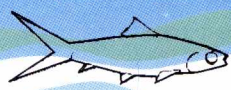


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Dr. Barry Hill, Secretary-General of the Paris-based Office International des Epizooties (OIE) lauded the efforts of countries around the world in reporting and dealing with diseases of marine animals that can threaten world trade

SEAFDEC and OIE hold disease workshop

Recognizing that the aquaculture industry is continuously threatened by diseases, SEAFDEC/AQD and the Paris-based Office International des Epizooties (OIE) organized a 2 and 1/2 day seminar-workshop on *Disease Control in Fish and Shrimp Aquaculture in Southeast Asia: Diagnosis and Husbandry Techniques*.

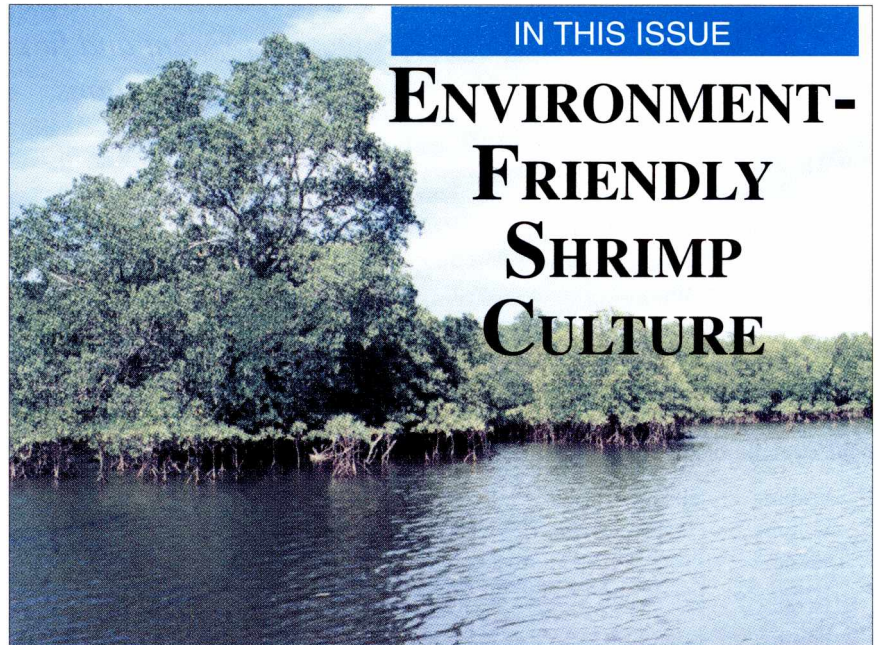
This was conducted December 4-6, 2001 in Iloilo City. As AQD Chief Dr. Rolando Platon noted in his welcome address, Asia is a major aquaculture site, and better regional cooperation can help the aquaculture industry attain its goal of sustainability. OIE Secretary General Dr. Barry Hill, on the other hand, said that there is a global monitor for aquatic animals and aquatic animal products. Further, the OIE disease control policy is based on regulations focused on certain diseases (what are called notifiable diseases) and

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Dr. Yasuo Inui, fish health expert at SEAFDEC/AQD, noted that Southeast Asia needs more skilled fish health workers who can diagnose and report diseases quickly and efficiently

7
on page 7, you'll
find more
SEAFDEC/AQD news



ENVIRONMENT-FRIENDLY SHRIMP CULTURE

THAILAND: OPERATING GUIDELINES FOR MARINE SHRIMP FARMS

By

Siri Tookwinas, Surasak Dirakkait, Waraporn Prompoj, Claude Boyd, Randy Shaw

The marine shrimp industry in Thailand has developed a code of conduct for its operations. This code is a set of principles and processes that provides a framework to meet the industry's goal for environmental, social, and economic responsibility. The foundation of the code of conduct is the following mission statement:

The marine shrimp farming industry in Thailand is committed to producing high quality, hygienic products in a sustainable manner that provides for environmental, social, and economic benefits to present and future generations.

Policy statements have been formulated to outline actions that the industry will undertake to meet its commitments under the statement. These policy statements cover a broad range of topics, including:

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www.seafdec.org.ph



A publication of the Aquaculture Department of the Southeast Asian Fisheries Development Center
SEAFDEC/AQD, Tigbauan 5021, Iloilo, Philippines

- Environmental protection
- Public consultation
- Regulatory compliance
- Location
- Quality and safety
- Continual improvement
- Efficiency
- Research and development
- Social responsibility
- Monitoring and auditing
- Education and training
- International trade

The code of conduct is voluntary, but it has been signed by a wide variety of industry stakeholders. The code commits the signatories to specific actions, including the development of a series of operating guidelines and procedural manuals. These actions will aid the industry in carrying out its operations in a manner consistent with the intent of the code of conduct.

The code of conduct for shrimp farms is the first in a series of operating guidelines and procedural manuals that will be developed for the marine shrimp culture industry of Thailand. Succeeding volumes would cover the other sectors of the industry.

Volume 1 – Shrimp Farms

Volume 2 – Hatcheries and Broodstock Capture

Volume 3 – Processing Facilities

Volume 4 – Feeds and Chemical Suppliers

The overall objective is to establish a consistent approach to industry operations through establishment of good management practices or GMPs. It is anticipated that implementation of these GMPs will enable the industry to operate in a sustainable manner.

Good management practices

Good management practices are defined here as practices that are thought to be effective, yet practical, in eliminating or reducing environmental and social impacts. GMPs may include structural (e.g., a settling basin to remove suspended solids), biological (e.g., wetland plants to remove nutrients in effluent) or management (e.g., minimize use of chemicals) practices to solve a particular problem.

A single GMP seldom solves a problem; rather a system of GMPs is normally required to prevent a particular type of farming or other activity from causing negative impacts. Therefore, for an activity such as shrimp farming, a system based on GMPs requires identification of

““ *The marine shrimp farming industry in Thailand is committed to producing high quality, hygienic products in a sustainable manner that provides for environmental, social, and economic benefits to present and future generations.* ””

potential impacts (environmental or social) and the installation of GMPs to prevent or mitigate possible impacts.

Shrimp farming in Thailand is conducted over a wide range of coastal environments within which, physical, chemical, and biological conditions and resource use patterns differ. A flexible system of GMPs has therefore been formulated, and selected combinations of GMPs can then be used to optimize the operating systems

for site-specific conditions in a given area and on individual farms.

Potential impacts of shrimp farms

As noted above, the first step in developing GMPs is to identify the key impacts that need to be stressed. Shrimp farming is a comparatively new activity, but possible impacts associated with operating shrimp farms are well known and include:

- Conversion of mangrove and other coastal wetlands to ponds
- Nutrient enrichment and eutrophication of coastal waters by pond effluents
- Discharge of potentially toxic and bioaccumulative chemicals into natural ecosystems
- Sedimentation in coastal waters because of erosion from ponds and other earthen infrastructure
- Salinization of freshwater sources by ponds effluents or seepage
- Reduction in biodiversity of coastal ecosystem caused by water pollution, sedimentation and toxicity of effluents
- Introduction of non-native species or new shrimp diseases into coastal waters
- Competition with other activities for natural resources
- Land use disputes

Operating guidelines and procedures for shrimp farms

This manual was developed with the input from international and national experts on shrimp farming operations and was reviewed by shrimp farmers at a series of workshops held in Thailand in February 1999.

GMPs are provided to eliminate or minimize the negative environmental impacts listed above. The following sections of the

ABOUT THE AUTHORS

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THAILAND'S DEPARTMENT OF FISHERIES IS A
COLLABORATING PARTNER OF THE SEAFDEC-ASEAN
MANGROVE-FRIENDLY SHRIMP CULTURE PROJECT

SEAWATER IRRIGATION SYSTEM FOR INTENSIVE MARINE SHRIMP FARMING IN THAILAND

By

Siri Tookwinas and Dhana Yingcharoen

The aim of seawater irrigation system (SIS) is to clean up shrimp pond effluent and provide high quality seawater for shrimp farming. The system has three components: water intake, treatment reservoir and discharge system. There are criteria for site selection because shrimp farmers are required to form associations so they can work closely together. The construction site must be on the coastal area outside a mangrove forest. The site must be located away from a productive agricultural area. All construction sites must have undergone an environmental impact assessment (EIA), and should be located on the area listed in Thailand's Coastal Zone Management Plan (CZMP).

Five SIS projects were completed and operated. These covered a culture area of 6,500 ha and 1,300 farmers (families). Department of Fisheries (DOF) has planned for another 28 projects. It will cover almost 44,000 ha of culture area.

When Thailand started producing shrimp, most of the farms depended on natural resources which turned out to be an inefficient way of production. Expensive shrimp farming occupied large areas along the coastal zone in the Upper Gulf. Large ponds of at least 1.6 ha were built in mangrove forests because shrimp larvae in the mangrove were automatically recruited into the ponds as water was pumped in. The shrimp were left in the pond, feeding on natural food, for about 6 months. After the rearing period, grown-up shrimp were harvested and sold to the local market. This primitive way of shrimp culture reduced mangrove forests. Harvests were low. Not until the last decade was intensive shrimp culture introduced in the country. Small ponds averaging 0.5 ha in size were built, and these replaced the large ponds in the mangroves. Culture areas also expanded to new locations outside the forests. Shrimp larvae from hatchery were stocked at high density and given artificial food. Antibiotic was administered for bacterial disease control.

