary Katsuyoshi Ishii and Economic Affairs Minister Tetsuya Ishii. They were given a tour of the Biotech Labs and shown the special equipment and facilities.

To advertise the use of the Biotech Labs, a brochure was released in July. Then a flyer was produced that lists all the analytical services offered by AQD for reasonable fees.

During the year, a large number of students, teachers, and researchers used the facilities of the Biotech Labs. An even larger number of visitors were shown the facilities.

AQD Service Laboratories

Fish Health Diagnostic Laboratory

A total of 235 diagnostic cases were examined. The samples consisted of 170 (72%) shrimps, 17 fish, 30 crab, 13 other samples, and 5 water samples. The bulk of the cases (200 samples, 85%) came from the private sector, 13% from within AQD, and four cases from BFAR. The diagnosed diseases included viral nervous necrosis (VNN), monodon baculovirus (MBV), white spot syndrome virus (WSSV), and taura syndrome virus (TSV). The frequency of disease occurrence was as follows: 23 of 36 fish samples VNN-positive, 12 of 45 shrimp samples MBV-positive by malachite green staining, 51 of 462 shrimp samples WSSV-positive, 18 of 129 crab samples WSSV-positive, and 8 of 8 shrimps TSV-negative.

Also received were 18 samples for bacterial identification, 183 samples for bacterial counts, and 573 samples of shrimps and crabs for diagnosis of WSSV. Other services included sale of master mix (P2,100/tube) for PCR diagnosis to private fish health laboratories and bacterial isolates (P100/isolate) to students.

Microtechnique Laboratory

A total of 875 histological slides were processed in support of research and disease diagnosis.

Natural Food Laboratory

A new algal strain from Qingdao, China, the *Platymonas helgolandicakylin* var. tsingtaoensis (depositor MR de la Peña) was added to the stock cultures of algae maintained at the laboratory. Maintenance of seaweed strains is continuing in tanks at the Seaweeds Wet Laboratory.

Private hatcheries were provided 54.7 liters of culture media, 226.4 liters of liquid cultures and 16 test tubes of solid cultures of microalgae, 58 liters of concentrated *Brachionus* sp. and 2.6 tons of *Chlorella* sp. Also served were requests from government and various universities for phytoplankton and zooplankton, for identification of species, and for practical training in natural food propagation.

Central Analytical Laboratory

CAL analyzed 542 water samples (for pH, phosphate, ammonia, nitrite, dissolved oxygen), 72 soil samples (for pH, organic matter, available iron, available sulfur, available phosphorus, nitrogen), and 95 feedstuff samples (for moisture, crude protein, crude fat, crude fiber, ash, nitrogen-free extract).

Electron Microscope Laboratory

A total of 22 samples were processed and analyzed for electron microscopy (transmission and scanning).

Pilot Feed Mill

Some 43,521 kg of various milled feeds were served to AQD researchers for use in-house and to the private sector for a fee.

Review and screening of milkfish technologies for dissemination

WG Yap, AC Villaluz, MN Santos, GH Garcia

SEAFDEC/AQD was involved in 2005 in the project, Dissemination and Adoption of the Milkfish Aquaculture Technology in the Philippines, with the Bureau of Fisheries and Aquatic Resources (BFAR) and theWorld Fish Center (formerly ICLARM), with funding from the Bureau of Agricultural Research (BAR) through the Consultative Group in Agriculture Research (CGIAR). Two project sites were selected: Barangay Bulao in Aringay, La Union and Barangay Malacapas in Dasol, Pangasinan. At these sites, the enabling factors and constraints in disseminating available milkfish technologies were identified and examined.

The role of SEAFDEC/AQD was to review and screen available milkfish technologies from seed production to post-harvest processing and to recommend appropriate technologies to be introduced to two target areas. The SEAFDEC/AQD team conducted rapid rural appraisal (RRA) of the pilot sites to determine the current status and practices in milkfish farming and processing in these areas. Actual dissemination or introduction of technologies was assigned to BFAR.

The benchmark data for the RRA were collected through site visits and focused group discussions with key informants—knowledgeable milkfish operators, local government officials, and municipal agriculturists and technicians. The RRA results and technology profiles served as basis for problem identification and needs assessment, and for matching appropriate technologies to the study areas. AQD's work has basically been completed except the final editing of the report (contents shown in box).

Recommended Technology Intervention for Project Sites

Barangay Dulao in Aringay, La Union

- Milkfish fingerling production in brackishwater ponds
- Milkfish deboning, smoking, and other value-adding
- Monitoring of environmental conditions of lagoon and river systems
- Good aquaculture practices
- Feed management in fish pens

Barangay Malacapas in Dasol, Pangasinan

- Milkfish fingerling production in brackishwater ponds
- Milkfish culture in pens or cages
- Modular/progression technique using existing pond design and structure
- Milkfish deboning and smoking
- Improved pond preparation and fertilizer use

Historical perspective of technology development

- Milestones in technology and industry development
- Institutions and people involved

Grow-out in brackishwater ponds

- Straight-run pond culture
- Modular or progression method
- Deep-water plankton method
- Semi-intensive culture
- Intensive culture
- Stock manipulation method
- Polyculture

Grow-out in pens and cages

- Pens in eutrophic freshwater lakes
- Marine and brackishwater fish pens
- Lake cages
- Sea cages

Seed production in the hatchery

- Broodstock development and maintenance
- Larval rearing and fry production

Post-harvest processing

- Traditional processes – drying and smoking
- Advanced processes – deboning, bottling, canning
- Value-added products – fish balls and kikiam

Hatchery production of milkfish was first accomplished at AQD in 1978

Regionalization of the Code of Conduct for Responsible Fisheries

Given the huge interest in farming of *Penaeus vannamei* in Asia, SEAFDEC/AQD convened the Regional Technical Consultation on the Aquaculture of *Penaeus vannamei* and Other Exotic Shrimps in Southeast Asia, in Makati, Philippines, on 1-2 March 2005. The RTC had 58 participants—country representatives comprising the SEAFDEC National Coordinators and specialists in shrimp farming, AQD researchers and officials, and observers from the private sector and the media. AQD's Research Division Head WG Yap chaired the RTC. During the RTC, the country representatives reported on the extent and status of aquaculture of *P. vannamei* and *other exotic shrimps* in Southeast Asia and China. Many were surprised at how much *P. vannamei* is now produced in Thailand (about 300,000 metric tons) and China (605,000 mt, most of it in fresh water). Indonesia, Vietnam, Myanmar, and Cambodia are also farming *P. vannamei*; Malaysia and the Philippines are still considering importation.

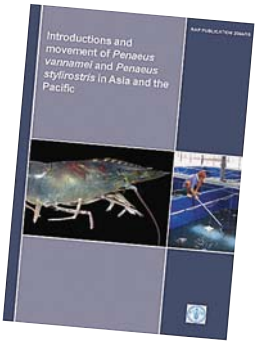
Penaeus vannamei is native to the tropical Pacific coast of Central and South America. After it was domesticated in Hawaii and Florida, it became widely available for farming and it now makes up more than 95% of the shrimp production in the world. The shrimp industry in Asia slumped in the 1990s due to widespread diseases that caused large losses to producers. Some shrimp growers stopped operations, some shifted to farming fishes, but many others shifted to *P. vannamei*. Relative to the native *Penaeus monodon*, *P. vannamei* has the following perceived advantages: lower feed cost, tolerance to higher stocking density, higher potential yield, commercially available specific pathogen-free seedstock and domesticated spawners. However, many Asian countries have legislation against the introduction and farming of exotic shrimp species such as *P. vannamei* for fear of new diseases that might be transmitted to wild shrimp populations through pond effluents.

The participants assessed the economic benefits of *P. vannamei* to the producing countries, and also the potential social and ecological impact of the introduction of *P. vannamei* in the region. No problems were identified in *P. vannamei* farming, but only in the procedures for import and the possible incidence of diseases.

It was deemed necessary to monitor all farming of exotic shrimp species, whether or not the entry was in accordance with the law. It was also agreed that the ASEAN should develop its own capability to produce specific pathogen-free and specific pathogen-resistant stocks of *P. vannamei* and also of the indigenous tiger shrimp *P. monodon*.

Proposed Plan of Action

1. Adopt the precautionary approach and formulate appropriate guidelines for the introducti on and farming of exotic shrimps.
2. Ascertain the extent of farming of exotic shrimps in each country. Determine and report actual production volumes of exotic shrimps.
3. Ascertain whether exotic shrimps have established themselves into the local ecosystem and study impact on native species.
4. Support research for the establishment and maintenance of captive or farmed shrimp broodstock, including specific pathogen-free stocks.
5. Integrate strategies of aquatic animal health management into aquaculture development plans.



FAO report used as reference during the RTC

Country Representatives and SEAFDEC officials during the RTC on Penaeus vannamei, Makati, Philippines, 1-2 March 2005

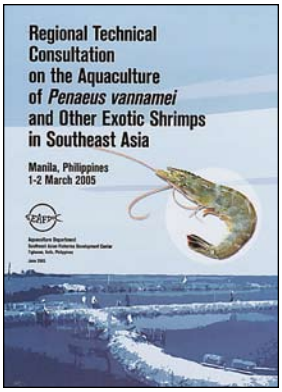
Before and after the RTC

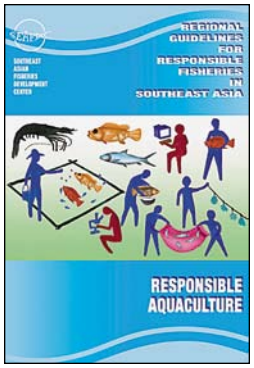
WG Yap

When SEAFDEC/AQD held the Regional Technical Consultation on the Culture of *Penaeus vannamei* and Other Exotic Shrimp Species in February 2005, the farming of *P. vannamei* was already widespread in the three major shrimp-producing countries in Southeast Asia: Thailand, Indonesia, and Vietnam. In 2004, Thailand reported a production of 276,600 metric tons of *P. vannamei* and only 110,000 mt of *P. monodon*. Indonesia and Vietnam produced 131,399 mt and 185,569 mt of *P. monodon* against 53,217 mt and 40,000 mt of *P. vannamei*. Brunei produced 432 mt of the exotic blue shrimp *P. stylirostris* and 61 mt of *P. monodon*. Thus, in Southeast Asia in 2004, more *P. monodon* (total 518,627mt) was produced than the exotic species (370,429 mt). Even then, however, the Southeast Asian production of *P. vannamei* was already more than double that of South America (172,105 mt) where the species is native. Asia-wide, slightly more *P. vannamei* (1,116,222 mt) was produced in 2004 than *P. monodon* and eight other native species combined (1,051,230 mt). This was due to the massive production of China with 735,055 mt of *P. vannamei* and only 200,889 mt of various native species.

Whereas Vietnam, Thailand and Indonesia were already reaping the benefits of farming the introduced but fully domesticated *P. vannamei* and have in fact already started their own breeding programs, Malaysia and the Philippines still banned the entry of this exotic shrimp ostensibly to prevent the entry of exotic diseases and protect local biodiversity. It was known, however, that in both countries, *P. vannamei* had already been brought in and farmed surreptitiously. The Philippines went one step further and made farming of *P. vannamei* illegal. The government zealously raided and closed down farms caught using *P. vanamei*.

About one month after the RTC, Malaysia lifted the ban on *P. vannamei* and allowed the entry of certified specific pathogen free (SPF) broodstock under specific guidelines and gave the choice of species to farmers. It has also made *P. vannamei* production a part of its national shrimp industry program. Malaysian shrimp production had always been modest compared to its neighbors—it reached 27,041 mt in 2001 of which some 662 mt was attributed to the Indo-Pacific white shrimp *P. merguiensis* and the rest to *P. monodon*. In 2002-2003, total production decreased to 25,000-26,000 mt as *P. monodon* declined, even as *P. merguiensis* increased to 800 mt. But in 2004, while *P. monodon* further languished, *P. merguiensis* surged to more than 5,000 mt and boosted total shrimp production to 30,000 mt. This production is believed to actually consist mostly of *P. vannamei*. Now that *P. vannamei* has become legal, its actual production may henceforth be reported. With the inclusion of *P. vannamei* in Malaysia's shrimp industry, it is likely that in 2005-2006, Malaysian shrimp production could surpass the Philippine production of about 37,000 mt a year since 2002.





The SEAFDEC Secretariat funded the RTC and the publication of the proceedings. AQD also produced the second edition (containing more explanations and background information) of the *Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Aquaculture*.

The current Philippine production is a far cry from the 95,816 mt in 1993 when the country was the third highest shrimp-producing country in the world. In the meantime, Philippine imports of fresh-chilled or frozen shrimps reached 1,464 mt valued at US$ 3.83 Million in 2004, a huge jump from 10 mt in 2001 and before. This imported shrimp is believed to consist mostly of low-value small-size peeled *P. vannamei* from China for the fastfood industry. It is also believed that uncertified *P. vannamei* continues to be farmed in Zambales and other provinces in Luzon due to the high local market demand but the limited supply of legal seedstock.

In 2005, the Philippines' Bureau of Fisheries and Aquatic Resources also loosened its strict ban against *P. vannamei*. BFAR has allowed one private company to import SPF broodstock on an experimental basis provided these are propagated only in its National Integrated Fisheries Technology Development Center in Bonuan, Dagupan City to ensure biosecurity. Only 500 pairs are allowed each time under very strict quarantine procedures. The company has imported three batches of broodstock. The first batch was found to have been contaminated by hepatopancreatic parvo-like virus (HPV) and was ordered destroyed. HPV is endemic to Asia and the first *P. vannamei* stock must have acquired the virus locally.

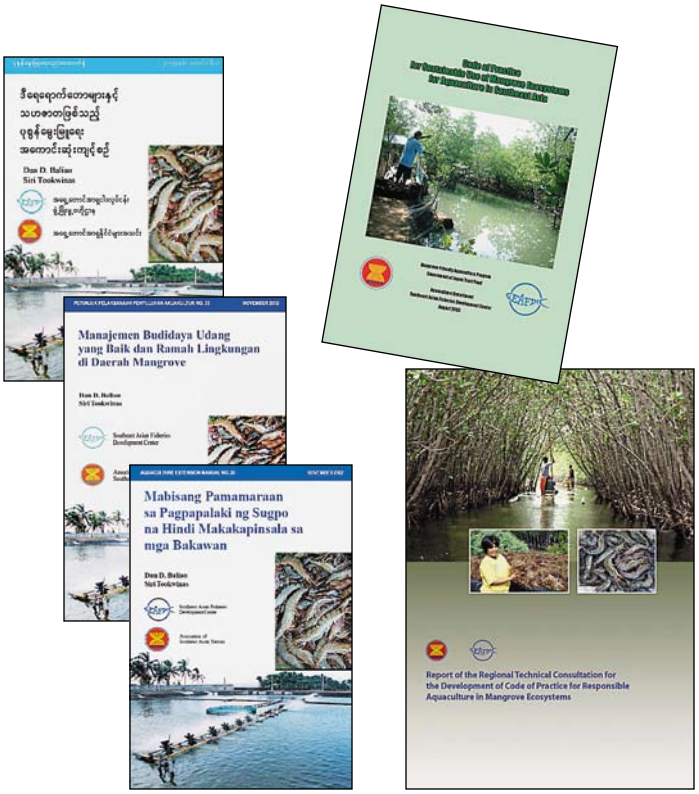
BFAR still considers *P. vannamei* an experimental culture species that requires thorough testing. The postlarvae produced are allowed to be grown only in a few accredited farms in Luzon. The harvest can be brought to market only when certified as having come from the experimental postlarvae, otherwise it is confiscated. Many shrimp farmers outside Luzon would like to use *P. vannamei* but are prevented from doing so by law. Some companies are also interested in importing their own SPF *P. vannamei* broodstock for their hatcheries. But until the ban on commercial farming of *P. vannamei* is lifted, no new import permits will likely be issued by BFAR.

