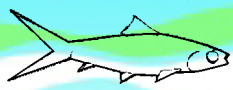


SEAFDEC Asian Aquaculture



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

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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.

Subscription

Subscription per year (six issues): P300 (local surface mail), US\$ 40 (foreign air mail). Please make remittances in postal money order, bank draft, or demand draft payable to SEAFDEC/AQD. For inquiries about **SAA** subscription and other AQD books and videos, e-mail: sales@aqd.seafdec.org.ph

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



Our cover

A shrimp pond is prepared -- the white substance is lime -- with reduction of organic pollution in mind. Note the blue pipes that will supply aeration and the circular net in the middle where biofilter fishes will be held. The picture was taken at AQD's Dumangas Brackishwater Station.

Photo by RY BUENDIA

Millennium conference

SEAFDEC is currently preparing to organize and host a conference on sustainable fisheries in the new millennium. The ASEAN-SEAFDEC Conference on Sustainable Fisheries for Food Security in the New Millennium is tentatively scheduled November 2001 in Bangkok, Thailand. It will have a theme "Fish for the People."

It is envisioned that the recommendations from the conference would be the basis for the formulation of a 5-year food security program on fisheries for the ASEAN region.

Tanzanians on a study tour at AQD

Four Tanzanians from the Lake Victoria Environment Management Project visited the AQD headquarters last May 24-25 as part of their observation and study tour funded by World Bank. Rashid Bakari Hoza, Senior Fishery Officer and Project Coordinator, said that the tour was part of their project to develop the 68,800 km² Lake Victoria (one of East Africa's biggest lake) and use its resources to benefit more than 1 million people living near the lake. Rashid was accompanied by Assistant Officers Andreas Madundo, Innocent Shangwa'bo and Shigalla Mahongo.

The Tanzanians said they were generally impressed by AQD's advanced state of aquaculture technologies particularly in tilapia (genetic modification, sex reversal, etc.). They were also impressed by the collaborative management scheme of coastal resources among local communities.

The Tanzanians were toured to various AQD facilities in Iloilo. They were also brought to Malalison, Banate Bay, Lemery, Ibajay, Bugtong-Bato, and the LIPASECU area to witness first-hand various AQD projects in community resource management and mangrove-friendly aquaculture.

In Luzon, they visited other BFAR and LLDA facilities including the seven Lakes in San Pablo City. They also visited AQD's Binangonan Freshwater Station.

Call for papers in marine science

The 6th Symposium of the Philippine Association of Marine Science (PAMS) will be held 19-21 October 2001 in Silliman University, Dumaguete City. This periodic symposium provides a setting for researchers and other practitioners of marine science and related fields such as fisheries, aquaculture, among others to share their findings and experiences.

The 2001 symposium will focus on the conservation of marine ecosystems and the role of community-based management. Papers for the following sessions may be submitted: biodiversity; mangrove/seagrass ecosystems; coral reef ecosystems; coastal



The Tanzanians are briefed on AQD's abalone R&D

resource management; aquaculture/mariculture; policy; ecophysiology/biochemistry; marine/aquatic biotechnology; marine geology and oceanography; and remote sensing.

PAMS will give the Dean Francisco Nemenzo Award to the best oral and poster papers among the student presentors. The awards honors the late Dr. Nemenzo, considered the Father of Philippine Coral Taxonomy.

The PAMS symposium is sponsored by UNESCO-Integrated Biodiversity Strategies for Islands and Coastal Areas. For more information, please contact: JH Primavera (PAMS president), SEAFDEC/AQD, Tigbauan, Iloilo. Fax: (033) 335 1008. Email: <jhprima@aqd.seafdec.org.ph>

Call for members

The recently-organized Philippine Aquaculture Society (PAS) is now accepting membership applications. PAS aims to advance the development of Philippine aquaculture, encourage research study and the development and exchange of information in aquaculture and in the sciences related to it, cooperate with various organizations to enhance public services and common weal, and affiliate with and advance the interest of the society with international organizations promoting aquaculture.

For more information, contact: Dr. Rolando Platon (interim president), SEAFDEC/AQD, Tigbauan, Iloilo. Email: <aqdchief@aqd.seafdec.org.ph>



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>

Bagarinao TU. 1998. Ecological considerations in milkfish farming in marine pens and cages. *UPV J. Nat. Sci.* 3: 67-82

Abstract. Milkfish farming in the Philippines has a long history and great importance, being widely regarded as the way to domestic food security. But the industry has faced new challenges in the past decade, with the advent of many other farmed aquatic species, mostly cash crops and "export winners," and with the increased pressure to intensify production in brackishwater ponds and in marine pens and cages. There are no up-to-date government statistics on the area and production of marine pens and cages, but industry insiders estimate a yearly production of about 25,000 mt of sea-grown milkfish in 1996-1998, mostly from Pangasinan, but also from Quezon, Davao, Cebu, Bohol, Panay, Samar, and Negros. High yields (2-38 kg/m³) were made possible by very high stocking rates (3-75 fingerlings/m³) and feeding rates (2-4 kg feed per kg of fish). The high production costs and the pollution from feed wastes and fish metabolites have stopped most operations within 1-2 years. This paper examines the trends and problems in milkfish farming in marine pens and cages, and discusses the ecological limits and the projected ecological footprint of this farming system. Milkfish farming in marine pens and cages, as presently practiced, is not the magic solution to the fish deficit in the Philippines and is not an appropriate technology to promote on a wide scale. The required investment is enormous. Properly made pens and cages set up in suitable clean-water locations cost much. The ability of milkfish to ensure domestic food security is negated by the use of fishmeal-based feeds. Fish feeds use up fish meal and other fisheries and agriculture products used by people and other sectors. If marine pens and cages must be promoted, integrated coastal area management, an informed precautionary approach, better infrastructure, and improved feeding management are important to ensure sustainability.

Bagarinao TU. 1999. Protected areas for biodiversity conservation and environment education in the Philippines. *Philipp. J. Sci.* 128:189-209

Abstract. The Philippine holds the distinction of having enormous biodiversity with the highest density of endemic species but has the problems of very fast decline in old-growth forests and the highest number of endangered mammal and bird faunas in the world. Among the recorded 53,577 species in the country are 512 unique species of land birds, mammals, reptiles and amphibians with 47-73% endemism. This biodiversity is seriously threatened by habitat destruction due to the expansion of

human populations and activities. Loss of biodiversity impairs ecosystem functions and results in floods, drought, erosion, pests and diseases, low productivity, and food shortages, with serious socioeconomic consequences. To arrest the loss of biodiversity, *in situ* conservation is imperative and the remaining natural habitats and biodiversity must be protected. But the 73 million Filipinos in 1997 demand more land, water, biological resources, and income. Most Filipinos are unaware about the country's biodiversity and the imperative for conservation. Environment education for the general public is essential, and nature recreation and ecotourism can be effective means towards 'greening' the minds of citizens. The National Integrated Protected Areas System includes 290 sites occupying about four million hectares (about 13% of the country's total land area), mostly in the remaining forests, but increasingly more in marine ecosystems in the country. This paper provides information about the biodiversity in the protected areas, their ecotourism status or potential, and the threats to them. Many protected areas have been exploited for products and energy, only some provide for ecotourism, and only a few are actually protected. Some accessible areas should be funded and managed more effectively for ecotourism and public education, but others must be left alone and actively protected. Encounters with nature engender pride in the national heritage, generates responsible citizen action, and helps ensure biodiversity conservation.

Bautista-Teruel MN and Subosa PF. 1998. Urease activity in soybean meal: effect on nutritional quality and on growth and survival of *Penaeus monodon* juveniles. In: Beveridge M, Fuchs R, Furberg J, Katusky N, Rely A and Sorgeloos P (eds). *Aquaculture Research and Sustainable Development in Inland and Coastal Regions in South-East Asia. Proceedings of an IFS/EU Workshop, 18-22 March 1996, Can Tho, Vietnam*: p 168-176

Abstract. Based on the results of a survey conducted on the urease activity (UA) in commercial shrimp feed containing soybean meal (SBM) (0.00-29.70 ppm UA), a study was carried out to determine the effects of different heat treatments on the UA, and on the nutritional quality of SBM. The effect of these heat treated SBMs when incorporated into shrimp diet on the growth and survival of *Penaeus monodon* juveniles was likewise tested. Various levels of UA in SBM were obtained with different the treatments. Six practical diets were formulated and contained 0.00 (SBM heated at 120°C for 20min); 0.50 (SBM heated at 60°C for 160min); 4.0 (SBM heated at 60°C for 80 min); 8.0 (SBM heated at 60°C for 40 min); 11.0(SBM heated at 60°C for

20 min) and 22.0 ppm UA (without heating). These diets were fed to *P. monodon* (average weight = 4.24 ± 0.10 g) juveniles for a period of 60 days. Results showed that protein quality in terms of amino acid content of SBM was not significantly affected by the different heat treatments. Weight gains of shrimps fed diets with 8.0, 11.0, 25.0 ppm UA were significantly lower than those fed other diets. Survival of shrimps was lowest with diets containing unheated SBM, but this was not significantly different from those heated at 60°C. Heat treatment of SBM at 120°C is adequate to be an effective ingredient in shrimp diets.

Hurtado-Ponce AQ, Agbayani RF and Samonte-Tan GPB. 1997. Growth rate, yield and economics of *Gracilariopsis bailinae* (*Gracilariiales, Rhodophyta*) using fixed bottom long-line method. Philipp. J. Sci. 126: 251-260

Abstract. Vegetative thalli of *Gracilariopsis bailinae* weighing 10 g each were tied to a 5-m monofilament line with plastic strips and laid horizontally on the substrate and were observed to grow at 30 d interval for 9 months. The monthly growth rate and yield were determined and a cost and return analysis of the culture system was made. The monthly growth rate of the seaweed was significantly different ($P=0.05$) over culture month. The highest average growth rate was 6.7% day⁻¹ while the lowest was 1.7%. The lowest and highest average yield (dry wt) was 72 g and 660 g m⁻² mo⁻¹, respectively. A capital asset of P1,680, working capital of P2,980, and annual production cost of P5,860 were calculated from the culture system. An annual net returns of P31,292 was computed based on a 1,000 m² area. Return on investment is 671.50% while payback period is 1.7 months.

Lio-Po G, Traxler G and Albright LJ. 1999. Establishment of cell lines from catfish (*Clarias batrachus*) and snakeheads (*Ophicephalus striatus*). Asian Fish. Sci. 12:343-349

Abstract. Primary cell cultures from catfish (*Clarias batrachus*) and snakeheads (*Ophicephalus striatus*) were prepared from whole fry and fingerling organ tissues of the brain, fins, gonad, heart, kidney, liver, skin and spleen. Four methods were tried: method A wherein explants were placed onto the surface of 25-cm² Primaria flasks (Falcon), allowed to attach for an hour before addition of Leibovitz medium (L-15) supplemented with 15% fetal bovine serum (FBS)(L15-15); Method B wherein explants were inoculated into 25-cm² Primaria flasks (Falcon) already containing L15-15; Method C which required forcing minced organ sections through a stainless steel sieve with the aid of a syringe plunger into a petri dish containing L15-15 medium; and Method D wherein immersed sections of minced tissues to 0.5% trypsin-EDTA slowly agitated using a magnetic stirrer for one hour at 25 °C. Method B was most effective in the establishment of cell cultures from both fish species. Passage

numbers of the cells are to date catfish gonad (CFG) P-56, catfish heart (CFH) P-51, catfish kidney (CFK) P-7, catfish liver (CFL) P-8, catfish spleen (CFS) P-54, snakehead gonad (SHG) P-26, snakehead heart (SHH) P-22, snakehead kidney (SHK) P-19, snakehead liver (SHL) P-49 and snakehead spleen (SHS) P-76. Attempts to derive primary cell cultures from organ tissues of the brain, fins, skin and whole fry were unsuccessful. Established cells were fibroblastic. The cells grew rapidly and became confluent 24 h after seeding at 20 and 25°C. Both SHS and CFS were susceptible to a virus isolated from EUS-affected fish in the Philippines. The cells were best maintained at 20 °C and stored in liquid nitrogen or -70 °C.

Millamena OM and Quinitio ET. 1999. Reproduction performance of pond-sourced *Scylla serrata* fed various broodstock diets. In: Keenan CP and Blackshaw A (eds). Mud Crab Aquaculture and Biology: Proceedings of an International Scientific Forum, 21-24 April 1997; Darwin, Australia. ACIAR Proceedings No. 78; Canberra: Australian Center for International Agricultural Research; p 114-117

Abstract. Feeding experiments were conducted to determine the effect of diet on reproduction of pond-sourced unablated and ablated *Scylla serrata* broodstock. Broodstock were fed either natural food (T1) consisting of mussel, squid, fish by-catch; a combination of natural food and formulated diet (T2); or formulated diet (T3). After 120 days of culture, best broodstock response in terms of total spawnings, spawnings with hatchings, number of eggs per g body wt (BW) of female, egg fertilization rate and total zoea produced was obtained in T2 and poorest response was in T1. Broodstock in T3 gave intermediate values among the treatments. Larval quality measured as zoea growth index and broodstock survival was also highest in T2. Results showed that combination diet feeding improves the reproductive performance and larval quality of unablated and ablated females compared with those fed on natural food or artificial diet alone. Latency period from stocking to maturation and spawning was shorter in ablated than in unablated females. Rematurations were observed both in unablated and ablated females in all dietary treatments.

Parado-Estepa FD and Quinitio ET. 1999. Larval survival and megalopa production of *Scylla* sp. at different salinities. In: Keenan CP and Blackshaw A (eds). Mud Crab Aquaculture and Biology: Proceedings of an International Scientific Forum, 21-24 April 1997; Darwin, Australia. ACIAR Proceedings No. 78; Canberra: Australian Center for International Agriculture Research; p 174-177

Abstract. Salinity tolerance was determined for each zoeal stage of *Scylla* sp. Larvae from ablated pond-grown females were abruptly transferred to salinities of 12, 16, 20, 24, 28 and 32 ppt.