These practices led to higher pond yield, with shrimp production increasing at an average of 8-18 mt/ha/yr. The result was the proliferation of intensive shrimp farms. Shrimp farms in Thailand comprised 40,769 ha in 1984; expanded to 75,332 ha in 1991; and decreased slightly to 70,400 ha in 1998 which produced 310,000 mt in 2000. Thailand has been the leading shrimp exporter since 1991 (Table 1 and Figure 1). Its major markets are USA, Japan, and the European Union countries.

Keys to success

The key reasons for Thailand's success in marine shrimp farming have been well discussed and reported. Key factors include favorable agroclimatic conditions, availability of wild

broodstock, farmers' long experience in aquaculture, strong infrastructure and support services, the fact that the industry is made up of small, efficient and nimble operations, and lately, strong control of environmental problems. An example of the latter is the Seawater Irrigation System or SIS, a solution introduced by the Department of Fisheries to the inadequate design of water supply that causes water pollution and shrimp diseases. The situation has occurred in many places, like Taiwan, where shrimp culture collapsed after a long period of growth.

Major constraints to Thai shrimp farming

Increasing attention has been given in recent years to some major constraints to marine shrimp farming industry in Thailand. One of these is water pollution from effluents. Pollution loading and toxic materials have been cited as the main reasons for the deterioration of coastal natural resources and the environment. Another concern is the loss of mangrove, which occurred during the expansion of shrimp farms.

Some studies show the quality of effluent and pollution loading from marine shrimp farms. A 1993 study revealed that the pollution loading from an intensive tiger shrimp farm in Ranot, Songkhla province was as follows: total nitrogen 202 kg/ha/day, total suspended solid 532.2 kg/ha/day and chlorophyll 0.11 kg/ha/day.

Other studies revealed that the total loading from marine shrimp farm in Kung Krabaen Bay, Chantaburi province discharged 67,400 t/ha/crop of used water. This contained total nitrogen 1.77 t/ha/crop, total organic carbon 160 t/ha/crop BOD₅ 35.10 t/ha/crop and sludge (wet weight) 134 t/ha/crop.

ABOUT THE AUTHORS

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TABLE 1. World production of marine shrimp (tons)¹

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Thailand	110,000	153,000	163,000	209,000	250,000	225,000	205,000	170,000	230,000	230,000
Indonesia	120,000	140,000	130,000	100,000	100,000	100,000	132,000	110,000	50,000	100,000
China	150,000	145,000	140,000	30,000	35,000	70,000	80,000	80,000	na	85,000
Ecuador	na	na	95,000	76,000	100,000	100,000	120,000	130,000	130,000	110,000
India	32,000	35,000	45,000	55,000	70,000	60,000	80,000	60,000	70,000	70,000
Bangladesh	25,000	25,000	25,000	30,000	35,000	30,000	35,000	34,000	na	na
Others	68,500	101,500	131,000	139,000	168,000	147,000	153,000	126,200	257,200	219,250
Total	505,500	599,500	729,000	639,000	758,000	732,000	805,000	710,200	737,200	814,250

¹World shrimp Farming (2000); na = production less than 25,000 tons.

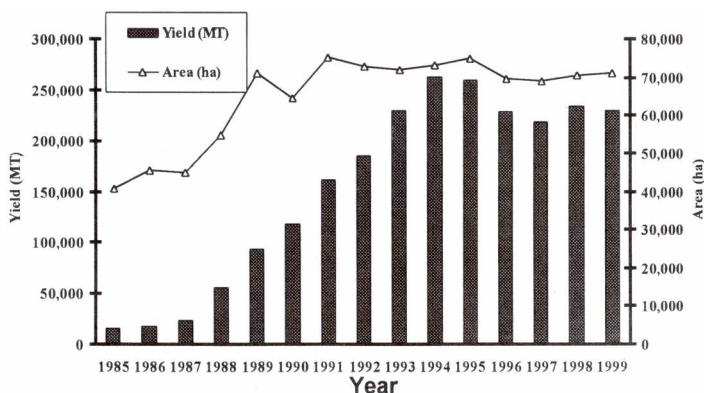


FIGURE 1. Shrimp production, culture area, annual yield from 1985 to 1999 in Thailand

Meanwhile, a 1995 survey showed that the utilization of mangrove in Thailand, synthesized from the satellite image in 1993 (Landsat TM: 50,000), was of three main types:

- 6,500 ha (17.5%) used for shrimp farm
- 138,785 ha (37.31%) used for land settlement and other purposes
- 168,028 ha representing the unused mangrove

Only a small portion of mangrove has been utilized for shrimp farming. However, through zoning or licensing, DOF has tried to move all shrimp farms from the productive mangrove to the unproductive mangrove areas, or to private land outside mangroves.

Macintosh and Phillips in a 1992 study compared the quality of shrimp farm effluent with that of effluent from other potential sources of pollution. They found that polluted water from shrimp farm has pollution loading considerably less than that of domestic or industrial wastewater.

However, polluted water from intensive shrimp farm still plays

a major role in the coastal water contamination. This is because the considerable amount of effluent contains a variety of suspended solid including excess feeds, fertilizers, chemicals and antibiotics.

Marine shrimp effluent is highly diluted but it is a large volume, requiring high investment for treatment. A 1994 study suggested that the suitable treatment process would be a combination between chemical and physical treatments. DOF has long studied the problems of inadequate design of water supply, water treatment process, as well as mangrove destruction to find the optimum solution for sustainable shrimp culture development. The conclusion: seawater irrigation system.

What seawater irrigation system (SIS) does

The aim of SIS is to clean up shrimp pond effluent and provide high quality seawater for shrimp culture. Its general purpose is to provide small-scale shrimp farms with a reliable supply of clean water. The SIS has three components:

- *Water intake.* Shrimp farms in the project are supplied with sufficient high quality seawater. The uncontaminated seawater is carefully taken from offshore via a pumping facility and through underground pipeline
- *Treatment reservoir.* The partially treated effluents from private shrimp farms are pumped into a common treatment reservoir and then treated by appropriate treatment procedures
- *Discharge.* After the water is treated, the effluent is drained offshore. The quality of discharged water will be controlled by the government or by shrimp culture groups and should not exceed the assimilative capacity of the adjacent sea

Because of non-uniform small-scale shrimp farms, the design engineers frequently find it difficult to design a simple seawater system existing in the shrimp culture area. Thus, a variety of seawater systems has been designed depending upon location, water resource availability and pond topography.

SEAFDEC-ASEAN PROJECT UPDATE: TRAINING ON MFSC IN MYANMAR AND A NEW WEBSITE

Mangrove-friendly shrimp culture (MFSC) course in Myanmar

Another session of the training course on mangrove-friendly shrimp aquaculture was conducted in Yangon, Myanmar from November 27 to December 7, 2001. The first one was conducted in Thailand and the Philippines in September-October. Both sessions are part of the output of the SEAFDEC-ASEAN collaborative project, and are funded by the Japanese Trust Fund.

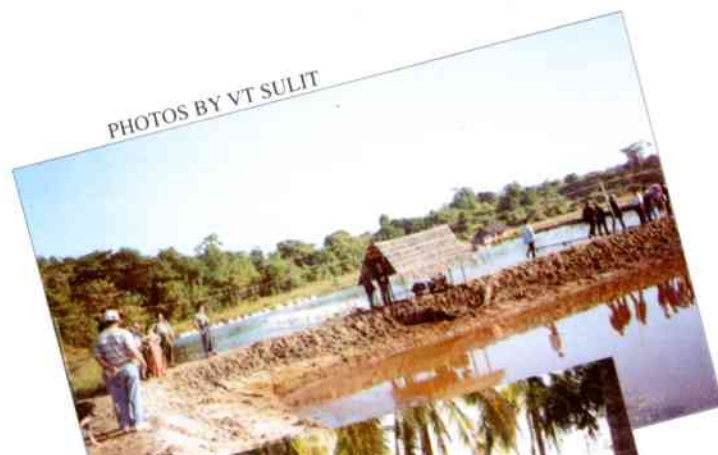
The Yangon session was attended by 41 participants composed of government fisheries officers and private entrepreneurs of Myanmar. It was conducted in collaboration with the country's Department of Fisheries.

Topics covered by the training included the status of aquaculture in Myanmar; general concepts of coastal resources management, conservation, and the mangrove ecosystem, as well as various ways of integrating aquaculture with the mangrove ecosystem. Thailand and the Philippines shared their experiences in mangrove-friendly shrimp aquaculture. Details of the role of probiotics, the use of molluscs and seaweeds as biofilters, nutrient cycles, recirculating systems, and shrimp health management were also discussed.

Since crop rotation is one of the approaches to sustainable aquaculture, there were also lectures on mudcrab culture, crustacean seed production, and fish seed production and grow-out. With these lectures, the trainees were made aware of alternative species that may be raised in areas in Myanmar not suitable for shrimp culture the whole year. A field trip to Comrades Shrimp Farm in Chaung Tha gave trainees an opportunity to relate the lectures with the actual operation of a private commercial shrimp farm.

☞ next page

@ Myanmar -- shrimp farm visited by the ASEAN-SEAFDEC trainees: the trainees preparing their group report; a visit to a cultural site to enhance understanding of a partner's traditions; and a courtesy call by SEAFDEC project administrators on Myanmar officials



www.mangroveweb.net

The SEAFDEC-ASEAN collaborative project aims to develop sustainable shrimp culture technology packages that will be disseminated through actual demonstration and training. A multi-media information campaign will be launched to make the international market aware of the “green” culture technology being pursued by SEAFDEC member-countries.