Mangrove-Friendly Shrimp Farming

Funded by the Government of Japan Trust Fund, the Program verified an environment-friendly shrimp farming technology in Thailand, the Philippines, Vietnam, Myanmar, Cambodia, and Malaysia. Technology demonstration in Myanmar and Malaysia was successfully completed in early 2005 and was much appreciated by the fisheries agencies involved and by the shrimp farmers.

The Program produced a *Report on the Regional Technical Consultation for the Development of Code of Practice for Sustainable Aquaculture in Mangrove Ecosystems* following the RTC in Tagbilaran City on 25-27 August 2004. Also finished in 2005 were the translations into Filipino, Thai, Vietnamese, Burmese, and Bahasa Indonesia of the extension manual of D Baliao and S Tookwinas: *Best Management Practices for Mangrove-Friendly Shrimp Farming*.

The *Code of Practice for Sustainable Use of Mangrove Ecosystems for Aquaculture in Southeast Asia* came off the press in August 2005. This *Code of Practice* contains desiderata and guidelines articulated by Country Representatives and other mangrove stakeholders during the RTC in August 2004. The desiderata were elaborated with principles, definitions, and examples by TU Bagarinao and JH Primavera. The Code is intended primarily for governments and the aquaculture sector, but can also be used by the education and research sector and by the local communities living in the mangroves.



Environment-friendly shrimp farming in Myanmar in 2005

	Pond 1	Pond 2
Pond area (m^2)	8,000	7,000
Culture system	Intensive	Intensive
Total postlarvae stocked	196,692	224,000
Stocking density (per m^2)	24	32
Postlarval stage at stocking	PL33	PL30
Salinity (ppt)	7-22 (ave 14.5)	7-22 (ave 14.5)
Water depth (cm)	85-142	85-145
Transparency (cm)	105-15	80-15
pH	7.3-8.7	7.3-8.7
Culture period	21 Mar – 27 Jul	16 Mar – 29 Jul
Days of culture	128	135
Average body weight (g)	31.0	31.92
Survival rate (%)	80%	80%
Harvested quantity (kg)	4,200	4,100
Feed conversion ratio (FCR)	1.23	1.12
Farm gate selling price/kg	$4.7	$4.7

The technology demonstration project in Myanmar was implemented for the second time on a commercial scale at the Department of Fisheries facility in Kyauktan. The project showcased SEAFDEC/AQD's best management practices for mangrove-friendly shrimp farming, including the use of reservoirs (both for water intake and for waste water), fish as biomanipulators, center sludge collector, filter box, and biofilter. This technology provided optimum pond conditions. Fish biomanipulators stocked in the reservoir and center sludge collectors conditioned the pond water and suppressed harmful bacteria. Physicochemical variables were closely monitored and remedial measures were taken as soon as detrimental levels were detected. The use of sand filter box prevented the entry of predatory and other unwanted species.

For the second time in Myanmar, the use of best management practices prevented infestation by luminous bacteria and virulent viruses. Only good-quality postlarvae were stocked. No antibiotics were used and the shrimp products could easily pass the stringent quality control of the export markets. Low-volume water exchange, low feed conversion ratios, and high survival resulted in high profitability.

The technology demonstration project in Malaysia was implemented on a commercial scale at the Brackishwater Aquaculture Research Center in Johor Bahru from 15 August 2004 to 15 February 2005. Two ponds were used and stocking densities were 25 and 15 postlarvae/m^2. Survival was 84% and the harvest was 1,385 kg and 961 kg. The costs and returns of the project are tabulated in the table next page. Shrimp feeds made up 56-60% of the total operating cost, followed by power consumption. Both ponds showed high returns on total expenses and investments.

BARC and AQD technicians work together

Environment-friendly shrimp farming in Malaysia in 2004-2005

Technical Data	Pond 1 (29)	Pond 2 (28)
Method	Intensive	Semi-intensive
Pond size (m^3)	2,500	2,500
Stocking density (pcs/m^2)	25	15
Days of culture (DOC)	124	124
Harvested quantity (kg)	1,385.0	960.5
Quantity of feeds consumed (kg)	2,323.0	1,601.7
Feed conversion ratio (FCR)	1.68	1.67
Average body weight (g)	26.25	30.56
Survival rate (%)	84.4	83.8
Farm gate selling price (RM/kg)	23.00	25.00
Duration of run (stocking to harvest)	Oct. 2, 2004 - Feb. 4, 2005	
Sales (RM) Note: US $ 1.00 = RM 3.78		
Shrimps	31,855.00	24,012.50
Expenses		
Variable Cost		
Fry @ RM 0.019/pc	1,187.50	712.50
Fish biomanipulator @ RM 0.37/pc (7,000 pcs)	1,480.00	1,110.00
Feeds	8,804.17	6,070.44
Feed additives (Vit. C, probiotic and squid oil)	1,903.00	1,259.00
Bioremediation	100.00	100.00
Bioaugmentation	157.50	157.50
Labor	1,250.00	1,250.00
Power – KW @ RM 0.288 rate/hr	1,583.40	1,068.32
Other costs (lime, fertilizer, etc)	1,168.08	1,251.93
Sub-total	17,633.65	12,929.69
Fixed Cost		
Depreciation – equipments/materials		
Pumps	270.00	200.00
Paddlewheels	667.50	460.00
Netting materials/structures	587.32	587.32
Sub-total	1,524.82	1,242.32
Total Operating Expenses	**19,158.47**	**14,177.01**
Capital Outlay		
Cost of pump	2,700.00	2,000.00
Cost of paddlewheels	6,675.00	4,600.00
Cost of netting materials/structures	2,936.60	2,936.60
Sub-total	12,311.60	9,536.60
Development Cost	4,800.00	4,800.00
Total Investment Requirement	**34,745.25**	**27,266.29**
(Variable cost + Capital Outlay + Development Cost)		
Cash Inflow	14,221.35	11,082.81
Net Profit	**12,696.53**	**9,835.49**
Return of Investment (%)	37.00	36.00
Payback Period (croppings)	2.4	2.5
Return of Total Expenses (%)	66.00	69.00
Break Even Yield (kg)	832.98	567.08
Break Even Price (RM)	13.83	14.76

Stock Enhancement for Threatened Species

SEAFDEC recently initiated the Program on Stock Enhancement for Threatened Species of International Concern, a five-year program under the auspices of the Government of Japan-Trust Fund. SEAFDEC implements this and many other programs to help the developing countries in the ASEAN achieve food security and reduce poverty. AQD is implementing a component of this Program focused on aquaculture-based stock enhancement.

To prepare for the Stock Enhancement Program, AQD convened the Regional Technical Consultation (RTC) on Stock Enhancement for Threatened Species of International Concern at the Iloilo Business Hotel in Mandurriao, Iloilo City, from 13 to 15 July. The meeting had 55 participants and was opened by AQD Chief Dr. Rolando Platon. SEAFDEC Policy and Program Coordinator Mr. Suriyan Vichitlekarn reviewed the ASEAN-SEAFDEC directives related to species of international concern, and AQD Deputy Chief Koichi Okuzawa reviewed AQD's past and ongoing work in stock enhancement.

Representatives from Indonesia, Lao PDR, Myanmar, Malaysia, Philippines, Thailand, and Vietnam spoke about the threatened species and the stock enhancement initiatives in their countries. Among the species they identified for stock enhancement were freshwater fishes, sea horses, sea cucumbers, and the humphead wrasse. Some countries already have technologies for seed production, but no one has done baseline surveys, tagging, and monitoring.

Invited scientists shared their research results and field experiences. Pew Fellow Dr. Edgardo Gomez described his successes in giant clam restocking and coral transplantation in the Philippines. Pew Fellow Dr. Amanda Vincent of Project Seahorse fame cautioned against restocking of hatchery-bred seahorses. Amazingly, a third Pew Fellow was at the RTC, AQD's own Dr. Jurgenne Primavera, who has ongoing projects in mangrove conservation and mud crab stock enhancement. The Pew Fellows in Marine Conservation are an elite group of marine scientists who work for conservation and sustainable use of species and ecosystems.

Dr. Katsuhiro Kiso talked about the giant clam project in Okinawa, and Dr. Takuma Sugaya reviewed recent technologies used for stock enhancement in Japan. Dr. Sena de Silva presented a review of stock enhancement for culture–based fisheries in freshwater lakes, reservoirs, and farm impoundments in Asia. Thailand's conservation and breeding program for the Mekong giant catfish Pangasianodon gigas was described by Dr. Naruepon Sukumasavin. Prof. Frances Nievales talked about farming of sea urchins and sea cucumbers, and Dr. Benjamin Gonzalez described his community-based stock enhancement project for the top shell Trochus niloticus. AQD's Dr. Ma. Rowena Eguia discussed the technologies for tagging and marking, including genetic marking techniques.

A workshop was held to chart the future directions for the Program, and the participants agreed on a Resolution and Plan of Action. The Closing Ceremony was graced by Speaker Jose de Venecia of the Philippine House of Representatives. The farewell dinner was seafood all around, including the resurgent angelwing Pholas orientalis, only recently bewailed as having become 'endangered.'

Country Representatives, resource persons, and AQD officials and scientists during the RTC on Stock Enhancement, Iloilo City, Philippines, 13-15 July 2005

Stock enhancement is a form of fishery intervention where juveniles (or young) of depleted or threatened species are released in natural waters to become part of the common fishery stocks. These released juveniles feed on natural food, fend off predators, grow, breed, and produce more young, some of which may then be harvested. Stock enhancement done at sea is called sea ranching. Japan is one country with a long history of sea ranching for the benefit of fishing communities.

Although restocking of juveniles appears to be a simple process, the preparation that goes with it is not. First and foremost is a thorough assessment of the resources of a given ecosystem to determine in what way an area can best be enhanced. Selection of the parent stock to be used is also crucial so as not to adversely affect the natural biodiversity of the area. Then there is the matter of how best to mark the juveniles so the releasing agency can assess the survival and the contribution of the released stocks to the fishery. Lastly, it is necessary to assess the costs versus the benefits of such releases.

RTC Resolution

- Stock enhancement should be undertaken as part of an integrated management strategy for sustainable use and conservation of aquatic resources.
- Stock enhancement should be considered only when other interventions, such as reduction of fishing pressure and habitat protection or restoration, have proven inadequate.
- Stock enhancement programs should use indigenous or native species to minimize adverse effects on ecosystems and biodiversity.
- For species that are now used for stock enhancement programs in the Member Countries, technological support should be strengthened to ensure success.
- Seed production technology for a species should be established before it can be considered for stock enhancement, but broodstocks may also be restocked to restore the breeding population.
- As basis for evaluating the risks and benefits of stock enhancement, baseline surveys must be conducted before any release of stocks, to obtain physico-chemical, biological, and socioeconomic information, especially the characteristics of the receiving ecosystem and the stakeholder communities.
- Hatchery-produced juveniles used for stock enhancement should be carefully screened for genetic makeup and health status to ensure that genetic diversity is conserved and only good quality juveniles are released.
- Impacts of the stock enhancement activity should be monitored and evaluated on a regular basis, using the same methods and covering the same area or ecosystem as the baseline survey.

Plans of Action

1. Research and development will be conducted on species of international concern based on:
   - List of species identified at the RTC
   - Regional concerns – priority given to common species and problem areas identified by the Member Countries
   - Technology gaps identified by each Member Country
   - Available resources of the Program
   - Mandate from the SEAFDEC Council

2. Appropriate technologies for stock enhancement will be verified:
   - Technologies developed by AQD
   - Technologies developed by Member Countries

3. The capability of the Member Countries for appropriate stock enhancement will be strengthened through training, study tours, publications, and dissemination of information regarding the following technical areas:
   - Planning and management of stock enhancement, including review of existing activities
   - Assessment of sites and resources
   - Seed production (broodstock, hatchery, nursery)
   - Release strategies, including tagging and marking
   - Monitoring and evaluation of impacts
   - Community-based resources management

The Country Representatives identified the threatened species for which stock enhancement may be a feasible and effective intervention. Sea horses, giant clams, abalone, and sea cucumbers were of common interest to several countries, and the Program will do research and development for these species.

SEAFDEC officials and researchers guide the consultation




Some of the invited speakers at the RTC

Population dynamics, breeding and seed production of sea horse

Adults of tiger-tailed sea horse *Hippocampus comes* were acquired from Manlot Island, Carles in Nov-Dec 2005. The broodstock (68 females and 63 males) ranged 9.4-16.4 cm in stretched height. About 80% of the males were pregnant and released juveniles within 20 days after arrival at the hatchery. Brood size ranged from 38 to 715 per male and a total of 6,948 juveniles were produced. Juveniles were fed newly hatched *Artemia* and copepods; average survival after two months was 3%.

Adult sea horses were fed enriched *Artemia*, mysids, and frozen shrimp *Acetes*. The biomass decreased after two months presumably due to insufficiency of food. Eight adults died due to pouch emphysema, internal gas bubble disease, and flesh erosion disease; two others died due to wounds at the tail suffered during collection.

Abalone fishery in Western Visayas and refinement of abalone seeding strategies for stock enhancement

Sagay Marine Reserve (SMR) in Negros Occidental has strong law enforcement capability and thus selected as the main site for the stock enhancement program. Juvenile abalone *Haliotis asinina* released at Carbin Reef in SMR in 2002 and 2003 were assessed in September 2005. Search was done 5 meters left and right of six permanent 30-meter transects installed at the site. No hatchery-bred abalone was found at any transect.

AQD research results generated at SMR were presented in October 2005 to the Protected Area Management Board (PAMB) of SMR, including the MSc thesis of RJ Maliao and the abalone seeding done by WG Gallardo. Also presented were the technologies for abalone hatchery and farming and their great potential for livelihood. A planning workshop for AQD-SMR collaboration in stock enhancement was conducted and a new Memorandum of Agreement was drafted. Progeny of the abalone broodstock from SMR were diet-tagged at the AQD hatchery and will be released at the SMR in 2006.