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Environment-friendly shrimp farming

NOTES ON THE PLANNING WORKSHOP
HELD 12-13 MAY 2000; ILOILO CITY, PHILIPPINES

SEAFDEC convened the *Mangrove-Friendly Shrimp Culture Planning Workshop* at Days Hotel in Iloilo City from 12 to 13 May 2000. The planning workshop reviewed the status of mangrove-friendly shrimp culture technologies in Southeast Asia, and finalized the research, demonstration and extension components of the sub-project on shrimp under SEAFDEC-ASEAN's Mangrove-friendly Aquaculture Program. The technologies developed by the project (with funding assistance from the Government of Japan) will be promoted within the ASEAN member-countries.

It was attended by 37 representatives from Vietnam, Thailand, the Philippines and as well as SEAFDEC officials and researchers.

A backgrounder

Southeast Asia holds more than a quarter of the world's 18 million hectares of mangroves. But human activities, including

aquaculture, have put these mangroves at risk. In the last three decades, mangrove loss has ranged from 25% in Malaysia to 50% in Thailand. In the Philippines, only about 50,000 has remain from about 400,000 ha in the 1920s; most of the destruction have



IN PERSPECTIVE ►
Proposed semi-intensive and mangrove-friendly shrimp ponds and crab pen

▲ ON TRIAL
The mangrove vegetation are left unharmed in this semi-intensive shrimp farm in Vietnam

happened during the last 15 years because of conversion to ponds. Shrimp farming in particular has been perceived to be destructive to mangroves, to produce substances potentially harmful to marine organisms, and to send excessive organic load to downstream riverine and marine ecosystems during regular water

change. This has raised concern among shrimp-producing countries including SEAFDEC member countries.

This prompted SEAFDEC to launch a *Mangrove-Friendly Aquaculture Program*. Under this program is an environment-friendly shrimp culture project (see box next page). The Philippine-based Aquaculture Department (AQD) of SEAFDEC has been designated as the lead institution for technology development and verification, and Thailand the coordinating country for promoting the technology within ASEAN. The shrimp project is funded by the Japanese Trust Fund. Collaborators include Thailand's Department of Fisheries and Vietnam's Research Institute for Marine Products.



Mr. Damrong Silpachai
SEAFDEC's program and policy coordinator



Dr. Jurgenne Primavera
AQD Senior Scientist



Mr. Siri Tookwinas
Department of Fisheries, Thailand

ASEAN/SEAFDEC Project on the Development of Mangrove-Friendly Shrimp Culture Technology (1998-2002)

The project's primary objective is to develop sustainable shrimp culture technology packages. It also aims to disseminate these techno-packages through actual demonstration and training; prepare position papers that can be used to shape policies to encourage the adoption of responsible shrimp culture techniques; and launch a multi-media information campaign to make the international market aware of the "green" culture technology being pursued by SEAFDEC member-countries.

The project will pursue research and verification runs side-by-side. For the research component, studies will be conducted on nutrient cycles, capacity of mangroves to absorb nutrients, the "greenwater" technology (microbial and phyto flora), and probiotics or bioaugmentation.

The verification runs, on the other hand, will determine whether techniques known to be successful in a particular country or area can be adopted in other countries or locations. One of these techniques is the use of mangrove irrigation and recirculating systems for intensive culture. Another is the use of bio-filtering organisms like tilapia in semi-intensive culture. Economic analyses will be made.

Dissemination of technology developed can take many forms, such as: technical papers for scientific journals; popular articles in newspapers and magazines; position papers; website on the internet; video-documentaries; and training. A hands-on manual on sustainable shrimp farming system will later be translated to Thai, Malay, Vietnamese, and Filipino.

The project sites are in the Philippines (semi-intensive and intensive); Thailand (intensive shrimp grow-out); and Vietnam (semi-intensive).



Dr. Rolando Platon
SEAFDEC/AQD Chief



Mr. Fred Yap
Aquaculture expert, AQD



Mr. Dan Baliao
Aquaculture expert, AQD

Review of available technologies in Southeast Asia

The first session of the planning workshop dealt with the review of available shrimp farming technologies. The resource speakers included Dr. Jurgenne Primavera (AQD's mangrove expert), Mr. Dan Baliao (head of AQD's technology verification program), Mr. Siri Tookwinas (director of the Thai government's shrimp research institute).

Extensive shrimp culture system. Dr. Primavera described two models -- (1) the low-density culture of fish, shrimps, crabs integrated with mangroves; and (2) the use of mangroves to process effluents from high-density aquaculture ponds. The first model can give substantial profit to poor families; for instance, more than US\$300 per crab pen of size >150 m² per month in Malaysia, about a Rp 1 million per ha of milkfish-shrimp pond per year

in Indonesia, over P55,000 per crab pen of size 4,000 m² per year in the Philippines, or about US\$250 per ha of shrimp pond in Vietnam. Mangroves, usually nipa, are also harvested and sold.

The second model is under study by AQD.

Semi-intensive systems. Mr. Baliao described the current improvements to the semi-intensive systems as follows: use of reservoirs, use of greenwater, and use of probiotics. He noted that the reservoir pond is set aside from the existing grow-out ponds. This reservoir has netcages where biomanipulators (tilapia, milkfish, siganids, for example) are stocked.

He said that researchers theorize that biomanipulators, especially tilapia, can directly help shrimp when the fishes produce enzymes or slime that inhibit the growth of luminous bac-

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teria. In addition, these fishes feed on the plankton that bloom with increased nutrient input in ponds, indirectly reducing organic load.

Baliao also noted that the grow-out ponds are stocked with biomanipulators, too. These ponds also have long-arm paddle wheels that continuously drive the water towards the netcages where sludge collectors are installed. The shrimp farm has independent supply and drain gate or canal system so that incoming and outgoing water do not mix. The farm only partially discharges water to the surrounding environment.

The test sites for the semi-intensive system are in the Philippines -- AQD's Dumangas Brackishwater Station in Iloilo and the government ponds in Pagbilao, Quezon; Cadiz, Negros; Calape, Bohol; and in Lala, Lanao del Norte -- and in Phu Long, Cat Ba island, northern Vietnam.

The Vietnam site (see the diagram on page 6) tests the same set-up as the Philippine sites except that there are mangroves in one pond and the culture of mud crab is integrated in the farm. The mangrove species is mostly *Kandelia candel*, widespread in northern Vietnam.

Intensive system. Mr. Siri Tookwinas talked about Thailand's R&D efforts in making the shrimp intensive system sustainable. He said that many experiments for the treatment of effluents have been conducted, and that the closed system (or water recycling system) has been successfully tested. The set-up is very similar to semi-intensive -- the use of air paddle wheels for surface aeration and air compressor line for bottom aeration of shrimp pond; pumping of shrimp water to a treatment pond where biofilters are kept; and pumping of the cleaned-up water from a sandfilter

in the treatment pond back to the shrimp pond. The biofilter or clean-up organisms are algae and tilapia, with seabass thrown in to control tilapia population.

Project workplan

The second session of the workshop discussed the progress already made in research and verification runs. AQD's Nelson Golez presented his results on nutrient cycles (phase 1 in tanks has been completed; phase 2 in ponds is ongoing); Ms. Teresa Mallare, the results of the probiotics study in tanks (a pond study is planned); and Dr. Primavera, the study on the capacity of mangroves to absorb nutrients. Technology verification activities in the Philippines, Thailand, and Vietnam (presented by Dr. Varin Tanasomwang of DOF-Thailand)

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Trial site in ► Songkhla, Thailand: a pond with bottom air diffusers



Dr. Varin Tanasomwang Government of Thailand **Dr. Le Xan** Government of Vietnam **Ms. Kwanruethai Thanomkiat**, Thailand **Mr. Nelson Golez** SEAFDEC/AQD



▲ *Trial site in Chachaengsao, Thailand: young mangroves and brackishwater weeds are maintained in a pond*

◀ *Workshop participants pose for a souvenir photo*

Mangroves and shrimp culture

INDEX OF SHRIMP AND MANGROVE SITES

[//www.earthsummitwatch.org/shrimp](http://www.earthsummitwatch.org/shrimp)

If you need an introduction to the international debate over the sustainability of the shrimp industry, this would be a good site. Maintained by the Earth Summit Watch (a non-government organization funded to hold governments accountable for commitments made to sustainable development starting with the 1992 summit in Rio de Janeiro), the site lists the important voices/differing positions on the web. It also gives an account of how the shrimp debate took world stage -- through the so-called shrimp tribunal convened by non-government organizations at the United Nations on April 29, 1996.

The site's index classifies institutions as policy players, information and statistics, and farmers. The policy players include the Earth Summit Watch, Mangrove Action Project, Sea Turtle Restoration Project, The Shrimp Council, Greenpeace, Environment Defense Fund, Thailand Shrimp Case, Habitat Productions, The World Trade Organization, Sierra Club of Canada, and the Natural Resources Defense Council.

Organizations that provide information and statistics include Shrimp News International, Pacific Regional Aquaculture Information Service for Education, Aquaculture Network Information Center, Gadus Associates, FAO Fisheries Department, and the Aquaculture Information Network.

The farmer-players include Penbur Farms Inc (Texas, USA), Bluewater Aquaculture (Belize), Contessa Farm-raised Shrimp (California), and Expalsa S.A. (Ecuador).

MANGROVES UNDER PRESSURE

[//www.agri-aqua.ait.ac.th/Mangroves](http://www.agri-aqua.ait.ac.th/Mangroves)

There are three articles pertaining to mangroves that are posted online: (1) mangrove, fisheries and economic valuation; (2) the mangrove questions; and (3) mangrove destruction and shrimp culture systems. The first two are written by John Hambrey of Thailand's Asian Institute of Technology (the "owner" of the website), the third is by Piamsak Menasveta of Chulalongkorn University. Hambrey also wrote the web editorial reproduced on page 10, this issue.

COMMUNITY EMPOWERMENT

[//ngo.asiapac.net/wetlands/index.htm](http://ngo.asiapac.net/wetlands/index.htm)

Wetlands International-Asia Pacific describe themselves as the world's leading non-profit organization concerned with the con-

servation of wetlands and wetland species. They are active in over 120 countries.

The website carries a good gallery of pictures, and useful links to other international sites like the United Nations Environment Programme and the World Wide Fund for Nature; specialist groups for ducks and swans, or migratory birds; and wetland centers and nature reserves in Japan, Korea, and Malaysia.

One of Wetlands International's project is community empowerment on coastal area management and conservation. They posted 20 slides on the website documenting mangrove restoration and environment-friendly shrimp culture in Indramayu, West Java. One can see the meeting and discussion of the community; the participation of children and women in mangrove planting; the mangrove trees at planting and after a year (some of the seedlings are encased in ceramic as protection from silt); exposure field trip of fish/shrimp farmers; the reconstruction of shrimp pond; the shrimp harvest; and the construction of crab pens. There is a special note attached to the crab pictures -- that fishers receive revolving fund (total of Rp. 30 million) on the condition that they plant mangroves in canals. For more info on the project: [<wiap@wiap.nasionet.net>](mailto:wiap@wiap.nasionet.net)



NEW PLANTING TECHNIQUE

[//www.mangrove.org](http://www.mangrove.org)

The mission of the Mangrove Replenishment Initiative (MRI) is to provide technology, foster education, and encourage proactive mangrove replenishment. MRI works mainly in Florida (USA),

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though its innovative planting methodology has been used in the Virgin Islands and Puerto Rico.

MRI's target species is *Rhizophora mangle* which can not be easily established in areas with significant tidal action, wave activity and upland run-off. To help this mangrove take root, MRI uses a polyvinyl chloride pipe (PVC) as encasement. The bottom end of the pipe is cut at 45° while the body is split vertically to allow for plant growth in later stages. MRI recommends a 1.5 inch diameter, thin-wall 160 psi PVC.

The website carries visual aids to explain what is now known as the "Riley Encased Methodology."



A red mangrove seedling (left) to be encased in PVC and a grown red mangrove

ECOTOURISM

[//www.sarawak.com.my/travel_features/national_park/bako/mangroves_bako.html](http://www.sarawak.com.my/travel_features/national_park/bako/mangroves_bako.html)

[//willow.ncfes.umn.edu/pubs/misc/mangroves/mangroves.htm](http://willow.ncfes.umn.edu/pubs/misc/mangroves/mangroves.htm)

The mangroves of Bako and the mangroves of Kiribati are government efforts to generate interest and sustain tourism in national parks or protected areas.

In Bako National Park (Malaysia), *Avicennia*, *Sonneratia*, *Rhizophora* and *Nipa* dominate. Visitors would also see mangrove "wanderers" like fiddler crabs, mudskippers, otters, monkeys (four types are described), lizards and a lot of birds (150 species have been recorded). The site also shows a plankwalk that snakes its way around the mangrove forest.

The Kiribati site (one of the islands in the Pacific) introduces the mangroves as a priceless resource that needs protection. A short factsheet describes the four species native to Kiribati -- *Rhizophora stylosa*, *Sonneratia alba*, *Bruguiera gymnorrhiza*, and *Lumnitzera littorea*.

VIDEOCLIPS

[//www.gullivermedia.com.au/wildlife.html](http://www.gullivermedia.com.au/wildlife.html)

Gulliver Films is a specialist producer of wildlife, natural history and environment programs and education videos. They offer "Mangroves and Wetlands," an 18-minute documentary that can be used by secondary school students studying society and the

EDITORIAL *from the* WEB

The debate over the sustainability of shrimp farming and mangrove destruction continues. This is all to the good: environmental interests -- which are everybody's long term interests -- continue to be compromised by development of all kinds. But it is essential that this debate be an informed one, driven by a desire to find the best way forward, rather than to score simplistic campaigning points. The issues are complex, and vary enormously throughout the world.