MFSC project website

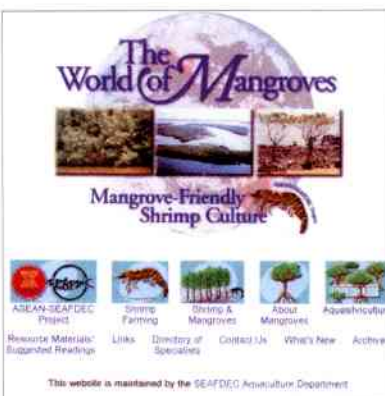
Do you know that of the SEAFDEC and ASEAN countries, Japan is the only one with no aquaculture development in their mangrove areas because they only have a total of 553 hec-

tares, all of which are protected? Do you know that Indonesia has the largest area, some 3.5 million hectares of mangrove forests? Do you know that Cambodia, Myanmar, and Brunei Darussalam are luckier countries than Thailand and the Philippines because they are just starting their shrimp culture industry and are benefitting from the lessons learned by countries grappling with the effects of mangrove deforestation?

All these and more can be learned from a new website -- www.mangroveweb.net -- which is the official site of the SEAFDEC-ASEAN collaborative project on mangrove-friendly shrimp culture (MFSC). The site is being maintained by SEAFDEC/AQD. Welcome to the world of mangroves and mangrove-friendly shrimp culture!

The progress of the MFSC project is extensively covered in the website. Funded by the Japanese Trust Fund, the MFSC has project sites in the Philippines, Thailand, Vietnam, and recently, Myanmar.

Thailand, which leads in the generation and field verification of closed recirculating shrimp systems, has four pilot activities: (1) *seawater irrigation for intensive marine shrimp farming* in Kung Krabaen Bay, Chantaburi (see also the article on pages 3-4,



where mangroves and shrimp come together

The features of these new improved shrimp systems include head and tail reservoirs; milk fish, tilapia and siganids as biomanipulators (“greenwater”); use of substrates and efficient feeds to reduce the feed conversion ratio; long-arm paddle wheels; and mechanical and biological waste filtration/degradation system. Skills development sessions have been conducted nationwide to update prawn growers and stakeholders about the environment-friendly technology.

Studies on nutrient cycles, capacity of mangroves to absorb nutrients, the use of probiotics and of molluscs and seaweeds as biofilters are being conducted in several places.

The project site in Vietnam is still undergoing physical improvement (semi-intensive shrimp system is being verified there), while that of Myanmar is being surveyed. Training sessions on MFSC have been conducted in both countries by SEAFDEC for government fisheries officers.

The mangrove website also offers several links to other mangrove and mangrove-related sites. The references on mangroves at the SEAFDEC/AQD Library can be accessed through the site as well. ###

and others – that roosted in the biofilter. Guano is rich in P and N, and is known as a natural fertilizer. Which goes on to show, the researchers conclude, that natural mangrove forests are uncontrolled ecosystems, and that their use for treatment of effluents can not be assumed on the basis of theoretical calculations. “The birds did it!”

Overall, it may be more practical for farms to use constructed wetlands, which are easier to control though expensive and takes up much space. The use of settling ponds is recommended as well. [REF: dgautier@acesag.auburn.edu; *Aquaculture Research* 32: 787-799 (2001)]

AROUND-THE-WORLD FROM PAGE 12

behind a 1 km wide mangrove area. The farm has practiced shrimp farm-mangrove forest system since 1995, producing about 2,000 kg of white shrimp *Penaeus vannamei* per ha per crop.

The researchers found that, after three months of measurements, suspended solids are drastically reduced by the mangrove biofilter. Removal rates for total and volatile suspended solids are 95% and 93% respectively. The bad news, however, is that dissolved inorganic nitrogen and phosphorus increased instead after biofiltration, and dissolved oxygen and pH are lower as well. The researchers explained that this is a consequence of the input of guano by a large bird community – thousands of egrets, herons,



Japan and Philippines: exchange of notes for biotech

Philippine Vice-President and Foreign Affairs Secretary Teofisto Guingona and Japanese Ambassador to the Philippines Yoshihisa Ara signed on behalf of their respective governments, the Exchange of Notes for the establishment of biotechnology laboratories in SEAFDEC/AQD's Tigbauan Main Station in Iloilo (photo at left).

The signing is the fourth step in Japan's grant aid procedure, and was done at the Philippine Department of Foreign Affairs in Manila on December 13, 2001. (The fifth and last step in the grant is implementation.) The cornerstone laying ceremony for the enclosed wet laboratory is scheduled for February 23, 2002.

The biotech grant is made up of four component laboratories: molecular endocrinology and genetics, molecular microbiology, feed technology, and algal production technology.

SEAFDEC AND OIE FROM PAGE 1

certification of acceptable sources of aquaculture products for national and international trade.

The topics covered in the seminar-workshop include marine fish and penaeid viral diseases. In the Americas, the most damage to shrimp farms has been caused by white spot shrimp virus and taura syndrome virus; in Asia, it is also white spot then yellow head virus, hepatopancreatic parvovirus, monodon baculovirus, and infectious hypodermal and hematopoietic necrosis virus. Fish culture has viral nervous necrosis and iridoviruses as big problems.

Meanwhile, the research community continues to develop accurate and practical diagnostic techniques as the number of viruses that can affect aquaculture is potentially numerous, and there is no known cure yet for viruses except prevention of transfer from animal to animal and limiting inadvertent spread of viral diseases from area to area. There have also been efforts to develop specific pathogen-free shrimp to exclude known viral killers from the culture system.

On bacteria, discussion was focused on controlling luminescent vibriosis in shrimp and crab culture, including the usage of probiotics, integration of fish in shrimp culture (the so-called "green water culture") as a disease prevention strategy.

The possibility of AQD conducting a training on *Diagnosis for important viral diseases in shrimp and marine fish* was also taken up. Participants prioritized the diseases and techniques to be included in the training.

Areas of possible collaboration among OIE, NACA, and SEAFDEC for the regional aquatic animal disease control system were also discussed.

More than 50 participants composed of the world's top researchers in shrimp/fish viruses and other disease agents attended the event, including Dr. Donald Lightner of the University of Arizona, Dr. Timothy Flegel of Mahidol University (Thailand), and Dr. Toshihiro Nakai of Hiroshima University. Organizations in Japan, SEAFDEC/AQD and NACA were able to present the progress of their work.

Dr. Yasuo Inui and AQD's fish health staff spearheaded the organization of the seminar-workshop.

Molecular diagnosis for shrimp and fish diseases now available at SEAFDEC/AQD

Viruses have been the long-time scourge of the aquaculture industry. Their presence or absence often spells the difference between profit and loss. White spot syndrome virus (WSSV) for shrimp, the viral nervous necrosis (VNN) and iridovirus for fishes are just three of immediate concern.

WSSV, whose causative agent is a baculovirus, affects shrimp postlarva, juvenile, adult and broodstock. Its manifestations include: presence of distinct white cuticular spots at the exoskeleton and epidermis of the shrimp, red discoloration, loose cuticle, and reduction in food consumption. It has a high mortality rate of up to 100% in three to ten days.

VNN, with the causative agent nodavirus, affects a number of fishes like grouper, seabass, red sea bream, sea bream, European bass, parrotfish, striped jack and others. The gross signs include: lethargy of larvae and juveniles, pale color, loss of appetite and equilibrium, and cork-screw swimming. The disease can cause mortality rates of 50-100%.

The iridovirus which affects groupers can cause up to 60% mortality rates. Among the signs shown by a diseased grouper are: swimming in circles, anemia, loss

AQD offers first distance learning course: AquaHealth Online

Stakeholders in the aquaculture industry — fish farmers, farm workers, technicians, farm managers, policy planners, development workers and members of fishing communities – as well as, faculty members, students enrolled in Colleges of Fisheries are invited to enroll in SEAFDEC/AQD's first distance learning course on fish health management. All learners must at least have taken a biology subject in college.

Distance learning is more convenient and practical than being in a traditional classroom. The learner can acquire knowledge and skills at his/her own place and time. The only requirements are a computer (a CD-ROM and a course guide will be provided at the start of the course) and Internet access to communicate with highly qualified teachers (AQD's senior fish health staff) and with fellow learners. The learning process occurs entirely via the Internet presided over by a designated Specialist of a particular Module. A Course Officer moderates the whole process. The learner uses a password to enter a secure learning environment.

The course answers the need for an effective health management program, which is important to the success of an aquaculture project. AquaHealth Online consists of four units divided into 13 modules.

Unit 1 – Introduction to Fish Health Management

Module 1 – Impact of Disease Development in Aquaculture

Unit 2 – Infectious Diseases

Module 2 – Viral Diseases of Fish and Crustaceans

Module 3 – Bacterial Diseases of Fish and Crustaceans

Module 4 – Fungal Diseases of Fish and Crustaceans

Module 5 – Parasitic Diseases and Pests of Fish and Crustaceans

Unit 3 – Non-Infectious Diseases

Module 6 – Nutritional Diseases

Module 7 – Environmental and Other Non-infectious Diseases

Module 8 – Harmful and Toxic Algae

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AQD Deputy Chief Susumu Ito attended to one of the regular visitors to the AQD booth, Dr. I-Chiu Liao of Taiwan (above); AQD's Dan Baliao and Jocelyn Ladja pose near one of the five posters presented by AQD (left)



PHOTOS BY WG YAP

AQD makes its presence felt in the stock enhancement symposium in Kobe

Three oral papers, five posters and an exhibit are AQD's contributions to the 2nd International symposium on stock enhancement and sea ranching held in Kobe, Japan from January 28 to February 1. [See related article on page 11, this issue.]

