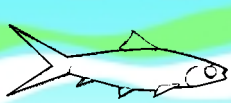


SEAFDEC Asian Aquaculture



IN THIS ISSUE The molluscs

abalone, pearl oysters, giant clams,
"agiis" and *Trochus*, imbao,
window-pane oyster, mussel-oyster

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

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Contributions

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

Gifts and exchanges

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

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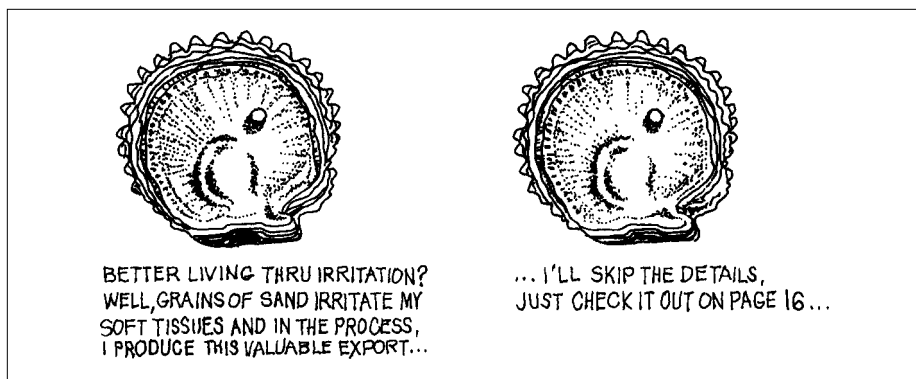
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Nota bene Mention of trade names in this publication is not an endorsement.

Our cover

A boatload of a shell locally known only as *agiis* (close-up below) has been cultured by fishfarmers in west central Philippines as live feed for tiger shrimp and mudcrab

Photo by RY BUENDIA





Indonesia's flag now flies at SEAFDEC

Indonesia is the newest SEAFDEC member-country

The SEAFDEC Secretariat in Bangkok, Thailand recently announced the official membership of Indonesia to SEAFDEC beginning August 8, 2000. Indonesia's membership was made official when its government deposited the Instrument of Accession with Thailand, the depository government of the Agreement Establishing the Center. Before this, Indonesia enjoyed observer status in top-level meetings.

Indonesia is an archipelago endowed with rich marine resources spread out in more than 17,000 islands. The country has a total coastline of about 81,000 km. It has also the largest concentration of mangrove forests in the world.

*Fish health expert
Dr. Yasuo Inui*



Fish disease studies at SEAFDEC

Aquaculture is one of the fastest growing food producing sectors of the world. However, disease outbreaks are increasingly recognized as significant constraints to aquaculture production and trade, affecting both economic and social development in many countries. Within the shrimp culture sector, the number of diseases has increased steadily with the expansion and intensification of large-scale commercial cultivation. Shrimp disease is considered the single most limiting factor to successful commercial production.

In answer to this problem, SEAFDEC has intensified its support to aquatic animal health. Fish health and disease problems particularly on shrimp and marine fish is the focus of the project being implemented by SEAFDEC under the auspices of the Japanese Trust Fund. Dr. Yasuo Inui, JICA expert on fish health whose tour-of-duty at SEAFDEC/AQD started last March, will work with SEAFDEC experts for two years to administer the said project.

The project consists of research and development of techniques for the prevention of fish disease; international workshop to standardize and regionalize the methods; training and dissemination; and finally, the establishment of a disease surveillance system. Almost all of the research aspect has been started early this year, except for some, where the equipment is not yet available; it is hoped that the project will continue for four years.

"First, we have to establish the diagnostic method to detect the disease, then we need to create ways to control it," explains Dr. Inui. The indiscriminate use of drugs must be avoided because of the danger of developing drug-resistant strains of the pathogens. The use of antibiotics should therefore be limited and other control methods should be used.

"The use of probiotic is one example of biological control method; but we have to know the mechanism -- how it works and the technique on its proper usage. SEAFDEC is already on the process of verifying this."

Once the control method is established, a monitoring method must be set-up. Through all these activities, extra precaution should be undertaken to ensure that the aquaculture product is safe and fit for human consumption.



AQD's fish health staff doing biochemical analysis of bacteria

☞ to page 8



SEAFDEC Special Advisor Dr. Yasuhisa Kato explains why the FAO Code needs to be regionalized, and SEAFDEC's program on this matter



AQD Chief Dr. Rolando Platon (in middle table) gives the background, objectives and agenda of the meeting



The representatives from SEAFDEC-ASEAN member-countries are briefed on AQD activities at AQD's main station

“FishWorld” opens to the public

FishWorld, the museum-aquarium-ecopark for aquaculture, fisheries, and environment education built by SEAFDEC/AQD in Iloilo, Philippines opened its doors to the public on July 7. The guests-of-honor were the Honorable Cesar Drilon, Undersecretary of the Philippine Department of Agriculture and SEAFDEC Council Director, and Honorable Mayor Myrna Torres of Tigbauan.

“FishWorld,” AQD Chief Dr. Rolando Platon said, “will provide informal public education so necessary for responsible aquaculture and fisheries, and for environment protection and sustainable development.” FishWorld has an Aquaculture Hall, Fisheries Hall, Oceanarium and Ecosystems Exhibit, Marine Science Hall, Culture and Arts Gallery, and Children’s Activity Room.

Among the environment education programs lined up are: Aquaculture and Nutrition Week, International Coastal Clean-up, Invited Lectures, Ecology Camp, Eco-Jobs for the Youth, Business for Kids and Nature, and Publications.

The FishWorld curator is Dr. Teodora Bagarinao.

Regionalization of the aquaculture code of conduct

SEAFDEC’s program on the Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) has moved on to the second phase - aquaculture development (AD). The Philippine-based SEAFDEC/AQD, the lead implementor of this phase, recently conducted the first consultation of experts at Days Hotel in Iloilo City.

Officially called the “Pre-technical meeting of core experts for RCCRF-AD,” it was held July 31 and August 1 and was attended by nearly 50 representatives from SEAFDEC and ASEAN Member-Countries and SEAFDEC staff.

The output of the meeting includes: (1) a listing of the issues or topics not included in the “FAO Code of Conduct for Responsible Fisheries (Article 9)” and the “FAO Technical Guidelines for Responsible Aquaculture Development” in as much as these apply to the aquaculture industry in Southeast Asia. Both FAO documents are the bases of RCCRF-AD. (2) A provisional listing of regional aquaculture experts who will finalize the RCCRF-AD document in succeeding meetings.



FishWorld is a 1,000 m² building. The middle interior will later hold a permanent live ecosystems exhibit



Usec Drilon and Mayor Torres did the ribbon-cutting with Dr. Platon looking on



Dr. Platon hands the textbook cover prototype, in formal ceremonies, to (Philippine) House Speaker Manny Villar. Looking on is Honorable Congressman Narciso Monfort

Author Ms. Celia Lavilla-Pitogo signs complimentary copies of the handbook on shrimp diseases during AQD's anniversary celebration on July 6 in Iloilo



Dr. Jurgenne Primavera

Ms. Didi Baticados



Two textbooks launched by AQD

SEAFDEC/AQD recently launched the prototypes of two of the six text books being prepared for tropical aquaculture courses. It was the Honorable Manny Villar Jr. who received the prototype cover and first copy of “Health Management in Aquaculture” and “Aquaculture Nutrition” which were handed over by the AQD Chief, Dr. Rolando Platon.

The ceremonial booklaunching was held August 21, 2000 at the Iloilo State College of Fisheries (ISCOF), Barotac Nuevo, Iloilo. ISCOF President, Dr. Elpidio Locsin, first urged AQD to meet the needs of students. Fishery schools use textbooks that usually deal with temperate, not tropical, fisheries and aquaculture. Dr. Locsin noted that AQD has the reputation of having the most number of experts in various fields of aquaculture who can be tapped as textbook writers.

Dr. Platon, on the other hand, said that AQD’s experts are armed with results of decades of R&D that will now go into these textbooks. He added that although the primary target readers are students, there are also other stakeholders in the aquaculture industry who can use the books for quick reference - the fishfarmers, farmworkers and technicians. For example, the textbook on health management authored by Dr. Gilda Lio-Po and her colleagues contains the most up-to-date knowledge of fish and crustacean diseases, the causative organisms, and measures for disease prevention and control in tropical aquaculture.

New handbooks in aquaculture

For aquaculturists in dire need of reference materials for their ventures, here’s some good news. SEAFDEC/AQD has recently released two how-to manuals with the following titles (1) “Net cage culture of tilapia in dams and small reservoirs” and (2) second edition of “Diseases of penaeid shrimps in the Philippines.”

The first book is authored by Dan Baliao, head of AQD’s technology verification team, and his colleagues. The book contents reflect AQD’s field tests in collaboration with the private sector. The viability, environment-friendliness and profitability of the technology described have been proven.

The second book is authored by Ms. Celia Lavilla-Pitogo and AQD’s fish health staff. It describes the causative agents, species affected and their stages, gross signs, effects on host, preventive measures and treatment of 25 diseases (7 are newly described vis-à-vis the first edition of the manual ten years ago).

Outstanding AQD researchers

Excellence is always recognized. Thus, it is no surprise that three AQD researchers won the prestigious 14th Dr. Elvira O. Tan Memorial Research Awards given out by the (Philippine) Department of Science and Technology.

AQD’s Senior Scientist Dr. Jurgenne Primavera won the Best Published Paper in Aquaculture with her “Tropical shrimp farming and its sustainability” paper published as a chapter of a book on Tropical Mariculture by Academic Press of New York, USA in 1998.

Likewise, researchers Ms. Didi Baticados and Mr. Renato Agbayani won the Best Published Paper in Marine Fisheries with their paper entitled “Fishing cooperatives in Capiz, central Philippines: their importance in managing fishery resources.” This paper has been published in Fisheries Research, a scientific journal, in 1998.

The researchers received the award on July 21 at Los Baños, Laguna.



AQD celebrates its 27th year, dialogues with fishing community

SEAFDEC/AQD marked its 27th anniversary on July 6 and 7. Several activities were organized. The first day of celebration was highlighted by the annual Dean DK Villaluz Memorial Lecture which featured Dr. Leocadio Sebastian, the Executive Director of the Philippine Rice Research Institute. Dr. Sebastian's topic - *Biotechnology for increased food production: prospects, issues and concerns* - was meant to generate interest in AQD's present thrust - the biotechnology program.

The second day was highlighted by the main anniversary program, with a keynote speech from Mr. Cesar Drilon, the DA Undersecretary and SEAFDEC Council Director. Mr. Drilon noted that AQD has been giving a much better service to the industry in the past 4 years. He urged AQD to continue developing and field-testing environment-friendly aquaculture technologies with the private sector.

Mr. Drilon, along with AQD Chief Dr. Rolando Platon and other AQD officials, later held a dialogue with the fishing community in Tigbauan, Iloilo, the collaborator in AQD's stock enhancement project on the window-pane oyster (*Placuna placenta*). Dr. Platon appealed to the community to defer harvest of the window-pane oyster until the middle of next year to allow time for spawning the next generation and ensure continued harvest. Window-pane oyster are used as raw materials for shellcraft products, a relatively big export industry in Panay Island.

Canadian intern at AQD

Ms. Nicole Caron, 25, is the newest aquaculture intern at SEAFDEC/AQD's breeding section. She will be at AQD for 8 months beginning August. Her internship was arranged thru the MI International Fisheries and Marine Institute, St. John's, Newfoundland, Canada.

Ms. Caron has Advanced Diploma in Aquaculture earned at the Memorial University in Newfoundland and a BS major in Marine Biology degree from Dalhousie University in Nova Scotia. She has also worked as a hatchery technician in Victoria, Australia. Welcome to SEAFDEC, Ms. Caron!