For example, shrimp farming is commonly portrayed as big international business which destroys huge areas of mangrove, ruins resources for poor local people, makes lots of money -- none of which is injected into the local economy, and then abandons ponds when diseases strikes, leaving an ecological wasteland. Elements of this scenario have occurred in some parts of the world (though rarely all together) and are to be deplored. But there is another side to the story. In 1994/5 Thailand produced 240,000 mt of shrimp with a farm gate value in excess of US\$1.6 billion. This shrimp was not produced by a few large multi-nationals, but rather by 20,000 farms, mostly less than 2 hectares in extent, and employing in total around 100,000 people. Most of the shrimp farmers in Thailand were previous poor rice farmers, and shrimp has brought a great improvement in living standards in many coastal areas. Although around 20% of these farms were built on what was previously mangrove, and a further 14% on other wetland habitat, the rest were mainly developed in old coconut plantations or paddy fields, many of which were already marginal due to brackishwater inundation in low coastal areas. In Vietnam, there are an estimated 30,000 shrimp farms, most of which are extensive (i.e. very limited feed inputs), and virtually all smallholder operated. The benefits that these farms bring to poor local people, as well as national economies struggling against national debt are highly significant. Much mangrove has indeed been destroyed for shrimp farming in the Mekong Delta and elsewhere, but this mangrove was already being destroyed for a variety of other activities, including agriculture, charcoal and wood chip production, and salt production.

In these circumstances, attacking shrimp farming without addressing the underlying causes of resource degradation, or offering less destructive alternative routes to improved livelihood

environment. Among the clips excerpted from this video are: a snail searching for a prey, a male mudcrab with an oversize nipper, a tree snail on mangroves, a flying fox or fruit bat, ibis and herons feeding, broilgas or cranes, salt crystals on a mangrove leaf, and arching prop roots.

in areas of great poverty and high population pressure, will do nothing for mangrove conservation.

Disease is also a problem in the shrimp farming industry. But this is far from unique -- disease has blighted all forms of agriculture for several centuries. Nor is it confined to more intensive production techniques. The causes of disease, and the means to address it, are complex and often require local solutions.

Conserving mangrove and other important coastal resources, while at the same time improving the livelihood of poor people, is a complex and difficult task. In some areas aquaculture may form an important element in an overall strategy for conservation and development -- or sustainable development, and should not be naively attacked as the problem. A much more comprehensive approach is required.

Several important documents will be published in the coming year which seek to promote more sustainable coastal aquaculture development and improved coastal management in general. The Secretariat for East African Coastal Area Management (SEACAM, website <http://www.seacam.mz>) has produced draft guidelines/manual for the environmental assessment of coastal aquaculture, which should be published in final form this summer. The UN Group of Experts on scientific aspects of marine environmental protection (GESAMP, <http://www/fao.org/WAICENT/FAOINFO/FISHERY/meetings/gesamp/wg31cm.htm>) will publish "Planning for Sustainable Coastal Aquaculture Development" later in the year. The World Bank is also working on a policy discussion document on Shrimp Farming and the Environment. The Global Aquaculture Alliance (<http://www.gaalliance.org/index.html>) has already drawn up a Code of Practice for Sustainable Shrimp Culture.

If environmental groups, industry representatives, academics, planners and others can all work together to try to promote these more rational, albeit difficult, approaches, then coastal aquaculture should become much more sustainable, and mangrove conservations more effective.

Dr. John Hambrey

www.agri-aqua.ait.ac.th/Mangroves/Policy.htm

GIFT BASKET OR PANDORA'S BOX?

[//www.ofimarkesa.com](http://www.ofimarkesa.com)

[//www.perc.flora.org/PEN/1998-10/duplisea.html](http://www.perc.flora.org/PEN/1998-10/duplisea.html)

OFI Markesa International farms their tiger shrimp in Indonesia, Thailand, and Vietnam. They also offer "Mexican shrimp", lob-

sters and crabs. The website includes ordering information (a "Maritime Treasure Basket" can be delivered overnight within the US), recipes, shrimp news, and a slide-tour of their shrimp processing plant.

Before you swallow that delicious shrimp though, consider what Bradford Duplisea reported in another website. (This is presented here as an example of the type of campaign mounted against the shrimp industry).

Duplisea is campaign director with the Sierra Club of Canada. He wrote: "The real costs of our appetite for this luxury item is severe and long-term ... those \$10 all-you-can-eat prawn platters are no bargain ... The latest cash crop has attracted the short-term attention of investors who want to get rich quick. In countries like Ecuador, locals say there are two ways to get rich: one is cocaine, the other is shrimp...

"Mangrove forests provide protection against tidal waves, flooding, and cyclones. According to the World Wildlife Fund, thousands of people were killed in 1991 by a tidal wave in Bangladesh, in an area where shrimp ponds had replaced mangroves. In 1960, a tidal wave of similar force has passed without loss of life due to the protection offered by the mangroves...

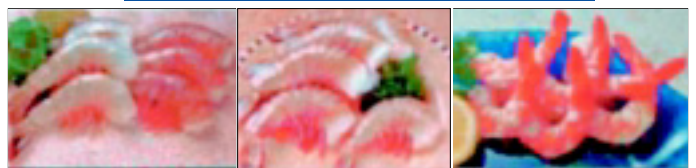
"Shrimp farms have displaced thousands of local people ... Most shrimp farms are short-term ventures, becoming unproductive and collapsing in only five to ten years.

"Seeing their way of life threatened, locals have stood up against the shrimp farms. They have faced violence in many cases. In Bangladesh alone, over 100 people have been killed in conflicts with commercial farm owners.

"Shrimp aquaculture is a poignant example of demand-driven industries, export-oriented trade and macro policies that often translate into environmental chaos and social misery.

"Those who eat shrimp in the world, they are eating the blood, sweat and livelihood of the poor people of the Third World."

www.ofimarkesa.com/productinfo.htm



Mexican shrimp, black tiger and some cooked shrimp

[Editor's note -- When a mangrove is not a mangrove: We hit no less than 50 sites with the search words mangrove(s) and/or aquaculture, fish/shrimp culture. To our surprise, mangrove was not only a plant, it was a computer program, too. Mangrove Version 3.0 is hawked as ideal for building documents or managing complex information in networks like artificial intelligence systems or adventure games (www.mangroves.com). The difference is in the dot coms vis-a-vis the dot orgs. -- MTC]

Into the 3rd millenium

By **AS Frio**

Globalization is fast spreading in the region. It is likewise bringing in new implications on how research and development activities in the region will be refocused.

For its part, SEAFDEC/AQD opens the third millennium with a bold step to address regional issues and concerns of the aquaculture industry. Based on the recommendations of a recent review by an international consulting organization, SEAFDEC/AQD will re-orient its programs to highlight its regional character as a treaty organization of Southeast Asian countries.

Firstly, it is intensifying its efforts of collaboration with the Association of Southeast Asian Nations (ASEAN). Through the ASEAN framework, SEAFDEC/AQD hopes that more countries in the region can benefit from its generated technologies in aquaculture.

"We have to chart new paths for our technologies. We have to find ways to influence formulation of national development programs. We need to ensure that our technologies are integrated in the mainstream of national aquaculture development programs," stresses Dr. Rolando Platon, SEAFDEC/AQD Chief.

Dr. Platon laments the fact that while aquaculture is a fast growing industry and a large contributor of fish products in the world trade, nary a government program in the region has a strong aquaculture component. He adds that this is reflected in lack of adequate support for the aquaculture industry and inadequate budgets for research and development.

Dr. Platon believes that with a formal collaboration with ASEAN, more SEAFDEC/AQD technologies can be incorporated in the formulation of the ASEAN countries' national development programs. He explains that SEAFDEC/AQD will be working closely with the ASEAN Fisheries Working Group, the ASEAN member countries' institutional forum for fishery concerns in the region.

Dr. Platon continues: "We have actually an ongoing collaboration. Our technology verification program is now verifying some mangrove-friendly shrimp culture technologies in Vietnam. We started this verification program mainly in the Phil-



*Dr. Rolando Platon
Chief of SEAFDEC/AQD*

ippines and at this time, we feel we have enough experience to spread this effort in the region. We're starting with Vietnam and soon, we shall be doing the same in the other ASEAN countries."

Secondly, SEAFDEC/AQD will expand its collaboration with the aquaculture industry. Dr. Platon feels that while SEAFDEC/AQD has generated a vast amount of information on aquaculture, it seems that the private sector has not taken much advantage of this information.

A strategy that Dr. Platon suggests is the development of appropriately packaged programs that are geared to the problems of the industry. "We will collaborate more with the industry in developing R&D program packages. These packages will feature a relevant problem being addressed by a working inter-

disciplinary team of our scientists within a given time frame, of let's say 4-5 years. This way, results will be more relevant and can be applied immediately."

"In this connection," Dr. Platon adds, "we need to determine the impact of our training program. We need to follow up on our trainees. We must find out how they have used the knowledge they gained from this training and how they have influenced the industry in their respective countries."

SEAFDEC/AQD is also into the biotechnology area of research. Dr. Platon reports that SEAFDEC/AQD is now installing a biotechnology laboratory. "This is a complete laboratory that will enable us to go into the cutting edge of technology. We are preparing for this important area of research with staff development. We are sending some of our staff for advanced studies in biotechnology. We are utilizing advanced techniques in biotechnology research. This way, we can contribute to generating relevant information on diseases, feed development, and breeding."

As donor funds continue to dwindle, SEAFDEC/AQD plans to tap non-traditional sources of funds to augment its financial requirements. Dr. Platon explains that SEAFDEC/AQD will pursue cost-recovery measures that will boost its R&D funds.

Dr. Platon explains that SEAFDEC/AQD will go into income-generating activities that will boost its R&D funds. "Of course, we shall not go commercial in its true sense, since we are more in public service," Dr. Platon points out, "but we shall offer consulting services of our staff to sectors who are able and willing to pay. We can contract for research, training and information-dissemination projects that funding agencies like the Asian Development Bank usually commission to appropriate parties.

"We will also generate added funds through sale of our products of research, through our patents and royalties, through aquaculture textbooks, publications and videos."

With all these activities, Dr. Platon further envisions SEAFDEC/AQD as the center for aquaculture research, training and information-dissemination activities in the Southeast Asian region. Summing up, Dr. Platon expresses confidence, that "with our expertise in aquaculture, our experiences in the industry and a working within the ASEAN framework, I feel we should be able to comfortably achieve this goal in the not distant future." ###

versity, Montreal, Canada) and Dr. Heather Hall with teams based in Canada, the UK, the Philippines, Vietnam and Hongkong.

One component of the project is to develop small-scale seahorse aquaculture in Vietnam supported by culture information databases held in UK and Canada. Their Philippine project based in Handumon in northwestern Bohol island is moving towards village-based seahorse culturing. The project welcomes involvement and support of individuals and organizations that share their objectives.

Dr. Bull, meanwhile, discussed how Shedd aquarium is tackling the seahorse depopulation program from a different angle. With an annual visitors of 2 million, the Shedd aquarium has a good opportunity to educate people on conservation of seahorses. The aquarium also raises awareness on freshwater resources (Shedd is facing Lake Michigan) as well as tropical marine resources.

Shedd aquarium is also involved in the Handumon project by encouraging villagers in handicraft industry. The Shedd gift shop now stocks different products made by Handumon fishers and their families. Straw beach mats and handbags with seahorse motifs are big sellers.

According to Dr. Bull, researchers and representatives of major public aquariums from around the world have identified priority work areas for seahorses. Among these are: communication and data sharing; taxonomy and collection; identification; record keeping; tagging and marking; acquisition/de-accession guidelines; and evaluation of current techniques and alternative feeds and combinations.

For further inquiries, Dr. Hall can be reached at <heather.hall@zsl.org> and Dr. Bull at <cbull@shedd-aquarium.org>.

By AP Surtida



Dr. Nadala



Dr. Hall



Dr. Bull

Coordinating seahorse conservation efforts in zoos and aquaria

Dr. Heather Hall, curator of London Zoo and Project Seahorse co-founder, together with Dr. Collin Bull of Chicago's John G. Shedd Aquarium, were at AQD last June 30.

Dr. Hall explained what Project Seahorse is all about. It is an integrated program of conservation and management initiatives which was organized to ensure the long-term persistence of wild seahorses, their relatives and their habitats while still respecting human needs and aspirations. This collective of biologists and social workers was created in 1996 in response to increasing evidence of the large, global and destructive fishery for seahorses.

Project Seahorse is led by Dr. Amanda Vincent (McGill Uni-

Detection of infectious agents by dipstick assay

Dr. Elpidio Cesar Nadala Jr, who is from Barotac Nuevo, Iloilo, is a native Ilonggo. He earned his BS in Microbiology from the University of the Philippines at Los Baños and his MS and PhD Microbiology at the University of Hawaii. Dr. Nadala is presently connected with the Department of Haematology, University of Cambridge, United Kingdom. He gave his seminar at AQD on the "Use Dipstick Assay" on June 7.

The assay method has potential for use in aquaculture, particularly in diagnosing fish and shrimp diseases. According to

☞ page 14

People in aquaculture ... from page 13

Dr. Nadala, it was originally used in pregnancy tests because of convenience and almost instantaneous results. But over time, it became an ideal testing detection particularly for sexually transmitted diseases (STDs).

Dr. Nadala was previously involved in the surveillance study of the White Spot Syndrome Virus (WSSV) while he was

still at the University of Hawaii together with Dr. Philip Loh. The study was in collaboration with the National Institute of Biotechnology, University of the Philippines at Los Baños, the University of Tsukuba and the Bureau of Fisheries and Aquatic Resources (BFAR). - APS

AQD scientific publications ... from page 5

Spawning salinity or previous rearing salinity was 32 ppt, except for Z5 which were previously reared at 26 ppt. The mean median lethal time or LT50 values were compared between salinities. for Z1 and Z2, highest values were obtained at 20-32 ppt. Z3 had highest LT50 values at 20-24 ppt and Z4 at 24-32 ppt. For Z5, highest LT50 values were obtained at 20-32 ppt. Another batch of Z3 and Z4 were subjected to the same abrupt salinity transfers and reared to the megalopa stage. Significantly higher percentages of larvae metamorphosed to the megalopa stage at salinities of 20-28 ppt when transfer to test salinities was at Z3. When transfer was at Z4 or Z5, the highest percentage of larvae moulted to the megalopa stage at 24-28 ppt or at 28 ppt, respectively.