Years ago, AQD had developed the method to diet-tag juvenile abalone and top shell *Trochus niloticus* by feeding them formulated feeds for some period during which they lay down bright green or bright red shell layers. After the tagged juveniles are released, the bright-colored shells make them easy to see out in the field.

Diet-tagged juvenile abalone and top shell

Regional Fish Diseases Program

AQD's Fish Health Section continued to be very active in research and training aimed at establishing a fish disease surveillance system in Southeast Asia under the Regional Fish Diseases Program. The projects implemented in 2005 included:

- Surveillance of emerging fish viral pathogens in some Southeast Asian countries
- Monitoring and surveillance of transboundary pathogens in farmed shrimps and freshwater prawns
- Optimization and standardization of PCR protocols for important viral diseases of farmed and wild shrimps in the Philippines
- Viral nervous necrosis in wild and farmed fish in the Philippines
- Immunostimulation and vaccination strategies for WSSV prevention among shrimps
- Control of luminous bacterial disease in tiger shrimp by fish, microalgae, and other agents
- Terminal report of Phase I: Recent Advances in Diagnosis and Prevention of Fish and Shrimp Diseases in Southeast Asia
- Website for the Regional Fish Diseases Program, http://rfdp.seafdec.org.ph, linked to the AQD website http://www.seafdec.org.ph
- Training course: Detection of Koi Herpes Virus and Taura Syndrome Virus, 7–12 Mar 2005
- Training course: AquaHealth Online, Aug–Dec 2005
- AQD-OIE training course: Important Viral Diseases of Fishes and Shrimps, 14–29 Nov 2005

The Regional Fish Diseases Program held its annual progress and planning meeting at Dusit Hotel Nikko in Makati, Philippines on 3 March 2005. In attendance were the Project implementors: Supranee Chinabut, Somkiat Kanchankhan, and Suppalak Puttinaowarat from Thailand; Agus Sunarto and Taukhid from Indonesia; and EC Amar, CR Lavilla-Pitogo, GD Lio-Po, LD de la Peña, and EA Tendencia from SEAFDEC/AQD. Program Leader Dr. Kazuya Nagasawa led the discussions and introduced Dr. Koichi Okuzawa, the new AQD Deputy Chief and GOJ-Trust Fund Co-Manager. Also present as Project evaluators were SEAFDEC Deputy Secretary-General and GOJ-Trust Fund Manager Junichiro Okamoto, and Japanese scientists Takaji Iida, Kazuhiro Nakajima, Ikunari Kiryu, Makoto Iwashita, Minoru Sorimachi, Yozo Kobayashi, and Nobuaki Okamoto.

In 2005, SEAFDEC/AQD continued its collaboration and partnership with the Network of Aquaculture Centres in the Asia-Pacific in the area of aquatic animal health management in the ASEAN countries. AQD Deputy Chief K Okuzawa and Fish Health Section Head CR Lavilla-Pitogo participated in the fourth meeting of the Asia Regional Advisory Group on Aquatic Animal Health held at Taj Samudra, Colombo, Sri Lanka on 22-24 October 2005. Other meetings attended included:

- 6th Symposium on Diseases in Asian Aquaculture, Colombo, Sri Lanka, 25–28 Oct 2005
- FAO Experts Workshop for the preparation of *Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Organisms*, Dambulla, Sri Lanka, 1–4 Nov 2005
- 24th Conference of the OIE Regional Commission for Asia, the Far East, and Oceania, Seoul, Korea, 15–18 Nov 2005

Planning Meeting of the Regional Fish Diseases Program, Makati, Philippines, 3 March 2005

Surveillance of emerging viral pathogens in fish in Southeast Asia

New cell lines were received from various collaborators: koi carp from M Sano (Japan), grass carp CO from Chi (Vietnam), grass carp CK from YL Jiang (China), and fathead minnow (FHM) from A Goodwin (USA). These new cell lines were propagated successfully. The KT-2 cell line was received from Dr A Sunarto (Indonesia) and carp brain cells from C Tu (Taiwan), but the cells did not grow. Cells of EPC, E-11, GF-1, WSSK, WSS2Cl, KF-1, CK, and FHM were also stored in liquid nitrogen at the Fish Health Section, Bureau of Fisheries and Aquatic Resources (BFAR) Manila. Likewise, spring viremia of carp virus (SVCV) was received from A Goodwin (USA) and grass carp hemorrhagic virus (GCHV) from YL Jiang (China). Cell passages of koi herpes virus (KHV), SVC, and GCHV yielded titers of $10^{3.12}$, $10^{7.6}$, and $10^{6.6}$ $TCID_{50}$/ml, respectively.

Tissues of common carp, koi carp, silver carp and grass carp were collected from Myanmar, Lao PDR, Cambodia, Taiwan and the Philippines and analyzed for GCHV and SVCV. Tissue filtrates of sampled fish were inoculated into KF-1, FHM, EPC and CK cells, but did not induce cytopathic effects. Intraperitoneal injection of the tissue filtrates into healthy common carp also did not induce any pathological signs or mortality.

A total of 148 samples of koi carp, common carp, grass carp, and tilapia from 6 countries were tested for KHV by the modified protocols for polymerase chain reaction (PCR). In general, the results were not consistent (positive results in the one-step, negative after nested step) in 34% of the fish samples. Explanations and solutions were sought.

PCR tests for SVCV showed that fish samples from Myanmar, Cambodia, Lao PDR, Vietnam and Laguna/Baguio, Philippines were negative for the virus by one-step and by semi-nested PCR. The PCR test for GCHV was standardized.

In addition, tissues of grouper and snapper were collected from Cambodia and assayed for viral nervous necrosis (VNN) virus and iridovirus by cell culture, PCR, and histopathology. No virus was isolated by cell culture, but nested PCR for VNN was positive in 8 of 9 fish samples. PCR tests for iridovirus is still pending. The histological profile of the grouper tissues was normal except for a few monogenean-like parasites on the gills. The snapper tissues showed inflammatory infiltration with focal necrosis of the kidneys. The brain and gills were relatively normal but the gills harbored monogenean-like parasites.

In the latter part of the year, koi carps were also collected from Pampanga, Jalajala and Davao in the Philippines. Virus isolation, pathogenicity tests, and PCR test showed these were negative for KHV. Tests for SVCV and GCHDV are ongoing.

Visits to government agencies indicated that Vietnam has facilities for cell culture and PCR, and Myanmar for PCR. Both Cambodia and Lao PDR do not conduct virus diagnosis. Lao PDR has one researcher with technical training in fish diseases but uses the laboratory facilities of the Veterinary Section. In the Philippines, BFAR provides viral detection services by PCR only.

AQD works with FRA Japan on KHV

The Fisheries Research Agency of Japan engaged SEAFDEC/AQD to develop methods to prevent and control koi herpes virus and other virulent diseases from spreading. Koi herpes virus (KHV) recently became a major threat to koi and common carp production worldwide, including the wild populations. Epizootics of the disease involving fish of all ages have been reported.

Comparison of characteristics of KHV isolates from Asia

GD Lio-Po, LD de la Peña, J Kurita, M Sano, S Miwa, K Way, C Tu, J Somga, ZA Orozco, MG Paner

Samples of koi or common carp *Cyprinus carpio* were obtained from Cambodia, PR China, Indonesia, Lao PDR, Myanmar, Philippines, Taiwan and Vietnam in Apr 2004 to Mar 2005 for detection of the koi herpes virus (KHV). Virus assays consisted of virus isolation by cell culture in KF-1 cells, pathogenicity tests in healthy, naïve common carp, and by PCR. All diagnostic tests yielded negative results, except the PR China and Taiwan samples that were positive by PCR—koi obtained from a fish trade show in PR China and intercepted by quarantine inspectors at the Manila airport, and koi (frozen at –80°C) from a KHV outbreak in Taiwan in Feb 2004. Similar fish samples were again obtained from Cambodia, Lao PDR, Myanmar, Philippines, and Vietnam in Sep 2005 and now being processed.

Isolates of KHV were also obtained from Malaysian fish imported into the United Kingdom. Pathogenicity tests of the Malaysian KHV showed that intraperitoneal injection caused 100% mortality among healthy, naïve common carp with 14 g fish dying 6-9 days post-exposure and 6 g fish dying in 10-14 days. Of carp exposed to KHV by bath 20% died among 14 g fish and 40% died among 6 g fish. Some experimentally infected fish manifested grayish gills, distended abdomens, and hemorrhagic or swollen eyes. No mortality occurred among sham-exposed fish.

KHV was exposed to temperatures (°C) of 35, 30, 25, 20, 15, 4, 0 to –5, and –80 and viability was assayed 1, 3, 5, 7, 14, 30, 60, 90, 120, and 365 days after exposure. The virus did not survive a 24-hour exposure to 35°C temperature, but remained viable for up to 3 days in storage at 20, 25 and 30°C. Temperatures from –5 to 15°C kept the virus viable for 5 days, and storage at –80°C kept KHV viable for one year.

Sequence analysis of the DNA of the three KHV isolates showed that KHV from PR China and Taiwan are of the Asian genotype, strains A1 and A2. The gene sequences of the Malaysian isolate classified this as E7 strain of KHV, a new strain of the European genotype.

Monitoring and surveillance of transboundary pathogens in farmed shrimps and freshwater prawns

Visits were made to Myanmar on 3-8 January, Cambodia on 31 Jan–7 Feb, and Vietnam on 3-9 Apr 2005. Aside from visits to farms and hatcheries for sample collection and familiarization with the operating conditions in those countries, small meetings and discussions were also held with Fish Health staff. *Macrobrachium rosenbergii* and *Penaeus monodon* obtained in Myanmar were negative for Taura syndrome virus (TSV), white spot syndrome virus (WSSV), and infectious hypodermal and hematopoietic necrosis virus (IHHNV) by polymerase chain reaction assays. Histological sections, however, show that P. monodon samples were positive for monodon baculovirus (MBV) and hepatopancreatic parvo virus (HPV). Juvenile Scylla serrata from Cambodia were WSSV-negative by PCR.

A trip to Zamboanga Sibugay was made in March to visit Alicia town's mud crab and shrimp farms. Mud crab samples from aqua-silviculture were negative for WSSV by PCR. So were the juvenile *P. monodon* from a private hatchery in Zamboanga City.

In June, four farms in Zambales growing *Penaeus vannamei* were visited and the shrimps sampled. The shrimps were pooled into 15 samples (5-7 individuals/sample) and all were negative for TSV and WSSV by reverse transciption-PCR and PCR. However, 6 samples were IHHNV-positive.

Sampling for *P. monodon* in Negros Occidental, Cebu, and Bohol was conducted in June and July. All samples obtained from farms were negative for WSSV and TSV, but some farms had shrimps that were positive for IHHNV and MBV.

Spawners collected from Panguil Bay in July and September showed high mortality after collection and were positive for WSSV by one-step PCR. Spawners that were sampled in August were negative for WSSV.

Sampling in October, November, and December showed WSSV in pond-reared *P. vannamei* from Pangasinan and tank-reared *M. rosenbergii* from Binangonan, Rizal. The tank rearing system of *M. rosenbergii* at BFS should be improved in order to avoid fungal infection that was diagnosed in several batches of larvae.

Sampling for fish diseases in Cambodia with the staff of the Ministry of Fisheries

Meeting with the staff of the Department of Fisheries in Myanmar

Packing koi samples in Vietnam

Screening of important viral diseases of farmed aquatic animals

Several PCR runs were made to optimize the detection of taura syndrome virus (TSV) by means of primers R4, F4, and F5, all designed by the laboratory of Dr. Grace Lo of National Taiwan University. AQD's optimized PCR protocol made use of anchor dTV as primer for the reverse transcription reaction using the commercially available Superscript II (Invitrogen, USA). One-step PCR used primer pairs R4 and F4 with an expected amplicon size of 708 base pairs. Nested PCR amplified an inner fragment of 231 bp by using primer pair R4 and F5. With a TSV plasmid, the optimized PCR protocol can detect a titer at a dilution of 10^{-6} and will be used for samples of *Penaeus monodon* and *P. vannamei*.

Viral nervous necrosis in wild and farmed fish in the Philippines

Broodstocks and larvae of the sea bass *Lates calcarifer* and the groupers *Epinephelus* spp. at the AQD hatchery were monitored for viral nervous necrosis. Eggs from VNN-positive spawners were also VNN-positive and only 2-3% of the larvae survived to 33-42 days. Transmission and scanning electron microscopy was used to ascertain whether the virus penetrated, or just attached to the surface of the eggs. Twenty species of fresh fish from Panay Gulf were examined for VNN; prevalence among these species was lower than among fish from the Iloilo Fishing Port sampled last year.

Immunostimulation and vaccination strategies for WSSV prevention

Experiments were done on tiger shrimp on the immunological effects of four test substances: natural extracts from *Vibrio harveyi* (NVh), synthetic oligonucleotides with CpG motifs, synthetic oligonucleotides with no CpG motifs, and phosphate-buffered saline as control. To determine the proper dose, the test substances were injected intramuscularly at 25 µg and 50 µg per shrimp. A dose of 25 µg was used thereafter to stimulate the immune response. *In vitro* immune indices were measured 5-6 days after injection. Most of the indices were higher in the NVh, CpG, and no CpG groups than in the control. To test the *in vivo* effects of the immunostimulants, a challenge experiment was done with WSSV as inoculum. Shrimp injected with the immunostimulants and challenged with WSSV survived better than those without. Thus, oligonucleotides and bacterial extracts are effective as immunostimulants in shrimp.

Control of luminous bacterial disease of tiger shrimp by means of fish and other aquaculture species

In vitro experiment in 500 ml sterile flasks showed that that growth of luminous bacteria is inhibited after 2 days in flasks with oyster culture water and after 6-7 days in those with seaweed culture water. Luminous bacteria could still be detected in flasks with filtered sea water until day 9 and in sterile sea water until day 10 when the experiment ended.

Experiment in concrete tanks stocked with shrimp (biomass 80 g/m^3) and inoculated with luminous bacteria (10^4 cfu/ml) showed significantly low luminous bacteria count in tanks with oysters (10 individuals/m^3) and tilapia (500 g/m^3) after one day. No luminous bacteria were recovered in tanks with the seaweed *Gracilaria* (1 kg/m^3) on day 13. Luminous bacteria could not be found even in control tanks (with shrimp only) on day 14. Shrimp survival was very low in all tanks including the control. Oyster survival was also very low.

Experiment in concrete tanks stocked with shrimp (100 g/m^3) and luminous bacteria (10^4 cfu/ml) with or without either oysters (density 368/m^3), brown mussels (158/m^3), or green mussels (137/m^3) showed significantly low luminous bacteria counts in tanks with bivalves (lowest with green mussel) than in those with shrimp only.

Experiment in concrete tanks stocked with shrimp (100 g/m^3) and luminous bacteria (10^4 cfu/ml) and the seaweeds *Gracilaria* sp. (biomass 3 kg/m^3) or *Kappaphycus* sp. (3 kg/m^3) showed lower luminous bacteria count in tanks with seaweeds.