Two international aquaculture courses concluded

SEAFDEC/AQD successfully conducted two international training courses. The first - *Management of Sustainable Aquafarming Systems* - was attended by 20 Asians coming from Brunei Darussalam, Vietnam, Singapore and Sri Lanka (1 trainee each); from Malaysia, Myanmar and Thailand (2 each); and from the Philippines (10). This was held May 30 to July 5.

The second course - *Marine Fisheries Hatchery* - was attended by 17 participants from Brunei (1); from Vietnam, Thailand, Myanmar and Malaysia (2 each); and from the Philippines (8). This was held June 6 to July 14.



A participant receives her training certificate from AQD officials

Uganda nationals train on tilapia and catfish hatchery

Two nationals from Kampala, Uganda (east Africa) trained at SEAFDEC/AQD on catfish and tilapia seed production. They were Mssrs. Godfrey Mbahinzireki, Research Officer, and Anthony Masaba, Senior Laboratory Assistant, both of the Kajjansi Fisheries Research Station, National Agricultural Research Organization, Uganda. Their training, from July 31 to August 11, was funded by FAO.

The first phase of the training was held at AQD's Binangonan Freshwater Station in Laguna de Bay for the seed production of tilapia. The trainees also visited tilapia grow-out facility in Taal Lake and tilapia hatcheries in Rizal and Laguna.

The following week, the trainees moved to AQD's Tigbauan Main Station in Iloilo for the catfish phase. This module included induced spawning, hatching, and nursery techniques of the catfish native to the Philippines, the *Clarias macrocephalus*. It was capped by a field trip to the catfish farm of Mr. Rudy Gentica, a successful farmer in San Jose, Antique.

The Ugandan nationals were joined by three Filipino trainees in Iloilo: Mssrs. Christopher Yana, Allan Rodriguez and Ms. Glenda Sanchez. The Filipinos were representatives of the local government units of Agusan del Sur in Mindanao and Tangalan, Aklan in Panay Island.

— Newsbriefs by MT Castaños, AP Surtida and RIY Adan



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>

Emata AC, Borlongan IG, Damaso JP. 2000. Dietary vitamin C and E supplementation and reproduction of milkfish *Chanos chanos* Forsskal. *Aquaculture Research* 31 (7): 557-564

Abstract. Milkfish *Chanos chanos* Forsskal broodstock (11 years old, average body weight 5.23-5.73 kg) reared in 10-m-diameter by 3-m-deep floating net cages (31-36 fish per cage) at SEAFDEC AQD's Igang Marine Substation in Guimaras Island, central Philippines, were fed daily at 3% of total body weight formulated diets (36% protein, 7-8% lipid) supplemented with 0.1% vitamin C, 0.05% vitamin E, both vitamin C and E or no vitamin supplementation (control) for 3 years. Reproductive performance was assessed in an attempt to determine the optimum nutrition for successful spawning of milkfish. The total egg production, mean number of eggs per spawning, number of spawns and mean egg diameter were not affected by dietary vitamin C and E supplementation. However, broodstock given dietary supplementation of vitamin C alone or in combination with vitamin E had a higher percentage of spawns with higher (> 90%) percentage egg viability, hatching and cumulative survival rate than those of the control. Broodstock given dietary vitamin E supplementation alone had few spawns, which made the results difficult to analyse. The results confirm the essentiality of vitamin C supplementation in producing more spawns with good egg and larval quality. The production of an adequate volume of good quality eggs and larvae to support hatchery operation is necessary to offset the huge investment in broodstock development, as it takes at least 5 years for milkfish to attain sexual maturation and spawning.

Garcia LMB, Hilomen-Garcia GV, Emata AC. 2000. Survival of captive milkfish *Chanos chanos* Forsskal broodstock subjected to handling and transport. *Aquaculture Research* 31(7):575-583

Abstract. The survival of milkfish broodstock (body weight range 1-11 kg) was determined until 30 days after handling and transport in open tanks or in sealed oxygenated bags containing chilled sea water (20-25 degrees C). Maintenance of cool sea water was achieved by the gradual addition of ice chunks or frozen gel packs. A survival rate of 50% after transporting fish at a loading density of 45 kg m⁻³ for 4 h in open tanks was not significantly different from those that were handled but not transported (86%). Similarly, survival rates (67-83%) among broodstock confined for 8 h in chilled sea water at 40 and 60 kg m⁻³ were not significantly different from each other or from a group not subjected to confinement. Nevertheless, low dissolved

oxygen (DO) and accumulation of total ammonia-nitrogen beginning 1 h after transport and confinement may be responsible for low survival rates of milkfish in open tanks. In contrast, all milkfish survived 10 h of overland transport in sealed bags with chilled and diluted (28 g L⁻¹) sea water. Likewise, all milkfish survived after being bagged and immediately transferred to a communal rearing tank, or bagged and placed in a styrofoam box for 10 h. Except for total ammonia-nitrogen levels, which increased slightly (0.7-0.8 mg L⁻¹) above background, seawater temperature (20-24 degrees C), salinity (28 g L⁻¹) and DO [6 to > 20 mg mL⁻¹] titres in transport bags were maintained during the 10-h test. The effectiveness of handling and transporting milkfish broodstock in sealed bags containing chilled sea water was verified in actual field trials. Spawning of sexually mature milkfish subjected to these stressors was not impaired. These results demonstrate that mortalities of large milkfish broodstock can be minimized when fish are handled and transported in sealed oxygenated bags containing chilled sea water.

Naylor RL, Goldberg RJ, **Primavera JH**, Kautsky N, Beveridge MCM, Clay J, Folke C, Lubchenco J, Mooney H, Troell M. Effect of aquaculture on world fish supplies. *Nature* 405 (6790): 1017-1024.

Abstract. Global production of farmed fish and shellfish has more than doubled in the past 15 years. Many people believe that such growth relieves pressure on ocean fisheries, but the opposite is true for some types of aquaculture. Farming carnivorous species requires large inputs of wild fish for feed. Some aquaculture systems also reduce wild fish supplies through habitat modification, wild seedstock collection and other ecological impacts. On balance, global aquaculture production still adds to world fish supplies; however, if the growing aquaculture industry is to sustain its contribution to world fish supplies, it must reduce wild fish inputs in feed and adopt more ecologically sound management practices.

Emata AC. 2000. Live transport of pond-reared milkfish *Chanos chanos* broodstock. *Journal of the World Aquaculture Society* 31 (2): 279-282

Eusebio PS, Coloso RM. 2000. Nutritional evaluation of vari-

ous plant protein sources in diets for Asian sea bass *Lates calcarifer*. *Journal of Applied Ichthyology* 16 (2): 56-60

Abstract. A biological assay was conducted to evaluate the suitability of various leguminous seed meals and leaf meals as dietary protein sources for Asian sea bass, *Lates calcarifer*. In the growth experiment, fish [initial mean weight +/- standard error (SE) of 3.8 +/- 0.5 g] were fed isonitrogenous and isocaloric diets containing test ingredients to replace 13-18% of the diet. The same diet formulations were used in a digestibility experiment, except that 1% Cr₂O₃ was added as an external indicator. The growth of the control fish was comparable to fish fed leguminous seed meal-based diets, and better than those given leaf meal-based diets. The control diet had the highest apparent protein digestibility (APD) value. No significant differences were observed between the APD of white cowpea (*Vigna unguiculata*), green mungbean (*V. radiata*) and papaya (*Carica papaya*) leaf meal-based diets. However, the cassava (*Manihot esculenta*) leaf meal-based diet had the lowest APD value. The present findings suggest that white cowpea and green mungbean meals can be used as protein sources in practical diets to replace 13-18% of the sea bass diet without affecting their growth.

Borlongan IG, Marte CL, Nocillado JN. 2000. Development of larval diets for milkfish (*Chanos chanos*). *Journal of Applied Ichthyology* 16 (2): 68-72

Abstract. This study aimed to develop nutritionally balanced and cost-effective processed diets for milkfish larvae (*Chanos chanos* Forsskal). Two larval diets (feed A and feed B) were formulated and prepared to contain 45% protein and 10% lipid. Several larval diet preparations were tried such as microbound/unpelleted (freeze-dried), microbound/pelleted (oven-dried) and microbound/flaked (drum-dried) and assessed in terms of feed particle size and buoyancy, water stability and feed acceptability. The preparation that gave the best particle size and buoyancy as well as good water stability was prepared as the microbound diet (using li-carrageenan as a binder) and flaked

using a drum drier. A series of feeding experiments were conducted to determine the growth and survival of milkfish larvae reared on various feeding schemes using these processed larval diets which were fed either solely or in combination with live feed. Larvae in control treatments were reared on live foods such as *Brachionus plicatilis* and *Artemia nauplii*. Larvae were observed to ingest the diets, indicating that the feeds had suitable physical characteristics and were attractive to the larvae. The overall results of the feeding trials showed that the artificial diets could be fed to milkfish larvae in combination with *Brachionus* rotifers starting on day 2 or day 8, and could be fed alone starting from day 15. These promising results would reduce the dependence of milkfish larvae on live feed and would have significant economic benefits in the form of simplified milkfish hatchery procedures.

Cruz-Lacierda ER, Toledo JD, Tan-Fermin JD, Burreson EM. 2000. Marine leech (*Zeylanicobdella arugamensis*) infestation in cultured orange-spotted grouper, *Epinephelus coioides*. *Aquaculture* 185 (3-4): 191-196

Abstract. Heavy infestation of a marine leech occurred among tank-reared juvenile and adult orange-spotted grouper, *Epinephelus coioides* Hamilton, at SEAFDEC AQD, Philippines with a prevalence of 83% and 17%, respectively. The leeches were attached in large numbers on the fins, lower jaw, under the operculum, eyes, and inside the mouth of the fish. The attachment and feeding sites exhibited frayed fins, hemorrhages and swelling of the host's skin. External and internal features indicate that the leech is *Zeylanicobdella arugamensis* De Silva (Hirudinea, Piscicolidae). The parasite can be effectively controlled using 50 ppm formalin bath treatment for 1 h.

ABSTRACTS FROM JOURNALS COVERED BY CURRENT CONTENTS ARE DOWNLOADED FROM THE CD-ROM VERSION (AGRICULTURE, BIOLOGY & ENVIRONMENTAL SCIENCES; 26 JULY 1999-17 JULY 2000). 2000. INSTITUTE FOR SCIENTIFIC INFORMATION, PENNSYLVANIA, USA

FISH DISEASE STUDIES ... from page 3

“When we get the techniques clear, we need to meet with other researchers from Southeast Asia to come up with the standardized methods and also, to regionalize the said techniques. It is very important to have a similar methodology and concept to control the diseases in the region; by that, we may control the

propagation of the disease and confine the disease. After this, training and dissemination will follow,” explains Dr. Inui. “We also need to discuss with other countries the surveillance system of the methods established.” ###

The shellfishes

By **MT Castaños**

They are called fishes only because they live in the sea. But they are without fins, which true fishes have, so, their fish name is qualified. Instead they have shells, and are called shellfishes. Their culture has become an important component of the aquaculture industry (see also the special feature on page 13 and the pages following).

Using shellfish and mollusk as keywords, the internet search yielded no less than 30 websites. The more substantial or interesting ones are featured below.

A GOOD SITE TO START YOUR SEARCH

www.shellfish.org

This is maintained by the National Shellfisheries Association, described as an international organization of scientists, management officials and members of the industry who are deeply concerned with the biology, ecology, production and management of shellfish resources (clams, oysters, mussels, scallops, snails, shrimp, lobsters, crabs, etc).

The website has information on annual meetings or fora, publications, membership, open positions, and news. The most useful part of the website is the links to different institutions and organizations. It is a good point to start further search.