Quinitio ET, Parado-Esteva F, Alava V. 1999. Development of hatchery techniques for the mud crab *Scylla serrata* Forskal: Comparison of feeding scheme. In: Keenan CP, Blackshaw A (eds.) Mud Crab Aquaculture and Biology: Proceedings of an International Scientific Forum, 21-24 April 1997. Darwin, Australia. ACIA Proceedings no. 78; Canberra: Australian Center for International Agricultural Research. PP 125-130.

Abstract. *Scylla serrata* larvae were reared in 3 L plastic containers and fed various amounts of artificial diets (AD) with or without natural food (NF: *Brachionus rotundiformis* and newly-hatched *Artemia*). The amounts of AD fed alone to zoea in treatments (T) 1 to 4 were as follows: 1) 2.0 mg/L/day + 0.25 mg/L/day increment/substage; 2) 2.0 mg/L/day + 0.5 mg/L/day increment/ substage; 3) 4.0 mg/L/day + 0.5 mg/L/day increment/ substage; 4) 4.0 mg/L/day + 1.0 mg/L/day increment/substage. NF were given in addition to the respective amounts of artificial diet in T5, T6, T7 and T8. T9 served as the control (NF only). Based on three experimental runs, only larvae in T5, T6, and T9 survived until the megalopa stage. Thus, only these three treatments were compared in succeeding experiments using a commercial shrimp diet in 250 L fiberglass tanks. Of the three runs conducted using a commercial diet, two runs showed significant differences ($P < 0.05$) in survival. T5 gave higher survival (3.71% and 1.33%) than T9 (1.84% and 0.45%) and T6 (1.37% and 0.45%). Population development index did not differ among treatments in three runs.

Triño AT, Millamena OM, Keenan CP. 1999. Monosex culture of the mud crab (*Scylla serrata*) at three stocking densities with *Gracilaria* as crab shelter. In: Keenan CP, Blackshaw A (eds.) Mud Crab Aquaculture and Biology: Proceedings of an International Scientific Forum. 21-24 April 1997; Darwin, Australia. ACIAR Proceedings no. 78; Canberra: Australian Center for International Agricultural Research: pp 61-66.

Abstract. The effects of three levels of stocking density (0.5, 1.5 or 3.0/m²) and monosex culture (male or female) on the growth survival and production of *Scylla serrata* were investigated. Juvenile crabs were stocked in 150 m² enclosures in earthen ponds with *Gracilaria* as shelter and fed a mixed diet of 75% fresh brown mussel flesh and 25% fish by catch. There was no interaction between stocking density levels and monosex culture ($P < 0.05$) so the data were pooled for each sex or stocking density treatment. Results showed that highest survival was obtained from a stocking density of 0.5/m² ($P < 0.05$). Crab growth at different stocking densities was not significantly different ($P > 0.05$). Highest return or investment (ROI) and lowest production costs were attained from 0.5/m². Partial budgeting analysis showed that no net benefit accrued from stocking beyond 1.5/m². Male crabs attained significantly better ($P < 0.05$) final weight and specific growth rate than female crabs. Length, width, survival and production between male and female crabs were not significantly different ($P < 0.05$). Male and female monoculture gave high net revenue and ROI of more than 100 but male monoculture is more profitable. Overall the results suggest that the culture of male or female mud crabs at 0.5-1.5/m² with *Gracilaria* is economically viable.

Envi-friendly shrimp ... from page 8

were also finalized. Likewise the training component and the plans for the production of instructional materials.

The workshop sessions were moderated by Mr. Damrong Silpachai of the SEAFDEC Secretariat in Thailand and by Mr. Wilfredo Yap, an AQD consultant. The AQD Chief, Dr. Rolando Platon, summarized the workshop recommendations. ###

Exotic aquaculture



Cages that hold sargeant fish or cobia (left) in southern Philippines
PHOTOS COURTESY OF JD TOLEDO



Crocodile farming is both a business and a tool for environment education



A sea cucumber in its natural habitat in central Philippines

EXOTIC CAN MEAN TWO THINGS -- AN ORGANISM THAT IS NOT NATIVE TO A PLACE OR A CULTURE SYSTEM THAT IS STRIKINGLY UNUSUAL AND UNCOMMON.

WE TAKE THE SECOND DEFINITION IN THIS ISSUE, DISCUSSING THE AQUACULTURE OF BULLFROG, TURTLE, SEA CUCUMBER, CROCODILE, SARGEANT FISH OR COBIA, EEL, TUNA, AND POMPAÑO.

THESE SPECIES ARE NOT LISTED AS PRIORITY COMMODITY FOR R&D AT SEAFDEC WHICH COULD ONLY MEAN THAT THEIR CULTURE IS NOT WIDESPREAD IN SEAFDEC MEMBER-COUNTRIES.

BUT TO PIONEERING FISHFARMERS, THE PROFITS ARE HEALTHY ENOUGH TO WARRANT VENTURING ON THEIR OWN R&D. READ ABOUT THEIR EXPERIENCES.

Malaysian school engages in bullfrog and turtle farming

By NJ Dagoon

“Sepang Today Aquaculture Centre is a private aquafarming training school in Malaysia,” says owner and president Mr. Khoo Eng Wah.

The school offers courses on the culture of two exotic animal species: the American bullfrog and the soft-shelled turtle.

What follows is a brief description of the culture method for each, taken from the school’s training brochures.

American bullfrog

The American bullfrog is the second largest and heaviest of frogs. It may reach a



Brooder frog size is about 300-350 g. In the male adult bullfrog, the diameter of the eardrum membrane is bigger than that of the

length of 30 cm and weight of 1.5 kg. Originating from North America, it is known by its peculiar booming call, which can be heard half a mile away. Among edible frog species, it is the dominant one for human consumption.

Commercial culture of the American bullfrog *Rana catesbeiana* in Malaysia is thought to have begun in the early 1980s. With the use of Taiwanese techniques on feeding, stocking and disease prevention, bullfrog farming has become a profitable industry.

Seed production

Sex differentiation among adult bullfrogs is easy. Small size, brown skin with black stripes and a black or white throat distinguish females. Large size, light green skin and yellow-colored throat characterize males.

Mature adults are separately raised by sex at a density of 3-4 frogs per m² in 4 x 10 m pens filled with constantly flowing

water at a 10 cm depth. Live food such as fish, tadpoles, crickets, and earthworms are given.

Breeding pens with 10-cm deep flowing water and modified bottom (to enable about 25% to be kept dry when in operation) are used to spawn broodstock at a ratio of 1 male to 2 females. These makeshift ponds are typically shaded by water hyacinth (*Eichhornia crassipes*).

With no feeding at all, spawning occurs after 3-4 days in the early morning hours. A female can lay about 10,000 eggs in a jelly-like mass or more 8-10 times a year.

Eggs are transferred to 2 x 1 m hatching tanks. The 10 cm water depth and shade are maintained. Each hatching pool is provided with a continuous fine spray of water for aeration and current flow. The water temperature range is maintained at 27-29°C. Larvae hatch within 36-48 hours. Within 24 hours, feeding is begun, and tadpoles are transferred to nursery ponds.

A 1-m water depth is maintained in earthen tadpole ponds (size, 4 x 4 m). As in hatching tanks, a continuous fine spray of water and shading is provided.

Aeration is needed when dissolved oxygen is low. Hatchlings are stocked at a rate of 300-400 tadpoles per m². Food such as spinach, cereals, brine shrimp, fish meal, liver, wheat bran-minced fish mixture should be available at all times. During the first 3 weeks and before late metamorphosis (appearance of front legs), daily food consumption is about 20% and 7% body weight, respectively. Young frogs are collected as they emerge to seek cover.

Grow-out

Size range of grow out ponds is 10-100 m². The pond is partly shaded; at least half is exposed. Regular running water is maintained at a 2-10 cm depth, depending on frog size. A fine mesh (1-3 mm) fence with minimum height of 1.5 m encloses the pond. Ponds are stocked at a rate of 50 frogs/m² after metamorphosis.

Water that is clean, recirculated, tepid, and oxygenated is vital. Strict hygiene and sanitary control is maintained during all



Trainees at the school's bullfrog farming pond

About the School

Selang Today Aquaculture Centre started in 1996. The school is located about 30 km from the Kuala Lumpur International Airport. It is owned and managed by Mr. Khoo Eng Wah who has a biology degree from Nanyang University of Singapore and a postgraduate diploma in fisheries from the University of Singapore. He once attended the 1st *International Conference on the Culture of Penaeid Prawns and Shrimps* in Iloilo, Philippines in 1983. Mr. Khoo's work experience includes having been a biology and agriculture teacher for a private high school and manager of various fish farming projects (freshwater prawn, fishes, ducks, etc.). Since 1996-97, he has been operating a tiger prawn hatchery and grow-out farm, operating a school for training aquafarmers and investors and investing in turtle and bullfrog farming.

For the past 3-4 years of its existence, the school has trained hundreds of aquaculture farmers and investors from different parts of the world. Some of these, he mentioned come from Saudi Arabia, Seychelles, Brunei, Colombia,

China, Taiwan, Indonesia, and Malaysia.

Though Mr. Khoo himself serves as the main lecturer at his school, he has invited a lot of part-time lecturers from Malaysian universities and other private aquafarm operators to give lectures and share their experiences with the course participants.

The school's farming pond facilities include ten units of 2,000 m² pond for tiger prawn/banana prawn, one unit 2,000 m² pond for seabass, one unit 1,000 m² pond for sea red tilapia, one 100 m² tank for mud crab, and one 50m² tank for swimming

crab. There are also hatcheries for breeding of seabass, and tiger prawn/banana prawn/freshwater prawn (each can produce about 1.5 million fry per run). The school has a well equipped laboratory for the performance of different tests.

Course offerings for year 2000, Mr. Khoo reveals, are Tiger prawn/*Penaeus indicus* hatchery and grow-out farming (30 days), Freshwater prawn (*Macrobrachium rosenbergii*) hatchery and grow-out (30 days) and Seabass (*Lates calcarifer*) hatchery and grow-out (30 days). Each course is US\$1,950 inclusive of food (3 meals per day, refreshments), lecture notes, practical work in hatchery and grow-out, tutorials, farm visits, etc.

Home study is also available for different species of aquatic products at US\$200 per course.

The school also offers 10-day intensive grow-out farming courses on tiger prawn/*Penaeus indicus*, seabass, freshwater prawn at US\$1,000 per course inclusive of food and lodging, tuition, materials, farm visits, practical work, etc. The school can be contacted at the website: www.Todayaqua.com.
-- NJD

stages of culture. Care must be taken to prevent contamination by pathogenic organisms. Culture tanks should be washed daily.

To reduce cannibalism (which may occur at the rate of 10-30% during the first 60 days), frogs are graded by size. Frogs are fed about 3-5% of their body weight per day. Bullfrogs have a good feed conversion ratio (1:1). In about 4 months, a bullfrog can reach the slaughter weight of 250-300 g. The animals are hand-collected, placed in sacks, and transported to the processing area.

Marketing and processing

Mr. Khoo explains the cost of bullfrog production. Frog farm construction is very cheap, he notes, requiring a capital of about RM 100,000 (note US\$1 = RM 3.8). With that investment, a farm can produce about 15 tons a year. Ex-farm price per ton is RM??. Annual sale realized is RM 150,000. Profit is RM 45,000 (maximum range, RM 100,000-150,000).

In Malaysia, cost of bullfrog production is RM 6-8 per kg.

☞ next page

“Ex-farm price for live frog is RM 9-13. It is a profitable venture,” says Mr. Khoo.

Currently, the domestic market absorbs most of Malaysia’s annual frog meat production. Domestic prices are higher than those offered by exporters. While exporters want just legs, local restaurants buy the whole carcass.

Bullfrog meat has fine texture and pleasant taste. Low in fat (0.5%), it is rich in protein and provides a good balance of amino acids. These characteristics appeal to health-conscious consumers.

Dressed bullfrog (beheaded, skinned, gutted, and digital extremities cut off) weighs 70% of its live weight. Legs account for 60% of dressed carcass weight.

Processing of frogs is similar to that of poultry. The final product is packed in polythene bags, individually quick-frozen and stored in a cold room at -23°C .

Various useful by-products can be obtained from frog processing. Tanned frog skin yields leather. Fat reserves in the frog’s abdominal cavity are processed into cosmetic oil. Dried and ground offal from frog processing may be used in the manufacture of frog feed.

Future potential

Bullfrog meat has a great potential in the local and international market, since it is a popular traditional gourmet food among Asian and European communities.

Frog culture also helps frog conservation as it minimizes uncontrolled collection of frogs from the wild. Frogs bred in captivity can be used to replenish depleted populations.

Soft-shelled turtle

People in China and Japan traditionally favor the soft-shelled turtle (*Trionyx sinensis* Weigmann) as a highly esteemed delicacy with nutritional and medicinal values.

There are only two well-established hatcheries and a few small scale grow-out farms operating in Peninsular Malaysia. These farms are located at Rawang, Mantin, Gemetar, Pagoh and Kota Tinggi.

Seed production

Soft-shelled turtle males and females take one year to reach maturity. One male or female adult is about 1 kg. One female can lay 10-20 eggs per batch and about 60-80 eggs per year. The eggs hatch out into baby turtles and each seedling weighs about 5 g. Farmers buy the seedling at this stage at about US\$1 per piece.

According to Mr. Khoo, the price per seedling has fallen to about US\$0.1 since 1999, because China is currently imposing a ban on the import of seedlings from ASEAN countries. The market price fell from US\$10 per kg to US\$4 per kg. Before the ban of imports to China, there were about 200 farmers in Malaysia, with most growing 50,000-500,000 seedlings.



PHOTO COURTESY OF KHOO ENG WAH

Breeding pond for turtles, note egg laying site on foreground

While maintaining their grow-out ponds, two Malaysian commercial hatcheries produce soft-shelled turtle seed for the industry. Broodstock are kept in ponds with vertical concrete embankments and sandy bottoms. These prevent turtles from escaping, and provide substrates that reduce chances of cannibalism and enhance growth of hatchlings. Floating wooden planks, besides being basking areas for turtles, also prevent algal or fungal growth. Size of turtles determines water level and substrate depth.