AQD Chief Dr. Rolando Platon presented the *Prospects and challenges of stock enhancement and sea ranching in Southeast Asia*; Dr. Gilda Lio-Po spoke on *Viral infections of hatchery-reared marine fishes in the Philippines*, and Dr. Jurgenne Primavera presented *Tagging and release strategies for stock enhancement of Penaeus monodon*.

The five poster presentations were by AQD research and technology verification staff Dan Baliao and colleagues (repopulating depleted *kapis* beds), NA Caron and Clarissa Marte (feeding trial of top shells), Wenresti Gallardo and colleagues (shell marking by artificial feeding of abalone), Jocelyn Ladja and colleagues (broodstock transplantation and natural seed production of *kapis*) and Eleanor Tendencia (bacterial flora of eggs from cage-reared and tank-reared grouper).

The AQD exhibit highlighted the *kapis* and the seahorse as stock enhancement species. Many booth visitors were amazed at the range of products that can be made out of *kapis*. ###

President Arroyo's advisers visit SEAFDEC/AQD

Secretary Paul Dominguez, adviser to Pres. Gloria Macapagal Arroyo, and Secretary Rene Villa, presidential assistant for Visayas, were in AQD's Tigbauan Main Station in Iloilo on January 29 to explore aquaculture technologies



that can be extended to Muslim communities in Mindanao. They were briefed on AQD's abalone R&D (above photo), seaweed site selection, and cage culture of fishes.



AQD Research Publications

Reprints of papers listed here may be requested directly from AQD authors or from the AQD Library

Compiled by the AQD LIBRARY <library@aqd.seafdec.org.ph>

Bombero-Tuburan I, Coniza EB, Rodriguez EM, Agbayani RF. 2001. Culture and economics of wild grouper (*Epinephelus coioides*) using three feed types in ponds. *Aquaculture* 201 (3-4): 229-240

Abstract. The performance of wild *Epinephelus coioides* juveniles was compared by feeding with live tilapia juveniles, fish by-catch, and formulated diet for 5 months in grow-out ponds. To minimize cannibalism, the groupers were graded into small (BW=24.9±7.3 g), medium (45.8±5.7 g), and large (84.1±30.0 g) size groups as block in a Randomized Complete Block Design (RCBD) and reared in nine 350 m² ponds. To supply the tilapia juveniles, adult tilapia were grown 2 months prior to stocking of grouper at a rate of 15 tilapia/grouper. Grouper fed by-catch were significantly higher (P<0.01) than the other treatments in terms of final length and total production. The quality of by-catch could be gleaned by its efficient feed conversion ratio (FCR) of 1.0 (dry basis), significantly better (P<0.01) than the formulated diet that had an FCR of 2.8. Using by-catch, 47% of the harvest weighed >400 g and only 14% was classified <200 g. The cost of juvenile grouper and feeds represented 88-89% of the total investment in all treatments. Economic sensitivity analysis showed that a combination of improvement in factors such as price of grouper juveniles, feeds, yield, survival, and FCR would result in higher return-on-investment (ROI). When cost and returns were considered, feeding juveniles with by-catch was more profitable because it resulted in net income of Php 361,623/ha/year, an ROI of 155%, and a payback period of 0.4 year. The results clearly show that these economic indicators appear to be attractive, thus making grouper pond culture using by-catch a viable industry. More research efforts should, however, be directed towards developing a cost-effective formulated diet for the grow-out culture of *E. coioides*.

Catacutan MR, Pagador GE, Teshima S. 2001. Effect of dietary protein and lipid levels and protein to energy ratios on growth, survival and body composition of the mangrove red snapper, *Lutjanus argentimaculatus* (Forsskal 1775). *Aquaculture Research* 32 (10): 811-818

Abstract. The approximate levels of dietary protein and energy that would sustain good growth and survival of the mangrove red snapper *Lutjanus argentimaculatus* (Forsskal) were determined in two feeding experiments. In the preliminary experiment, six fish meal-based diets were formulated to contain three protein levels (35%, 42.5% and 50%) and two lipid levels (6% and 12%) for each protein, with dietary energy ranging from 14.6 MJ kg⁻¹ to 20.5 MJ kg⁻¹. The protein to energy (P/E) ratios of diets ranged from 20.6 mg protein kJ⁻¹ to 27.5 mg protein kJ⁻¹. Diets were fed for 100 days to triplicate groups of snappers with an average initial weight of 24.8±0.4 g. No significant interaction between different levels of protein and lipid was observed. Survival rates (93.8% to 100%), feed conversion ratios (FCR) (2.61-3.06) and condition factors (K) were not affected by different dietary treatments. Regardless of lipid level, fish fed 50% protein diets had a significantly higher specific growth rate (SGR) than fish fed the 35% protein diets, but not compared

with the 42.5% diets (P<0.05). Increasing lipid to 12% in all, protein levels resulted in no improvement in growth over the level. Fish body moisture did not vary while lipid levels based on dry matter were high (27.9% to 33.7%). Snapper appear to require more than 40% dietary protein and a high dietary energy level for good growth. In the second experiment, fish (21.1±0.1 g) in four replicate groups were fed for 94 days with three diets (39%, 44% and 49% protein with P/E ratios of 21.1, 23.3 and 25.5 mg protein kJ⁻¹ respectively) containing similar dietary energy levels of about 19 MJ kg⁻¹. Average final weight, SGR and FCR were significantly higher in diets containing 44% and 49% protein diets (P>0.05). There were no differences in survival rates, protein efficiency ratio (PER) and nutrient composition of snapper flesh. All fish had fatty livers. Results indicated that the diet containing 44% protein with a P/E ratio of 23.3 mg protein kJ⁻¹ was optimum for snapper growth under the experimental conditions used in the study.

Coloso RM, Basantes SP, King K, Hendrix MA, Fletcher JW, Weis P, Ferraris RP. 2001. Effect of dietary phosphorus and vitamin D-3 on phosphorus levels in effluent from the experimental culture of rainbow trout (*Oncorhynchus mykiss*). *Aquaculture* 202 (1-2): 145-161

Abstract. Excessive phosphorus (P) levels in aquaculture effluents violate federally mandated limits and pose a serious threat to the freshwater environment. In rainbow trout culture, effluent P probably originates as fecal and metabolic waste product because assimilation of dietary P is relatively low. We therefore decreased dietary P and increased dietary vitamin D-3 levels, methods that enhance P assimilation in mammals, in purified and semi-purified trout diets, then monitored effluent P. Soluble effluent P reached a peak right after feeding and returned to baseline levels in between feeding times. The peak and average concentrations of soluble P in the effluent were mainly influenced by dietary P. Average P in fecal dry matter also decreased with dietary P. Neither dietary P nor vitamin D-3, under the conditions of the experiment, had significant effects on whole body P content but P deposition (as a percentage of P intake) decreased with increased dietary P. The dietary combination of low P and high vitamin D-3 decreased soluble and fecal P levels in the effluent, indicating a strategy whereby effluent P concentrations can be reduced by regulation of P metabolism.

Cruz-Lacierda ER, Lester RJG, Eusebio PS, Marcial HS, Pedrajas SAG. 2001. Occurrence and histopathogenesis of a didymozoid trematode (*Gonapodasmius epinepheli*) in pond-reared orange-spotted grouper, *Epinephelus coioides*. *Aquaculture* 201 (3-4): 211-217

Abstract. A didymozoid trematode encapsulated in the gills of orange-spotted grouper, *Epinephelus coioides* Hamilton, was observed in October 1997 and September 1999 among pond-reared fish in the Philippines. Capsule prevalence was 33% and 18% and mean intensity 2 and 1, respectively. The opaque-white and yellowish capsules were found only on the first gill arch and were attached lengthwise along the poste-

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rior surface of the primary gill filaments. When the capsules were opened, long thread-like worms were revealed, which were identified as *Gonapodasmius epinepheli* Abdul-Salam, Sreelatha and Farah. The parasites were encapsulated between the basement membrane of the epithelium and the efferent artery of the gill filament. The response of the host included mild hyperplasia of the interlamellar epithelium and an increase in the number of mucus cells.

de la Pena LD, Lavilla-Pitogo CR, Paner MG. 2001. Luminescent vibrios associated with mortality in pond-cultured shrimp *Penaeus monodon* in the Philippines: Species composition. *Fish Pathology* 36 (3):133-138

Abstract. Heavy mortalities due to luminescent vibriosis have been observed among pond-cultured *Penaeus monodon* shrimp in the Philippines. The species composition of luminescent *Vibrio* associated with mortalities was determined. A total of 189 luminescent bacteria isolated from the hepatopancreas of affected shrimps, rearing water and seawater from different shrimp farms in 11 provinces of the Philippines were examined for their morphological, physiological and biochemical characteristics. Results revealed a varied composition of *Vibrio* species. The most dominant luminescent *Vibrio* species was *V. harveyi* (65.5%) followed by *V. logei* (7%), *Photobacterium* sp. (6%) and *V. orientalis* (1%). Some isolates, based on their characteristics, were identified as *V. campbellii* (16%), *V. mediterranei* (3%), *V. fluvialis* (0.5%), *V. cholerae* (0.5%) and *V. splendidus* II (0.5%), which are known as non-luminescent vibrios. *V. harveyi* is thought to be the major etiological agent associated with the luminescent vibriosis in pond-cultured *P. monodon* and its pathogenicity was confirmed through intramuscular injection to shrimp. Experimental infection showed that *V. campbellii* was also pathogenic to *P. monodon*.