Hit the button tagged "Web Resources," and it will bring a list of servers/discussion groups on the internet, classified as (general) shellfish, aquaculture, fisheries, environment, organizations including government offices. However, most of the links are focused on Canadian and U.S. shellfisheries, not tropical or Southeast Asian shellfish culture.



www.cepri.cl/mobydick/lfis.htm

FOOD SAFETY
REQUIREMENTS FOR THE
INDUSTRY

www.seafood.ucdavis.edu/home.htm

This Seafood Network Information Center is maintained by the

University of California's extension program on food science and technology. The website can be an important reference for shellfish processors considering that seafood HACCP is described in detail. HACCP -- Hazard Analysis and Critical Control Point -- is the new industry standard for ensuring food safety of consuming public. By "critical point" HACCP means "the point, step, or procedure in food processing at which control can be applied, and a food safety hazard can, as a result, be prevented, eliminated, or reduced to acceptable levels."

The discussion in the website is a bit technical although several documents can be downloaded for longer study. There are general HACCP plans for clam, crabs, lobster, mussels, oysters, shrimps, and several fishes; also for aquaculture drugs in farmed catfish and shrimp, chemical contaminants in cultured species, pathogen growth in crab meat, to name a few. The website also notes that plans are underway to develop a seafood HACCP curriculum designed for food inspectors and the seafood industry, and to prepare educational materials.

www.aquatic-eco.com/divisions/mollusc/mollusc.html



Oyster sticks (above) used to collect oyster larvae, and a tray (left) for culturing oysters, sea urchin, abalone and scallop in open water



EQUIPMENT AND
SUPPLIES

www.aquaticecosystems.com

Gadgets and supplies you will find in this website, noted as manufacturing and distributing "a full inventory of aquaculture and aeration systems and equipment."

➡ next page

The company, based in Florida in the US, also distributes a complete line of environmental monitoring equipment, pollution control equipment, aquarium and pond supplies, and hydroponic equipment.

If bamboo technology (which will suffice for most shellfish culture in the tropics) does not do it for you, more sophisticated equipment can be had (pictures on previous page).

SUPPLIERS AND BUYERS
www.cepri.cl/mobydick/english.htm

www.sydneyfishmarket.com.au
 In the city of Ancud in Chile can be found Mobydick Food SA, a company that processes and markets various seafood and fishes. The company said they are focused on the search of new markets and that they have a strong investment in research and development. Their product list includes shellfish paste, shellfish mix (picture on previous page), pink clams, hard shell clams, sea urchin pate, limpets, stone crab, mussels, abalone, and Pacific clams.

The Sydney Fish Market on the other hand describes itself as a “colorful and vibrant meeting place for the fishing industry and consumers” and having the largest seafood sale in the southern hemisphere, trading 1,000 crates every hour and auctioning 65 tons of fresh catch every day. Their website describes the market’s facilities, auction system, and the benefits in selling through this fish market -- low commission rate, guaranteed payment, 170 eager buyers, HACCP quality assurance program. The site also provide links to other markets and government support institutions (mostly Australian). For individual consumers, the site offers tips for selecting and keeping seafood fresh. For example, when buying molluscs, choose those shells that are tightly closed, smell pleasantly, and not discolored; and if these must be stored, keep these in bags in a cool, dark place and use within 3 days.

[//handel.pacific.net.sg/~chansy](http://handel.pacific.net.sg/~chansy)



Enthusiasts observe shell in its natural habitat (Trochus radiatus, top), collect shells (Cassis cornuta, middle) and shell figurines (pepper and salt shaker)

LIFESTYLE AND RECIPES

www.virtualcities.com/ons/0rec/07shell.htm

[//diabeticgourmet.com/dishes/00recipes/136.shtml](http://diabeticgourmet.com/dishes/00recipes/136.shtml)

The first site is called the “1st Traveler’s Choice Internet Cookbook” which recommends recipes from bed-and-breakfast lodging places mostly in north America. Recipes for shellfish include paella, clam chowder, crab cakes, oyster wontons, grilled scallops in cheese, and lobster quiche. Each recipe has an accompanying view of the B&B inn which offers the item on its menu. Delicious, excellent view.

The second site is the online version of “Diabetic Gourmet,” a magazine for diabetics. Shellfishes also figure prominently in diabetic menus, like this “New English Style Clam Chowder” which can be prepared in 25 minutes --

INGREDIENTS

- 1 medium onion
- 1 cup water
- 2 medium potatoes, peeled and cubed
- 6 oz. chopped or minced clam
- 3 tsp chicken bouillon granules
- 4 cups low-fat milk
- 3 tbsp each of flour and cornstarch mixed in 1/2 cup water
- Pepper to taste
- 1/4 cup very lean, cooked bacon bits

DIRECTIONS

In a large pan, stir-fry onion over medium heat until soft. Add water, potatoes, clam and chicken bouillon. Simmer until potatoes are tender. Add milk, flour-cornstarch, and pepper. Continue cooking, stirring constantly, until thickened. Ladle into soup bowls and garnish with bacon bits. Serves 6

COLLECTORS AND ENTHUSIASTS

[//handel.pacific.net.sg/~chansy/index.html](http://handel.pacific.net.sg/~chansy/index.html)

This website for shell enthusiasts is called “Molluscan Pictures: A Singapore Molluscan Point of View” and is owned by Chan Sow Yan. It lists molluscs by species and by locality. Although some parts of the site are accessible only to members of their intranet, the visitor access parts are delightful enough. The site also smoothly integrates the websites of other enthusiasts -- like Leo’s snail figurines, Leong’s X-rayed shells, and *Scaphopoda* (site for tusk shells). So, if you have a shell or snail website and you desire to link up with fellow enthusiasts, you would be comfortably at home.

THE ANIMAL RIGHTS EQUATION

www.environweb.org/arc/shellfish/boiling.html

The Animal Rights Coalition notes that it maintains itself as a concept that links a network of over 300 local groups and

Innovation: milkfish offal as “polvoron”



Award-winning innovator Dr. Calmorin and her milkfish polvoron



By **AP Surtida**

“Polvo” is the Spanish word for dust or powder, and “polvoron” is a popular Philippine dessert in fully-packed powder form with these ingredients: all-purpose flour, powdered milk, sugar, butter, and vanilla extract.

Now, a researcher from the Northern Iloilo Polytechnic State College (NISPC) in Estancia, Iloilo, central Philippines, adds more value to the popular dessert by enriching it with calcium and protein. Dr. Calmorin, a professor and researcher at NISPC, conducted a study utilizing milkfish bones, which is considered offal or waste by the boneless *bangus* or milkfish industry, as additional ingredient in making polvoron. According to Dr. Calmorin, the idea started as an offshoot of their 50 kg a week quota of boneless milkfish being sent to Manila. The milkfish bones had been piling up high.

Dr. Calmorin decided to utilize the bones as an ingredient in polvoron by grinding it into powder. Three kinds of polvoron had been produced by the study. The difference is in the formulation, that is, the ratio of bone meal powder to powdered milk. The

ordinary polvoron has a ratio of one part bone meal to one-half part powdered milk; semi-special has a 1:1 ratio, and the special polvoron has a 1:2 bone meal to milk ratio.

In a taste test at NISPC, Dr. Calmorin reported that majority of the panelists who evaluated product acceptability in terms of odor, color, flavor, and texture said that they “like the polvoron very much.”

This innovative study won the second prize of the *Aquatic Technology Enterprise Award* sponsored by the Philippine Council on Aquatic and Marine Research and Development (PCAMRD). The awarding was made on 21 July 2000 in Los Banos, Laguna during the science community’s national S & T week 2000. Dr. Calmorin received a plaque and cash award of P30,000.

Dr. Calmorin averred that since milkfish bone polvoron (MBP) is very much acceptable, saleable, and profitable, towns where milkfish is abundant can adopt MBP as livelihood and augment the income of rural folks.

She also suggested that a study of MBP’s shelf life should be conducted so that its expiry date can be determined. Likewise, the MBP’s nutritional values should be analyzed so that these would be reflected as nutrition facts on the label, and to entice more consumers. Microbial tests of MBP should also be done, and an attractive packaging design should be studied to attract consumers.

Other fishbones that can be utilized, according to Dr. Calmorin, are from tuna, siganid (rabbitfish), and goatfish (*tapa*) which are sold in commercial scale. Fishbones from these species should also be studied.

Other than the polvoron study, Dr. Calmorin is also studying the possibility of a milkfish bone meal burger. Again, she utilizes milkfish offal such as backbone,

How to make milkfish bone polvoron

INGREDIENTS

All purpose flour
Powdered milk
Sugar
Butter
Vanilla extract
Milkfish bones

PROCEDURE

- 1 Soak milkfish bone in a marinating solution overnight.
- 2 Pressure cook for 1 hour at 10 psi
- 3 Grind until powdery. Sundry
- 4 Toast flour until golden brown
- 5 Sift flour. Press the lumps, and sift flour again
- 6 Blend all ingredients except for butter and vanilla extract
- 7 Heat butter and vanilla extract
- 8 Thoroughly blend all ingredients with butter solution. Cool, mold and wrap, and pack

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New recipe: golden *kuhol* chicharon

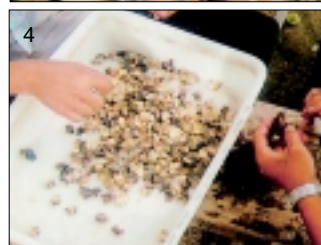
Dr. Ravindra Joshi, senior research fellow at the Crop Protection Division of DA-Philippine Rice Research Institute (PhilRice) sent in this recipe which he developed with a colleague, Mr. M.S. de la Cruz. Dr. Joshi noted that this new recipe is unique compared with other golden apple snail or golden *kuhol* recipes in that --

- it is ready to cook, cholesterol-free, and has no bad odor
- can be stored for a long time, as it is devoid of water
- does not endanger biodiversity unlike chicharon from kibit which is already getting extinct

Dr. Joshi also noted that they are making every effort to promote golden *kuhol* as food, not only to enrich the protein diet of Filipinos but also to stop the use of pesticides in freshwater bodies. Golden *kuhol* is considered a pest in rice farming.

Dr. Joshi wrote about the golden *kuhol* menace in the country's Ifugao Rice Terraces in the January-February 2000 issue of this newsletter.

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loc. 227 or
<joshiravi@hotmail.com>



PHOTOS COURTESY OF RC JOSHI

COLLECTION AND PREPARATION

- 1 Collect large adults of golden *kuhol* in the paddy, canals, and fishponds during early morning or late in the afternoon. Use attractants -- *gabi*, azolla, banana leaves or newspaper -- to facilitate quick collection
- 2 Soak the collected golden *kuhol* in water for 24 hours to remove undigested food. Remove dead *kuhol*
- 3 Boil the golden *kuhol* in a large container for 20-30 min. Boiling makes it easier to remove the flesh from the shell
- 4 Clean the flesh again while removing the stomach. Rinse the flesh with alum (*tawas*) to remove the unpleasant odor
- 5 Prepare the recipe, as follows:

INGREDIENTS

- 4-5 kg of golden *kuhol* with shell (= can yield about 0.75-1.0 kg of *kuhol* flesh)
- 1 tsp black pepper
- 1/4 c soy sauce
- 3 tbsp vinegar
- 3 cloves garlic
- 1-2 red chilli
- 1/2 tsp alum
- 1 c vegetable cooking oil (for frying)
- 1/2 c cornstarch or flour
- 1 egg

COOKING PROCEDURE

- a Mix black pepper, soy sauce, vinegar, garlic, red chilli and golden *kuhol*. Marinate for 24 hours
- b Sun-dry the marinated *kuhol* for 2-3 days or place in the oven at 40°C for 48 hours
- c Deep fry in vegetable cooking oil for 2 min
- d Air-dry the prepared *kuhol* for 3 days. Such *kuhol* can be stored (place in plastic bag and seal)

OPTION: ROLL THE *KUHOL* IN BATTER (CORNSTARCH OR FLOUR WITH EGG MIXTURE) BEFORE FINAL COOKING

- e For final cooking, deep dry again for 5 min or until the *kuhol* is crispy. Let cool and serve

Based on the "kibit" recipe of CM Pasion of Baler, Aurora as modified by MS de la Cruz and RC Joshi

The Molluscs

ABALONE, PEARL OYSTERS, GIANT CLAMS, AGIIS, TROCHUS, IMBAO, WINDOW-PANE OYSTER, GREEN MUSSEL-PACIFIC OYSTER



You eat them, you wear them, you decorate with them. No aquaculture product can be as versatile or as appealing as the molluscs.