4th Meeting of the Asia Regional Advisory Group on Aquatic Animal Health, Colombo, Sri Lanka, 22-24 Oct 2005

24th Conference of the OIE Regional Commission for Asia, the Far East, and Oceania, Seoul, Korea, 15–18 Nov 2005

Dr. Nagasawa says *sayonara*

After two years, two scientific conferences, and six books and manuals at the helm of the Regional Fish Diseases Program, Dr. Kazuya Nagasawa said goodbye to AQD on 22 March 2005. The AQD Chief acknowledged his able leadership and thanked him for his contributions to AQD's achievements. The Fish Health scientists attested to his leadership, how he encouraged them to accomplish their research and publish their results both in scientific journals and in books and manuals.

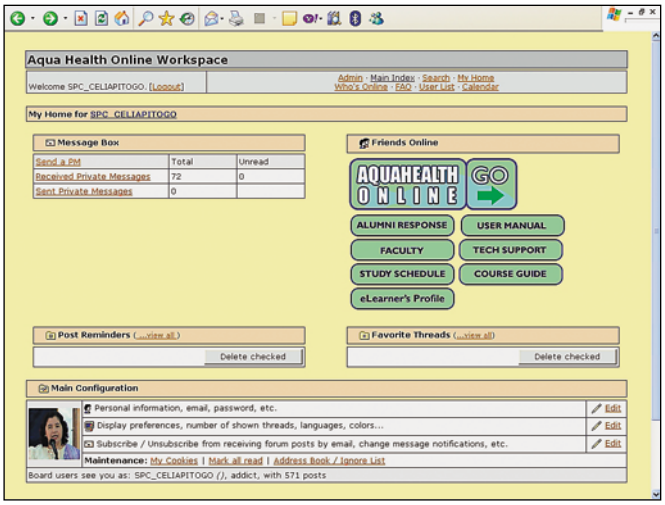
Launching of five publications of the Regional Fish Diseases Project, 7 July

The terminal report of Phase I of the Regional Fish Diseases Program

Participants in the training on KHV and TSV, March 2005

Training on Detection of Koi Herpes Virus and Taura Syndrome Virus in Fish/Shrimp was carried out at SEAFDEC/AQD in Tigbauan on 7–12 March 2005. There were seven trainees – five sponsored by GOJ-TF (two from the Philippines and one each from Cambodia, Myanmar, and Vietnam) and two paying trainees from Vietnam. The hands-on training included lectures and practical laboratory sessions in cell culture and polymerase chain reaction assay for the detection of KHV and TSV.

The Training Course on Important Viral Diseases of Shrimps and Fishes was conducted at SEAFDEC/AQD on 14-30 November 2005 in cooperation with the Office International des Epizooties, Tokyo. There were three men and seven women trainees, seven of whom had participated in the 2003 and 2004 AquaHealth Online. The resource persons for this training course were nearly all the staff of AQD's Fish Health Section. Dr. Yoshiyuki Oketani from OIE Tokyo lectured on the International Aquatic Animal Health Code and discussed the Diagnostic Manual for Aquatic Animal Diseases – Viral Pathogens of Fish and Shrimp. Dr. Toshihiro Nakai from Hiroshima University lectured on epidemiology of viral diseases of fish.



AquaHealth Online, the distance-learning course with 12 different modules was implemented from August to December 2005, again with Dr. Celia Lavilla-Pitogo as Course Officer. There were 22 elearners (8 women and 14 men) from 11 countries. Nine government personnel from the Member Countries were funded by SEAFDEC. The participants from the private sector included one from England, one from Malta, and 5 from the Philippines (3 from BFAR, one working in Madagascar, and a veterinarian). SEAFDEC/AQD also signed up six of its research assistants in the course. Of the 22 elearners, 11 passed and were given Certificates of Training. The batch valedictorian was Mary Nia Santos of SEAFDEC/AQD who got a grade of 95%. The next three topnotchers were also from the Philippines and the fifth placer was from Myanmar.

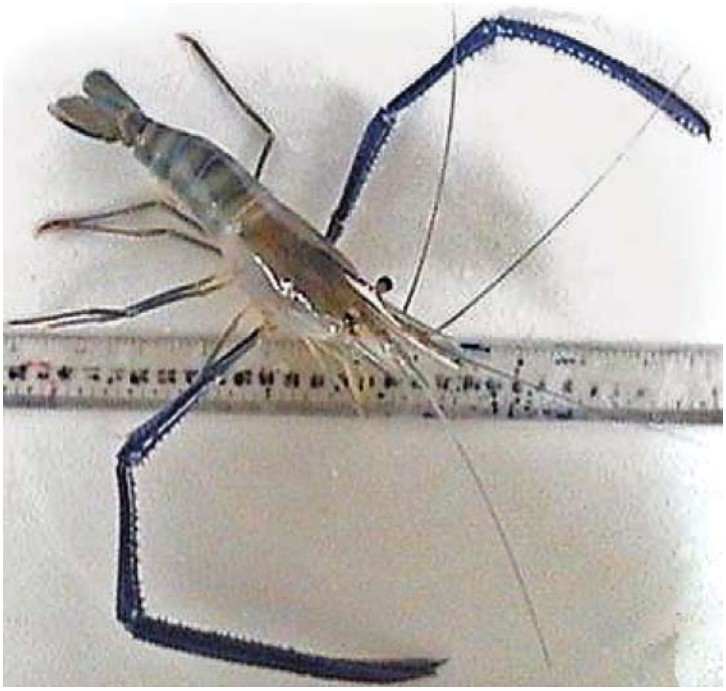
Trainees get their hands on the electron microscope and some cell cultures

Dr. Yoshiyuki Oketani from OIE Tokyo lectures at AQD, November 2005

Integrated Regional Aquaculture Program

This Program included a variety of projects and activities according to the needs of the Member Countries, as identified during the Program Committee Meeting, and the site surveys conducted by AQD in 2003. Many of the requests were for training in seed production and rural aquaculture. IRAP funded a project to verify hatchery technologies for marine fishes. SEAFDEC/AQD, Indonesia, Thailand, and the Philippines also agreed to collaborate in research to improve the genetic characteristics of the giant freshwater prawn *Macrobrachium rosenbergii* and produce quality seedstock for farming.

- Genetic improvement of *Macrobrachium rosenbergii* (collaborative research of Indonesia, Thailand, Philippines)
- Verification of seed production technologies and low-cost feeds for aquaculture
- Third *Macrobrachium* Roundtable Discussion, 3 – 4 Dec 2005
- Regional Planning Workshop for IRAP 2006-2010, 30 Nov – 2 Dec 2005
- Technical assistance for aquaculture projects in the ASEAN member countries
- Attachment and on-site training
- Training course on Tilapia Hatchery and Grow-out, 1-10 Aug
- Training course: Crab Seed Production, 14 Sep–14 Oct 2005
- Training course: AquaHealth Online, August – December 2005
- Participation in aquaculture fairs and exhibits



Macrobrachium rosenbergii

Morphometric characterization and performance evaluation of *Macrobrachium rosenbergii* and closely related species in the Philippines

Samples of *Macrobrachium* were collected from seven wild populations—Calumpit, Bulacan in Luzon and Dinas, Siay, Tambulig, Mangagoy, Lake Mainit and Lake Lanao in Mindanao (stocks from Mindanao were collected by Prof. Henry Dejarme of Mindanao State University Naawan). Also sampled were two hatchery stocks from SEAFDEC/AQD Binangonan and one from the BFAR-NIFTDC (Bureau of Fisheries and Aquatic Resources National Institute of Fisheries Technology and Demonstration Center) in Dagupan, Pangasinan. The samples were preserved in 80% ethanol for subsequent laboratory identification. Taxonomic verification of the samples by crustacean taxonomists Prof. Peter Ng. and Dr. Daisy Wowor of the National University of Singapore identified the samples as: *M rosenbergii rosenbergii* and *M rosenbergii dacqueti* from Calumpit, Dinas, Siay and Tambulig; *M mamillodactylus* and *M latidactylus* from Mangagoy; *M lanceifrons* from Lake Mainit; *M latidactylus* from Lake Lanao. The three hatchery stocks were mostly *M rosenbergii dacqueti*. The samples were distinguished mainly through the shape of the rostrum, body size, and color pattern.

Spawning sets (1M:5F) of four-month old prawn from a hatchery stock (BFAR strain, *M rosenbergii rosenbergii*) and a wild stock (Calumpit strain, possibly *M rosenbergii rosenbergii* x *M rosenbergii dacqueti* F1s) were placed in replicate outdoor concrete tanks (2x2x1m) in April 2005. Stocks were fed as follows:

- Treatment A: low protein (commercial fish feed) at 2% of the prawn biomass
- Treatment B: high protein (prawn feed) at 2% of the prawn biomass
- Treatment C: low protein (commercial fish feed) given *ad libitum*

The reproductive efficiencies of the stocks were compared. After six months, the BFAR stock fed low protein diet (fish feeds) *ad libitum* spawned more frequently (average 16 spawning episodes) than prawns given fixed amounts of fish feed (10.7) and prawn feed (6.3). Calumpit stocks spawned less frequently: 9 in treatment A and C and 6 in B. The average number of hatchlings produced per gram body weight of the female prawn was higher in the BFAR stock (670 in treatment C, 665 in B, and 567 in A) than in the Calumpit stock (598 in treatment C, 533 in B, and 439 in A).

Growth of two strains of *Macrobrachium rosenbergii* in cages in Laguna de Bay

Postlarvae from two separate stocks of *Macrobrachium rosenbergii* were used: CAL (progeny of the native strain from Calumpit, Bulacan) and BFAR (progeny of the strain from BFAR, originally from Thailand). They were stocked at 15/m^2 in net cages in Laguna de Bay and reared for five months, the first run from October 2004 to March 2005 and the second from April to September 2005. In the first run, CAL showed significantly better specific growth rate (SGR) than BFAR (4.6 vs 3.9%) but no differences in final weight, yield, and feed conversion ratio (FCR). Survival was not significant different. In the second run, CAL was significantly better than BFAR in survival (80.4 vs 61.1%), SGR (2.9 vs 2.6%), and FCR (2.1 vs 2.7), but not in the final weight (24.0 vs 24.3g).

Macrobrachium farming, Philippines

AQD scientist MRR Eguia participated in the World Fish Center Workshop on the Dissemination of Improved Fish Strains: Country-Specific Action Plans held in Shanghai, China on 21-22 September and the 8th Steering Committee Meeting of the International Network on Genetics in Aquaculture (INGA) on 23 September. Travel was funded by IRAP.

World Fish Center Workshop and INGA Meeting in Shanghai, September 2005

Project members present research results

The project Genetic Improvement and Seed Production of *Macrobrachium rosenbergii* has been going on since 2003 under the Aquaculture Component of the Special Five-Year Program. To assess the progress of the project, the Third Roundtable Discussion was held in Bangkok, Thailand on 3-4 December 2005. The Round Table was attended by 32 participants from the collaborating countries and from AQD, the SEAFDEC Secretariat, and the Training Department.

The researchers working in the *Macrobrachium* project each presented their latest results, which were discussed in open forum. Indonesia presented the final report on the evaluation of the growth rate of GI Macro II strain in different locations. Thailand reported the progress of their work on selective breeding for genetic improvement of *M rosenbergii*. The Philippines presented four reports.

Genetic Improvement of *M. rosenbergii* was identified as a priority project for the Integrated Regional Aquaculture Program 2006-2010. During the Round Table, a detailed plan and schedule of activities was agreed upon for implementation in 2006-2010.

A set of resolutions was also formulated for submission to the SEAFDEC Council:

- Research collaboration between Indonesia, Philippines and Thailand should be further strengthened through increased communication.
- AQD should encourage more active participation of other Member Countries.
- AQD should package a proposal for genetic improvement of *Macrobrachium*, in consultation with the countries involved, for submission to funding agencies.
- SEAFDEC-ASEAN Member Countries should be cautious in introducing exotic or new stocks of *M rosenbergii*.

Although *Macrobrachium* species are native to most of the Member Countries, bringing in *Macrobrachium* stocks from another country poses risks in terms of disease transfer and contamination of local genetic resources.

SEAFDEC/AQD sent Aquaculture Assistant Esteban Garibay to Hue, Vietnam, to provide technical assistance to the Thua Thien Hue Fishery Extension Center in its project on rabbitfish seed production. Steve worked with the hatchery staff from 15 to 30 June 2005. Using the technologies developed at AQD, the Hue staff were able to spawn the rabbitfish *Siganus guttatus* and to rear the larvae. Larval survival, however, was still low because of low quality and quantity of larval food, mainly rotifers. The hatchery staff were taught the techniques for rotifer enhancement.

AQD staff visited Thua Thien in mid-2003 to assess the hatchery facilities, and again from 10 to 24 November 2004 to train hatchery and extension personnel in spawning rabbitfish and producing larvae. Under the Program, Vietnam implements projects in rabbitfish aquaculture in Hue and milkfish aquaculture in Binh Dinh.

Myanmar participant in AquaHealth Online

Floating cages for transport of rabbitfish broodstock

The distance-learning course AquaHealth Online was offered by AQD from August to December 2005. Of the 22 eLearners from 11 countries, nine participants from the ASEAN Member Countries (except Lao PDR) were funded through IRAP.

IRAP funded two participants, Mi Mi Khaing from Myanmar and Seng Heng from Cambodia, in the training course Tilapia Hatchery and Grow-out conducted by the Binangonan Freshwater Station on 1-10 August 2005. In addition to the lectures and practicals, the trainees visited the ABCDEFI farm in Jalajala, the tilapia farms in Taal Lake, and the Freshwater Aquaculture Center at the Central Luzon State University in Munoz, Nueva Ecija.

Similarly, IRAP funded the participation of Pg. Asamadi Pg. Mhd. Salleh of Brunei Darussalam and Lisa Ruliaty of Indonesia in the training course Crab Seed Production at Tigbauan Main Station from 14 September to 13 October. These two took a post-training tour of AQD's Binangonan Freshwater Station, the ABCDEFI's Jalajala farm, and Tagaytay to see the fish cages in Taal Lake.

AQD's EV Aralar and MA Laron on attachment training at the Surat Thani Inland Fisheries Research and Development Center, 6-30 Nov 2005

Two IRAP-funded trainees (both in blue) join the CrabSeed course

Calendars and posters about the ASEAN-SEAFDEC FCG Programs were produced with IRAP funding

The SEAFDEC Aquaculture Department joined many research and development institutions from around the world in Bali, Indonesia, from 9 to 13 May for World Aquaculture 2005, the latest of the annual forum-event organized by the World Aquaculture Society.