Erazo-Pagador G, Shariff MD. 2001. Rapid wound healing in African catfish, *Clarias gariepinus*, fed diets supplemented with ascorbic acid. *The Israeli Journal of Aquaculture-Bamidgeh* 53 (2): 69-79

Abstract. Wound healing in African catfish *Clarias gariepinus* fed diets supplemented with ascorbic acid was studied under laboratory conditions. Fish weighing approximately 80-110 g were stocked in 500 l aquaria in a static water system and fed one of five test diets containing different levels of microencapsulated ascorbic acid (0, 0.06, 0.10, 0.30, and 0.70 g AsA/100 g feed). After two weeks, all experimental fish were wounded by making a 1x1 cm dorsal-lateral incision above the lateral line of the fish. Wounded tissues were sampled for histopathological analysis 4, 8, 12, 24, 48 and 96 hours; and 6, 8, 10, 12 and 14 days after making the incision. There were significant differences in weight gain, specific growth rate (SGR) and feed conversion ratio among the dietary treatments. Weight gain and SGR of fish fed ascorbic acid free diet were lower than those of fish fed diets supplemented with ascorbic acid. The wound healing response showed a direct correlation to ascorbate level in the diet. Fibroblasts were present at 96 h irrespective of the ascorbic acid level. At 14 days, fish fed no ascorbic acid had some regeneration of muscle tissues, whereas fish fed diets containing supplemental ascorbic acid had a normal epidermis, dermis and muscle structure. There was no mortality during the experimental period, and fish fed ascorbic acid-free diets did not exhibit any deficiency signs. Results of this study indicate that about 0.10-0.70 g AsA/100 g feed is needed for wound repair in African catfish.

Lantin-Olaguer I, Bagarinao TU. 2001. Gonadal maturation, fecundity, spawning, and timing of reproduction in the mud snail, *Cerithidea cingulata*, a pest in milkfish ponds in the Philippines. *Invertebrate Reproduction & Development* 39 (3): 195-207

Abstract. Gonadal maturation, spawning, fecundity and timing of reproduction of the snail *Cerithidea cingulata* in a brackish water pond in Molo, Iloilo, Philippines, are described. Snails 4-41 mm in shell length were sampled monthly from May 1997 to May 1998; 25% were <25 mm, 67% were 20-30 mm, and 8% were >30 mm. The sexes are separate and could first be distinguished at 15 mm. Males are aphyallic, have narrower shells than females of the same length, and have bright yellow-orange testes overlying the digestive gland deep inside the shell. Females have more robust shells, an ovipositor at the right side of the foot, and yellow-green ovaries overlying the digestive gland. The sex ratio was one male to two females in the pond population studied. Gonadal maturation was monitored by means of gonadosomatic index (GSI, gonad weight as a percent of visceral weight); maturation stages were based on the gonad appearance (immature, developing, mature) and histology (immature, developing, mature, redeveloping). GSI increased with snail size, and reached 16% in a 33-mm female. The smallest mature males and females were 18-19 mm, and most snails >20 mm were mature, spawning, or redeveloping. Histological sections showed all stages of gametogenesis in mature male snails. The oocyte size-frequency distributions in mature females showed mostly mature oocytes and secondary oocytes, but also oogonia and primary oocytes. GSI and the frequency of snails at different maturation stages varied over the year. Both GSI and the frequency of mature snails were highest during the summer months, April to August. Nevertheless, mature snails occurred throughout the whole year, as did mating and egg-laying. Fecundity (= number of oocytes >70 μ m) increased with size in mature females 20-41 mm; an average 25 mm female produced about 1,500 oocytes and larger females produced a maximum of about 2,500 oocytes. Eggs strings laid on the pond bottom were 45-75 mm long; an average 64 mm string contained 2,000 eggs 210 ± 20 μ m in diameter. The density of eggs strings was highest (80-120/m²) during March-September. Eggs hatched after 6-7 d into planktonic veligers, which in turn settle on the pond bottom 11-12 d later as juveniles. Juveniles 2-6-mm long were most abundant in the pond during August-October.

Lebata MJHL. 2001. Oxygen, sulphide and nutrient uptake of the mangrove mud clam *Anodontia edentula* (Family : Lucinidae). *Marine Pollution Bulletin* 42 (11): 1133-1138

Abstract. Oxygen, sulphide and nutrient (ammonia, nitrite and phosphate) uptake of *Anodontia edentula* was measured. Oxygen and sulphide were measured from sealed containers provided with 1 l fresh mangrove mud (sulphide source) and seawater (oxygen source) with two treatments (with and without clam) at 16 replicates each. Oxygen, sulphide and other parameters were measured at days 1 (initial), 3 and 5 (final). Nutrients were measured from containers filled with 1.5 l wastewater from a milkfish broodstock tank with two treatments (with and without clam) at eight replicates each. Ammonia, NO₂ and PO₄ were measured at days 0 (initial) 3, 6, 9 and 12 (final). Results showed significantly decreasing oxygen and sulphide concentrations in treatment with clams (ANOVA, p<0.001). A significantly higher ammonia concentration (ANOVA, p<0.05) was observed in treatment with clams while no significant difference was observed in nitrite and phosphate between the



FROM AROUND THE WORLD

Kobe, Japan: “jury still out” on effectivity of stock enhancement

After a five-day symposium from January 28 to February 1, experts from all over the world are by no means unanimous on the actual benefits of stock enhancement. The symposium posed as a challenge to the participants to prove (or disprove) the hypothesis that “large hatchery programs (for the production of fry for seeding) can cause a major increase in total production.” The competing hypothesis presented is that “large hatchery programs cause a major decline in wild stock abundance (hatchery fish replace wild).” Many other research topics were suggested to resolve nagging questions involved in releasing hatchery-reared seeds to the natural environment. Among the suggestions are field studies to field test hypotheses dealing with density-dependent effects and genetic diversity/fitness.

The 2nd *International Symposium on Stock Enhancement and Sea Ranching* brought together experts on the subject from 14 different countries in Asia, Europe and the Americas to Kobe, Japan. It was hosted by the Fisheries Agency of Japan and the Japan Sea-Farming Association, and SEAFDEC was one of the 12 co-sponsors.

Since stock enhancement actually straddles between aquaculture and fisheries management the expertise represented was varied as can be gleaned from the session topics:

- Seed quality and techniques for effective stocking
- Health management in hatchery stocks
- Methods for evaluating stocking effectiveness
- Population management in stock enhancement and sea ranching
- Socio-economics of stock enhancement
- Case studies

A total of 78 papers were presented in the oral sessions. The session covering population management had the most number of papers; it was subdivided into three sub-sessions covering management of stocked population, ecological interaction with wild stocks, and genetic management of hatchery and wild stocks.

The next symposium will be held in the USA in three or four years. -- *WG Yap*

Grouper culture: Indonesia’s option to the live reef fish trade

An alarm is being raised on current destructive fishing methods that are used to catch live groupers in Indonesia. As Abdul Halim of the Department of Marine Affairs, University of Rhode Island, notes, the common method to capture live reef fish, including grouper, involves spraying the fish with cyanide solution. The damage is two-fold: (1) loss of live coral cover which can range 0.05 to 0.06 m² per 100 m² of reef per year and (2) paralysis from decompression sickness, or the “bends,” and possibly death to diver-fishers.

Grouper culture is, of course, an option to capture fisheries. But, Halim notes, it has attendant problems like unreliable source of seeds. The availability of mature male broodstock from the wild, for spawning in the hatchery, has become erratic because of the high exploitation rate of certain fish sizes. Grouper matures as female first (this size is more exploited) before it inverts sex – to male.

There is social impact as well. Stakeholders in the live reef fish trade might oppose commercial grouper culture, says Halim, as it might be incompatible with their traditional work patterns and up-

end the interdependence between middlemen and fishers in marketing live fish. Halim cautions that any grouper culture program to be implemented must consider the participation of all players in the live reef fish trade.

At present, fisher income in Indonesia from the live reef fish trade is about US\$150-500 per month which is 3-10 times the average monthly salary of an artisanal fisher and 1-3 times that of university lecturers. Indonesia supplies more than 50% of the wild-caught live reef fish to Hong Kong and Singapore. [REF: ahalim@fulbrightweb.org; *Coastal Management* 29: 319-326 (2001)]

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The Kobe exhibit (upper photo) and some participants during a reception

PHOTOS BY WG YAP



Abalone cultivation in South Africa

A recent review of abalone R&D in South Africa shows the successful partnership of industry with government research institutions in developing and innovating culture techniques. Dr. James Sales and Dr. PJ Britz of the Department of Ichthyology and Fisheries Science of Rhodes University (Grahamstown, South Africa) reports that after successful spawning of abalone in 1981, South Africa today has 12 abalone farms with estimated investment value of US\$12 million. Potential farm production is 500-800 tons of *Haliotis midae* (market size, 100 mm shell length) in 5 years. Note that in the wild, it takes 30 years or more for *H. midae* to reach its maximum size of 200 mm. Growth rate in the farms is about 0.08-4.5% body weight per day and feed conversion ratio is 0.9-2.4. Growers prefer to feed diatoms, then formulated feed pellets (fish meal and the algae *Spirulina* are protein sources; other plant proteins are being studied) and kelp as the abalone grows older. *H. midae* eats at roughly 0.5% of its body mass per hour.

H. midae sexually matures in 3-7 years, and then spawns several million eggs twice a year during spring and autumn. It prefers temperatures of 12-20°C, and farmers are advised to cease feeding at >20°C. *H. midae* can only be mechanically removed from tanks with minimal stress by the use of magnesium sulphate as anaesthetic. If transported, time is limited to less than 36 hours.

The main problem area in terms of abalone health is a polychaete parasite which is indigenous to South Africa, Dr. Sales notes. This is solved by improvements in hygiene and husbandry. In general, however, there is lack of knowledge on abalone diseases since most research efforts are focused on nutrition.