Spawners are selected from fast-growing and good quality 2- to 3-year-old adults. They are stocked at a sex-ratio of 1:3-4 (male: female). In tropical countries, eggs are laid all-year-round with a short inter-nesting period. Spawning normally takes place at night. Female selects a nesting site; digs a 15-20 cm diameter hole with a depth of 8-12 cm; and then lays eggs in it before covering it up. Number of eggs per clutch is about 10-15, depending on spawner size.

Spawning and grower pond area varies at 200-1000 m². Each spawning pond has an egg-laying site, a 1.5-2.5 m² rectangular platform that contains 15-25 cm deep sand. Each site has wooden walkways extending into the water. The roof is made of galvanized iron sheets raised 1-1.2 m above floor level.

Egg-laying sites are checked every morning for signs of nesting. If there are signs, the eggs are dug out. When transferring to plastic containers, eggs must be handled with care. Eggs are kept in wooden boxes for 1-2 days before fertilized eggs (those with small “white caps”) are selected.

Fertilized eggs are then transferred to sand beds in the hatchery for incubation. Eggs are arranged in rows with the “white cap” facing upward, spaced at a distance of 1-2 cm apart, and buried under a 5 cm layer of sand.



Turtle eggs



Just hatched baby turtles



Turtle adults readied for the market

Fencing the incubation site guard against predators and pests such as ants, rats and snakes. This site must be sheltered from direct sunlight and rain.

Humidity of sand beds must be closely monitored, as sand beds that are too wet or dry damage fertilized eggs. Under normal conditions (25-30°C), hatching takes place in 45-60 days. A small basin of water is placed at the corner of the incubation bed. Newly hatched turtles will come out from the sand and crawl to the basin.

Newly hatched turtles are removed daily from the basin in the incubation site and transferred to the nursery tank. One hatchery setup uses concrete tanks with fine sand substrate and good water quality; the other nurses hatchlings in covered netcages suspended in a small river or pond. Depth of water is adjusted according to the level desired.

Hatchlings are fed with high quality food such as commercial feed, bloodworm, fresh trash fish or poor grade chicks. Growth rate of hatchlings is dependent on quality of feed, stocking density and water quality. To reduce cannibalism and improve the growth rate of smaller hatchlings, segregation must be carried out when size differences become apparent. Hatchlings are nursed up to about 10-12 cm in carapace length before being transferred into grow-out ponds.

Grow-out

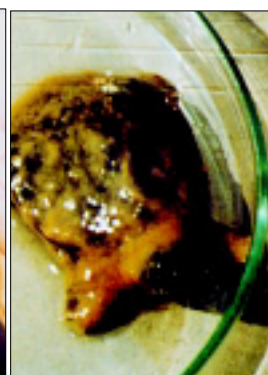
Grow-out ponds, vertical concrete embankments with sandy bottoms, vary from 200 to 1000 m². Depth of water range is 50-70 cm with freeboard allowance of 30 cm to prevent turtles from escaping.

Pond preparation is an important aspect of management. Before stocking, ponds are prepared by drying the bottom. Lime is added to disinfect and improve the soil condition. Algae and aquatic weeds are removed because they may prevent turtles from coming up to breathe. Pond bottoms are cleaned to prevent anaerobiosis.

Water quality is determined by observing color of water as well as activity and behavior of turtles. Phytoplankton blooms are controlled at about 15-30 cm secchi disk visibility. Water quality is maintained by water exchange. Water parameters to be

☞ page 29

From left to right: turtle with head ulcer disease, shell ulcer disease, deformed shell; and a baby turtle covered by the protozoa Zoothamnium



A glimpse into some sea cucumbers in Panay, Philippines

By **MB Surtida** and **RY Buendia**

Except for coastal dwellers, most Filipinos do not know what sea cucumbers (*Beche de Mer*, *Trepang*) are and how they look. Most must have dined on them at some time especially those affluent enough to dine out but were not aware of it. Its popular name *balat* is known only to traders and gatherers. This story attempts to give an idea of what sea cucumbers are, how they look, processed, and perhaps cultured. The culture aspect has been gathered from other countries because the Philippines does not culture it.

Sea cucumbers

Sea cucumbers are sea animals belonging to the families Holothuridae and Stichopodidae. They have worldwide distribution and found in large numbers in the Indo-west Pacific region. It is known to reach a maximum length of 400 mm and weight in live condition 500 g. It prefers sandy-muddy substratum and is often buried with the posterior end always above the surface of mud. It is known to prefer slightly less saline areas; smaller kinds are found near the shore. As they grow, they migrate to deeper waters for breeding. It breeds twice a year.



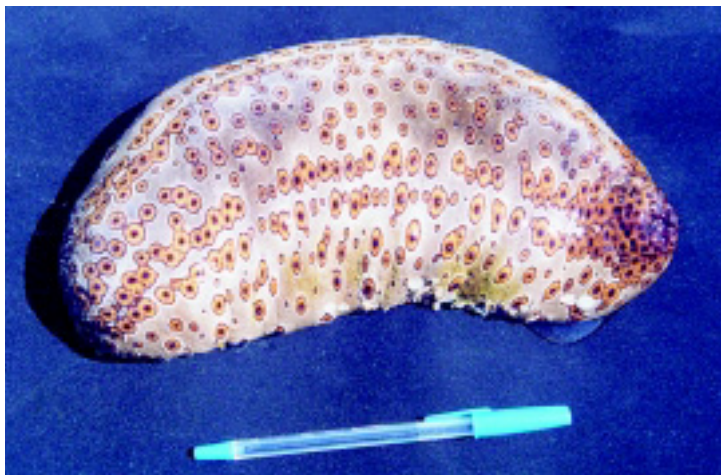
Sea cucumbers are gathered, partially processed, and traded in this town in Pandan, Antique in Panay Island. However, decreasing wild supply most likely due to

Sea cucumbers have been considered as delicacies for the past thousand years especially in Asia. In some countries, its industry is considered ancient, mainly originating from China.

Despite this history little is known about its science. Perhaps scientific studies in some countries have not been considered important because wild catch was plentiful and threats to its supply never occurred. The industry has flourished.

Today, widespread trading occurs in Hong Kong and Singapore, the two major export centers of sea cucumber in the world. Dried sea cucumbers are processed and reexported to the USA, Canada, Europe, Taiwan, Republic of Korea, China, Australia, Malaysia, Thailand, and others. In 1996, Philippine export of sea cucumbers was P125 million. Total export in 1958 was 5 tons, then jumped to 1,389 tons in 1996.

But the Asian economic crisis in 1997 drastically affected the catering business and demand for sea cucumbers decreased. This may as well be, as this decrease would take off the pressure on sea cucumber resources for a while, being now in danger of depletion in many producing countries.



Two kinds of sea cucumber gathered in Pandan; their exact scientific names are not yet known



Sea cucumbers occur in many coastal places in the Philippines. In Pandan, Antique, west central Philippines, Nonio Antang, a local legislative member, traded dried sea cucumbers from 1988-1991. "Then," he said, "I sold 2-3 tons of dried sea cucumber per week during hot, summer days. I had several gatherers as sea cucumbers have been plentiful around here."

Mr. Antang mentioned eleven kinds that he encountered and traded, all of them edible. He said he didn't know of inedible ones because those caught around his home place were all edible.

He processed and dried what he sold. According to him, one must know the intricacies of drying or else all fresh stock would go to waste. He knew of several neighbors who attempted to dry them for business but failed because of faulty processing. He said that sea cucumbers are first boiled to its exact time (he said the duration is a secret), buried in the sand (shoreline) for a while to hasten decomposition of the thick outer membrane that causes a strong fishy smell, and dried in the hot sun for 1-2 hours. By then, he said, the sea cucumbers are as hard as a rock and ready to be sold to Chinese traders. He stopped trading and processing after 1991 because the traders did not pay him well, he said. He learned that the traders sold his sea cucumbers to the international market so much more than what they were paying him. "Today," he said, "the most expensive kinds sell for almost P1,000 per kilo while the cheapest sell for P300 per kilo."

Culture of sea cucumbers

In the Philippines, sea cucumbers have never been cultured, although it is one of the sources of dried sea cucumbers in the international market. Although the commodity is market driven, wild supply apparently has been sufficient for trading.

In countries like China and Japan, sea cucumbers are not cultured to marketable size. When length of 20-30 mm are reached in the hatchery, they are stocked in natural suitable areas for further growth and enriching of the natural populations. This is so because sea cucumbers grow slowly and maintaining them in closed conditions can be expensive.

In India, grow out culture is carried out in net boxes or tanks fixed with poles driven in 1 m depth in suitable areas. Tank culture is described, thus: An old one-ton tank is fixed at the bottom of the sea at 1.5 m depth. A rectangular frame, slightly larger than the box is fixed at the sea bottom and the tank slipped into the frame. One fourth of the tank is first filled with fine sand taken from the sea cucumber's natural habitat. The sand must be free from unwanted predators such as crabs. Fresh algae from the sea is dried, pulverized, and mixed with fine sand and transferred to the tank. The algal powder helps in the growth of the juveniles. The tank is covered by a fine mesh net to prevent entry of unwanted organisms. Sea cucumbers have been found to grow better in tanks than in cages and mortality lesser.

Successful grow-out culture is dependent on an efficient hatchery and nursery system. Breeders are carefully selected from the caught batch. They are stocked at 2-30 adults per tank). Only



Nonio Antang attests to the sea cucumber's lucrative market. He says traders dictate the price but gatherers and processors are measly paid

the best are chosen during the spawning season (March to May and October to December) since most of the specimens would be ripe and ready to release eggs. A

small rise in temperature is enough to induce them to spawn. At present, there is no known method to hasten the maturation process. Temperature stimulation is carried out by heating sea water with an immersion rod and hot water is carefully mixed with normal sea water to get the desired temperature. A rise of 3-5°C is enough to induce them to spawn. This is a widely used technique.

The larvae are fed the microalga *Isochrysis galbana*, and after 4-5 days, *Chaetoceros* sp. is mixed with the microalga. The quantity of the diet should be increased or decreased depending on the quantity of food in the stomach of the larvae. This can be visually checked before feeding them.

Temperature for rearing of the larvae should be 27-29°C. Temperature of the water must be checked twice during the day, morning and evening. Normal range of dissolved oxygen is 5-6 ppm. Aeration should be provided; one ton tank needs two aerators. Ideally, pH should be 7.5 to 8.6 but 6 to 9 can be tolerated; for salinity, 26- 33 ppt.

Sea cucumber larvae must be protected from predators like copepods and ciliates. They attack the larvae at the sides and injure them. These predators can be controlled by chemicals containing organophosphorus. The solution should be evenly sprinkled into tanks and the water of the tank must be completely changed after 2 hours, otherwise the juveniles would be affected.

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Crocodile farming: a multi-million dollar industry

By RIY Adan

Crocodiles in the Filipino culture symbolize corrupt government officials, but this image is fast vanishing with the economic potential that crocodiles offer.

Crocodiles are among the oldest creatures on earth, having survived for more than 200 million years. It is the last remaining member of the dinosaur family, and has not changed biologically through the years. Crocodiles have a long breeding life, which ranges from 25-30 years and a life span of almost 100 years.

There are 27 species and subspecies of crocodiles throughout the world. Eighteen of these are in danger of extinction and the rest are threatened with declining population due to overhunting and habitat destruction. Two known crocodile species in the Philippines exists, the *Crocodylus mindorensis* (freshwater crocodile), also known as the Philippine crocodile, and *Crocodylus porosus* (saltwater crocodile).

C. mindorensis is endemic in the Philippines. They are dwarf species, usually less than two meters in length, although rare individuals may reach nearly three meters and weigh less than 100 kg. They live in freshwater lakes, rivers, and marshes, where they feed on fish, water birds, lizards, and snakes. Babies prey on insects, small fishes, and frogs.

In contrast, the *C. porosus* that live in brackish and salt waters in the Philippines and elsewhere from Asia to Australia typically reached 4-5 meters in length and weighs over 1000 kg. They feed on large fishes and turtles. They are also the largest reptiles on earth, and among the most dangerous.

The crocodile's nature has always inspired reverence and fear in man. Crocodiles can attack at any time of the year, but they are more active in the warmer months and when in search of mates. Large males will assert their dominance by jealously par-



Skeleton of a 5.3 meter long crocodile and its hide will meet visitors in the CFI

trolling their stretch of territory. Savage supremacy battles rage, often leaving the vanquished dead or seriously injured.

The female crocodile is ready to breed when it is about 7 years old. After a long and often noisy courtship, the female builds a large, deep nest of layered soil and vegetation, which is heated by decomposing plants. There, she lays her eggs. Saltwater crocodile lays about 50-70 eggs while the freshwater crocodile lays about 30-40 eggs within a year.

Although feared in

nearly every place they live, crocodiles are among the best of parents. The female crocodile tends the eggs carefully for 18 hours daily for the next three months, adding, removing, and shifting soil and vegetation to maintain just the right amount of temperature for her offspring. As hatching time approaches, she becomes increasingly aggressive, chasing away other crocodiles and any potential predators. The mother stands guard until the sound of peeping rouses her to dig out the 1 foot-long hatchlings and carry them gently in a pouch of skin stretched over her lower jaw to a crèche at a water's edge. Unfortunately, only about 1% of all baby crocodiles make it to adulthood. Thousands drown during flooding or are picked off by fishes and even by larger crocs.

Killing adult crocodiles, as is being done now, also drastically reduces the potential population. Moreover, toxic wastes from mines, destruction of marshes and riverine habitats, and the conversion of their natural habitats for fishponds additionally threaten their populations. Estimates have it that there are only about 100 Philippine crocodiles in the wild now.