They have been dubbed as aphrodisiacs (Pacific oysters), as gifts worthy of emperors (abalone), as high-fashion (pearl oyster and trochus), as tools for environment education (giant clams), as handicrafts like lamp shades and chess sets (window-pane oyster), as shrimp or crab food (*agiis*), even as hope for communities for a better economic life (*imbao* and green mussel culture).



Each article in this issue carries a short introduction to the industry in Southeast Asia, some useful tips to mollusc farmers, and the efforts of SEAFDEC/AQD and other institutions to develop or refine culture technologies.



We hope you will find this issue practical and thought-provoking as well.



Taking the pearl from the oyster

[Above photos from Okutani T, Tomiyama T, Hibiya T. 1985. Fisheries in Japan Vol 12: Bivalves. Japan Marine Products Photo Materials Association]

Aquaculture for resource conservation: giant clam R&D in the Philippines



Abalone

By **AP Surtida**

Abalone is a type of conch belonging to the family *Haliotidae* of the class *Gastropoda*. It inhabits rocky reef areas of coasts facing the outer sea. It feeds mainly on seaweeds, and has a demonstrated limited mobility.

There are about 100 species of abalone around the world, but the bigger species that are useful for commercial fishery are found in the temperate zone. Cold water and tropical zone species tend to be small in body size and is distributed in small numbers (Fishery Journal 1992). Countries which have commercial fishery of abalone include Japan, Korea, the Pacific coast of North America, South Africa, Australia, New Zealand and Mexico.

Japan's annual catch of abalone is about 4,000 tons. Japan also imports about 1,000 tons of fresh, frozen and refrigerated abalone annually from China, Korea and New Zealand, and another 1,000 tons of canned abalone and several hundred tons of processed (cooked) abalone from Australia. In addition, Japan exports several dozen tons of dried abalone to Hongkong and Taiwan.

According to Martin Johnston (Seafood International 1997), abalone is among the main contenders along with dolphin fish, scallops, Atlantic halibut, spotted wolffish, red drum, freshwater prawns and Atlantic cod, which constitutes aquaculture's third wave.

Johnston reports that intensive fish farming is a mere 30 years old, yet in such a short time producers have successfully managed to make farmed Atlantic salmon and rainbow trout a permanent fixture in European supermarkets.

A second wave of aquaculture products according to Johnston, reached the shelves in the early 1990s. This was dominated by imported farmed products such as: turbot, seabass, sea bream, tilapia and tiger prawn.

Like any healthy business, expansion and diversification are high on the fish farming agenda. The prime considerations for selecting new species are market demand and profitability, reports Johnston.

Abalone is considered the most valuable marine mollusc, which is available fresh, frozen, canned or dried and can be eaten raw or cooked. The foot of the larger varieties can provide several sliced steaks.

Abalone shells can be used to make jewelry, buttons and ornaments. In the Far East, it is also used as part of traditional medicine.

The largest species is the red abalone (*Haliotis rufescens*), found in North America, while the most economically important is *H. discus hannai* from Japan.

Different techniques have been used to induce them to spawn in captivity, including irradiated sea water in Japan and hydrogen peroxide in the US.

Upon reaching 5 mm, juveniles are transferred to growing tanks or can be seeded in the seabed. Mortalities are high. Recovery rates in Japan are 15-20%.

The first abalone farm in Mexico, Abulones Cultivados, was set up in 1992. Five years later, the first harvest consisted of 60,000 pieces measuring 7.5-9.0 cm each. They were sold at US\$35 per kilo (10-12 pcs).

Again, the Japanese are the biggest buyers of Mexican live abalone. They were sent to Japan by air in specially chilled and aerated containers. The trip was 36 hours, but the high retail price justified the effort.

Haliotis rubra abalone are farmed in the Channel Islands, according to the Johnston reports. In 1994, six tons worth US\$ 167,000 was sold to the French market.

Abalone farming is now underway in a number of countries, including South Africa, Australia, and New Zealand. The latter variety (*H. iris*), known as *pana*, is especially valued for its beautiful purple and turquoise colored shell.

Tips for the new abalone farmer

For the would-be abalone farmer, it is important that one should familiarize himself with the product form and standards in order to deal effectively with the market. Below is a list (Oakes FR and Ponte RD, Aquaculture 1996) which provides a few broad generalizations about the relationships between abalone quality, value and marketplace which help distinguish the major product standards.

- **Color** - the color that is relevant in the market is that of the foot. Species with lighter pigmentation are generally considered better and usually command the highest prices. The darker,

heavily pigmented species are graded lower and require more trimming, washing or bleaching prior to sale.

- **Texture** - traditional abalone recipes use the meat in three general texture forms: tenderized by cooking, canning or pounding, raw meat with crisp texture, and dried.
- **Tenderized products** - canned and steak abalone are the best examples of tender forms in which abalone is marketed.

In the major markets of China and Southeast Asia, most of the product consumed is imported canned abalone.

Quality is determined by uniformity of the texture and whiteness of the meat. Subtidal species, such as *H. fulgens* and *H. laevigata*, are preferred for these attributes.

- **Abalone steak** - this is the traditional presentation in North America. The product is prepared by hand-pounding thin slices of meat from the foot portion of the large, west coast species (*H. rufescens*, *H. corrugata*, *H. fulgens*, *H. sorenseni*, *H. cracherodii*). Quality standards are based on tenderness, size

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Hatchery-bred abalone broodstock



AQD
researcher
Armando
Fermin

The work of SEAFDEC/AQD

At SEAFDEC/AQD in Iloilo, Philippines, researchers have successfully spawned *Haliotis asinina* in captivity, and have grown the hatchlings into broodstock in 12 months.

According to AQD researcher Armando Fermin, abalone suffer from heavy fishing pressure like any other fishery stocks. That's why AQD is continuously refining the breeding and hatchery techniques it has developed to easily produce sufficient seeds for restocking, thus, helping restore natural abalone populations.

Fermin adds that they are also looking at the hatchery technology as a catalyst to the development of the abalone aquaculture industry in the Philippines.

"Our country is one of the major producers of abalone from capture fishery. In fact, the Philippine production of abalone from capture fishery is still on an upward trend, which is in contrast to other major producing countries like Australia, Japan, Mexico and New Zealand," says Fermin. "There are already processing plants in Cebu that are exporting canned abalone. These are sourced from fishers who collect abalone from nearby provinces of Samar, Negros and Surigao."

In addition to studies on broodstock and hatchery techniques, AQD is also exploring new research areas like larval settlement by artificial methods and grow-out culture in net cages in a nearby coastal community.

AQD has also refined some nursery practices that can now be recommended. According to Fermin, smaller juveniles (5-8 mm) should be sorted and separated from the large

(14-16 mm) ones before they are reared in the nursery. This would prevent stunting the growth of the smaller ones.

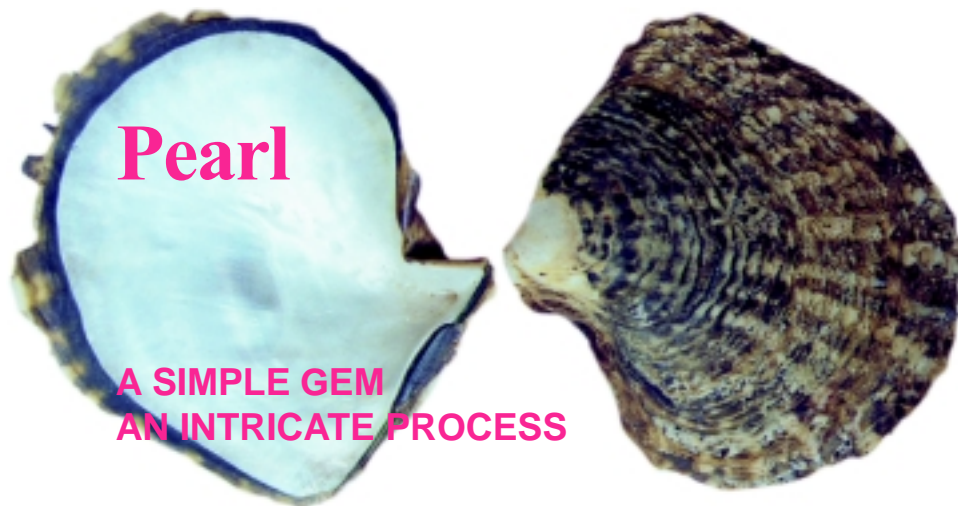
Also, juveniles measuring 11 mm and weighing less than half gram can be stocked at 685 individuals per m². Fermin also recommends rearing juveniles in outdoor tanks as sunlight favors growth of microalgae, a natural source of food.

Juveniles reared outdoors consume more food, resulting in faster growth rates and shorter rearing period.

In terms of practical diet for juveniles, a diet with an optimal crude protein level at 27%; lipid at 5% and carbohydrates at 40% supports abalone growth better than seaweed alone.

Fermin concludes that AQD's future research results on abalone shall be able to provide hatchery seeds for aquaculture and searanching purposes.

A reseedling program to enhance natural populations shall also be developed to provide equal livelihood opportunities for small-scale fishers. -- APS



By **RIY Adan**

Pearl aquaculture is fast becoming a promising and sustainable form of economic activity. Governments are assessing their water resources, both marine and freshwater as pearl farming can be accomplished in either, so long as it is clean and clear.

The simplicity of the pearl makes it one of the most enduring of jewels. Yet, it would be erroneous to conclude that the process of making a pearl is similarly simple. In fact, part of the pearl's mystic lies in the fortuitous way pearls are produced. Pearls were solely a lone act of nature before but through time, man has slowly learned the secret in assisting nature in producing these jewels. However, nature's hand is not completely eliminated, for only she alone determines the character of any potential pearl.

The first practical work to produce pearls artificially was done by the Chinese in the 13th century, producing the classical pearly Buddha images in the freshwater mussel in Lake Tahu in central China. However, the credit for the development of modern pearl culture goes to Japan. The Japanese have succeeded in evolving a method of culturing perfectly spherical pearls; although there is a controversy as to who exactly among them did it. It appears that credit for the achievement should go to Mise and Nishikawa although it was Kokichi Mikimoto who established an industry for cultured pearls, earning the title of "Pearl King." Pearl culture then spread, with Japanese assistance, to Australia, Papua New Guinea, Philippines, Burma, Thailand, Malaysia, and Indonesia.

Pearl formation and various pearl types

Pearls are produced from pearl oysters both in seawater and freshwater (see table).

There are essentially three types of pearls: natural, cultured, and imitation. A natural pearl (often called an Oriental pearl) forms when an irritant, such as a piece of sand, works its way into a particular species of oyster, mussel, or clam. As a defense mechanism, the mollusc secretes a fluid called nacre which coat the irritant. Layer upon layer of this coating is deposited on the irritant until a lustrous pearl is formed.

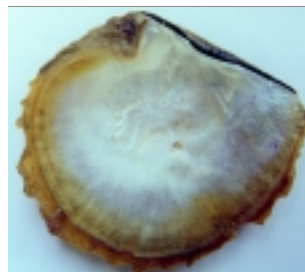
A cultured pearl undergoes the same process. The only difference is that the irritant is a surgically implanted bead or piece of shell called Mother of Pearl. Often, these shells are ground oyster shells that are worth significant amounts of money in their

Common / English name	Scientific name
SEAWATER SPECIES	
"Akoya" pearl oyster	<i>Pinctada fucata</i>
Silver-lipped pearl oyster	<i>Pinctada maxima</i>
Black-lipped pearl oyster	<i>Pinctada margaritifera</i>
"Mabe" pearl oyster	<i>Pteria penguin</i>
FRESHWATER SPECIES	
"Ikecho" mussel (Japan)	<i>Hyriopsis schlegeli</i>
"Sankaku" mussel (China)	<i>Hyriopsis cumingii</i>
"Karasu" mussel (China and Japan)	<i>Cristaria plicata</i>

own right as irritant-catalysts for quality pearls. The resulting core is, therefore, much larger than a natural pearl. A few years ago, producers successfully implanted as many as four beads or irritants in one oyster, and still produced high quality pearls.