AQD Chief RR Platon receives visitors and answers queries in Bali

IRRI Deputy Director W Padolina, AQD Chief RR Platon, and SEAFDEC Special Advisor Y Kato at the SOM-AMAF+3

The 27th Summit of Ministers—ASEAN Ministers of Agriculture and Forestry and the 5th Meeting of AMAF + 3 was held at the Taal Vista Hotel, Tagaytay City, from 26 to 30 September 2005. Ministers and Secretaries of Agriculture and Forestry (which include fisheries and aquaculture) of the 10 Member Countries of the Association of Southeast Asian Nations (ASEAN), plus Japan, China, and Korea (+3) conducted a series of closed-door meetings together with delegates from international research and development organizations. Dr. Yasuhisa Kato and Mr. Robert Lee of the Secretariat based in Bangkok represented SEAFDEC at the meetings. SEAFDEC/AQD Chief Rolando Platon also attended some of the sessions. Vice-President Noli de Castro of the Philippines formally opened the Summit.

Participants in the Planning Workshop for the Integrated Regional Aquaculture Program, Bangkok, 30 Nov—2 Dec 2005

SEAFDEC/AQD held an evaluation and planning meeting for the Integrated Rural Aquaculture Program in Bangkok in February 2005, where the Member Countries identified R&D areas for the second phase:

- Aquaculture of indigenous freshwater species
- Integrated agri-aquaculture systems
- Coastal aquaculture and mariculture
- Development of captive broodstock

AQD then convened the Planning Workshop for IRAP 2006-2010 in Bangkok, Thailand from 30 November to 2 December 2005. The Workshop had 44 participants comprising representatives from the ASEAN-SEAFDEC Member Countries and SEAFDEC officials. The Workshop in December discussed the output of IRAP 2003-2005 and identified the problems that would be addressed during the second phase.

The country representatives also presented reports on the status of R&D in their respective countries according to a survey format where they:

- confirmed or specified priority species for each R&D area
- indicated the status of aquaculture technologies available in their respective countries
- identified the training needs and indicated whether the training should be at AQD, on-site in host country, attachment in another country, or study visits for farmers
- identified the information needs, in terms of manuals, farm demonstration, workshops, or other means

The participants then developed the detailed plan of action for IRAP 2006-2010, including research, verification, training, information dissemination, study visits, and farm demonstration. Countries that have well developed farming technologies for particular commodities were identified as Core Countries that can provide technical assistance to recipient countries. Technology packages that are well developed in one country and known to be economically viable and environment-friendly will be considered for verification in another country. Countries with common interests in specific commodities were urged to collaborate in R&D.

During the Workshop, the country representatives recommended 14 priority projects and identified the countries to be involved in specific activities. Some of the recommended projects are already ongoing concerns at AQD in one form or another. The recommendations were adopted at the Workshop as the proposed program of activities for IRAP 2006-2010, comprising two parts: Development of Technologies for Sustainable Aquaculture and Capacity-Building for Sustainable Aquaculture. The proposed program was submitted to the SEAFDEC Program Committee during its 28th Meeting in Bangkok, Thailand from 7 to 9 December 2005, for endorsement to the SEAFDEC Council and the ASEAN Working Group on Fisheries.

Research Publications

As of December 2005, AQD researchers have published 1,197 scientific papers, 605 in *Current Contents*-covered journals, 201 in local journals, and 391 in proceedings and books. Many of AQD's researchers left during the streamlining in 2004, and the resulting disruption led to a lower output of scientific papers in 2005—only 23 scientific papers in journals and books. The shift in emphasis from discipline-based research to commodity-based programs also meant changes in the research projects that were henceforth pursued. The results of the ongoing and new studies will be out in journals 1-2 years later.

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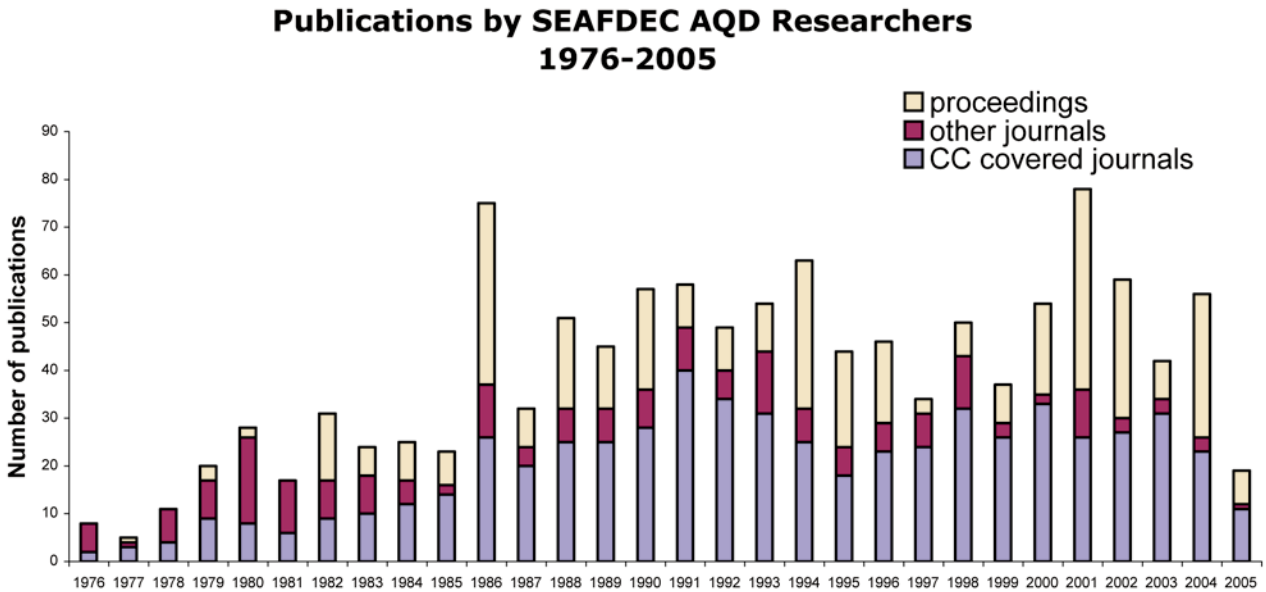

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Elvira O. Tan Memorial Award 2005

Best Paper in Aquaculture

ZU Basiao, RW Doyle, AL Arago
A farmer-oriented Nile tilapia, *Oreochromis niloticus* L. breed improvement in the Philippines
Aquaculture Research 36: 113-119 (2005)

DA-BAR R&D Paper Awards 2005

ET Quinitio, VR Alava, J de Pedro, Z Orozco, M Wille
Reproductive performance of mud crab *Scylla serrata* fed dietary lipids

FDP Estepa, ET Quinitio, EM Rodriguez
Seed production of *Charybdis feriatus*

EA Tendencia, MR de la Peña, CH Choresca
Presence of snapper, seabass, and siganid inhibit the growth of luminous bacteria in a simulated shrimp culture system

Seminars in 2005

22 Feb	JH Primavera	Integration of mangroves and aquaculture
04 May	CL Pitogo	Where in the world is *Penaeus vannamei*?
24 May	C Graf	Hatchery broodstock improvement for *Penaeus vannamei*
24 May	C Graf	Use of bacteria for pond treatment or soil improvement in *Penaeus vannamei* culture
17 Jun	EFC Doyola, JB Biñas, SB Alayon	The 2005 Japan-ASEAN Youth Friendship Programme: Agriculture (Aquaculture)
23 Jun	WG Yap	Constraints to optimizing milkfish production potentials in the Philippines
26 Jul	CM Caipang	Development of DNA vaccines for marine fish
28 Jul	M Langdown K Hutchinson	The zonation and distribution of mangrove flora and fauna in relation to topographical height and tidal inundation
16 Aug	JA Amar	Evaluation of amino acid-chelated trace elements as dietary supplements in rainbow trout *Oncorhynchus mykiss*
01 Sep	K Hoffman	DNA nucleotides and Vannagen
15 Sep	JH Primavera CL Pitogo ET Quinitio FDP Estepa ME Rodriguez	EC-CAMS and EASY GOES in Nha Trang, Vietnam
10 Nov	JM Oclarit MR de la Peña	Application of marine biotechnology in aquaculture and medicine
25 Nov	JH Primavera TU Bagarinao	Agusan Marsh and Mainit Lake

Training

Training courses at SEAFDEC/AQD in 2005

Training Courses	Duration	Trainees (type, group)	Number, gender	Age (yr)	Countries represented	Funding
Farmers Training in Integrated Fish Farming (AQD-BFS with ABCDEFI; 4 sessions)	27–28 Jan 31 Jan–1 Feb 10–11 Feb 31 Mar–1 Apr	Fish farmers, Municipal Agriculture Officers	174M + 41F	33–65	Philippines	DOST
Farmers' Training in Freshwater Aquaculture	24–25 Feb 26-27 Apr	Fish farmers, Municipal Agriculture Officers	32M + 2F 17M + 14 F	37–51	Philippines	DOST
Tilapia Hatchery and Grow-Out Operations	14–18 Mar	Private farmers	2M	26, 50	Philippines	Personal
Induced Spawning of Bighead Carp	14–18 Mar	Private farmers	1M	40	Philippines	Personal
Use of PCR in the Detection of White Spot Syndrome Virus	12–15 Jan 15–19 Mar	Govt officers, private sector	1M + 2F	22–33	Philippines	Capiz Province 2, Personal 1
Detection of Koi Herpes Virus and Taura Syndrome Virus in Fish/Shrimp	7–12 Mar	Govt officers	4M + 3F	24–47	Philippines, Cambodia, Myanmar, Vietnam	GOJ-TF 5, NAFIQAVED 2
Use of PCR in the Detection of Shrimp Viruses	15–19 Mar	Govt officers	1M + 4F	31–44	Philippines	BFAR-AQD
Responsible Aquaculture as a Component of Integrated Ecosystems Management	18–29 Apr	Govt officers, lecturers, researchers, environment advocates	8M + 3F	25–45	Philippines, China, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, Vietnam	UNESCO-MAB-SeaBRnet, AQD
Marine Fish Hatchery	4 May–16 Jun	Govt officers, technician, aquaculturists	12M + 2F	18–44	Philippines, Singapore, Iran, Sri Lanka, Saudi Arabia	Iran govt, personal
Freshwater Aquaculture	18 May–4 Jun	College instructors	4M + 4F	30–51	Philippines	TESDA 8
Research Internship for Faculty	1 Jul–30 Nov	College instructor	1F	32	Philippines	Cavite State Univ - Naic
Environment-Friendly Shrimp Farming	19 Jul–15 Aug	Hatchery technicians	3M	28	Saudi Arabia	Saudi National Prawn Co. 3
Freshwater Aquaculture	26–27 Jul	Vigan fish farmers	37M + 7F		Philippines	Vigan City 44
Tilapia Hatchery and Grow-Out Operation	1–10 Aug	Govt officers	1M + 5F	23–52	Myanmar, Cambodia, Philippines	GOJ-TF 2 Rizal LGU 4
AquaHealth Online	Aug – Dec (19 weeks)	Govt officers, Veterinarian, private sector	14M + 9F	22–52	Philippines, Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, Vietnam, Malta	ASEAN 9, BFAR 3, AQD 7, personal 4
Biotech Techniques and Instrumentation	7–14 Aug	Govt officers	5M + 10F	22–49	Philippines	BFAR, AQD
Freshwater Aquaculture	17 Aug – 6 Sep	Students, farmer	2M + 1F	29–32	Philippines, Chile, Ecuador	Personal
Crab Seed Production	14 Sep – 14 Oct	Govt officers, academe, private sector	6M + 4F	32–55	Philippines, Indonesia, Brunei Darussalam, China, Malaysia, Federated States of Micronesia	GOJ-TF 2; AQD 1 Cavite State Univ 1 personal 6
Important Viral Diseases of Shrimps and Fishes	14–29 Nov	Govt officers	3M + 7F	24–45	Philippines, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Singapore, Thailand, Vietnam	GOJ-TF 10, OIE
Hatchery and Grow-out of Abalone	14–29 Nov	Govt officers, researcher, technicians	10 M	22–45	Philippines, Vietnam, Canada, Federated States of Micronesia	Personal
BIMP-EAGA Participatory Workshop on Responsible Aquaculture Development	13–16 Dec	Govt officers	36M + 4F		Malaysia	ASEAN Foundation
Total	25 sessions		356M + 106F			

AQD Aquaculture Department; BFS Binangonan Freshwater Station; DOST Department of Science and Technology; ABCDEFI Aquaculture-Based Countryside Development Enterprises Foundation, Inc.; TESDA Technical Education and Skills Development Authority; UNESCO United Nations Educational Social and Cultural Organization; MAB Man and the Biosphere Reserve; SeaBRnet Southeast Asian Biosphere Reserves Network; GOJ-TF Government of Japan Trust Fund; NAFIQAVED National Fisheries Quality Assurance and Veterinary Directorate of Vietnam; DA-BFAR Department of Agriculture Bureau of Fisheries and Aquatic Resources; OIE Office International des Epizooties; BIMP-EAGA Brunei-Indonesia-Malaysia-Philippines East Asian Growth Area; ASEAN Association of Southeast Asian Nations