There are six other haliotid species in southern African waters but only *H. midae* has commercial importance. Given that abalone is among the most highly valued seafood in the world, Dr. Sales is optimistic of the increasing level of success in abalone farming in South Africa. [REF: J.Sales@ru.ac.za; Aquaculture Research 32: 863-874 (2001)]

Colombia: mangrove wetland as shrimp effluent biofilter

A case in Colombia once again proved that a mangrove biofilter can reduce suspended solids from shrimp farm effluent; however, the farm may not be able to reuse the water directly. Researchers from CENIACUA (Centro de Investigacion de la Acuicultura de Colombia) in Cartagena measured water quality changes in a 286 ha shrimp farm in northern Colombia (Caribbean side) and in the 120 ha mangrove wetland being used by the farm as biofilter. The mangrove biofilter is 46% *Rhizophora mangle* and 41% fern, *Laguncularia racemosa*, and about 80% of farm effluents flow through it with residence time of up to 4 days. Average depth of the biofilter is 52 cm.

Researcher Dominique Gautier and colleagues describe this farm, Agrosoledad, as being constructed 5 meters above sea level,

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two treatments. A decreasing ammonia and an increasing nitrite trend was also observed in both treatments starting at day 3. ###

DISTANCE LEARNING COURSE FROM PAGE 8

Unit 4 – Disease Diagnosis, Prevention and Control

Module 9 – Histology as a Tool in Disease Diagnosis

Module 10 – Serology and Molecular Techniques in Diagnosis

Module 11 – Immunity and Biological Methods of Disease Prevention and Control

Module 12 – Chemical Methods of Disease Prevention and Control

Module 13 – Environmental and Physical Methods of Disease Prevention and Control

The course will start on April 29, run for 16 weeks, and cost US\$250 per learner (or P 6,500 for Philippine nationals). Of the 30 maximum number of learners who can be accommodated, 20 can avail of JICA fellowship grants. Nationals of SEAFDEC member countries can compete for these grants; they can apply through their respective Council Directors.

AquaHealth Online is developed by the SEAFDEC/AQD with technical support from the University of the Philippines Open University. For more information, contact: training@aqd.seafdec.org.ph/ ###

MOLECULAR DIAGNOSIS FROM PAGE 8

of weight, and lethargy. The same type of disease has also seriously damaged stocks of cultured marine fish such as yellowtail and seabass.

The good news is that SEAFDEC/AQD now accepts shrimp samples for WSSV screening. Similarly, grouper, seabass, red snapper, milkfish and other marine fish samples for VNN and iridovirus screenings are accepted.

AQD uses the Polymerase Chain Reaction (PCR) in the diagnosis of shrimp and fish diseases. The cost for WSSV analysis per sample is P300 and P550 for one-step and nested PCR, respectively. VNN analysis costs P400 and P650 for one-step and nested RT-PCR, respectively. Analysis for iridovirus costs P300.

For protocols in sending samples, please contact:

Dr. Erlinda Lacierda
Head, Fish Health Section
SEAFDEC/AQD
Tigbauan, Iloilo 5021
eclacier@aqd.seafdec.org.ph

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THAILAND'S GUIDELINES FROM PAGE 2

manual discuss general guidelines for shrimp farm operations, specific procedures for implementing these guidelines, and a series of checklists and record keeping forms for farm management.

Site selection for new shrimp farms

Proper location of a shrimp farm is important to minimize adverse environmental and social impacts and in maximizing production rates.

GMPs for site selection include:

- The shrimp farm owner should have clear title or right to their property or other, legal or concession agreements
- All stakeholders should be involved in area zoning for shrimp farming
- The carrying capacity of an area should be determined in order to prevent too many shrimp farms in one place
- The water and soil quality should be suitable for shrimp farming and farms should be located far away from pollution sources
- Farmers should register with the appropriate government agencies

General pond management

Good pond management helps prevent water pollution, loss of biodiversity, and other negative environmental impacts, and it will improve the efficiency of shrimp production.

GMPs for pond management include:

- Good water quality should be maintained by using stocking and feeding rates that do not exceed the assimilative capacity of the culture system and by using high quality feeds and good feeding practices
- Water exchange should be reduced as much as possible
- Fertilizers, liming materials, and all chemicals should be used in a responsible manner and only as needed
- Good shrimp health management should be used
- Aerators should be positioned and operated to minimize erosion and creation of sediment mounds in pond bottoms
- Water inlets and outlet to ponds should be screened to prevent entrance of competitors and release of culture species
- Predator control methods that do not require destruction of ecologically important species in receiving water should be used

Stocking density

Stocking density is an important consideration in shrimp farming because the amount of feed needed to culture shrimp to market size increases in direct proportion to the stocking density. As feeding rates increase, water and soil quality in ponds tends to deteriorate. Ponds with high stocking rates tend to have poorer water quality than ponds stocked at moderate density. Impaired water quality stresses shrimp and reduces the efficiency with which they convert feed to shrimp flesh. Effluents from ponds with excessive stocking and feeding rates are of lower quality and have a greater potential to cause water pollution than effluents from ponds stocked at more reasonable rates.

GMPs for optimizing stocking density include:

- Stocking densities should be based on anticipated survival, desired size at harvest, and carrying capacity of ponds
- The size and age of shrimp fry should be considered

Feed management

Feed is the basis for high levels of shrimp production in intensive shrimp culture ponds. However, shrimp do not eat all of the feed provided to them, and only a portion of the feed consumed is converted to shrimp flesh. Uneaten feed, feces, and metabolic wastes enter ponds and serve as nutrients for phytoplankton. Ammonia excreted into pond water by shrimp can reach toxic concentrations. As feeding rates increase, water and soil quality in ponds usually deteriorate.

Good feed quality and careful feed management are essential ingredients for efficient shrimp culture. By using high quality feeds in reasonable quantities, water and soil quality in ponds is protected. This reduces stress in shrimp; there is less likelihood of disease; and shrimp convert feed more efficiently to improve the feed conversion ratio and minimize feed costs. Better water quality effluent reduces the possibility of negative environmental impact in receiving water bodies.

GMPs for feed management include:


- Feed should be purchased fresh and not stored for more than a few months
- Feed should be stored in cool and dry areas
- Feed management practices should be implemented to make sure that shrimp consume the feed as completely as possible
- Medicated feed should be used only if necessary for the control of a specific diagnosis of disease
- Cut fish (= trash fish) should not be used as shrimp feed, but if it is, care should be taken to prevent overfeeding
- Pond managers should keep careful records of daily feed application rates so that feed conversion ratio (FCR) can be assessed

Shrimp health management

Authorities on shrimp health management recognize that stress reduction through better handling, reasonable stocking densities, good nutrition, and optimal environmental conditions in ponds can prevent most infectious and non-infectious diseases. Treatment should be undertaken only when a specific disease has been diagnosed and it is known that this disease is treatable. Also, effective measures must be taken to minimize the spread of disease between farm stocks and natural stocks.

GMPs for shrimp health management include:

- Water quality evaluation and management should be implemented to avoid stressing shrimp, but when stressful conditions are observed, shrimp should be checked for disease
- For non-infectious diseases related to pond conditions, carry out the best option for disease treatment or for correcting pond conditions

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- For infectious diseases that may spread widely, isolate the pond, net harvest remaining shrimp, and disinfect the pond before discharging water

Therapeutic agents and other chemicals

There is considerable use of therapeutic agents and other chemicals in shrimp culture in Thailand. Some of the chemicals can be toxic to shrimp or accumulate in the flesh of shrimp and represent a potential hazard to the consumer. Also, some chemicals may exist in effluents as residues and be harmful to natural aquatic ecosystems. Reducing the use of these agents and chemicals will improve environment performance but also reduce cost of operating shrimp farms. Shrimp health management should focus on disease prevention through good nutrition, sound pond management, and overall stress reduction rather than disease treatment.

GMPs for safe use of therapeutic agents and other chemicals include:

- Shrimp farmers should follow reliable information regarding dosage, withdrawal period, proper use, storage, disposal, and other constraints on the use of a chemical including environmental and human safety precautions
- When potentially toxic or bioaccumulative chemicals are used in ponds, water should not be discharged until compounds have naturally decomposed to nontoxic form
- Careful records should be maintained regarding use of chemicals in ponds
- Store therapeutants in a cool place and in a secure manner where they will be inaccessible to unauthorized personnel, children, and animals. Dispose of unused compounds by methods that prevent environmental contamination
- Drug, antibiotic, and other chemical treatments should be done in accordance with recommended practices and comply with all national and international regulations

Effluent and solid wastes management

Pond effluent often contains elevated concentrations of nutrients, suspended solids, and possibly other potential pollutants. Pond management GMPs outlined previously can help improve effluent quality and reduce effluent volume. Effluent quality can be further improved by alterations of the discharge infrastructure and by the timing and manner of final discharge. Shrimp farms also generate solid wastes that should be disposed of in a manner that does not damage the aquatic or terrestrial ecosystem.

GMPs for effluent and solid wastes management include:

- Canals and embankments should be maintained in a manner to reduce erosion of above water portions
- Minimize water exchange to the extent feasible
- Use efficient fertilization and feeding practices to promote natural primary productivity while minimizing nutrient inputs
- Store and use fuels, feeds and other products in a responsible manner to avoid accidental spills that could contaminate water.