Pearls can come from either salt or freshwater sources. Typically, saltwater pearls tend to be higher quality, although there are several types of freshwater pearls that are considered high in quality as well. Freshwater pearls tend to be irregular in shape, with a puffed rice appearance the most prevalent. Nevertheless, it is each individual pearl that determines value more than the source of the pearl.

Regardless of the method used to produce a pearl, the process usually takes several years. Mussels must reach a mature age, which can take up to 3 years, and then be implanted



Two of the three types of pearl oysters cultured by a people's cooperative in Guimaras island, west central Philippines



Community-based pearl farming

Pearl culture not only presents opportunities for foreign exchange earnings but also economic advancement of coastal communities.

The Guimaras Compressor, Operators and Divers Multi-purpose Cooperative now experiences this. The group, headed by Noel Infante of Sabang Sibunag in the island of Guimaras, used to fish and culture lobster for their main source of income. But three years ago, they came across some pearl oysters in their waters and found irregular pearls in some. This prompted them to approach the Department of Science and Technology (DOST) and request for pearl culture training.

“That started everything,” said Delia Tabanao, DOST Regional Coordinator for Guimaras. Neri Adventur from another DOST field office surveyed the site and trained the 25 members of the cooperative on how to implant irritants and beads, and the proper culture techniques. Luckily too, the cooperative was well supported – in terms of financial, technical and management aspect - by DOST and the Guimaras provincial and local government units.

The group uses three species of pearl oyster: the *wasay-wasay* (*Pteria penguin*) which is fast growing and produces a pinkish pearl; *tipay-bato* (*Pinctada margaritifera*) which produces the black pearl and *tipay* (*Pinctada maxima*) which produces the famous and expensive South Sea Pearl. They focus on *tipay* as this demands a higher price.



Ms. Delia Tabanao, the government science and technology coordinator for Guimaras province

They used to buy their irritants from the US but now, they have a supplier from Zambales, northern Philippines. At present, the group is producing half moon or blister pearls only – as they have not yet perfected the technique of inserting irritants in the gonads, which results to round pearls. Nevertheless, they already have a ready market for their produce – despite its small quantity (limited to only 150 pearls a month). Blister pearls are ready for harvest after 8 months to one year. Moreover, rejected shells are converted to souvenir items and some are made into plaques, shellcraft-making being another activity the group undertakes.

“Pearl culture in the area indeed has a very good potential,” said Tabanao, “but it’s not environment-friendly since stock are extracted from the wild. The cooperative is already looking for technology to produce their own oysters to avoid depleting the natural stock.”

On the other hand, the group which was impatient at first to harvest their pearls before these are even harvestable, has already learned the value of patience. They are interested and more enthusiastic with their project, now that they have sold the first batch of pearls.

Tabanao concludes: “Pearl culture is very feasible for coastal communities – but not as a major source of income. They still need other forms of livelihood to tide them over while waiting for the pearls to grow.”

And as they say: Patience is the name of the game. -- RIIYA

or naturally receive an irritant. Once the irritant is in place, it can take up another 3 years for nacre to coat the irritant and for the pearl to reach its full size. Often, the irritant may be rejected, the pearl will be misshapen, or the oyster may simply die from disease or countless other complications.

By the end of a 5 to 10 year cycle, only 50% of the oysters will have survived. And of the pearls produced, only approximately 5% are of substantial quality for top jewelry makers. From the outset, a pearl farmer can figure on spending over \$100 for every oyster that is farmed, of which many will produce nothing or die. However, technological advances and thorough understanding of pearl culture have made pearl culture easier to manage.

Imitation pearls are a different story altogether. In most cases, a glass bead is dipped into a solution made from fish scales. This coating is thin and may eventually wear off. One can usually tell an imitation by biting on it. Fake pearls glide across your teeth, while the layers of nacre on real pearls feel gritty. The Island of

Mallorca is known for its imitation pearl industry.

Pearls also come in many colors. The most popular colors are white, cream, and pink. Silver, black, and gold are also gaining increasing interest. In fact, a deep black pearl is becoming popular. Tahiti produces by far the most black pearls, though culture also goes on in Fiji, New Zealand and Japan. At present, black pearls dominate over white ones in Japan. Black pearls were not favored by Western buyers, but are gradually becoming popular due to their large variety of color. The soft gray pearls are especially in demand now.

Among cultured pearls, “Akoya” pearls from Japan are some of the most lustrous. A good quality necklace of 40 pearls measuring 7 mm in diameter sells for about \$1,500, while a super-high quality strand sells for about \$4,500. The South Sea pearls of Australia, Myanmar, and Indonesia are rarer and larger, with diameters of 10-20 mm, and cost far more even though they tend

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Farming the giant clam



The breeding tank at Silliman University (SU) contains breeders of two species. Drs. Hilconida Calumpong, Director, and Janet Estacion, Assistant Director of the SU Marine Laboratory with Ms. Agnes Apao and Mrs. Jacinta Lucanas, both study leaders, explain the breeding habits of the giant clams being studied

The giant clam culture project in the Philippines

The giant clam culture project in the Philippines started in 1984 with a joint collaborative project of eight Indo-Pacific countries spearheaded by Australia and supported by the Australian Center for International Agricultural Research (ACIAR). The objectives of the project were to develop culture techniques for giant clams for food and for restocking of depleted reef areas. Collaborating institutions were the Silliman University - Marine Laboratory in Dumaguete City, and the University of the Philippines - Marine Science Institute in Diliman, Quezon City. Today, after many scientific studies and conferences, culture techniques are nearing perfection, and hopefully would be picked up by an industry to supply a growing market and continue what has been initiated in the restocking of depleted reefs.

The institutions working under the ACIAR collaboration are willing to extend information and technology to interested parties. -- MBS

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

Aquaculture and enhancing stock density along reef coasts: hitting two birds with one stone. That's what the culture of giant clam promises.

The Philippines is home to seven giant clam species (*Tridacna gigas*, *T. derasa*, *T. squamosa*, *T. crocea*, *T. maxima*, *Hippopus hippopus* and *H. porcellanus*).

In 1983, *T. gigas* and *T. derasa* were included in the list of endangered species during the convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to regulate its commercial trade. In 1985, all the other species of giant clams were included in the list (the so-called Appendix II) to eliminate problems in identifying giant clam derivatives of the different species. As signatory to the convention, the Philippines has banned the exportation of all giant clams.

The Fisheries Statistics of the Philippines has reported harvests of giant clams to be 243 tons in 1976, 11,930 tons in 1980, 7 tons in 1983, and 68 tons in 1984. This decline has been attested to by Dr. Hilconida

Calumpong, Director of the Silliman University Marine Laboratory (SUML) in Dumaguete City when she said that when she was in Cuyo Island in 1978, she could walk on wide areas of giant clams in the intertidal areas. Ten years later, the giant clams were gone. A distribution study by Calumpong and Cadiz in 1993 (five of 6 sample sites are protected areas) again showed that no *T. gigas* and *T. derasa* were found while *T. crocea* and *T. maxima* populations were stable. The last two are boring clams (they embed in coral heads) and are thus more difficult to harvest; it is safe to assume that the other three species are endangered.

What are giant clams?

Giant clams are slow growing, long living organisms, and the largest living bivalve shells in the world. They are found in tropical waters (in clear water, barrier protected lagoon environments) of the Indo-Pacific like Papua New Guinea, Indonesia, Malaysia, Palau, Northern Australia, and the Philippines. They reach sexual maturity in 4-5 years. Experts refer to them as unique because they manufacture their own food through the algae that live on them, similar to corals. The algae supply food to the clams through photosynthesis which supply sugars and nitrogen-rich compounds. Referred to as "built-in food factories," giant clams need only sunlight, water, and carbon dioxide in order to make their food. This is considered an advantage because in culture, feeding is entirely omitted.

When sexually mature, clams continuously release millions

of eggs in a day, spawning being triggered by diurnal, lunar, and environmental cues. However, mortality in the wild is high during this period. Lucky survivors settle on hard substrate, transform into juveniles, attach their byssal threads on reefs for anchor, and arrange themselves so that their mantles face the sun. Until 2.5 years, clams are vulnerable to predation. Growth during this period is fast, about 2.5 cm per yr in ideal reef flats. In degraded coasts, clam survival at this point is almost nil.

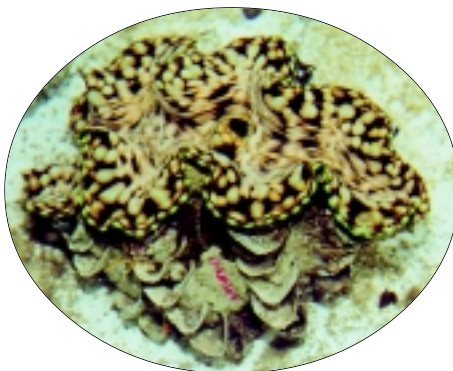
Until clams become adults, they undergo several development stages much like other bivalves: egg, gastrula, trocophore, veliger, juvenile. Fertilized eggs undergo gastrula to trocophore stages in 12 hr. After this, they become trocophores, by which time, they are still incapable of ingesting food particles. When the digestive system is complete (the veliger stage), they can now take small phytoplankton, three days after fertilization. In SUML, they are fed *Isochrysis galbana*. Veligers then metamorphose to juvenile clams 2 weeks after fertilization. Juveniles can be harvested 3-4 months after fertilization when they range from sizes 1-10 mm. From egg to juvenile, mortality is 99%.

How may clams be farmed?

Transfer of juveniles to the ocean environment can be done in intertidal areas with clear water, high salinity (away from freshwater runoffs), and good circulation. Clams are placed in trays, cages, enclosures or a combination of either on or without substrates. These areas would ensure that there is less fouling of cages, predation on clams is less severe, and human access for farm management is easier. For a cage size 1 x 5 x 0.3 m, approximately 100 juveniles (30-40 mm) can be stocked. For bigger juveniles, (70-80 mm), fewer clams should be stocked (30 ind).

By this time, clams are now relatively ready to survive by themselves. After 12-18 months in the nursery, giant clams of size 20 mm may be transferred to the growout phase. The site must first be considered with regard to the species used.

Tridacna squamosa (top), has ruffles on its shell, well distinguishable from *H. hippopus* (middle) and the rest of the giant clams which have none while *T. crocea* (bottom) is the smallest giant clam species now being studied at SUML. The *T. squamosa* photo shows the ruffles on its shell and an open colorful mantle. Giant clams close shells when taken from the water.



T. gigas and *H. hippopus* are suited to intertidal zones while *T. derasa* and the others are grown best in shallow subtidal sites. By this time, protective cages are no longer necessary. A nylon netting attached to floats (similar to a floating fence) may be helpful in excluding large predators and marking the farm area. The clams may be left in these areas for several years until harvest.

It is best to refer to a paper from SUML by Calumpong and Solis-Duran about constraints to restocking. The paper showed that of 26 sites restocked (more than half were marine sanctuaries, two were resorts, and one seaweed farm), the coral reefs yielded highest overall survival, followed by sandy areas and seagrass beds. Growth rates were comparable in these areas. The study also showed that restocking can be successful especially if the areas are protected from typhoons and poaching, and careful handling of clams is practiced. Survival is as much as 60%. But restocking must be measured not in terms of survival but on the recruits that have been traced to the restocking, thus, the necessity for markers.