Internships (for a fee) and on-the-job training, 2005

Interns' Institution	Academic course	Assignment at AQD	Sessions	# by gender
Iloilo and Western Visayas				
Phil Science High School - Western Visayas	High School Year 2	FishWorld	13 Apr-18 May	1M + 9F
University of the Philippines High School, Iloilo	High School Year 3	FishWorld	02-27 May	1M + 5F
Northern Iloilo Polytechnic State College,Concepcion	BS Fisheries	Dumangas Brackishwater Station	11 Apr - 11 May	6M + 2F
Northern Iloilo Polytechnic State College, Estancia	BS Fisheries	Fish Hatchery	17 Apr - 17 May	2F
Southern Iloilo Polytechnic College	AB Info Tech	Library, Data Bank	11 Apr - 27 May	1M + 6F
Southern Iloilo Polytechnic College	BS InfoTech	Engineering Section	2 Jun - 18 Oct	4M
Southern Iloilo Polytechnic College	BS Info Tech	Engineering Section	06 Jun - 26 Oct	4M
University of the Philippines in the Visayas	BS Chemistry	Central Analytical Lab	13 Apr-18 May	3F
West Visayas College of Science & Technology	BS Electrical Engg	Engineering Section	25 Apr- 25 May	2M
STI College	BS Computer Sci	Data Bank	25 Apr - 25 May	1M
Aklan State University	BS Vet Med	Fish Health Section	26 Apr - 25 May	1M + 2F
Capiz State University, Dayao, Roxas City	BS Fisheries	Different hatcheries	24 Oct - 13 Nov	6M
Collegio de San Agustin, Bacolod	BS Chemistry	Centralized Analytical Lab	04 Apr - 17 May	1M
Individual, Tigbauan, Iloilo	BS Fisheries	Fish Health Section	12 - 14 Jan	1F
Individual, Tigbauan, Iloilo	BS Fisheries	Fish Hatchery	18 Jul - 18 Aug	1F
Individual, Tigbauan, Iloilo	College	Abalone Hatchery	25 Jul - 25 Aug	1M
Individuals, Tigbauan, Iloilo	College, high school	Natural Food Lab	01 Aug - 01 Sep	1M + 1F
Individual, Tigbauan, Iloilo	Vocational Course	Engineering Section	30 Aug - 30 Sep	1M
Individual, Tigbauan, Iloilo	High School	Mud Crab Hatchery	21 Oct - 21 Nov	1M
Individual, Tigbauan, Iloilo	BS Biology	Natural Food Lab	02 Nov - 02 Dec	1F
Individual, Oton, Iloilo	BS Fisheries	Abalone Hatchery	14 Feb - 23 Mar	1F
Individuals, Oton, Iloilo	BS Aquaculture	Fish Health Section, Fish Hatchery	14 Feb - 14 Mar	2F
Individual, Iloilo City	BS Biology	Molecular Biology Lab	11 Jul - 11 Aug	1F
Individual, Iloilo City	BS Fisheries	Fish Hatchery	08 Nov -07 Jan	2F
Individual, Iloilo City	BS Biology	Natural Food Lab	21 Nov - 07 Dec	1F
Individual, San Joaquin, Iloilo	Bs Fisheries	Abalone Hatchery	14 Feb - 23 Mar	1F
Individual, San Joaquin, Iloilo	BS Fisheries	Mud Crab Hatchery	27 May- 27 Jun	1F
Individual, Miagao, Iloilo	BS Fisheries	Fish Hatchery	14 Jun - 14 Jul	1F
Individual, San Miguel, Iloilo	BS Biology	Abalone Hatchery	04 Jul - 04 Aug	1M
Individual, Barotac Nuevo, Iloilo	BS Fisheries	Fish Health Section	01 Aug - 01 Sep	1F
Individual, Leganes, Iloilo	BS Biology	Abalone Hatchery	06 Jul - 06 Aug	1F
Individual, Nueva Valencia, Guimaras	BS Fisheries	Igang Marine Station	27 Apr- 27 May	1F
Individual, Patnongon, Antique	BS Aquaculture	Fish Health Section	01 Aug - 01 Sep	1F
Individual, Patnongon, Antique	BS Aquaculture	Phycology Lab	29 Aug - 08 Sep	1F
Individual, Roxas City	BS Med Tech, Fisheries	Fish Health Section	12 - 14 Jan	1 M + 1F
Individual, Roxas City	Masters in Aquaculture	Mud Crab Hatchery	01 - 06 Nov	1M
Individual, Ibajay, Aklan	BS Fisheries	Mud Crab Hatchery	27 May- 27 Jun	1M
Individual, Bacolod City	BS Aquaculture	Fish Health Section	14 Feb - 14 Mar	1F
Individual, Bacolod City	BS Aquaculture	Fish Health Section	22 Feb - 08 Mar	1F
Outside Western Visayas				
Don Mariano Marcos Memorial State University	BS Fisheries	Binangonan Station, Jalajala	2005	2M + 1F
Pangasinan State University	BS Fisheries	Binangonan Station, Jalajala	2005	3M
University of Rizal System	BS Fisheries	Binangonan Station, Jalajala	14 Nov - 6 Jan	4M + 5F
Cavite State University	BS Fisheries	Binangonan Station, Jalajala	2005	9F
Mindanao State University, Marawi	BS Fisheries	Different laboratories	07 Apr - 10 May	9M + 4F
Mindanao State University, Naawan	BS Fisheries	Mud Crab Hatchery/Fish Health Section	14 Apr - 27 May	2M + 4F
Zamboanga State College Marine Sci & Technology	BS Aquaculture	Different laboratories	06 Apr - 13 May	8M + 6F
Mindanao Polytechnic State College, Panaon	BS Marine Biology	Fish Hatchery	07 Apr - 16 May	3F
Davao del Norte State College	BS Fisheries	Different laboratories	14 Apr - 19 May	6M + 4F
Dipolog School of Fisheries	Aquaculture Technician	Different hatcheries	15 Nov - 12 Feb	8M
Southern Phil Agribusiness & Marine & Aquatic School of Technology	BS Marine Biology	Fish Health Section	14 Apr - 31 May	1F, 1M
Individual, Pagsanjan, Laguna	Undergraduate	Abalone Hatchery	13-24 May	1M
Individual, Naic, Cavite	MA General Science	Abalone Hatchery	04 Jul - 04 Nov	1F
Individual, Naic, Cavite	BS Fisheries	Mud Crab Hatchery	28 Oct - 28 Nov	1 M
Individual, Surigao del Norte	BS Commerce Year 3	Abalone Hatchery	27 Jun - 30 July	1F
Individual, Zamboanga City	BS Marine Biology	Natural Food Lab	18 Jan - 12 Feb	1M
Individual, Bangladesh	BSc Fisheries	Shrimp Hatchery	19 Oct - 6 Nov	1M
Total **20 institutions**			**58 sessions**	**75 M + 84 F**

SeaBRnet
Southeast Asian Biosphere Reserves Network

UNESCO – MAB – SeaBRnet Training Course
Responsible Aquaculture
as a Component of Integrated Ecosystems Management

Aquaculture Department
Southeast Asian Fisheries Development Center
Tigbauan, Iloilo, Philippines
18-29 April 2005

Biosphere Reserves are important means to ensure biodiversity conservation and sustainable development. Integrated ecosystems management is the recommended approach to the sustainable use and management of Biosphere Reserves. Many Biosphere Reserves already have aquaculture activities within their boundaries, or can reasonably expect to include aquaculture in the near future. The site managers and stakeholder representatives at these Biosphere Reserves are well advised to be knowledgeable about aquaculture so that they can properly integrate it in the planning and management of the sites—along with the other economic sectors, and with due consideration of the environment and the people.

Aquaculture is an important solution to the problem of declining fisheries catch brought about by intense fishing pressure due to the rapidly increasing world population and demand for food. Aquaculture is particularly important in Asia, which accounts for 90% of the world production. The species farmed in Asia range from seaweeds to herbivorous fishes and mollusks to carnivorous fishes, shrimps, and crabs. Farming of carps has been practiced for three thousand years in China and probably a few hundred years in parts of Southeast Asia. Farming of milkfish is hundreds of years old in Indonesia, the Philippines, and Taiwan. Such length of time indicates that aquaculture can be sustainable. Indeed, aquaculture can be carried out in responsible ways in harmony with the environment and has great potential to benefit the local people and the national economy.

The SEAFDEC Aquaculture Department successfully implemented the Training Course on Responsible Aquaculture as a Component of Integrated Ecosystems Management. Eleven site managers and stakeholder representatives from eight SeaBRnet Member Countries participated in the course—two each from Cambodia, Thailand, and Vietnam, and one each from China, Indonesia, Malaysia, Myanmar, and the Philippines. The lectures and field trips were conducted at AQD in Iloilo and in various places around the Philippines from 18 to 29 April 2005.

At a crab farm in the mangroves in Batan, Aklan

At a tilapia farm in Taal Lake

AQD hosts ASEM Workshop on Education and Training, 24-27 September 2005

The Asia-Europe Meeting (ASEM) Aquaculture Platform held its Workshop #4 on Education and Training (E&T) at the SEAFDEC Aquaculture Department, Tigbauan, Iloilo, Philippines, from 24 to 27 September. Thirty participants came from Australia, Belgium, Cambodia, China, France, Germany, Greece, Hungary, Ireland, Japan, Malaysia, Philippines, Singapore, Spain, United Kingdom, and Vietnam. Many participants were the Who's Who in aquaculture education and research, including Prof. Patrick Sorgeloos, AQD's friend of 30 years.

The general objectives of the ASEM Workshops are:

- To formulate very specific recommendations (for the European Commission) on future directions in research, trade and production between Asia and Europe
- To forge new alliances or reinforce existing ones between the European Union and Asian partners for joint research, trade policies, and production methods

The E&T Workshop aimed to determine future actions to improve the interaction and networking between Asia and Europe with respect to aquaculture education and training. On the first day, the participants talked about the advances in E&T in the two regions and got some sense of the strengths and opportunities. Margaret Eleftheriou described the new imperatives in European education, including the Erasmus Mundus and the Bologna process. Indeed, the wealth of aquaculture courses and information that were reported to be available, especially on the internet, was dizzying. AQD Chief Rolando Platon presented the SEAFDEC/AQD's initiatives and programs in aquaculture training and information.

The participants then discussed ways for universities and international organizations in Asia and Europe to work better to improve aquaculture E&T. They agreed that ASEM cooperation in E&T would be more immediately fruitful if focused initially on formal academic courses at the postgraduate level. Existing informal cooperation and exchanges between professors and students from Asian and European institutions may be expanded and formalized into an ASEM-based network. The workshop identified the topics of common concern that should be emphasized in formal academic and informal training courses to make them more relevant to the needs of the aquaculture sector.

Finally, the Workshop formulated specific 'doable' recommendations for consideration by the European Commission. These recommendations and the other documents and output of the E&T Workshop have been posted at www.asemaquaculture.org for the participants' use.

SEAFDEC works with BIMP-EAGA

AQD conducted the Training-Workshop on Responsible Aquaculture Development in Sandakan, Sabah from 13 to 16 December, the first of five such sessions under the ASEAN Human Resources Development Project for Sustainable Fisheries in the BIMP-EAGA— Brunei, Indonesia, Malaysia, Philippines East Asia Growth Area. Local arrangements for the workshop were made by the Sabah Department of Fisheries headed by Mr. Awang Hj Pakar and the Fisheries Central Office in Kota Kinabalu. The training in Sandakan was to involve only 18 persons based on the BIMP budget, but 40 attended, the others funded by Sabah. Mr. Pakar presented the vision of the Sabah Department of Fisheries: a modern, commercial, progressive, and sustainable fisheries industry.

The AQD team consisted of lecturers WG Yap (who taught about responsible aquaculture, project planning and development), NRS Jamon (about crab culture and culture of marine fish in cages), CM Ganancial (about mangrove-friendly shrimp culture), and Training Officer TD Mallare (about seaweeds, oysters and mussels). The technical lectures were held during the first and second days.

On the third day, the participants were grouped into four to prepare project proposals for grouper farming in sea cages, crab farming in mangrove pens, brackishwater pond culture (shrimps and grouper), and seaweed farming. The four teams were guided in developing technical and financial assumptions, making costs-and-returns estimates, and determining the viability of their respective projects. The teams then presented their feasibility studies in a plenary session. Mr. Awang himself made a presentation on producing 10,000 tons of grouper in Sandakan. Crab farming in mangrove pens was found not profitable because mangrove crabs are abundant and available at low price in Sabah. The brackishwater pond culture team showed that shrimps are more profitable than groupers. The seaweed team led had the most innovative presentation—Mr. Ruzlee Jumatin introduced himself as the CEO making a presentation to his Board of Directors! Two of the participants had trained at AQD before.

BIMP-EAGA trainees in Sandakan work on their project proposals

The AQD Library

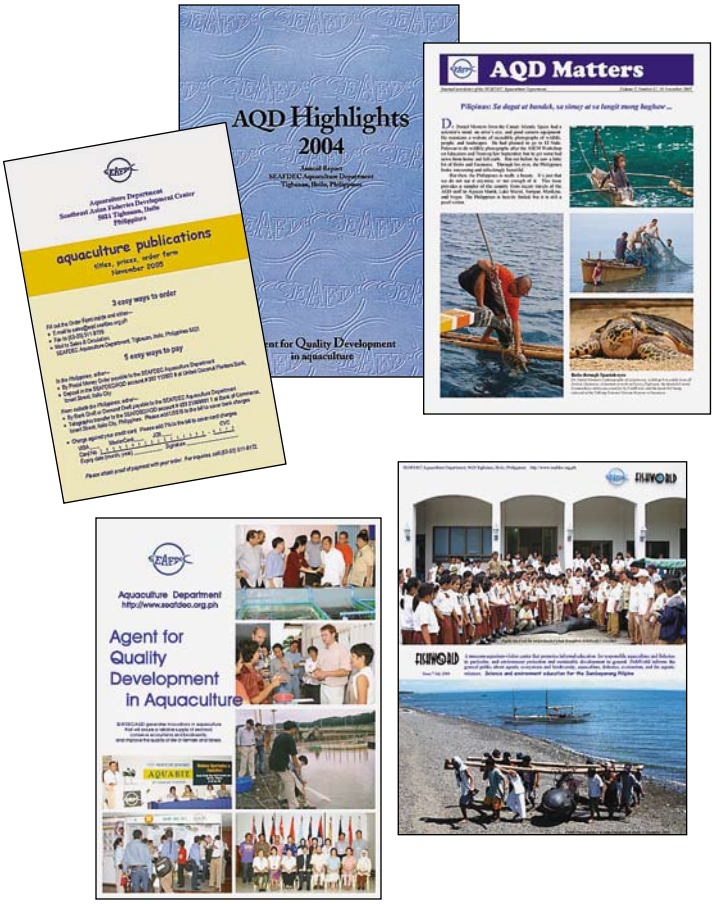
The AQD Library is still the best aquaculture library in Southeast Asia. The present collection based on the accession book stands at 18,210 monographs, 4,247 SEAFDEC publications, 8,075 bound serial volumes, 9,457 pamphlets, and a variety of maps, posters, microfiche and CD-ROMs. Our Follet database collections stands at 34,150 titles and 52,825 volumes/copies as of 31 Dec 2005. The Follet database collections are available for use at the Library, through the internet via online public access (OPAC) at the AQD website and at the library local area network. Data encoding, barcoding, and updating of library materials in the Follet database are continuing concerns.

The AQD Librarian attended the International Book Fair at the World Trade Center in Pasay City from 31 Aug to 4 Sep 2005 and bought 10 aquaculture books with funds from payments for lost library materials. The Library received 91 journal titles/issues of 2004-2005 subscriptions, and renewed 16 serial subscriptions. In exchange for AQD publications, 112 books, 8 CDs, 46 pamphlets, 15 reprints, 545 journal titles/issues were received from different libraries and institutions. News items on science including news stories on SEAFDEC AQD were posted.

The Library served 8,151 readers and lent out 1,847 materials over 245 days of library service. About 1,379 library users came from 126 different schools, government agencies, and the private sector. Some 28,059 global searchers visited the AQD Library's WebOpac in 2005. The WebOPAC records were regularly updated and the in-house IT service network is in place. Queries from 22 countries were received and answered. The Library served 2,985 search requests and generated 1,452 records from Online Public Access and from CD-ROM databases like the Aquatic Sciences and Fisheries Abstracts (ASFA), Aquatic Biology, Aquaculture & Fisheries Resources, FishBase, and Current Contents ABES and Life Sciences. In August, the Library received a new format of ASFA CD-ROM database 1971-1993/1994-current and this was installed with the web browser program. Libraries from different schools in Panay were invited and given free books and other materials during the 32nd Anniversary in July.