Crocodile Farming Institute

To save the crocodiles from extinction in the country, the Crocodile Farming Institute (CFI) was established in August 20, 1987

The Samutprakan Crocodile Farm and Zoo in Thailand is the world's largest croc farm with over 60,000 crocs (right and below); ladies' bags and accessories made of crocodile skin (far right)



FROM THE INFO BROCHURE OF THE SAMUTPRAKAN CROCODILE FARM AND ZOO

at Barangay Irawan, Puerto Princesa City, Palawan. It started as a joint project of the governments of Philippines and Japan through the Department of Environment and Natural Resources (DENR) and the Japan International Co-operation Agency (JICA). In 1995, JICA funding ended and since then, the Philippine government solely manage and fund CFI through the Protected Areas Wildlife Bureau (PAWB) and the Palawan Provincial Environment and Natural Resources Office (PENRO). CFI is now one of the components of the Palawan Wildlife and Conservation Center. It aims to conserve the two endangered species of crocodiles in the Philippines, and to develop and introduce a suitable crocodile farming technology that will help uplift the socio-economic well-being of the Filipino people.

Captive breeding of both species is one of the strategies employed by CFI to fulfill its mandate of conserving the endangered crocodiles. They use artificial insemination and artificial incubation, which is easier and more efficient than depending on the crocodiles to mate and incubate their eggs naturally. Aside from the crocodile breeding and rearing activities, they also conduct ecological and biological studies, nutritional and biochemical studies and physiological and pathological studies. Moreover, CFI has entered into rearing agreement with private firms in the country to breed and propagate crocodiles. This move was spurred by the successful breeding of around 5,600 crocodiles out of the 79 heads CFI has bred since its establishment.

Several things are required before one becomes a cooperator of CFI. First, of course, is funding to start up a crocodile farm. The farmer must also undergo CFI training on safe and profitable crocodile cultivation and submit a barangay clearance certificate of community acceptance. The potential farm must also

have an abundant supply of food and water. There are six co-operators farming crocodiles in the country now. They buy the hatchlings from CFI and CFI monitors and give technical assistance to them.

CFI believes in the potential of commercial utilization of crocodiles as dollar-generating industry for the country. Crocodile farming is a very profitable business and could be a multi-million dollar industry.

Economic potentials

Some Filipino entrepreneurs found out a few years ago that there is money in crocodiles. Every bit and piece of this reptile is useful with nothing thrown to waste. Crocodiles are commercially viable once they reached 1.5 to 2 meters in size.

The economics of farming crocodiles actually depends on: (1) the ability to raise a large percentage of stock to harvest size in no more than three years; (2) availability of a cheap food source; (3) high leather prices; (4) maximizing tourist (gate toll); (5) the sale of by-products; and (6) continued research to refine husbandry techniques.

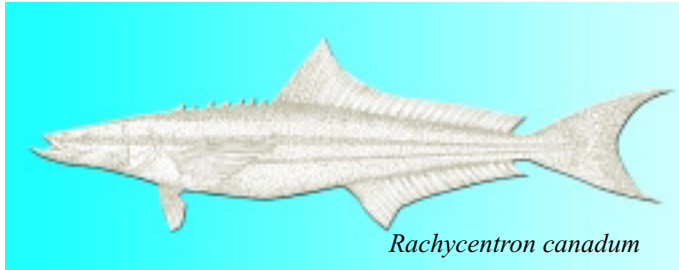
Crocodile's skin is prominently rare and expensive when converted to shoes, handbags, belts, wallets, jackets and other leather crafts. A bag made from crocodile skin is worth US\$5,000 in a boutique in New York. Skin prices are variable and range from US\$10-12 per inch belly width in the producing country. The highest prices are paid for species with relatively small scutes,



LIVE CROC PHOTOS BY I TENDECIA

The sargeant fish and the eel

By AP Surtida



Sargeant fish or cobia

Locally known as *kume*, *dalag-dagat*, *gile* or *pandawan* (Rau and Rau 1980), the sargeant fish or cobia (*Rachycentron canadum*) is one species that possesses desirable characteristics for fish farming. Cobia is recognized as a fine food fish.

The cobia has a worldwide distribution in tropical and subtropical areas and is found seasonally in temperate waters. Within this geographic range, cobia encounters both marine and estuarine environments and is therefore able to tolerate a wide range of environmental conditions.

Cobia favors crustaceans for food, but will feed on other invertebrates and fishes as well. Hassler and Rainville (1975) said that cobia grows fast, up to 67 lbs in the first 7 years of its life. It attains a maximum size of over 60 kg. Sexual maturity is attained by male cobia at about 52 cm fork length in its second year and by female at about 70 cm in its third year. Fecundity for females 100-125 cm fork length varies from 1.9 to 5.4 million eggs.

A well-established, commercial market has been hindered by the small and unpredictable nature of the catch. Cobia is caught incidentally by commercial hook-and-line and net fishers, and by sport fishers as well. In the US, which ranks behind Pakistan, Mexico and the Philippines in commercial production of cobia, recreational landings exceed commercial landings by more than ten fold (Shaffer and Nakamura 1989).

In Singapore, cobia is known as black king fish, *hai wei* (in Fokkien) or *aruan tasik* (in Malay). Singapore has started the culture of cobia with fry imported from Taipei in 1996 (Lim et al. 1999).

Recently in the Philippines, the Chung Chen Development Corp (CCDC), a joint venture of Taiwanese and Filipino investors, started farming cobia (Fish Farming International 1998). The fish cage farm is situated in Barangay Lago, Sarangani Province in southern Philippines.

According to Charlie Ng, Operations manager of CCDC, the project was set-up in 1997. He admits that the project is really a gamble considering that sargeant fish has yet to find a solid

market in Asia. However, Ng is optimistic that in time, Taiwan and its neighboring countries -- where sargeant fish is served as sashimi and is considered a close competitor of the popular yellowfin tuna sashimi -- will soon acquire a taste for sargeant fish.

In General Santos City in southern Philippines, cobia sells for up to US\$10/kg whole and as much as US\$15/kg if packed as fillets. CCDC is also trying to penetrate other markets by introducing the fish to consumers in Japan, the US and Singapore.

The fish is grown in cages about 500 meters offshore. Starting with 10 cm fingerlings from Taiwan -- the main distributor of the fish -- CCDC grows them to more than 5 kg in six months. Each 216 m³ cage can accommodate 250 fish. So far, the biggest specimen that Ng has produced was about 40 kg.

Ng says his company spends more than P30,000 (US\$750) a day to feed 2000 fish currently growing in eight cages. They are voracious eaters and can consume about 1.5 tons of feed daily. Feed comprises raw reef fish, chopped and distributed at carefully monitored intervals.

According to Ng, the current demand requires the fish to weigh 5-10 kg. With their present stocking, their fish are not crowded in their cages. Faster growing fish are transferred to cages with other larger fish, so the smaller ones would get their equal share of feed.

Ng spends most of his time monitoring growth and tracking signs of disease by monitoring fish skin, behavior, and feeding patterns.

The company has high hopes for a major success. The biggest edge in the market is the fish itself. It has a distinct taste that would surely attract large consumers like Japan and the US, says Ng. With a creamy white flesh, connoisseurs say it tastes like blue marlin but has the smoother texture of tuna.

The breeding of sargeant fish is one of the many projects the CCDC is planning. With spawning technology, it would give the company control over the quality of the fingerlings and also would lessen operating costs, removing the need to import fingerlings.

The company also would like to expand into other high-value species such as groupers and lobsters in a couple of years time, according to Ng.

For inquiries about sargeant fish cage culture contact: Charlie Ng, Chung Chem Development Corp, at fax 552 3168.

Eel culture

All cultured eels belong to the genus *Anguilla*. These snake-like fishes have very small scales and their skin is rich in mucous



The eel (above) is grown in hapa nets inside a small concrete pond in southern Philippines (left)

Glass eel or elvers are stocked in a concrete tank with a glass front to better monitor fish condition

glands. The eel habitat includes: marine and coastal waters, brackishwaters (estuaries, lagoons, mangroves), and inland waters (rivers, streams, lakes and marshes). For most of their lives (3-12 to 15 years), eels are mainly sedentary though they migrate from time to time (Brusle 1990)

Eels are extremely carnivorous. They feed on crustaceans, insect larvae, polychaetes, gastropods and small fishes.

Their color varies (yellowish, brownish, greenish, blackish or silver) depending on age and their environment. Male eels generally measure 20-40 cm; females are longer, they can exceed 50 cm and may reach 150 cm!

Nineteen species are recognized, but only three are cultured: the European eel (*Anguilla anguilla*), the Japanese eel (*A. japonica*) and the American eel (*A. rostrata*). The main eel-eating areas are Europe and the Far East. The main catches of eels are in Europe, North America, the Far East, Australia and New Zealand.

Eel meat generally ends up as *kabayaki*, the Japanese style of marinated roasting; smoked, mainly done in continental Europe; and jellied and stewed, the London method (Usui 1991).

An unusual feature of the eel is that it is exploited at almost all stages of development. Still, it has proved impossible to breed eels in captivity, although attempts have been made. So far, development relies on a steady and adequate source of elvers.

In Asia, the major players are: Japan which started eel culture in 1894, China, Taiwan, Korea, Australia and New Zealand. According to Juan Torres (*Fish Farming International*, June



1997), managing director of Valencia De Acuicultura, Spain's biggest producers of eels, the top producers in Europe are: Italy, Holland, Denmark and Germany. In 1995, Mr. Torres said, Europe's total production was 7,720 tons. In Asia, Mr. Torres added, Japan catches an average of 35,000 tons of elvers a year, 10,000 tons come from Korea and Taiwan, and 50-55,000 tons from China. Still, this volume is not enough to supply the farms serving the huge Japanese market.

Mr. Torres estimated that European glass eels being caught is between 30-50 tons a year and the bulk winds up in the Far East, particularly, China. Japan is said to import over 72,000 tons of live and processed eels mainly from China (over 49,000 tons)

Tuna markets and farming: Japan and Australia

By E Gasataya

As a result of changing market needs, tunas have assumed a position of major importance in commercial fisheries throughout the world. From 1977 to 1994, Japan was the overall top importer, getting 30% of the total world imports by value. Japan is also the top importer, and the single largest market, of fresh or chilled and frozen tunas. In 1994, almost US\$2,000 million was spent in tuna imports (Hassan 1997).

Tuna: important species

Tuna is one of 13 species of fish that belong to the tribe Thunnini within the family Scombridae. The commercially important tuna species are the following:

| Common name | Scientific name | Size | Weight |
|------------------|---------------------------|------------|-----------|
| Yellowfin | <i>Thunnus albacares</i> | 160-200cm | 40-130 kg |
| Bigeye | <i>Thunnus obesus</i> | 90-180 cm | 20-80 kg |
| Bluefin | | | |
| Northern bluefin | <i>Thunnus thynnus</i> | 160-200 cm | 40-130 kg |
| Southern bluefin | <i>Thunnus maccoyii</i> | 160-200 cm | 40-130 kg |
| Skipjack | <i>Katsuwonus pelamis</i> | 48-80 cm | 3-6 kg |
| Albacore | <i>Thunnus alalunga</i> | 40-90 cm | 4-15 kg |

Source: ADB/INFOFISH. 1991 Global Industry Update: Tuna

Tuna size is important in the Japanese market because only larger fish have the deep color and high fat content desired for a good *sashimi* and *sushi*. Yellowfin and bigeye tunas have specific minimum market sizes -- 25-30 and 30-40 kg, respectively. Prices vary greatly and depend on many factors including supply and demand, amount of *sashimi* fish held in reserve, amount and type of arriving tuna, season and time of year, and quality of the fish.

Tuna products

Sashimi and *sushi* are Japan's major tuna products. *Sashimi* is more than "raw seafood" since it denotes an eating experience, which includes appearance, freshness, presentation, texture and flavor. *Sashimi* is popular during the summer months (June and July). Fishes with red meat, especially tuna and bonito, are commonly used for *sashimi*.

Sashimi is usually uncooked, chilled at 12°C, and served thinly sliced with shredded Japanese radish (*daikon*), a small amount of pungent green paste made from horseradish (*wasabi*), and soy sauce (*shoyu*). It is a popular treat for special occasions like New Year, public holidays, and other festivals.

Sushi is another delicacy made from raw seafood. *Sushi* means snack made with rice (*sushi-meshi*) seasoned with vinegar and salt, and sugar. There are many types of *sushi* depend-

ing on the way they are made. There are *makizushi* (raw seafood or pickled vegetable rolled up in a cylinder of rice, wrapped in a dark-green seaweed); *nigiri-zushi* (a ball of rice with a topping of raw seafood); *chirashi-zushi* (raw seafood, rice, and vegetables tossed together); and *chakin-zushi* (raw seafood wrapped in omelette and tied with a thin strip of seaweed).

Sushi is usually served as a complete meal at the counter in restaurants (*sushi-ya*), and often comprises a "set" of different kinds of *sushi* (such as *nigiri-zushi* and *maki-zushi*) served with green tea, grated ginger, and a "special" soy sauce made of closely-guarded recipe.

The main tuna species used for these products are the northern bluefin, southern bluefin, bigeye, and yellowfin. The preference of this species varies from area to area. In Tokyo for example, the bluefins are generally considered superior to bigeye and yellowfin while Osaka and Nagoya prefers yellowfin.

Other than *sashimi* and *sushi*, a new, processed product called "Negitoro" has been developed. This is bigeye or yellowfin tuna meat pasted with vegetable oil. Other products are the "Toro-Katsuo" (*Toro*-skipjack) and "Toro-Bin" (*Toro*-albacore); these are new names for fatty skipjack and albacore that used to be eaten only at certain localities in Japan. The above three are good examples of marketing success.

The tuna market is expanding. This is attributed to countries like Taiwan and China that have large numbers of fishing vessels and that have changed their operations to land fresh tuna. In addition, the distribution, transportation and retail sectors have become more efficient, playing a central role in selling huge quantities of fresh tuna in retail and as bargain or brand products. Katsuo (1995) also noted that the Japanese market has become diversified and segmented. Because of this, imports of low-priced tuna products would increase.

Although most of the tuna is landed by commercial fisheries (nearly 300,000 tons in 1994), aquaculture has started in Australia and Japan with some success.