Adult giant clams can grow to over 1 m length (*T. gigas*) making it the world's biggest bivalve mollusc. According to Tisdell, this species is sometimes referred to as the killer clam, arising from the reputation for closing on divers, thus preventing them from returning to the surface. *T. derasa* is the second largest while *T. crocea* is the smallest. In SUML, 8-9 year old *T. crocea* are about 20 cm length.

The market for giant clams

In the Philippines, giant clam meat is popular to coastal dwellers, especially if typhoons and monsoon rains prevent the fishers from going farther out to sea to fish. In 1987 (clams must still have been plentiful), fresh clam meat cost ranges were P7-25 in Guiuan, Samar; Naic, Cavite; Polillo, Quezon; and Alaminos, Pangasinan. In Bongao, Tawi-Tawi, giant clams cost P5 per bunch.

In Cebu and Negros Oriental, live *T. squamosa*, *T. maxima*, and *H. hippopus* 7.5 - 40 cm long cost P2-50 per pc. These are usually sold for the marine aquarium industry.

In Palawan, dried adductor muscle cost P70-120 per kg reportedly sold offshore to Taiwanese and Japanese vessels while in Cagayancillo Island, shells of giant clam (paired and unpaired) 7.5 - 13 cm long cost P0.60-14/kg. Adductor muscles of large

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Agiis: a bivalve cultivated as live shrimp feed

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

Agiis (no scientific name) is the Hiligaynon term for a tiny bivalve: shell length 1.2 cm, width 0.6 cm, shell color greyish with light brown patches. Its shell is soft, readily crushed by shrimp and crab. It is cultivated in the province of Capiz in the island of Panay, west central Philippines as live feed for shrimp and mudcrab, and sometimes for tilapia and milkfish.

water means mortality.

Agiis juveniles are gathered in the open sea (Pilar Bay) near the mouth of the Pontevedra River. Gatherers scoop them with a fine meshed scoop net with a bamboo frame. Depth of the scoop is ≥ 0.5 m; circular bamboo frame (with a handle) dia is ≥ 0.75 m. A can of juveniles sells for P30 but if one cultivates it, he can pay



One would think that these men are packing gravel. A very close look would show that it is cultivated agiis, being readied for market to shrimp owners



Agiis picked up from muddy substrate. Note the byssal threads that keep them attached to each other

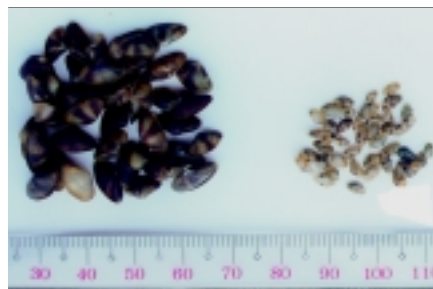


Boy Bayhon examines shrimp fry offered by a fry dealer

Alejandro “Boy” Bayhon of Pontevedra, Capiz uses live *agiis* in his shrimp ponds in combination with trash fish (50:50) for the past 10 years. He cultivates *agiis* along Pontevedra River in Brgy. Mandulano and Quiaho in the town of Pres. Roxas on a 7-ha area. “It is good business,” he says. He considers *agiis* lucrative as he sells a can at P45-60 (can size is about 0.5 m³). Most shrimp and mudcrab farmers near his area use *agiis* as live feed.

***Agiis* cultivation**

Agiis is stocked in a substrate of pure mud with constant exchange of sea and freshwater. In parts of Pontevedra River where *agiis* are stocked, the mud substrate is almost 0.5 m thick. The River runs along several towns in the province of Capiz, thus it is sheltered and does not have much disturbance. Tidal exchange is constant. This exchange is considered important by *agiis* farmers because they say that shells turn hard in pure saline water, making the *agiis* feed suitable only for mudcrab while pure fresh-



Adult (left) and juvenile agiis

The muddy cultivation area of agiis in Brgy. Mandulano, Pres. Roxas, Capiz. If one runs a hand over the muddy site, one would feel the numerous small shells beneath one’s palm



P5 per can to his gatherers. A gatherer can sell 10-20 cans a day. In his 7-ha *agiis* cultivation field, Mr. Bayhon stocks 100-500 cans of juveniles. Broadcast of juveniles is usually done during low tide when the mud substrate is exposed. He would then leave the juveniles for two months, after which time he would harvest them.

The muddy substrate must have a depth of at least 0.25 m. Thicker mud is much better for sufficient shelter because the cultivated *agiis* can reach a thickness of about 0.25 m in the mud. A can of juveniles easily translates to 3-5 cans during harvest. Thus,

a can of juveniles (P30) can fetch P90-150 at harvest after a month.

February to October is the period when *agiis* juveniles are plentiful. But Bayhon says that most of the time, *agiis* is abundant year round. When *agiis* is not available in his area, he gets his juveniles from Hinigaran, Negros Island, but he complains that *agiis* from Negros are harder shelled than *agiis* from his home place.

Agiis is harvested with the use of a nylon mesh net sewed to resemble a cone almost 5 m long attached to a bamboo frame. At the muddy bottom, *agiis* (including mud) are scooped into the net, and pushed to the farthest end of the



A gatherer uses one hand to push agiis into the a net



A gatherer, at right, rinses the net of harvested agiis while another transfer agiis to the boat

cone while continuously rinsing it of mud as *agiis* is pushed to the closed end of the net. The *agiis* are further rinsed and transferred to boats.

Feeding

Bayhon polycultures shrimp with milkfish and mudcrab in 110-ha ponds. At a stocking density of 3 shrimp per m², he feeds 10 cans live *agiis* per day in combination with trash fish at age 1.5 months or at weight 20 g of shrimp. If he feeds *agiis* in the

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Trochus: the mollusc for buttons

By **MB Surtida**

Except for those who trade it, little is known about trochus, also called top shell (*Trochus niloticus*). It can be referred to as the button mollusc because its shell is a highly priced export commodity that is manufactured into buttons for fashion houses in many developed countries like Italy, Japan, United States, the United Kingdom, and Austria.

The trochus is a marine mollusc that resembles a spinning top. The iridescent, inner layer of the top shell called mother-of-pearl is the preferred part for manufacturing buttons. Aside from its shell being exported to developed countries, the trochus meat is edible and cooked, dried or canned occasionally for consumption. In 1994, it was estimated that 80% of the trochus harvest in the South Pacific were taken for subsistence purposes. Thus, trochus growing is a possible entry for social and economic development in coastal areas in the South Pacific and Southeast Asia.

The trochus characteristics

Trochus lives on coral reefs and reef flats. Its natural range is limited to a region from Ryukyu, through the Philippines, Indonesia, to Fiji, Vanuatu and northern Australia. But its geographical range has been "greatly enlarged by artificial distributions." They have been introduced successfully in many South Pacific countries because of its commercial value.

Trochus are mostly found in slabs of dead coral covered by small algae, diatoms, and marine protozoans (foraminifers). Large trochus stay in reefs that are exposed to wind. They usually cling to reef flats with their muscled feet. The depth they usually inhabit are the first ten meters but researchers have found some in 24 m depth.

Many countries in the South Pacific have been successful in collecting broodstock, inducing them to spawn, rearing larvae, and growing them to the preferred harvest size of 65-100 mm. Trochus broodstock are usually sizes 65-120 mm. It has been found that trochus spawns year-round every 2-4 months but in some places, spawning is defined during the warm months, October - April.

Twelve hours after fertilization, trochus eggs hatch. From trocophore to pediveliger stage, larvae are stocked 4-8 larvae per ml. Water is gently aerated and changed at least once daily. Larvae are then reared to veliger stage then transferred to juvenile rearing tanks.

One month prior to transfer of larvae to juvenile rearing tanks, algal cultivation should be started. The juveniles will be stocked in these rearing tanks when algae have grown on the walls and

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Imbao, the mangrove clam



By **RIY Adan**

Thirty to 90 cm deep in the mud lies the mangrove clam – one of the most noteworthy species among the edible mangrove-associated mollusks.

This mangrove clam *Anodontia edentula* (locally known as *imbao*) is widely distributed in the Indo-West Pacific, from East and South Africa, including Madagascar and the Red Sea, to eastern Polynesia; north to southern Japan and Hawaii, and south to New South Wales. It inhabits the muddy bottom of mangrove areas, or the adjacent mudflats. It grows to a maximum size 8-9 cm shell length, total weight of 180-210 g and is a potential aquaculture species.

Imbao is a highly-prized shellfish in coastal areas where it is abundant; hence an important source of food and livelihood. In the Philippines, *imbao* is ample in Visayas and Mindanao. It is sold in some seafood restaurants at prices slightly higher than other clam species, at P5-8 apiece. *Imbao* is often cooked as soup, steamed or broiled, others prefer to eat it raw. However, overexploitation and habitat destruction has led to the decline of its population.

In 1997, SEAFDEC/AQD started work on *imbao* – as a component of its mangrove-friendly aquaculture program. AQD sees stock enhancement within a wider program of mangrove conservation and rehabilitation as a way to bring it back. Towards this end, AQD researchers led by Senior Scientist Dr. Jurgenne Primavera has undertaken studies on the shell's reproductive biology and existing fisheries.

Mangrove clams were collected in San Roque, Estancia, Iloilo using the “mata” system – a non-destructive collection method. They hired the services of skilled *imbao* collectors; people who can pinpoint the exact location of *imbao* through the opening of its siphon – or what is locally called “mata” (a reference to the hole or opening in the substrate). This method spares mangroves from damage caused by digging.

Field samplings revealed that *imbao* can be collected at mean depths of 30-40 cm. Monthly range of sizes of *imbao* was 43 –51 mm mean shell length and 21 - 170 g total weight. Moreover, female and male adults were successfully induced to spawn using serotonin. Females that spawned ranged from 60 g, 57 mm shell length to 125 g, 73 mm shell length. The maximum number of eggs spawned by a 71 g female was 1 million.

AQD researchers are also studying the potential of *imbao* as sediment cleaner. *Imbao* belongs to a shell family (Order Veneroida, Family



Juvenile Anodontia edentula inside the cavity of an adult clam



AQD researcher Junemie Lebata injecting serotonin in imbao to induce spawning



Using the “mata” method in collecting A. edentula from the burrow in mangrove mud

The window-pane (*kapis* shell) industry

By **RIY Adan**

Philippines' once thriving window-pane oyster or *kapis* shell industry still has a chance to be revived – if and only if there is a concerted effort from the people to save it. Research has done its job – now, the people has to do its share. This is the only solution left if the country wants this shell industry back.

The industry

Window-pane oyster or *kapis* shell (*Placuna placenta*) is a bivalve mollusc commercially and economically important because of its translucent shell.

Kapis shells are used as raw materials for home decoration and construction. They can be made into beautiful handicrafts like window sills, lamp shades, flower vases, chandeliers, chessboards, glass covers and coasters, wind chimes, wall panels, ashtrays, among others. They can also be used for making animal glue, chalk, shellack, soldering lead, and paint. These shellcraft products are exported to the USA, Japan, West Germany, and other European countries.

Kapis shells gathered from the wild are dried and graded according to quality and size. Proper handling of the shells should be ensured to get its maximum value. Shells that square above 75 mm are classified as first class while those that square less than 60 mm are graded as fourth class. Empty shells are soaked overnight in freshwater, scraped to produce the desired luster and rubbed against a rock or earthen jar to smoothen the edges.

For *kapis* to open naturally, the shells are dried, thus avoiding damage to the shells while the meat inside is removed. The meat is edible and has a higher protein content (23.2 g per 100g of fresh meat) than mussel and oyster. However, it is sacrificed during drying, but not wasted. It is often made as a component for poultry and shrimp feeds.

Distribution

The only source of *kapis* is wild stocks that used to abound in some selected areas. Window-pane shell is found in the Gulf of Aden around India, the Malay Peninsula, the southern coasts of China and along the northern coasts of Borneo to the Philippines.