SEAFDEC/AQD publications and duplicate materials were donated to the libraries of the several universities around the Philippines, whose students or faculty members came to visit AQD for training or meetings. The Library also sent materials to Sri Lanka's Department of Fisheries and Aquatic Resources and several European universities whose faculty members attended the ASEM Workshop on Education and Training held at AQD in September 2005.

Information Dissemination



The SEAFDEC Aquaculture Department actively produces information about aquaculture science and technology in a variety of formats and makes these widely available to researchers and technologists, students and teachers, farmers and technicians, managers and entrepreneurs, regulators and policy-makers. Information-sharing is a shared function of AQD researchers, librarians, as well as training, information, and development communication specialists. The target clients and users of AQD's information services and products range from local (Iloilo) to national (Philippines) to regional (Southeast Asia) to global.

The information that AQD delivers comes mostly from its own research, technology verification, and related work, but also from the global information pool. AQD's researchers and aquaculturists generate the data, knowledge, and techniques, and share these directly with others through conferences and training courses, or indirectly through both primary journal publications and extension manuals and books.

AQD publications in 2005 are listed under the programs elsewhere in this report. The annual report, *AQD Highlights 2004* was released in April. The newsletter *AQD Matters* was issued monthly through email and uploaded to the website. Several flyers were produced to advertise AQD's services and products for aquaculture. A set of tarpaulin posters were made about AQD's regional programs—these usually hang in the conference room, but are also used during exhibits and fairs. These new information materials are not fancy, but they are information-packed and relatively inexpensive to produce.

The AQD Bookstore sold about P760,000 worth of books and manuals in 2005. More than 150 free copies of AQD publications were given to various stakeholders during the AQD Anniversary in July. AQD guests over the year also got AQD publications in their information kits. Congressman Luis Villafuerte reproduced thousands of copies of several AQD manuals for distribution to fish farmers during the National Aquaculture Congress on 27 October 2005.

AQD joined several aquaculture fairs and exhibits in 2005. The staff of the Binangonan Freshwater Station put up the AQD exhibits in and around Metro Manila.

AQD maintains the website www.seafdec.org.ph and hosts the website of the Fish Health Section of the Asian Fisheries Society at www.afs-fhs.seafdec.org.ph. The AQD website is currently being revised and updated.

TID Head TU Bagarinao, Information Assistant AS Ledesma, and Network and Systems Administrator JB Gebucion attended the Sixth Meeting of the Information Staff Exchange Program of SEAFDEC, held in Pattaya, Thailand from 14 to 16 December 2005. ISEP supports capacity-building for the information staff of the Secretariat and the Departments.

Visitors from the Secretariat of the Pacific Community take a tour of AQD facilities, December 2005

Upon the request of the Secretariat of the Pacific Community, AQD arranged a study tour for a party of five headed by Dr. Satya Nandlal to visit the AQD facilities and some private mud crab farms in Panay from 5 to 10 December 2005. The SPC visitors discussed their interests with AQD researchers and aquaculturists.

AQD booth at the Bangus Congress

SEAFDEC/AQD joined the 2nd Bangus Congress and Exhibition on 28-29 April 2005 at Bonuan Binloc, Dagupan City. The aim was to unify the bangus industry towards global competitiveness. The Bangus Congress focused on industry needs, issues, problems, and solutions. AQD aquaculture experts spoke during the technical sessions and led the discussion of issues and concerns, both local and global. At the end of the Congress, a resolution was formulated that highlighted the problems of the bangus industry and proposed the solutions — for government and industry to act on. The Congress coincided with Dagupan's fiesta celebration.

OFCA staff members K Sasamoto and K Sakurai assist AQD's WG Yap man the SEAFDEC/AQD booth in Fukuoka

Upon the invitation of the Overseas Fisheries Consultants Association (OFCA), SEAFDEC/AQD participated in the 3rd Aquaculture Technology Exposition in Fukuoka, Japan, on 21-22 September 2005 by putting up a booth where AQD publications were exhibited and sold. The Aquaculture Technology Expo was one of three events during the Aquaculture Technology Convention held at the Fukuoka International Convention Center under the co-sponsorship of OFCA and the Asian Fisheries Society, Japan Chapter.

AQD Scientist MLC Aralar explains SEAFDEC to some Japanese during the SOM-AMAF+3 in Tagaytay

AQD set up an information booth during the the 27th Summit of the ASEAN +3 Ministers of Agriculture and Fisheries in Tagaytay City from 26 to 30 September 2005. AQD also participated in the International AgriLink Fair on 6-8 October 2005 at the Philippine World Trade Center in Manila. The Meralco Foundation Inc. invited AQD to share a booth with the joint theme *Empowering the countryside*.

Agriculture Secretary Domingo Panganiban visits the MFI-AQD booth during AgriLink 2005

SEAFDEC's information staff commit themselves to enhancing SEAFDEC visibility and communication

FishWorld Matters

SEAFDEC FishWorld is a museum-aquarium-visitor center established by the SEAFDEC Aquaculture Department (AQD) in July 2000 to inform the general public about responsible aquaculture and fisheries, biodiversity conservation, environment protection, and sustainable development. In 2005, FishWorld received 8,500 visitors in 125 groups (72 schools) and earned about P 99,000 in entrance fees. In April-May, FishWorld conducted the R&D Internships for 16 students from the Philippine Science High School Western Visayas and the University of the Philippines High School in Iloilo. In July, FishWorld held the 10th Aquaculture Week. In November, FishWorld Curator TU Bagarinao and Visitor Guide EF Doyola visited Agusan Marsh and Lake Mainit in Mindanao and collected a variety of freshwater fishes and invertebrates. Several beach towns and fish markets were also visited for marine specimens.

High school science students visit fishing villages, April 2005

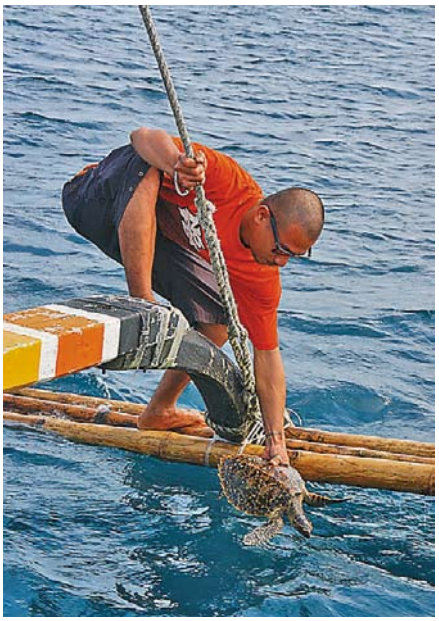
Agusan Marsh, Nov 2005

Mabua, Surigao City, Nov 2005

The Museum of Aquatic Biodiversity now has about 3,000 species of fishes, mollusks, crustaceans, echinoderms, corals, seaweeds, and other taxa, and the collections are still expanding. The collections serve as reference materials for students, teachers, and researchers working on systematics and ecology in Philippine waters.

Since the establishment of FishWorld, the people of Iloilo have reported the incidental capture or stranding of endangered marine animals along the coasts and have brought some of them under the care of FishWorld. These included three dugongs *Dugong dugon*, three Fraser dolphins *Lagenodelphis hosei*, an Irrawaddy dolphin *Orcaella brevirostris*, a short-finned pilot whale *Globicephala macrorhynchus*, a melon-headed whale *Peponocephala electra*, a megamouth shark *Megachasma pelagios*, three whale sharks *Rhincodon typus*, a sunfish *Mola ramsayi*, a leatherback turtle *Dermochelys coriacea*, seven olive ridleys *Lepidochelys olivacea*, six hawksbills *Eretmochelys imbricata*, and 12 green turtles *Chelonia mydas*.

Marine turtles are quite often caught by fish corrals in Tigbauan, Iloilo. Captured turtles and dugongs were reported to the Pawikan Conservation Project of the Department of Environment and Natural Resources. All healthy turtles were tagged and released back to sea. However, turtles that were sick, injured, or domesticated and confiscated were held and rehabilitated in the hatchery tanks at SEAFDEC AQD. Two neonate dugongs were nursed at SEAFDEC AQD by the staff of DENR, FishWorld, and Conservation International, but both died within several days. FishWorld now has a Huge Creatures Collection—the carcasses of the megamouth, whale shark, Irrawaddy dolphin, sunfish, and leatherback caught in 2005.



Endangered marine animals brought to FishWorld in 2005 (clockwise): hawsksbill turtle later released off Igang; sunfish caught at the mouth of Iloilo River; confiscated hawksbill from Boracay; leatherback turtle caught off Parara, Tigbauan; Irrawaddy dolphin caught off Siete Pecados, Iloilo; dugong caught off Guimaras; whale shark caught off Jordan, Guimaras

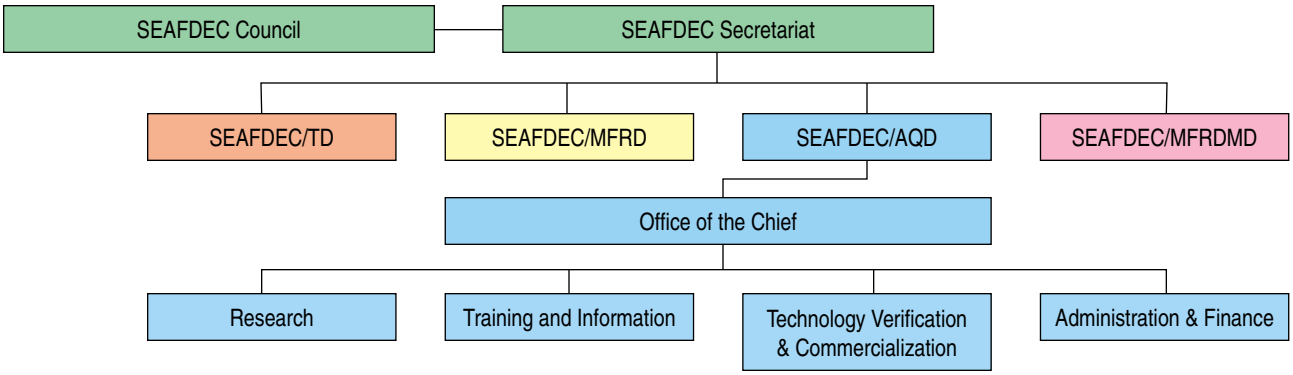
Finances

SOURCES OF FUNDS 1 Jan to 31 Dec 2005	Amount
Contribution of the Government of the Philippines	**100,000,000**
General Operating Funds	
Contribution of the Government of Japan	**2,609,745**
Operating Funds for ASEAN-SEAFDEC Special Five-Year Program	
Government of Japan Trust Fund	**7,331,030**
Development of Disease Surveillance System for Aquatic Animals	4,371,280
Stock Enhancement for Threatened Species of International Concern	1,082,000
Regionalization of Code of Conduct for Responsible Fisheries	1,877,750
External Grants	**10,471,099**
Japan International Research Center for Agricultural Sciences (JIRCAS)	1,331,364
Republic of Palau	1,673,642
Australian Centre for International Agricultural Research (ACIAR)	359,475
Fisheries Research Agency (FRA) Japan	730,893
World Fish Center	435,000
European Commission	4,166,675
Asia-Europe Meeting (ASEM) Aquaculture Platform	67,219
Degussa Texturant, France	51,899
Cavite State University, Naic	250,000
Technical Education & Skills Development Authority (TESDA)	190,000
United Nations Educational Scientific & Cultural Organization (UNESCO)	1,160,732
Deparment of Science & Technology (DOST)	54,200
Department Agriculture Bureau of Fisheries and Aquatic Resources	**600,764**
Production income from JMANTTP projects	400,764
Private sector cooperators	200,000
DA National Fisheries Research and Development Institute	**3,800,000**
Income of Research Division	**2,660,380**
Service laboratories	832,380
Integrated Milkfish Broodstock & Hatchery	497,410
Finfishes Hatchery	311,955
Abalone Hatchery	351,617
Mudcrab Hatchery	66,325
Feed Mill	117,168
Miscellaneous income	483,525
Income of Training & Information Division	**3,479,125**
Training & Internship fees	2,506,571
Sale of publications	628,543
Sale of UNESCO Handbook on Mangroves	129,726
FishWorld income	98,953
Miscellaneous income	115,332
Income of Technology Verification & Commercialization Division	**1,324,224**
Production of shrimps	890,765
Production of mud crabs	21,928
Production of fishes	405,992
Miscellaneous income	5,540
Income of Administration & Finance Division	**6,460,787**
Housing rentals, TMS & BFS	1,582,420
Vehicle use	1,696,414
Interest/dividends	2,450,625
Income from bidding of assets	195,979
Miscellaneous income	535,349
Total	**138,737,154**

The Host Government of the Philippines (GOP) approved for 2005 a contribution of P100 Million to the SEAFDEC Aquaculture Department through the Department of Foreign Affairs' International Commitment Fund. Fortunately for AQD, non-GOP external sources of funds were also available for various Departmental programs and projects in research, training and information, and technology verification and commercialization. The GOJ Trust Fund also provides the budget for the programs undertaken by the Secretariat and the four Departments under the ASEAN-SEAFDEC Fisheries Consultative Group mechanism. More than P33 Million of the GOP contribution paid for Personnel Services at AQD.

APPLICATIONS OF FUNDS 1 Jan to 31 Dec 2005	Amount
General Operating Expenses	**82,931,793**
Personnel Services	33,070,108
Maintenance and Operations	34,399,024
Capital Outlay/Repairs	3,626,712
Project Expenses Research Division	6,957,317
Project Expenses Training & Information Division	1,805,205
Project Expenses Technology Verification & Commercialization Division	3,073,427
ASEAN-SEAFDEC Special Five-Year Program	**5,239,359**
Aquaculture for Rural Development	3,027,414
Supply of Good Quality Seeds	2,211,945
Government of Japan Trust Fund	**12,411,899**
Development of Disease Surveillance System for Aquatic Animals	6,943,097
Stock Enhancement for Threatened Species of International Concern	1,352,852
Regionalization of the Code of Conduct for Responsible Fisheries	2,069,247
Mangrove-Friendly Aquaculture	2,046,704
Externally funded projects	**9,755,656**
AusAID-Pacap -Poverty alleviation through aquaculture in Manlot Island	214,173
Aquaculture consultancy project in Ngatpang State, Republic of Palau	1,819,409
ACIAR research on growth factors	402,103
European Commission - Culture and Management of Scylla species	2,526,442
ASEM Workshop on Education and Training	140,210
JIRCAS research on essential fatty acids and viral nervous necrosis	1,457,739
Fisheries Research Agency - research on koi herpes virus	472,017
World Fish Center - Survey milkfish technologies	717,103
University of Mahajanga, Madagascar training course in shrimp farming	51,900
Cavite State University - Research internship for faculty	155,611
TESDA-Training course on freshwater aquaculture	182,733
UNESCO-MAB-SeaBRnet Training course on responsible aquaculture	1,161,135
DOST X -Seaweeds production in Lanao del Norte	36,726
DA-BAR Fisheries Sector Program publication of research reports	164,825
BIMP-EAGA Training course on responsible aquaculture	189,339
Frabelle Fishing Corp production of bighead carp seedstock	64,192
Department of Agriculture Bureau of Fisheries and Aquatic Resources	**889,435**
Joint Mission for Accelerated Nationwide Technology Transfer (JMANTTP)	410,940
Collaborative projects with the private sector	478,495
DA-National Fisheries Research and Development Institute	**5,854,176**
Aquaculture biotechnology projects	437,672
Laboratory Facilities for Advanced Aquaculture Technologies	5,416,504
Committed Funds	**21,654,835**
Ongoing projects	6,678,422
Ongoing capital outlay/equipment/repairs	14,976,413
Total	**138,737,154**

Personnel and Management



Dr. Koichi Okuzawa
AQD Deputy Chief

From the Fisheries Research Agency of Japan, particularly the National Research Institute of Aquaculture in Mie, Japan, Dr. Koichi Okuzawa joins the SEAFDEC Aquaculture Department as Deputy Chief and GOJ-Trust Fund Co-Manager, effective 1 March 2005.