Tuna farming in Australia

One of the most successful companies in tuna farming in 1996 was MG Kailis, one of Australia's largest and most diversified fishing company. The company is well known for its involvement in the pearl industry in western Australia.

MG Kailis established the tuna farm off Boston Bay. The 30 ha site is situated in more than 20 m deep water. The company started with two pens -- both second hand, 40 m in diameter, double-ring Polar-Cirkel design. The next season, another pen was ordered, this time a single ring design. The pens were used for both towing and grow-out culture. The company wanted the

The pompano



By **MB Surtida**

The pompano *Trachinotus blochii* is a high-value fish by virtue of its tasty meat and appealing appearance. Fry production was started in 1989 in Taiwan. Since then, culture of pompano has been carried out continuously and profitably not only in Taiwan but in China and Singapore too. In the Philippines, the culture of pompano is not popular. Although literature points to the usual aquaculture management, no commercial operation is known, except for one corporation that has recently started to test its market after producing several crops for export with fry imported from Taiwan. This is not surprising because catch from the wild finds its way to the domestic market, thus its culture and market potential is virtually unexplored. Besides, its availability in the local market for everyday use does not yet label pompano as exclusively high-value as in other countries. This makes pompano culture a lucrative possibility especially when export is considered.

The following culture method is described from literature based in Taiwan as actual culture in the Philippines is not documented.

Pompano is highly valued in Hong Kong, Singapore, and Taiwan. It is abundant in the Philippines from wild catch. Hatchery and growout methods have now been developed in Singapore and Taiwan because of the high demand in Asian markets. In Philippine markets, it sells for more than P120 per kg

In 20-30 days, fry attains a total body length 2.5 cm that can be stocked in grow-out ponds, and in 7-12 months, attain market size of 400-600 g. Fry produced during summer are stocked directly into ponds but those produced in winter are stocked in the nursery for overwintering. After hatchery stage, grading is done to avoid growth disparity and cannibalistic behavior. Custom-sized sinking dry pellets are fed throughout the culture period because the pompano's pharynx is small and its feeding behavior is voracious. Although chopped trash fish can be given, it has been found that it causes increased growth difference among individual fish. Feeds can be made available to the fish by an automatic feeder one hour in the morning and one hour before sunset. Feed conversion ratio is 1.6-2.0:1.

Stocking density is 2-3 fish per m² and production is 10-15 tons per ha per crop. Pompano is euryhaline and may be cultured in salinities of 3-33 ppt. Fish grow fast in salinities below 20 ppt and poorly in full seawater. Pompano are not tolerant of low temperature. Minimum water temperature for survival is 14°C and when temperature drops for 2 days, mortality occurs.

The tiger shrimp *Penaeus monodon* has been found to be an effective water quality stabilizer in pompano ponds. Pompano ponds can be stocked with 60,000 tiger shrimp per ha because leftover feeds can be efficiently consumed, harvested with a trap net and becomes an additional aquaculture product 3-4 months after stocking.

(From a conference proceedings; 8-12 Aug 1994; Honolulu)

pens in a standard size to allow easy management.

The Badinotti mesh netting is used as culture and predator control nets, and has 22 cm mesh size. The nets are changed from black to white every year. The net is hung from the ring and can reach up to 17-18 m deep at its center.

The tuna are fed 25 kg blocks of frozen feed in the morning and fresh feed in the afternoon. Grow-out culture is 4-6 months.

The preferred market size is in excess of 30 kg with a fat score of at least 25%. The fish are taken by handlines and killed using a wire threaded up to the spinal column to destroy the nerves ("reaming"). Tuna are then gutted, and placed in an ice bath.

About 200 fish are harvested each day. Tuna are transported to the packaging facility, where they are packed in fresh ice. To

maintain a low core temperature, bags of ice are also put into the gill cavity and the gut. Then, they are placed in polystyrene boxes, sealed, labeled and trucked for an air freight to Japan.

MG Kailis attributed their success to the support of local residents.

Tuna mariculture in Japan

In Japan, two companies -- Maruha and Nihon Haigo Shiryou -- have succeeded in spawning and hatching the tuna in captivity. Maruha has started their breeding experiments since 1986, and they succeeded in June 1991. More than 3.5 million eggs were obtained in 1992. They also succeeded in rearing tuna eggs for

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Crocodile farming . . . from page 23

such as salt-water crocodiles. With the influx of wild skins diminishing due to depleted numbers and protective legislation, the market for farmed skins is expected to be relatively strong in the future.

Japan and France purchase approximately 80% of the crocodilian skins marketed annually. The rest are purchased by Singapore, USA, West Germany and United Kingdom (listed in descending order). France dominates the African and American market while Japan predominates in Southeast Asia. Philippines, on the other hand, has long been exporting reptile and aquatic animal skins mostly to Japan.

Processed crocodile meat is a delicacy in some countries. In the United States, people are eating dishes like cojambalaya, 'gator steak, and croco-spiced Cajun. Crocodile meat tastes like chicken meat if properly cooked. Its meat is tender, juicy and deliciously good even if it's 18 or 80 years old. Its meat is also good for people with Asthma, according to some Chinese traditions. Soup made from the reptile's penis is believed to be an aphrodisiac. The meat can also be canned for export to Hong Kong, Japan and other Asian and European countries. Crocodile meat pegs at \$20 per kilo in the international market.

Oil derived from its flesh also has a big market abroad. The teeth, head and bones of crocodile are turned into jewelry, unique souvenir items or decorative products. The bones can also be processed into animal feed.

The international trade in crocodiles and crocodile products is controlled by the IUCN (International Union for the Conservation of Nature) through CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna). The IUCN encourages sustainable use of crocodiles for skins and meat production as it is a legitimate conservation tool provided the use is sustainable and it creates commercial or other incentives to con-

serve both the crocodiles and the wetland habitats they occupy.

Tourism is another aspect of this reptile's marketing. Crocodilians are interesting animals and many farms are open to the general public who pay to view these "ferocious" animals and their tiny hatchlings in clean, natural surroundings. Many farms capitalize on this potential.

On another development, a recent news report revealed that the Department of Environment and Natural Resources (DENR) has proposed the use of crocodiles for industrial purposes. They can serve as efficient cleaners of big farms by eating the dead animals, thus eliminating the use of incinerators. This proposal (the "Adopt a Crocodile Program") came with the implementation of the Clean-Air Act where incinerators would be phased out within a three-year period.

Indeed, crocodile farming is gaining popularity. Thanks to current captive-breeding programs, crocodiles are save from extinction. But as with other endangered species, protection of the crocodiles' natural habitats is still the best course in the long run, since these lakes, rivers, and marshes are of critical importance to the stability of watersheds and marine fisheries.

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Tuna . . . from page 27

150 days, with the eggs weighing up to 50 g. In 1993, they obtained 100 million eggs and were able to rear 250 immature fish offshore. However, a storm hit their site; about half survived but later died. The young tuna were known to have grown to 1 kg.

The technology to rear wild-caught fingerlings has been successful to some extent. Tuna mariculture will be practical if the supply of farmed fingerlings will become stable. Fingerling size for stocking in offshore cages is 10-20 cm.

On the other hand, Japan's Fisheries Agency since 1993 has spent Y1.2 billion in establishing bluefin tuna parent fish rearing and spawning facility in Amami Oshima. The project has been rearing 200 yearlings for breeding stock.

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Malaysian school . . . from page 19

observed are a pH of 6.5-8, alkalinity of 30-40 ppm, salinity of 5 ppt (more than that level, mortality will occur), and iron content of not more than 0.2 ppm. Dissolved oxygen should not be less than 3 ppm.

Turtles are stocked at a density of 8-12 per m². Being a carnivorous species, *Trionyx sinensis* requires high protein (45-55%) and low fat diet. They are fed with trash fish, poor grade chicks, and intestines of poultry. Feeding is done once or twice daily, in the morning and/or afternoon at about 2% body weight.

To reach the size that can be sold in the Chinese market (400-600 g), farming period is about 6-8 months. Sex segregation is generally undertaken when the turtles mature, as females become subject to male biting attacks.

Marketable sized turtles may be harvested partially or completely. Partial harvest is done by lowering the water level and capturing the animals by hand. Complete harvest involves draining the water. Turtles of insufficient size are transferred to grow-out ponds for further culture. The marketable turtles are placed in tanks with running water to clean them before delivery to customers. Fast-growing turtles may be chosen as broodstock.

Markets

To prevent fighting, turtles bound for market are segregated individually in small nets or black perforated plastic bags. Adult turtles are normally sold live to export and local markets. Poor grade hatchlings can be also sold to aquarium shops as pets. Unfertilized eggs can be processed into medicinal food.

Outside Malaysia, the major market for turtles are China, Japan, Taiwan, Hongkong and Singapore. Local demand for cultured turtles has increased recently due to lack of supply from the wild.

Future potential

The potential of rearing soft-shelled turtles in tropical environments seems bright. Higher ambient temperatures for poikilotherms like reptiles and fish stimulate rapid and consistent growth patterns.

Taste for the soft-shelled turtle has to be acquired. Currently, only those with exotic, epicurean taste appreciate it. (Muslims do not eat it.) There is a need, therefore, to develop the delicacy's mass appeal, as well as explore and prove its medicinal value. Gory displays of public slaughter should be stopped to avoid casting a negative light on the development of turtle-derived products.

Conclusion

Cultural prejudices against exotic aquaculture species must be overcome to ensure the continuous development of their industries and markets.

This article is based on extension materials from the Sepang Today Aquaculture Centre and from responses to a questionnaire emailed by Mr. Khoo Eng Wah to NJ Dagoon

Sargeant fish and eel . . . from page 25

and Taiwan (over 20,000 tons) and 2,500 tons from elsewhere.

According to Mr. Torres, the biggest challenge to European growers is the high price of growing glass eel. There is huge demand for European elvers from China. He said the bigger problem is sustainability -- there may be no glass eels left in four or five years. EU should either stop or regulate this trade. *Fish Farming International* estimated that 65-75% of Europe's glass eels are being exported to the Far East.

The European Eel Fisheries Conservation Group (EEFCGO) has already issued a strong warning last year that too many eels from European waters are being exported across the world. Most die before they reach maturity and their steady depletion threatens eel fishing in Europe, as well as the further development of eel cultivation (*Fish Farming International*, February 1999). There are also reports that the International Council for Exploration of the Seas (ICES) has concluded that adult spawning stock of European eel (*A. anguilla*) is now outside safe biological limits. Between 1996 and 1997, France exported 150 tons; Spain, 70 tons; and UK, 30 tons at prices reaching up to US\$327 per kg of elvers.

Aquaculture potential

The factors that favor eel culture include the following (Usui 1991):

- Biological: high survival rates in culture, high tolerance to water quality variables (salinity, oxygen, nitrogenous waste), highly adaptable to a variety of diets (natural and artificial), high satisfactory growth rates (commercial size of 150-250 g can be reached in 12-24 months at optimum temperatures of 22-24°C).
- Technology: highly established rearing methods
- Economics: high value as food, high sale price, high commercial demand which exceeds supply (deficit in Europe is estimated at 13,5000 tons a year), elvers and young eels are available in the wild (estuaries and lagoons), and there are some opportunities to combine fishing and rearing
- Scientific: there is active research and extensive literature (Brusle 1990). The principles of eel culture are the same as for all fish culture

Eel culture in the Philippines

Eel culture is still in its fledgling stage. Known as *igat*, *casili* or *palos*, it started in the early '70s when the estuarine delta of the Cagayan river in northern Luzon has been discovered to yield commercial quantity of elvers. The elver season in the Philippines occurs most of the year but it peaks in March and August.

Sargeant fish and eel . . . from page 29

The two most dominant species caught in Philippine waters are *A. marmorata* and *A. celebesensis*, while the minor species are *A. bicolor pacifica* and *A. japonica*. The dominant ones appear mainly in October to February, while the minor species only in January and February (Magsumbol, undated).

In addition to the Cagayan river system, the rivers of Cotabato and Davao del Sur provinces in southern Philippines also yield elvers in commercial quantity. We manage to interview one eel farmer from Isulan, Sultan Kudarat, Mindanao, Southern Philippines.

Lister Granada, a former trainee at SEAFDEC and a native of the place owns Sultan Feed, a manufacturing, retail and marketing enterprise of hog and poultry feeds. He is also into fish feeds which he hopes to market to eel and catfish farmers in the area.

According to Lister, Metro Manila price for adult eels is P300-400 per kg depending on size. In Cotabato City in Mindanao, price ranges from P180-280 per kg for wild-caught eels. But, Lister said, the ideal market size of eels would be about 300 g a piece. This is the size required by Manila exporters who ship to Japan and Taiwan.

Lister sourced his elvers from the surrounding area which can supply in commercial quantities. Elvers are available 10 months a year. Lister's problem is determining the seasonality.

Two other companies in General Santos City, also in Mindanao, are into eel culture, but the mortality rate is extremely high. Lister's demonstration farm is at Barangay Palian, Tupi South Cotabato. Here, Lester experiments and conducts feeding trials with eels and catfish.

To get the ideal market size, Lister said the culture period must be 9-10 months. Eels can be cultured in tanks or in ponds (area, 5 x 5 m²; water depth, 1 m). Stocking density is around 200-300 elvers per tank or pond. Continuous water flow and sufficient feeding are the secrets to faster growth.

Lister said he feeds 7 kg of fresh fish or 1.3-1.5 kg of commercial diet to get 1 kg of eel flesh. He feeds his own formulated moist feed which was designed according to locally available feedstuffs. He said the formulation is based on the protein and amino acid requirements of carnivores.

With regards to handling and diseases, Lister said eels need extra-care because they are "supersensitive." If eels get hurt, they die within 3-5 days. With diseases, it can be easily cured if symptoms are detected early on. He mixes his medicines with the moist feed.

Lister clarified that he has four kinds of eels in his stock: *A. marmorata*, *A. bicolor pacifica*, *A. celebesensis* and *A. japonica*. These species were identified and verified by Dr. Tabrez Nasser, Sr, an aquaculture expert of the International Institute of Rural Reconstruction (IIRR) on a recent visit to his farm. Lister described the color of his eels as blackish, some brownish, with white dotted brown.