An emergency plan should be made for containing accidental spills

- The effluent should be treated before discharging if it does not comply with existing standards
- Ponds should be drained in a manner to minimize resuspension of sediment and prevent excessive water velocities in canals and at effluent outfalls
- Design outfalls so that no significant impacts of effluents on natural waters occur beyond the mixing zone
- Shrimp pond effluents should not be discharged into freshwater areas or onto agricultural land
- Sediment from ponds, canals or settling basins should be put back into areas from which it was eroded, used as earthfill, or disposed in some other environmentally-responsible way
- Sanitary facilities for disposal of human wastes and other health facilities should be provided
- Garbage and other farm wastes should be managed by acceptable methods
- Shrimp farms should comply with existing governmental regulations related to effluents and other wastes
- Managers should routinely evaluate wastes management procedures and continually attempt to improve them

Social responsibility

Sometimes, conflicts arise between shrimp farmers and others who either live in the coastal zone or depend upon coastal zone resources for their livelihood. Shrimp farmers also employ people, and conflicts may arise over employee-employer relationships. Public relations and employee welfare are complex issues, but general guidelines presented in the GMPs will be useful in enhancing the prospects of harmonious interactions among large shrimp farming companies, worker, and the local community. In Thailand there are many small shrimp farmers in addition to large company-operated farms, and many of the issues related to community relations will be addressed through other sectors of the industry, such as government regulations and shrimp farming associations.

GMPs for improving community relations include:

- Shrimp farmers or associations should communicate with community leaders
- This is particularly important in the planning stages for new farms or expansions
- Shrimp farmers or associations should attempt to accommodate traditional uses of coastal resources and encourage mangrove replantation activities through a cooperative attitude towards established local interests and environmental stewardship
- Shrimp farmers or associations should contribute to community efforts to improve local environmental conditions, public health and safety, and education
- Local workers should be employed as possible, and they should be fairly compensated with respect to local wage scales

- Healthy and safe living and working conditions should be provided
- Shrimp farm management should have clearly defined and posted security policies
- Employees should have a clear understanding of their duties and of company expectations regarding their performance

Farmer associations and education

Shrimp farmers should form cooperatives or associations by region in order to exchange technology and to achieve cooperation in water use and waste management. Shrimp culture techniques are also constantly improving, and it is important that shrimp operators continue to increase their knowledge of sustainable farming techniques.

GMPs for farmer association and education include:

- Farmer associations should be encouraged. Meeting among members should be routinely held for exchanging information on shrimp culture
- The farmers would participate in training in the aspects of shrimp farm management, in the manner of friendly environment practices, and for law and regulation for shrimp culture industry
- The association should promote “environmentally-friendly” practices

Data collection

Data collection on the above topics and farm accounts should be done. Shrimp farming associations should cooperate with the department of Fisheries to collect, organize, and evaluate data to demonstrate the adoption of GMPs and document the benefits of their use.

SEAWATER IRRIGATION FROM PAGE 5

What is SIS

Several Seawater Irrigation Systems have been built and it is likely that more will be constructed in the near future. The systems differ because of the variety of pond layout, different ecological systems and limitation of land utilization in different areas. They are normally designed using three types of water management.

- *Open Sea System (SIS type I)*. In private shrimp farms most of which have their own water intake facilities, the DOF will provide a drainage pumping system to collect shrimp farm effluent which is then given appropriate treatment in a common reservoir. The water is pumped out to a safe distance offshore
- *Bay System (SIS type II)*. High quality water supply will be provided by pumping through an underground pipeline. The length

of the pipe depends on the distance of the best all-season water quality found offshore. The effluent will be treated in shrimp farms before release into a common treatment facility and then discharged into the water resource nearshore

- *Shrimp Farm Consolidated System (SIS type III)*. The system is the combination of the first two management systems. The water will be provided via a pumping system and stored in a common treatment facility. The drainage pumping system is also provided. This type of water management is ideal for the shrimp industry; it must be operated in a large area by the same management team and shrimp pond layout must be completely redesigned. Therefore, a land reclamation program is required

Criteria for site selection

Thailand has large areas for shrimp culture. It has developed site selection criteria for future construction plans as follows:

- *A Shrimp Farming Association* is required in order to keep farmers working closely together. The association committee selected from the members provides linkage between farmers and the government. They will transfer the new technologies and government regulations to the farmers while informing the government about the problems during the rearing period (e.g. shrimp disease) and the difficulties of doing shrimp culture under the new environmental protection law
- *The construction site must be on the coastal area outside a mangrove forest*, preserving land for environmental protection or other purposes, and protecting the area for tourism
- The site must be located away from a productive agricultural area. If necessary, the construction sites near agricultural areas must have additional studies on environmental impact
- *All construction sites must have undergone an EIA* which is included in the feasibility study prior to the engineering design work
- *The construction sites should be located on the area listed in the Country's Coastal Zone Management Plan (CZMP)*

Implementation

Several SIS projects have been completed – in Ranot, Songkhla province; Ban Nakot, Nakorn Sri Thammarat province; and Kung Krabaen Bay, Chanthaburi province. Others are in varying stages of completion, and 28 more locations are on the list for feasibility study and engineering design. The ongoing project will cover a shrimp culture area of 44,000 ha. The government has invested US\$ 77.28 million. Farmers are expected to pay for the operation and maintenance cost through the farmers cooperatives management system.

Project details

There are a few sites that have been completed on the southern coast of Thailand, in Ranot, Songkhla province and Nakot, Nakorn

TABLE 2. Water quality at Ranot project before the project construction (1994)

Offshore Distance (m)		Depth (m)	Vis (m)	Sal (ppt)	pH	TAN (ppm)	TP (ppm)	TN gen (ppm)	TOC (ppm)
100	x	3.01	1.50	28.0	7.88	0.022	0.0095	0.59	0.31
	SD	0.30	0.00	0.0	0.09	0.012	0.030	0.11	0.14
500	x	4.95	2.36	27.7	8.02	0.009	0.133	0.897	0.15
	SD	0.30	0.312	0.6	0.03	0.001	0.086	0.411	0.06
1,000	x	6.28	1.88	27.7	8.04	0.009	0.009	0.417	0.17
	SD	0.24	0.537	0.6	0.01	0.004	0.004	0.098	0.05
1,500	x	6.90	2.21	28.0	8.08	0.004	0.138	0.597	0.10
	SD	0.173	0.26	0.0	0.03	0.003	0.028	0.064	0.07
2,000	x	7.07	2.17	27.7	8.11	0.005	0.085	0.313	0.16
	SD	0.40	0.29	0.6	0.03	0.005	0.025	0.164	0.1

TABLE 3. Water quality at Ranot project (near shore station) after operation, October 1999 to September 2000

Date	W.T (°C)	Sal (ppt)	pH	D.O. (mg/l)	TAN (mg/l)	No ₂ -N (mg/l)	No ₃ -N (mg/l)	PO4 (mg/l)	BOD (mg/l)
Oct '99	29	11	7.50	5.3	0.371	0.055	0.056	0.016	2.60
Nov '99	28	9	7.43	5.5	0.604	0.086	0.051	0.034	2.71
Dec '99	26	4	0.00	5.3	0.429	0.077	0.039	0.029	2.72
Jan '00	28	9	0.00	5.6	0.276	0.68	0.071	0.015	2.45
Feb '00	28	10	7.72	6.5	0.339	0.061	0.052	0.022	2.36
Mar '00	29	3	6.96	5.1	0.242	0.032	0.36	0.020	2.48
April '00	30	4	7.11	4.9	0.273	0.048	0.044	0.017	2.11
May '00	30	21	7.74	6.2	0.620	0.187	0.187	0.007	2.62
June '00	29	17	7.98	6.7	0.832	0.926	0.124	0.003	3.57
July '00	29	21	8.10	6.5	0.803	0.110	0.077	0.007	3.14
Aug '00	29	24	8.06	6.6	1.037	0.124	0.059	0.013	2.91
Sept '00	29	13	7.50	5.4	0.811	0.159	0.063	0.016	2.60

Sri Thamrat province. Details of the Ranot project are as follows:

Design	SIS – 1 design (Open Sea System)
Drainage area	4,800 ha
Farms covered	2,000 small and medium scale farm
Year started	Mid 1996
Treatment process	Physical aerated sedimentation
Period	10 hours
Pumping system	6 vertical mixed flow pumps; 2 underground HDPE pipelines 1 m in diameter placed 2 km offshore

The Ranot project was designed for pumping treated water offshore. The effluent collected from shrimp farms in the project area are treated by aeration and sedimentation along the drainage canal. The physical aeration and sedimentation process are the main treatment processes. Residence time is 10 hours. The water is rechecked at the pumping station for final treatment. If the water quality is acceptable, coagulant such as calcium oxide, alum and zeolite are added. The National Institute of Coastal Aquaculture

and Songkhla Coastal Aquaculture Station conducted the environmental impact assessment (EIA) before construction work and after the project started. The results showed that water quality meets the coastal quality standard as shown in Tables 2 and 3.

Conclusion

The Seawater Irrigation System is one of the first attempts to prevent environmental degradation resulting from shrimp culture. The aquaculture industry produces excessive metabolic waste products. Uneaten food may be flushed into adjacent environment during pond preparation for the coming crop.

As the world's leading marine shrimp producer, the Thai government has realized its responsibility towards minimizing negative impacts of intensive shrimp culture operation. It has tried to devise several solutions to sustain its marine shrimp culture industry and protect the environment.

One solution that has shown promise is the Seawater Irrigation System. The system would incorporate pre- and post-water treatment through mechanical and biological measures. The pollution load in pond effluent is significantly reduced.

Although SIS can help reduce pollution loading from shrimp pond effluent

and provide high quality water supply resulting from increasing shrimp production, it is only contributory to a sustainable shrimp farm management. There are other crucial parts.