There are 27 natural *kapis* beds in the Philippines. The major sources are found in Sapian Bay and Roxas City, Capiz; Oton and Tigbauan, Iloilo; San Miguel Bay, Camarines; Hinigaran and Pontevedra, Negros Occidental; Mangarin Bay, Mindoro Occidental; and Panguil bay, Misamis Occidental.

Kapis shells are found in muddy or sandy-muddy substratum in shallow areas or up to 100 m deep. They thrive best in

areas with bluish-soft mud (*lab-no*) or slightly sandy-muddy substratum.

Kapis shells are filter feeders. Their diet consist primarily of plankton and organic detritus, thus they need areas with high primary production devoid of macrobenthic algae and eel grass community. They are also highly prolific, and they spawn periodically. Sexes are separate though males and females are easily differentiated externally by the color of the gonad. Fertilizations occur externally; maturity commences at shell diameters of 70-100 mm but gonads are observed at sizes 50-80 mm.

Seedlings are usually collected during the first half of the year while bigger sizes and adults are gathered in the second half. They are usually found in bays, coves, and estuaries but not in sandy and or coralline areas.

Kapis shells can be cultured or transplanted in areas with the following physico-chemical parameters: water temperature, 24.5-30°C; salinity, 18–38 ppt; pH, 6.4–7.7; and dissolved oxygen, 2.5–5 ppm.

The larvae are planktonic for about 14 days. Juveniles and adult *kapis* are benthic and sedentary. They are incapable of spatial movement since newly settled juveniles have only feeble locomotor capability. In view of the inherent inability of post juveniles to move substantial distances, transplantation of segments of the population of a crowded area to a less densely populated one is beneficial. Density should be limited to approximately 150-200 per m² (1.5–2.0 million seedlings per ha) to allow normal growth and prevent overcrowding.

The downfall of the industry

Time was when *kapis* shells were among the Philippines' export products. In fact, *kapis* ranked fifth among the major fishery exports of the country in 1991, raking US\$35 million.

Today, however, their number is dwindling and worst, in some places have totally disappeared.

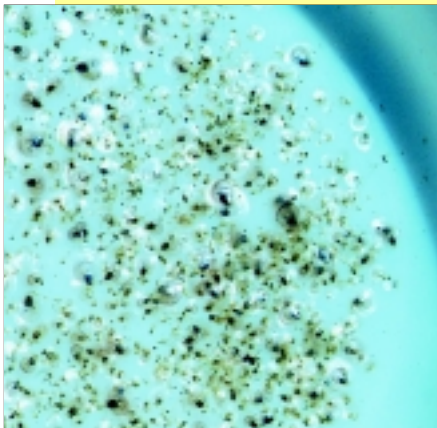
Overexploitation of *kapis* has been observed from the late 1970s until their disappearance in the late 1980s when the demand in the world market dramatically increased with the opening of the Japanese and European markets. With the high market demand, gatherers collected all they could – despite government's prohibition on the harvest of shell with sizes less than 80 mm and more than 100 mm - thus depleting the resource. Moreover, being an open-access type of fishery, harvest is not regulated.

Among other causes of *kapis* depletion are destructive methods of fishing and gathering such as trawling, use of mechanical

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SEAFDEC/AQD and the *kapis* shell

AQD researcher Jo Ladja



A year after breeders have been stocked, *kapis* juveniles are present in the project site south of Iloilo City

SEAFDEC/AQD started studies on the *kapis* shell (*Placuna placenta*) in the 1980s. Since then, AQD has taken strides in understanding the settlement behavior of the species to complement studies on the development of *kapis* farming technology. Moreover, previous studies included hatchery (focused on salinity requirement and food preference) and broodstock management (feed concentration). Induced spawning and hatchery rearing were successfully carried out, while refinement of hatchery seed production has been on-going.

Areas of research that AQD is eyeing in the future include broodstock development, refinement of larval rearing techniques, and nursery rearing.

Last year, AQD through its technology verification and extension program collaborated with the local government units (LGUs) of Oton, Tigbauan and Guimbal, all in southern Iloilo, to revive the industry along Panay Gulf. *Kapis* breeders from Himamaylan and Hinigiran in Negros Occidental were stocked in 1999. The aim of this artificial reseeding is the rehabilitation of the *kapis* industry. AQD assisted the LGUs in dispersing *kapis* breeders in their respective territorial waters. The seedstock produced from wild breeders induced to spawn at AQD's mollusc laboratory were also dispersed along the Buyuan coast (part of Tigbauan).

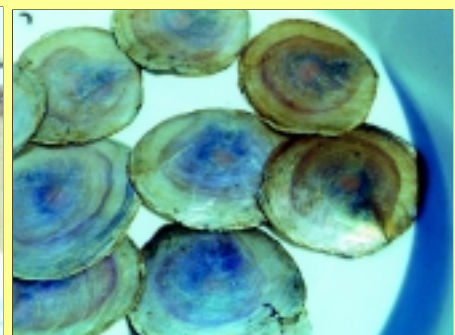
Samplings last May showed the presence of juveniles along the Oton coast that are harvestable by mid 2000. But SEAFDEC officials appealed to the residents not to harvest the said stock until early 2001, as they are needed to grow and reproduce until there is abundant supply in the area.

"But we were greatly disappointed when a month later, only a few live *kapis* and damaged shells were left," said Ms. Jocelyn Madrones-Ladja, AQD researcher. "We suspect that the shells were secretly harvested."

She added, "Although there are community patrols to guard the sites, they don't have the facilities (like motorized boats) to go after big time fishers."

Ms. Ladja is again asking the people to increase security in the sites to sustain the stock enhancement program.

"If we don't leave the stocks to grow and multiply, then there is no way we can bring back the *kapis* shell industry!" she concluded. -- RIYA



The Hon. DA Undersecretary Cesar Dylon (middle photo, left) and SEAFDEC/AQD Chief Dr. Rolando Platon inspects the *kapis* breeders (above) in the Tigbauan, Iloilo reseeding site (leftmost photo)

Mussel: festivals and producers

By **E Gasataya**

Since ancient times, mussels have been gathered from the wild for food. There had been tales regarding mussel eating, and one of the earliest is from the west coast of America 2,400 years ago when the inhabitants turned to mussels because they had eaten so many abalone that the colonies were almost wiped out.

All through the centuries man has learned to raise and harvest mussels in different ways. Cultured mussels can be harvested all year round, while mussel fisheries is defined by season. The start of a new season always calls for a celebration.

The Dutch celebrates the most popular festival each year in mid-July in Yerseke, the country's "mussel capital." All the major operators attend the event that attracts attention from the world's media. The harvest is loaded onto lorries which are lined up behind an enormous banner depicting bowls of mussels.

In Menai Strait in North Wales, there is also a mussel festival. This is supported by a Belgian mussel-and-chips chain whose chefs cook nearly 3,000 mussels. This event comprises of parades and races, mussel cooking competition and demonstrations, fairs and exhibits, and many more.

In Bantry Bay, Ireland, an annual mussel festival is also held, and is supported by the individual operators and the Irish Sea Fisheries Board. The event includes jazz festival with non-stop music, mussel eating competitions, seafood stalls, helicopter trips around the bay, boat trips and a gala seafood banquet.

Other countries have also their own mussel festival like in Europe such as Italy, France and Spain and in the other side of Atlantic in Nova Scotia and Canada.

Aquaculture production

With the worldwide popularity of mussels, it is thus no surprise that over 203,000 tons of mussels from the wild and more than a million tons of farmed mussels were landed in 1998 (FAO data).

In terms of production and consumption, the European Union plays a dominant role with 500,000 tons produced each year. Spain is the largest producer among EU countries with 130,000 tons followed by Netherlands (80,000-100,000 tons), Italy (70,000 tons) and France (70,000 tons).



A mussel farmer in the Philippines stands by his harvest

In Asia, China has become an important source, with production jumping from 100,000 tons in 1983 to 400,000 in 1995.

New Zealand on the other hand produced 16,000 tons in 1986 which increased to 67,000 tons in 1997. The company Sealord has a total farmed production of 17,000 tons, an equivalent live weight of a total of 67,000 tons. This made the company the number one producer. Sealord does not only produce but also process

and export frozen items, including: blanched mussels in half shell, blanched mussels IQF, vacuum-packed mussels in sauce (garlic butter, chilli coriander) in shell, hot smoked mussels meat in sauce (plain garlic, barbeque, Tandoori, Teriyaki sauce) and coated mussels meat.

From Basavarajappa et al. (2000) we have two examples of mussel producers -- Spain, the largest, and the Philippines, a modest one.

The case of Spain

Mussel farmers in Spain use seed collectors consisting of loosely woven and heavily tarred ropes, 12-15 cm in diameter, made of sparto grass or nylon. These ropes are 10-m long and are hung from rafts; the rafts also serve as grow-out ropes. To prevent the mussels from slipping, wooden spacers about 12 mm thick are used. If spats fail to settle, farmers resort to collecting seed from natural beds on rocky shores.

The collected seed mussels are tied around ropes in clumps using a fine, large meshed rayon netting which disintegrates in a few days leaving the mussel seed firmly attached to the ropes and then suspended from rafts floated over sunken river beds.

When the ropes become heavy, they are thinned out and distributed over a greater length of rope. The harvested mussels are then sold to canneries or placed in depuration tanks before export.

The case of the Philippines

In the Philippines, extensive bamboo structures are erected in muddy seashore areas to collect mussel seed. Since no transplantation is done once the spats settle, spat collection and grow-out

☞ next page

are combined. In six months, the mussels have grown to marketable size. Divers pull out the planted poles and strip them of grown mussels which are then graded and cleaned. The stock is transported to the market rapidly.

The farmed mussels give better yield than from the natural beds. Mussel farming production rate is 8 kg per m of rope, which works out to 150 tons per ha in a 5-month period. Average edible portion of the meat in the cultured mussel is 35-40% while in natural beds, it is only 27-33% of total weight.

A community raises oyster

Oysters are farmed in some parts of the Philippines. In Bohol, an island in central Philippines known for its pristine waters, a community from Buenavista has applied for a P20 million loan to the World Bank through the Coastal Resource Management Project (CRMP), a five-year project of the (Philippine) Department of Environment and Natural Resources. CRMP was organized to help communities conserve and at the same time benefit from its natural resources.

The beneficiary of the CRMP link-up is Bry. Kambuhat, Buenavista, which has 27 households; the plan is an oyster culture project. Each household was awarded an area not exceeding 500 m² of mangrove forest. Each household fenced the area, and was provided financial and technical assistance. A family needs only about P1,000 to purchase the required production materials for the hanging method of oyster culture. The period of growing oysters is about 6 months. After which a harvest amounting to P70,000 to P80,000 is reasonably expected.

The community is also actively supported by the local government unit (LGU). The local legislators and executives have enacted ordinances protecting the local environment, including an ordinance proclaiming Brgy. Kambuhat a marine sanctuary.

The community project entails a 70% grant component and 20% loan from the World Bank, and a 10% equity in the form of equipment and other development costs by the LGU. -- EG



SEAFDEC/AQD's model of the hanging raft culture system for mussels and oysters

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SHELLFISH WEBSITES ... from page 10

thousands of individuals campaigning against animal abuse in Great Britain and around the world.

One of their targets is the treatment of shellfishes, and their website offers downloadable leaflets. The issue on shellfish is as follows --

BOILING THEM ALIVE ISN'T REALLY CRUEL, IS IT?
Compared with other animal welfare issues, the treatment of shellfish has aroused very little effective opposition. They are commonly boiled alive, though for some dishes living crabs or lobsters are cut-up, and for lobster mousse, the flesh is scraped out of the live animal. Perhaps most people see shellfish as cold-blooded creatures that cannot feel pain. This cannot be taken for granted. Crabs and lobsters in particular have a complex nervous system and there is a body of scientific research which suggests that they do feel pain and distress.