Dr. Okuzawa also serves as Program Leader of the of the new Stock Enhancement Program and of the Regional Fish Diseases Program, vice Dr. Kazuya Nagasawa. He earned his PhD in Fisheries in 1989 from the Department of Fisheries, Faculty of Agriculture, University of Tokyo. Dr. Okuzawa brings to AQD plenty of expertise in endocrinological research and technical experience in histology, biochemistry, radioimmunoassay, molecular biology and biotechnology, and marine fish breeding and rearing.

Atty. Jerry T. Opinion
Head, AFD

The new Head of Administration and Finance is an amiable lawyer and accountant, part-time Instructor at the College of Commerce and Accountancy of the University of San Agustin, former Vice-President of Panay Electric Company, Inc., and former Auditor in the Commission on Audit. Atty. Opinion is 52 years young, married to Judge Ma. Elena G. Opinion, with four children, and residing in Fundidor, Iloilo City.

Ruel Eguia
FAO Specialist

Ruel Eguia, BFS Aquaculture Specialist and ABCDEF Inc. Extension and Marketing Coordinator, was in Zimbabwe in May 2005 for a month-long assignment with the United Nations' Food and Agriculture Organization. Ruel served as FAO Specialist and assessed the feasibility of fish farming in cages in selected dams and other small communal water bodies in Zimbabwe.

From the Office of the Chief

Executive Order No. 1
Creation of a Management Committee
In the interest of the service and in order to institutionalize and broaden participation of staff in major decisions affecting the Department, a Management Committee is created composed of the Chief as Chair, the Deputy Chief as Vice-Chair, and Division Heads and Program Leaders as Members. The Management Committee is a consultative body that the Chief may convene to discuss important matters.

Administrative Order No. 19
Designation of Program Leaders
Upon further refinement in the restructuring of departmental programs and in order to provide focus and ensure continuity in technology development through all the production phases of aquaculture species, program implementation shall be based on problem areas of specific commodities. The problem-based programs and the respective Program Leaders are:

Programs	*Program Leaders*
Integrated Abalone Production	SMB Ursua
Mud Crab Seed Production	ET Quinitio
Shrimp Domestication	FDP Estepa
Marine Fish Seed Production	DR Chavez
Freshwater Aquaculture	MLC Aralar

Administrative Order No. 22
Designation of Atty. Jerry T. Opinion as Head of the Administration and Finance Division

Administrative Order No. 44
Designation of Office Heads effective 1 Oct 2005

Technology Verification and Commercialization Division	DD Baliao
Training and Information Division	TU Bagarinao
Binangonan Freshwater Station	MLC Aralar
Fish Health Section	CL Pitogo
Igang Marine Station	NRS Jamon
Biotech Laboratory	LD de la Peña

Executive Order No. 2
Amended Hospitalization Benefits of Fixed-Term/ Contractual Employees
Starting 1 August 2005, the hospitalization benefits of fixed-term/contractual employees shall be equal to the benefits enjoyed by regular employees. Coverage excludes their dependents.

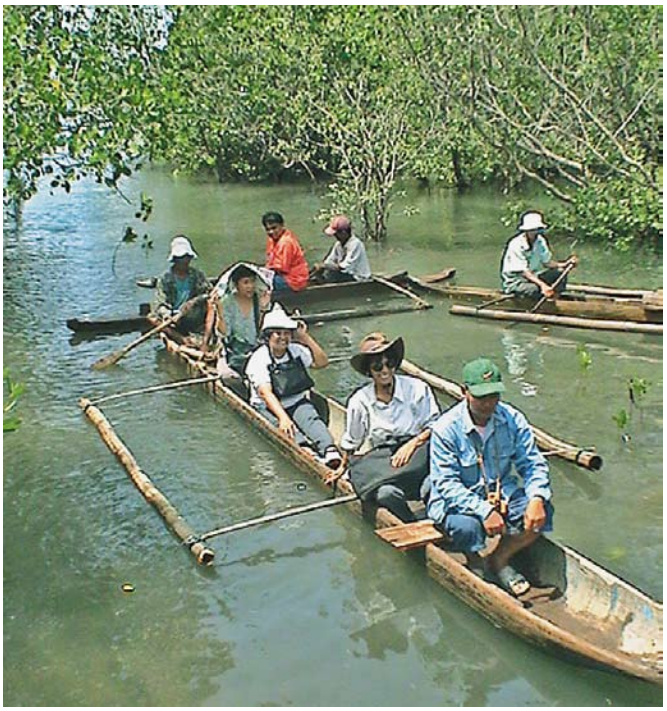
Executive Order No. 5
New SEAFDEC/AQD Job Classification and Compensation (Salary) Structure
The new SEAFDEC/AQD Job Classification and Salary Structure shall take effect starting 1 October 2005.

Dr. Jurgenne H. Primavera

• AQD Senior Scientist
• PhD Marine Science, UP-Diliman
• PhD Science *honoris causa*, Stockholm University 2004
• Pew Fellow in Marine Conservation 2005
• Outstanding Filipino Woman in Fisheries and Aquatic Resources Research, Development, and Industry 2005
• NAST Outstanding Book Awardee 2005

AQD Senior Scientist Dr. Jurgenne Honculada Primavera was chosen as one of five Pew Fellows in Marine Conservation in 2005. She was awarded $150,000 for a three-year project to protect mangrove habitats. She thus becomes part of the world's most prestigious network for ocean science and conservation. The Pew Fellows Program has selected 89 Fellows who have completed marine conservation projects across the globe. Fellowships are funded by the Pew Charitable Trusts and administered by the Pew Institute for Ocean Science.

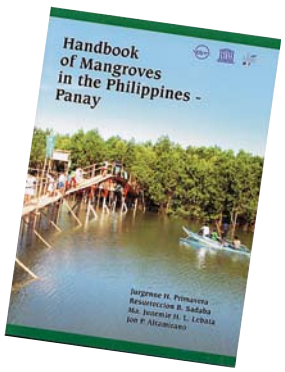
Dr. Primavera organized a Mangrove Education Seminar Workshop on 1-5 May 2005 for 28 teachers from secondary and tertiary schools in Panay and Guimaras, in collaboration with the Department of Education and the Commission on Higher Education. The seminar-workshop included various lectures about mangroves and discussed ways to incorporate mangrove awareness and conservation in the formal education system in the Philippines. The teachers also visited mangrove sites in Aklan.



Dr. Josette Biyo lectures during the Mangrove Education Seminar-Workshop, 1-5 May 2005

Dr. JHP, the ecologist and teacher—equally at home in the mangroves as in the conference room

Dr. Primavera and coauthors Dr. Resurreccion Sadaba, Junemie Lebata, and Jon Altamirano won the Outstanding Book Award for *Handbook of Mangroves in the Philippines—Panay*, published by the SEAFDEC Aquaculture Department with funds from the UNESCO Jakarta Office. This book has launched a thousand praises.



Dr. Jurgenne Primavera and Dr. Resurreccion Sadaba, receive the Outstanding Book Award from the National Academy of Science and Technology, Manila Hotel, 14 July 2005

SEAFDEC / AQD at 32

Research Division Head WG Yap talks about the research accomplishments of the first AQD Chief, Dean Domiciano K. Villaluz Sr., and gives an overview of the DKV Memorial Lectures, 7 July

DK Villaluz Memorial Lectures

Sustainable Shrimp Culture
Chris Mitchum Ganancial

Mud Crab Seed Production
Emilia Quinitio

Abalone Culture
Shelah Mae Buen-Ursua

Grouper Seed production
Denny Chavez

Guided Tours

Mud Crab Hatchery
E Quinitio / Q Ganon

Abalone Hatchery
S Buen-Ursua / N Bayona

Grouper Hatchery
D Chavez / E Garibay

Stakeholders get free AQD manuals and books, 7 July

150 Gifts for AQD Stakeholders

- Pen Culture of Mudcrab in Mangroves
- Modular Method of Milkfish Pond Culture
- Net Cage Culture of Tilapia in Dams
- Farming of the Seaweed *Kappaphycus*
- Pagpapaanak o Pagpaparami ng Tilapya
- Pagpapalaki ng Tilapya
- Induced Breeding and Seed Production of Bighead Carp
- Environment-Friendly Schemes in Intensive Shrimp Farming
- Closed Recirculating Shrimp Farming System
- Biology and Hatchery of Mud crabs *Scylla* spp.
- Breeding and Seed Production of Cultured Finfishes in Philippines
- Ecology and Farming of Milkfish
- Biology and Culture of Siganids
- Mangrove-Friendly Aquaculture
- Responsible Aquaculture Development in Southeast Asia
- Use of Chemicals in Aquaculture in Asia
- Regional Guidelines for Responsible Fisheries in Southeast Asia—Responsible Aquaculture
- Third Shrimp Congress
- Promotion of Mangrove-Friendly Shrimp Aquaculture in SE Asia
- Report of the Round Table Discussion on the Development of Genetically Improved Strain of *Macrobrachium*

BFS is 29

Binangonan Freshwater Station celebrates its 29th anniversary, 1 Aug

AQD Chief Dr. Rolando Platon welcomes all to the AQD Anniversary, 8 July

Anniversary Program

Thanksgiving Mass
Pambansang Awit
Welcome by AQD Chief RR Platon
Message by DA UnderSecretary CM Drilon, Jr.
Website launching by CR Lavilla-Pitogo
Book launching by GD Lio-Po
Closing by AQD Deputy Chief K Okuzawa

Book Launching

- Transboundary Fish Diseases in Southeast Asia: Occurrence, Surveillance, Research and Training (edited by CR Lavilla-Pitogo and K Nagasawa)
- Disease in Farmed Mud Crabs *Scylla* spp.: Diagnosis, Prevention and Control (by CR Lavilla-Pitogo and LD de la Peña)
- Diseases of Cultured Groupers (edited by K Nagasawa and ER Cruz-Lacierda)
- Laboratory Manual of Standardized Methods for Antimicrobial Sensitivity Tests for Bacteria Isolated from Aquatic Animals and Environment (by L Ruangpan and EA Tendencia)
- Mabisang Pamamaraan sa Papapalaki ng Sugpo na Hindi Makakapinsala sa mga Bakawan (by D Baliao and S Tookwinas)
- Regional Guidelines for Responsible Fisheries in Southeast Asia—Responsible Aquaculture (by TU Bagarinao)
- Regional Technical Consultation for the Development of the Code of Practice for Responsible Aquaculture in Mangrove Ecosystems (by VT Sulit)
- Regional Technical Consultation on the Aquaculture of *Penaeus vannamei* and Other Exotic Shrimps in Southeast Asia (by VT Sulit)

Website Launching

GOJ Trust Fund
Regional Fish Diseases Program
http://rfdp.seafdec.org.ph

SEAFDEC / AQD at 32: Speaker Jose de Venecia visits AQD

AQD breaks ground for the shrimp broodstock facility at Tigbauan

Speaker JDV graced the closing ceremony of the RTC on stock enhancement

Speaker Jose De Venecia Jr. visited SEAFDEC/AQD on the occasion of its 32nd anniversary. AQD Chief RR Platon gave him a tour of facilities. The Speaker was an interested learner who asked many questions (and answered many others from interviewers). He expressed appreciation for AQD's R&D work and pledged moral and financial support for new initiatives, such as the new facility for shrimp broodstock.

At the closing ceremony for the Regional Technical Consultation on Stock Enhancement, JDV told everyone how his family made good in fisheries and aquaculture and asked AQD to continue to help these sectors to prosper.

The Speaker also expressed appreciation for FishWorld

Speaker Jose De Venecia, Jr., Iloilo First District Representative Janette Garin, and company go on a guided tour of AQD's hatcheries for seaweeds, fishes, abalone, and mud crabs

Shyne Marie Tanghal, 15 yrs old,
Colegio del Sagrado Corazon de Jesus
First Prize Winner

Aquaculture is important to the lives of Filipinos

July 2005 was FishWorld's fifth anniversary and Aquaculture Week's Year 10. From 25 to 29 July, some 90 pupils and 64 teachers from 16 elementary schools joined four contests, and 75 students and 54 teachers from 17 high schools joined five contests. AQD Chief Dr. Rolando R. Platon graced the Closing Ceremony, delivered a message of encouragement, and awarded the Certificates of Merit to the winners and their coaches, as well as SEAFDEC FishWorld trophies to the best performing schools, Leganes Central Elementary School and Ramon Avanceña National High School. The winners also got cash prizes, funded from the FishWorld entrance fees. It was smiles all around.

The first Aquaculture Week was held in July 1996 at the then AQD Museum in the Research Building. AQD was Open House for a week, and nature films were shown to pupils from the four elementary schools in AQD's immediate neighborhood. For the very first Bring, Show, and Tell, the pupils brought a green turtle, a clownfish with its anemone, some catfish, and various colored plankton. It was fun!Aquaculture Week became a hit among pupils and teachers. More contests were held—painting, essay-writing, story-telling, quizzes, etc. High schools were invited. Aquaculture Week became a regular part of AQD's anniversary celebration.

SEAFDEC/AQD responds to the Philippines

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

SEAFDEC conducts research on fisheries problems; generates appropriate fisheries technologies; trains researchers, technicians, fishers and aquafarmers, and managers; disseminates information on fisheries science and technologies; and recommends policies pertaining to the fisheries sector.

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

- The Training Department (TD) in Samut Prakan, Thailand (1967) for training in marine capture fisheries
- The Marine Fisheries Research Department (MFRD) in Singapore (1967) for post-harvest technologies
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- The Marine Fishery Resources Development and 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

SEAFDEC/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

The Aquaculture Department in the Philippines maintains four stations: the Tigbauan Main Station and Dumangas Brackishwater Station in Iloilo; the Igang Marine Station in Guimaras; and the Binangonan Freshwater Station in Rizal.


Tigbauan Main Station


Dumangas Brackishwater Station


Igang Marine Station


Binangonan Freshwater Station


Tigbauan Main Station