Farmers should be well educated on sustainability shrimp farm practice e.g. a limit of 10 mg/l biological oxygen demand (BOD) in all shrimp farm effluents, a ban of flushing of mud or silt from shrimp farm area into natural water source or public area, a ban on releasing of saltwater into public freshwater resources and a limit on stocking and amount of feeding.

Regulations have been established, but enforcement is another issue partly because of budget and manpower constraints. Therefore, farmers should be given incentives such as tax reduction or export privileges. These could provide strong incentives to follow environmentally sound shrimp culture practices.

The experience of SIS in shrimp farming in Thailand could be adopted by other countries in the region. The system has shown results that warrant serious consideration. It is environmentally friendly and can promote sustainable shrimp farming. ###

Training, websites, EXTENSION MATERIALS

Year 2002 AQD TRAINING COURSES

- Health Management in Aquaculture**, April 10 to May 14 (5 weeks)
Freshwater Aquaculture, April 2 to 30 (4 wks)
Marine Fish Hatchery, May 28 to June 26 (4 wks)
Management of Sustainable Aquafarming Systems (includes module on Aquaculture Management), July 2 to 31 (4 wks)
Responsible Aquaculture Development (Third Country Training Program funded by JICA), by invitation, August 6 to October 4 (8 wks)

DISTANCE LEARNING

- Principles of Health Management in Aquaculture**, April 29 to August 3 (16 wks)
Basic Principles of Aquaculture Nutrition, August 6 to December 3 (16 weeks)

For application forms and further information, please contact

SEAFDEC Aquaculture Department
 Tigbauan 5021, Iloilo, Philippines
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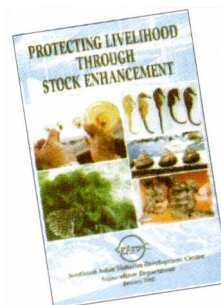
For local applicants who wish to apply for fellowships, contact

Hon. Cesar Drilon, SEAFDEC Council Director for the Philippines
 Office of the Undersecretary for Fisheries and Legislative Affairs
 Department of Agriculture, Elliptical Road, 1104 Diliman, Quezon City
 FAX: (02) 927 8405

For fellowship applicants from other countries,
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SEAFDEC websites on the internet

- www.seafdec.org
 maintained by the SEAFDEC Secretariat and SEAFDEC Training Department in Samut Prakan (Thailand) with contributions from the various SEAFDEC departments. Regional programs are highlighted
- www.seafdec.org.ph
 all about the SEAFDEC Aquaculture Department based in Iloilo, Philippines
- www.mangroveweb.net
 all about the ASEAN-SEAFDEC mangrove-friendly shrimp culture project
- www.agrolink.moa.my/dof/seafdec
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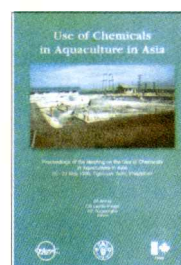
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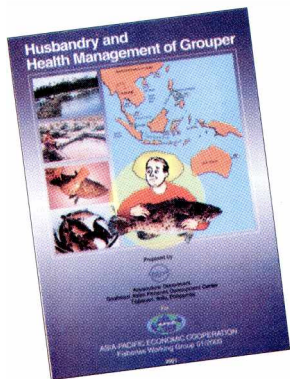
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Husbandry and health management of grouper

A 94-page fully illustrated, full color book prepared by SEAFDEC/AQD for the Asia-Pacific Economic Cooperation (APEC) Fisheries Working Group. 2001.

The project team writers from AQD -- ER Cruz-Lacierda, CR Lavilla, JD Toledo, NV Golez -- is

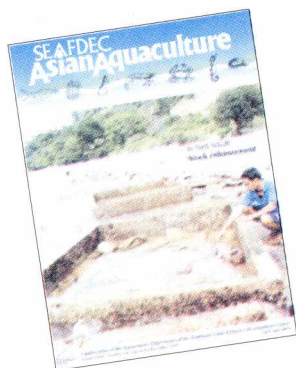
joined by NJ Ogburn of AJ Aqua Intercon Pty Ltd Australia.

The 94-page book, which is divided into seven sections and written in English, will help farmers improve production and reduce mortality, and thus utilize existing grouper seed resources more efficiently. Future versions of the book will be available in different translations to represent the languages within the region. The chapters are: (1) species of grouper farmed, (2) farm location and facilities, (3) sourcing grouper seed, (4) nursery and growout operations, (5) harvest and marketing of live fish, and (6) keeping the grouper healthy.

For book copies, contact Dr. Erlinda Cruz-Lacierda, eclacier@aqd.seafdec.org.ph. Fax (63-33) 336 2891, 335 1009.

Aquaculture nutrition textbook

A textbook on aquaculture nutrition for fisheries students will be available in May 2002 from SEAFDEC/AQD. It will cover the essentials of fish nutrition, feed and feeding of tropical aquatic species, and the economics of feed management. The chapters are written by AQD researchers who have had more than 20 years of research and training- extension experience. Send advance orders to sales@aqd.seafdec.org.ph/



From 6 to 4 issues a year, with regrets

With the budget constraints imposed on SEAFDEC/AQD by the Philippine government, the host country of AQD and its main funding support, we regret to announce that we are reducing the number of issues we normally print of *SEAFDEC Asian Aquaculture (SAA)*. And with the rising cost of printing and mailing-

handling costs, we are reducing the number of pages as well.

Beginning 2002, SAA will be issued quarterly, every 15th of March, June, September and December. More news of AQD activities will be posted on our website www.seafdec.org.ph and the AQD project website www.mangroveweb.net/

Thank you for your continued support and patronage.

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

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

This newsletter **SEAFDEC Asian Aquaculture (SAA)** reports on sustainable aquaculture. It is intended for fishfarmers, aquaculturists, extensionists, policymakers, researchers, and the general public. **SAA** is published four times a year by SEAFDEC/AQD.

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Contributions

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

Gifts and exchanges

Publication exchanges with **SAA** are encouraged. AQD has publications exchange agreements with 800 institutions worldwide.

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Nota bene Mention of trade names in this publication is not an endorsement.

European Union funds crab project

The European Union through the European Commission is funding a project on the *Culture and Management of Scylla Species* which is being undertaken by four institutions world-wide — University of Wales (Bangor) in the United Kingdom, Artemia Reference Center of the University of Ghent in Belgium, Can Tho University in Vietnam, and SEAFDEC/AQD in the Philippines. The overall aim is to improve the reliability and economic viability of mudcrab hatchery and nursery production for mangrove-pond aquasilviculture production systems and stock enhancement.

The project will run for three years beginning January 2002 with funding of ~ P9 million from EU. It is divided into six research work packages: bacterial disease control in the crab hatchery, improvement of broodstock and larval quality, nursery and aquasilviculture, technical identification of larvae and juveniles of four crab species, crab fisheries and population dynamics, and stock enhancement.

The project has training and information components, too. Developed techniques will be incorporated into course training materials for the MSc Aquaculture offered by Can Tho and to support training at SEAFDEC. A project website will be constructed, an illustrated field guide to identifying crabs will be produced, and studies published in peer-reviewed journals. Exchange of scientists among partner institutions will also be made.

To date, the first organizational meeting of the project was con-



ducted January 9-11 at AQD. The participants were Dr. Lewis Le Vay and Mark Walton of Bangor; Malthieu Wille of Ghent; Truong Trong Nghia, Vu Ngoc Ut, and Tran Cong Binh of Can Tho; Jurgenne Primavera, Emilia Quintio, Fe Dolores Estepa, Veronica Alava, Celia Lavilla Torres and Eduard Rodriguez of AQD.

The project was first conceived in 2000 at the meeting of the World Aquaculture Society (WAS) in Nice, France. Drs. Primavera and Quintio met with WAS President Dr. Patrick Sorgeloos of the University of Ghent, Dr. David Jones, and Dr. Le Vay to discuss the proposal which was later presented to and approved by the European Union in 2001.

Mudcrabs are of strategic importance to mangrove-friendly aquaculture systems. They live in mangrove areas; are highly prized in the markets of Vietnam, the Philippines and elsewhere; and their culture is affordable to poor rural communities who depend on mangroves for sustenance.

EU crab project's first meeting at AQD (below); participants later visit the replanted mangroves in Kalibo, Aklan, northern Panay as a possible study site



Dear readers, thank you for your feedback.

Some 37 of you wrote us last year to give your opinion about what you like and not like in this newsletter, SEAFDEC Asian Aquaculture (SAA). The coverage you most found interesting is in the following order: (1) Aquafarm news or the special feature section; (2) the abstracts of journal articles authored by SEAFDEC/AQD researchers; (3) the contributed papers by experts; and (4) AQD news. This new, redesigned SAA will still carry the above, although the Aquafarm news section has morphed into "From around the world" (page 11, this issue) to consider the developments from other aquafarms around the globe. The change is also because you'd like to see more coverage of research and development progress, technology news, and environment/sustainability issues. We'll expand this section in future issues.

You also said that the issues on grouper and milkfish were most relevant; next to the issues on catfish culture, local government units and fish marketing; followed by exotic aquaculture, molluscs, and tiger shrimp.

SAA is easy to read and the layout is easy on the eyes, too. We believe you [:+] because you have been reading us for about 2-5 years; most of you subscribing upon seeing a back issue and upon the recommendation of your friendly librarian. Most of you still prefer the hard copy though this takes awhile to arrive; but do remember that SAA issues are downloadable from SEAFDEC/AQD's website (www.seafdec.org.ph) in pdf format.

"This publication is worth reading!" most of you say. Thank you very much, you are our inspiration! -- SAA production staff