Ask about harvesting his stock, Lister said it is the same method as harvesting tilapia and other fishes.

Lister painted a rosy picture for eel culture. There is abundance of elvers (at least in his place) in commercial quantity almost all year round, he has got his own formulated moist feed, and the warm waters of the tropics can be very conducive to fast growth rates. Diseases are under control, and there is a ready market abroad. "I am extremely grateful to SEAFDEC for my knowledge in feed formulation. I spent long hours at the AQD Library reading all the eel literature I could get my hands on."

For inquiries about eel culture contact:

- Lister Granada
Sultan Feeds
Arellano Bldg, Isulan Public Market
Sultan Kudarat, Philippines
Tel. (63-084) 471 0081
- Rafael Magsumbol (*Senior Aquaculturist*)
Bureau of Fisheries and Aquatic Resources
860 Arcadia bldg. Quezon Avenue
Quezon City, Philippines
Tel. No. (63-2) 373 0792
- Dr. Tabrez Nasser (*Senior Aquaculture Specialist*)
International Institute of Rural Reconstruction (IIRR)
Silang, Cavite, Philippines

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A Q U A C U L T U R E I L L U S T R A T E D

by a.p. surtida &
e.t. ledesma

POSSIBLE OTHER SPECIES FOR CULTURE

TRADITIONAL SPECIES SUCH AS MILKFISH, TILAPIA, SHRIMP, SEAWEEDS, CARP, CATFISH, MUSSELS AND OYSTERS ARE STAPLE OF FISHFARMERS FOR YEARS... CULTURE TECHNOLOGY AND A READY MARKET ARE ALREADY ESTABLISHED...



IN RECENT YEARS, HIGH VALUE SPECIES SUCH AS GROUPER, SEABASS AND MUDCRAB HAS PROVEN THAT THEY CAN BE PROFITABLE TOO...



LATELY IN GLAN SARANGANI PROVINCE IN MINDANAO, A PIONEERING GROUP VENTURED IN GROWING SARGEANT FISH OR COBIA. THE COMPANY'S TARGET IS THE LUCRATIVE MARKET IN TAIWAN, HONGKONG, SINGAPORE AND THE U.S.



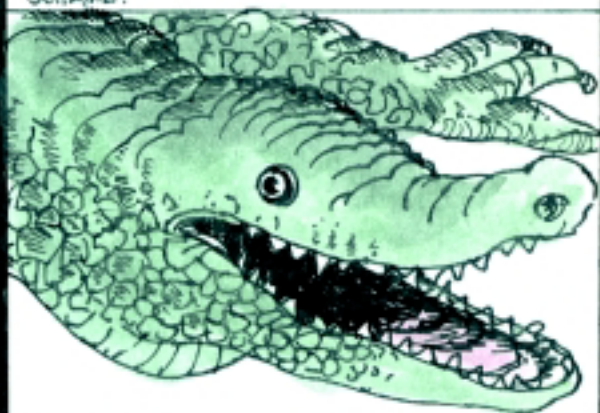
STILL THERE ARE OTHER AQUATIC SPECIES WAITING TO BE EXPLOITED... THE EEL (*Anguilla* sp.) WHICH HAS COMMERCIAL QUANTITIES OF ELVERS IN CAGAYAN PROVINCE IN THE NORTH AND DAVAO AND COTABATO IN THE SOUTH IS AN EXAMPLE...



ANOTHER SPECIES OF EEL - THE RICEFIELD EEL (*Monopterus Albus*) OR FRESHWATER EEL IS EXCELLENT FOR CULTURE BECAUSE IT CAN BE EASILY BRED IN CAPTIVITY AND DOES NOT REQUIRE MUCH WATER BECAUSE OF ITS AIR-BREATHING ABILITY. IT BUILDS ITS NEST IN THE BANKS OF RIVERS, PONDS AND RICE PADDIES.



CROCODILE FARMING IN SAMUT PRAKAN, THAILAND IS AN ESTABLISHED INDUSTRY... THERE'S NO REASON WHY IT CANNOT BE DUPLICATED ELSEWHERE. CROCODILE MEAT AND OIL DERIVED FROM ITS FLESH ARE ALL VALUABLE. TOURISM IS AN ADDED TO ITS MARKETING SCHEME.



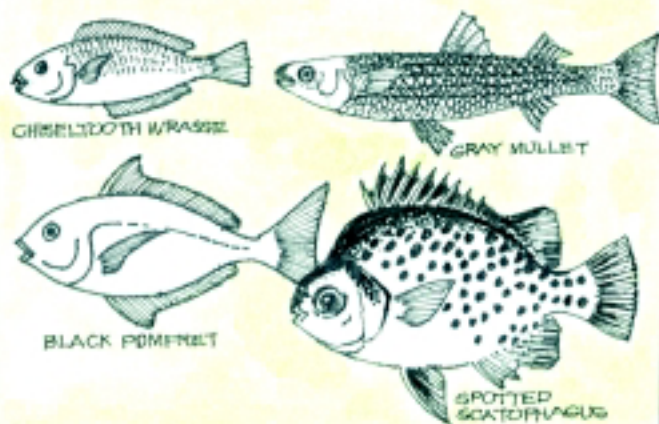
A CROCODILE SKIN BAG IS REPORTEDLY WORTH US\$5000 IN AN UPSCALE BOUTIQUE IN NEW YORK. A CROCODILE BREEDER CAN EARN A NET INCOME OF ABOUT US\$3000 IN THREE YEARS, MAINLY BY SELLING THE SKIN TO FASHION MARKETS IN JAPAN, EUROPE AND THE U.S.



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Videos from SEAFDEC/AQD

Bighead carp hatchery technology, 25 minutes. Shows techniques of hatching bighead carp as practiced by fishfarmers in Laguna de Bay, Philippines, and by SEAFDEC's freshwater fish experts.

Milkfish hatchery operations, 12 minutes. Describes SEAFDEC/AQD's recommended mode of operations for a milkfish hatchery.

A CFRM experience: the Malalison story, a 30-minute video documentary that shows the lessons gained by SEAFDEC's 7-year coastal fishery resource management project (CFRM) in Malalison Island, west central Philippines.

Culture of oyster and mussel using raft method, a 9-minute documentary that depicts the AQD favored method of using the environment-friendly hanging raft for oyster and mussel culture.

Grouper cage culture, 16 minutes. Promotes a profitable way of raising grouper in cages. Describes briefly the processes of site selection, cage construction, and grow-out culture.

Grouper culture in brackishwater ponds, an 8.5-minute video documentary showing the different stages of grouper culture: grow-out, harvest, and post-harvest, as well as site selection and pond preparation. It also describes the economics of one grouper crop, and marketing and transport techniques.

Conserving our mangrove resources, a 12-minute video documentary that describes the plight of mangroves in the wake of the fishpond boom and efforts to sustain the mangroves.

Price for each video title: ₱500 within the Philippines; US\$45 for other countries. Postage is included in price. Kindly indicate format of VHS tape (eg. NTSC, PAL, etc). See next page for ordering address.

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New publications



Diseases of penaeid shrimps in the Philippines, a 83-page second edition of a book first published in 1988. Of the 25 major diseases described, five are new. Entries have been updated, and include causative agent, penaeid species and stages affected, gross signs, effects on host, preventive methods and treatment. Price (includes postage): P200 in the Philippines, US\$ 45 other countries.



Net cage culture of tilapia in dams and small farm reservoirs, a 14-page manual that gives details on net cage design and farm management. Profitability analysis is also included. Price (includes postage): P80 in the Philippines, US\$ 30 other countries.



Ecology and farming of milkfish, a 117-page monograph that discusses the life history and ecology and various aspects of the farming industry in the Philippines. Price (includes postage): P300 in the Philippines, US\$50 other countries.



Mudcrab, a 32-page manual that gives a general overview of mudcrab species of commercial value and their grow-out monoculture in ponds; polyculture with milkfish; and fattening in ponds, mangroves, and cages. Price (including postage): P100 in the Philippines, US\$ 35 other countries.



Mudcrab *Scylla* spp. production in brackish-water ponds, a 14-page manual that covers the specifics of grow-out operation. Price (includes postage): P80 in the Philippines, US\$ 30 other countries.



Pen culture of mudcrab in mangroves, a 10-page manual that details the operation of net enclosures in mangroves for mudcrab culture. Includes site selection, net installation, stock management, and marketing. Price (including postage): P80 in the Philippines, US\$ 30 other countries.

Grouper culture in ponds, a 17-page manual discussing basic information about groupers and detailing brackishwater pond culture: sourcing fry and fingerlings, site selection, pond preparation, nursery operation, grow-out culture, harvest, and post-harvest. It also describes the economics of one grouper crop, marketing and transport techniques and diseases. Price (including postage): P80 in the Philippines, US\$ 30 other countries.

Grouper culture in floating net cages, a 10-page manual that details grow-out culture. Price (includes postage): P80 in the Philippines, US\$ 30 other countries.

The modular method: milkfish pond culture, an 18-page manual that describes a better way of raising milkfish in brackishwater ponds. The modular method is an improvement of the traditional extensive method. Price (including postage): P80 in the Philippines, US\$ 30 other countries.



Promoting appropriate aquaculture technology for more fish in Southeast Asia, a 24-page report that discusses AQD's technology verification trials on (1) milkfish hatchery, pond culture using hatchery-raised fry, and polyculture of milkfish and seaweeds; (2) the use of environment-friendly schemes in tiger shrimp culture; (3) mudcrab culture in ponds and net enclosures in mangroves; (4) cage culture of hybrid tilapia; (5) catfish hatchery technology; and (6) oyster and mussel culture in rafts. This report is free upon request.

1998 Highlights, a 31-page report on AQD's research and development activities for 1998. A special insert on AQD's 25th year anniversary celebration is included, describing the organization's contributions to the aquaculture industry in the Philippines and other Southeast Asian countries. What's new for 1998 is AQD's thrust on mangrove-friendly aquaculture; preliminary results are presented. This report is free upon request.

1999 Highlights, a 32-page report of AQD's 1999 activities. It highlights AQD's collaborative projects with the private sector, and three international symposia that AQD hosted.

Aquaculture, volume 164, 374 pages. A special issue of the Elsevier journal that contains the papers presented at the *Second international conference on the culture of penaeid prawns and shrimps* held 13-17 May 1996 at Iloilo City, Philippines. This volume is guest-edited by AQD researchers ET Quintino and JH Primavera. Price: P600 in the Philippines or US\$30 other countries.



Milkfish breeding and hatchery fry production. Summarizes the integrated milkfish broodstock and hatchery operation technology developed by AQD.

Milkfish breeding and hatchery technology at SEAFDEC/AQD. Describes the techniques already adopted by the private sector: broodstock management, broodstock diet, commercial fry production, live transport, and larval diet. A list of AQD research publications on milkfish is included.

The commercialization of SEAFDEC/AQD's milkfish fry production technology. Illustrates AQD's newest hatchery facility -- the Integrated Fish Broodstock and Hatchery Demonstration Complex -- and the extension program that go with it -- Accelerated Transfer of Milkfish Fry Production Technology.

NEW BOOKS / FLYERS / VIDEOS from SEAFDEC Aquaculture Department



Mangroves and community aquaculture. Describes the efforts of AQD to raise mudcrab in pens in mangrove areas in Palawan and Aklan with the participation of local communities.

Grouper culture. Describes the technology of growing grouper in net cages and in brackishwater ponds.

R&D: Abalone seed production and culture. Details the research conducted at AQD for the tropical abalone *Haliotis asinina*. AQD has developed the rudiments of a hatchery protocol.

Seed production of the native catfish Clarias macrocephalus. Describes SEAFDEC/AQD's work on artificially propagating the catfish.

Mudcrab culture. Summarizes the available technologies on mudcrab grow-out -- monoculture in ponds, polyculture with milkfish in ponds, monoculture in tidal flats with existing mangroves -- and mudcrab fattening. Details on stocking density, some management tips and investment costs are given.

Netcage culture of tilapia in small freshwater reservoirs. Includes details on site and net cage construction and tilapia farm management.

The farming of Kappaphycus. Introduces the red seaweed *Kappaphycus* with notes on the types of culture systems, the environmental factors required, initial investment needed, and crop management.

Aquaculture training program. 20-page brochure that introduces SEAFDEC/AQD's short-term regular courses.

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Improved shrimp culture

Efforts are underway at the SEAFDEC Aquaculture Department to test a zero discharge system for semi-intensive shrimp culture (*Penaeus monodon*). This closed, recirculating system makes use of biofilter organisms like tilapia, molluscs, or seaweeds inside culture ponds or in canals; sedimentation ponds and reservoirs; and bottom aeration (see cover photo) and long-arm paddlewheel aerators. These modifications in the shrimp culture system are aimed at maintaining optimal water quality conditions; prevent the occurrence of diseases; and minimizing, if not eliminating, discharge of wastewater to the surrounding environment.

The stocking density tested in the 0.876-ha site is 25 shrimp per m². Notes Mr. Dan Baliao who oversees the project: "We have not been hit by luminous bacteria which had devastated commercial farms in the Philippines and elsewhere. The survival at 140 days is estimated at 80%."

RELATED STORY ON PAGE 6.

Checking shrimp stock, at nearly 5 months



Preparation for the hanging line culture of molluscs on wide canals where shrimp pond effluent is first discharged



A view of the SEAFDEC test ponds



Better life through aquaculture

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SEAFDEC Aquaculture Department supports the Philippine government's Agrikulturang MakaMASA program. This is the banner program of the Estrada Administration for modernizing the agriculture sector.

The goals of the program for the fisheries sub-sector are: (1) food security through sustainable development and management of fisheries resources; (2) socio-economic upliftment of subsistence fisherfolk; and (3) fisherfolk empowerment. The program components are as follows:

- fisheries production
- conservation and management
- fisheries training and extension services
- fisheries information and marketing support
- research and development in fisheries
- fisheries infrastructure
- rural finance for fisheries
- program organization and management for the fisheries sector