Oxford University zoologist Dr. John Baker found that lobsters dropped into boiling water showed "powerful struggling movements" for up to 2 minutes, and he concluded that these were not reflex actions but indications of pain.

Alternative cooking methods, claimed to be humane, have been put forward by animal welfare organizations. They involve precise techniques of piercing, cutting or freezing which quickly kill the animals, or stun them, so that they allegedly feel no pain, immediately before boiling or chopping up.

But even if these methods -- which some experts do not accept as humane -- were universally adopted, shellfish would still have endured often cruel forms of trapping, transport and storage. Traps lost on the seabed or washed ashore onto inaccessible beaches leave their victims trapped indefinitely. Crabs and lobsters are often transported in densely packed containers and stored in overcrowded tanks with their claws tied.

(Support guidelines) to the catering industry on avoiding cruelty to shellfish. ###

reader feedback

Recently, our editorial consultant, Mr. Renato Agbayani, received the following email from Dr. Theo Ebbers, a consultant on coastal resource management fielded by the German Development Service in the province of Aklan.

Dear Mr. Agbayani:

Attached you'll find a draft proposal for a seminar-workshop on aquaculture which basically follows the frame set by the SEAFDEC aquaculture magazine "A beginner's guide to aquaculture." [This is our issue Vol. XXII, No. 2, March-April 2000. -- Ed.] The goal of the proposed workshop is to provide (the local resource management council) with a basis for project planning ...

Dr. Theo Ebbers <thebbers@kalibo.i-next.net>

We have always known that extension materials on aquaculture are difficult to come by considering that few institutions produce them and in limited numbers. This SAA newsletter for instance has a circulation of 2,500 -- potential aquaculturists and the general public (42%), government extensionists (22%), research and academic community (22%), private sector or industry (9%), and policymakers and local government executives (5%). It is produced every two months. We are therefore heartened to know that one of our newsletter issues has a direct, practical impact on the practitioners of aquaculture.

We have seen a slow but steady increase in the number of paying subscribers, more than 70 new subscribers by mid-year 2000. We take this opportunity to welcome them. Happy reading!

SAA Editorial Staff

Another reader-contributor wrote to thank us for publishing his article on the golden apple snail --

Dear Ms. Castaños:

I wish to thank you for all your assistance. Since the special report on the golden apple snail was published in the SEAFDEC Asian Aquaculture newsletter [This is our issue Vol. XXII, No. 1, January-February 2000.], many golden "kuhol" workers have contacted me and we are making progress in this direction.

We are also very confident that the Government of Thailand's Department of Agriculture (DOA) and the Bureau of Agricultural Research (BAR), Philippines collaborative project on agriculture, fisheries and livestock will soon start. You will be happy to note that our proposal on golden "kuhol" in one of the priority projects of the Thai government ...

Yours sincerely,

Dr. Ravindra Joshi, DA-PhilRice

Dr. Joshi's new contribution, a unique recipe for golden "kuhol" can be found on page 12, this issue. More power, Dr. Joshi!

happy landing

One of our writers, Ms. Nellie Joy Dagoon, has left to pursue a 1-year study program -- MS in Scientific and Technical Communication -- at the University of Minnesota under an assistantship from the American Association of University Women (AAUW). The best of luck, NJ!

MILKFISH POLVORON . . . from page 11

spines, and dorsal fins, excluding viscera and gills. The burger is 100% bone meal with a binder of flour and eggs.

At present, the burger sells for P5 a piece to the faculty and students of NISPC. They produce an average of 200 burgers a day. She wants to make it an official entry to the PCAMRD Regional R&D Review.

She is also developing an *embotido* (meat loaf) with the same milkfish offal as ingredient together with pickles, onions, garlic, peas, and eggs. The *embotido* sells for P15 per roll to the same clientele.

Other products being developed in Dr. Calmorin's laboratory are: milkfish bone soup, bonemeal baby food, sardines spread, and canned seaweeds (*Gracilaria*).

Aside from product development, Dr. Calmorin is also a

prolific author of books. She has published seven books ranging from education, fisheries research, statistics, and mathematics. Her publishers are Rex Book Store and National Bookstore. She also has seven pending manuscripts for the two publishers on fish processing, methods of research, statistics, measurement and evaluation, and income-generating projects from boneless milkfish.

Dr. Calmorin has also published several national and regional scientific papers. She thinks that more than 95% of studies and researches in the Philippines gathers dust in the libraries. If she has her way, she wants all those studies to have a high rate of investment by commercializing them. "It is a huge waste of government money to keep funding researches that have no entrepreneurial potential."

Dr. Calmorin is married to Professor Melchor Calmorin, also of NISPC and has a daughter. ###

ABALONE . . . from page 15

and color. Premium large white steaks sell for US\$100 per kg.

- **Raw abalone** - in Japanese cuisine such as sushi and sashimi dishes where abalone meat is eaten raw, a firm and crisp texture reminiscent of fresh cucumber is preferred.

The desired texture comes from the firm meat of the cold water species (*H. discus*, *H. discus hannai*, *H. cracherodii*).

- **Dried abalone** - the most common type of processed abalone in Japan. This traditional Japanese product is prepared by boiling the meat and drying it in the sun. This product is produced in Japan's northern prefectures and is mostly exported to China. Historically, this was one of Japan's largest export items to China, but the Japanese domestic demand has virtually eliminated this trade.

- **Size** - Abalone are routinely graded by size, with certain sizes commanding premium pricing in each particular market. Larger is better but within certain limits. In Japan, the preferred size is 300 g abalone; in North America, the minimum size is 600-800 g. The Chinese fishery is dominated by *H. diversicolor diversicolor* and *H. diversicolor supertexta*, which mature at 60-85 g, and this product is exported to Southeast Asia. The Chinese consume primarily canned abalone with premium sizes determined by uniform piece count (pc) in each can -- for example, 1 pc or 715 g; 2 pc, 350 g; 3 pc, 240 g; etc.

Demand and prices for premium abalone products have risen steadily during the last few years, creating an economic environment in which abalone aquaculture is becoming increasingly attractive as a financial investment. As the industry becomes more established it will be important for abalone culturists to specialize in specific products designed for specific market niches.

Elsewhere, in Australia, in a report by Trevor Rees (Fish Farming International 1997), researchers at the University of Queensland are making great advances in a project to develop a viable tropical abalone aquaculture for *H. asinina*, otherwise known as the cocktail abalone. *H. asinina* is the fastest growing abalone in the world, has a delicate flavor, and has a convenient size for banquets, making it ideal for aquaculture.

The abalone industry in Australia contributes US\$ 86 million a year to the Australian economy. *H. asinina* is targeted for both the domestic and export market for Southeast Asia, North America and Europe. They estimate *H. asinina* would fetch about US\$ 38 a kilo in the Asian market.

H. asinina is ready for market in less than a year, compared with five years for some temperate species. In Thailand, the Eastern Marine Fisheries Development Center (EMDC) succeeded in the experimental breeding of *H. asinina* in 1989 (Singhagraiwan and Doi 1993). Since then they have intensively conducted relevant rearing experiments in order to establish reliable seed production techniques for *H. asinina*.

Presently, there is no commercial fishery for abalone in Thai-

land since wild stocks are not abundant and they are not a familiar food item to Thai people. However, when large-scale production becomes possible, potential demand for these abalone species will be created on the domestic and international markets. Aside from *H. asinina* other abalone species found in Thailand are *H. ovina* and *H. varia*.

The situation is similar in the Philippines, although there is an existing commercial abalone fisheries in the provinces of Iloilo, Guimaras, Negros, Samar, Surigao, Zamboanga, Palawan and Tawi-Tawi.

H. asinina is known locally as "lapas" or "sobra-sobra", *H. varia* is known as "kapinan." The other abalone found in Philippine waters is *H. ovina*.

H. asinina can grow to a maximum size of 10-11 cm in shell length while *H. varia* and *H. ovina* are relatively smaller with a maximum shell length of 6-8 cm.

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AGIIS . . . from page 21

morning, he would feed trash fish in the evening or vice versa. Bayhon observes that shrimp fed *agiis* is good quality shrimp -- he terms it "masinaw" or smooth, healthy-looking shrimp -- and pollution is not a problem. As shrimp feeds, it leaves a fine powdery residue from uneaten shells. Tough-shelled *agiis* are eaten by mudcrab. "Mudcrab are ravenous eaters of *agiis*," says Mr. Bayhon. "Thus, *agiis* not eaten by shrimp are consumed by mudcrab. There's not much waste," he continues.

Summary

Live *agiis* have been proven to be a good feed for shrimp for the past ten years by polyculture fish farmers in Capiz. It is particularly used in the area. Its cultivation period is short and seeds are readily available. It can reduce dependence on trash fish which is now getting to be scarce; it also seems much cheaper.

Perhaps the fast-growing tiny bivalve *agiis* can be scientifically investigated by students of aquaculture as feed for other commercial aquaculture species. Its scientific identification can be a good start. ###

PEARL . . . from page 17

to be less lustrous. A 16-inch strand of white South Sea pearls retail for \$40,000 to 50,000.

The world record for the highest price paid for a cultured pearl necklace was \$2.3 million at Sotheby's in 1992. The 17-inch strand had 23 pearls with diameters ranging from 16 to 20 mm (about the diameter of a dime), with a bead-shaped platinum clasp with 60 round diamonds.

Quality improvement

The quality of pearls determines its economics. The size, shape, color and luster determine the quality and value. Apart from the bulk rates by weight, individual pearls of exceptional quality would command special premium price.

The quality of cultured pearls can be determined and improved through appropriate care at surgery and farming. Size and shape can be better controlled at surgery. But color and luster can only be improved if the oyster biology and physiology and farm conditions are understood.

The luster of pearl is due to two sensations of light, namely 'lustre' and 'iridescence', and is brought about by the absorption and reflection of the waves of incident light. The nacre is composed of several concentric layers of mineral lamellae of aragonite, each layer with a thickness of 0.29-0.60 μm . Conchiolin forms the organic matrix on which the aragonite crystals are laid and the layers bound. Homogeneity, thinness and smoothness of these layers are responsible for the pearl's luster. Minerals and trace elements in the seawater and the chemical composition of the phytoplankton components also influences the color of pearls. The abundance and quality of phytoplankton in pearl culture grounds determine the state of nutrition of the oyster.

Depth also affects the quality of pearls; those that are produced in deeper water, beyond 10 m, are observed to be of high quality. Fouling and boring problems are insignificant at depths below 10 m as compared to the subsurface waters.

Temperature generally controls the metabolic rate of the molluscs. Higher temperatures lead to faster growth of oyster and also higher rate of deposition of nacre. While this hastens production, the quality would suffer. Thinner laminar nacreous layers which result from lower temperature are more desirable than the thicker layers resulting from higher temperature, at least in the later phase of culture. Therefore, pearl harvest should be done during low temperatures. The pH should also be low.

The ecology of the culture grounds should therefore be thoroughly understood. Japanese pearl culturists shift the rafts from region to region seeking grounds of better conditions during the last phase before harvest. Several old pearl culture grounds are abandoned as culture in the same ground year after year results in poor quality of pearls. Alternation of grounds is considered important. Areas of pollution should also be totally avoided.

On the other hand, the quality of donor oysters also influence the quality of the pearl. Utmost care should be taken in selection of donor oysters and in the process of nucleus implantation.

Pearls produced in the ventral gonad region are generally superior. Pearl-sacs are formed within or in contact with the hepatopancreas produced largely grey colored pearls, though good cream colored pearls may also be produced. Pearl-sacs growing in the gonad region should be free from contact with other organs such as intestine, hepatopancreas, pedal retractor muscle and the byssal gland.

Distribution and market trends

World market for loose cultured pearls (1997)

EXPORT		IMPORT	
Australia	30.44%	Japan	67.01%
French Polynesia	25.93%	Hong Kong	11.39%
Indonesia	8.35%	USA	8.67%
Japan	11.17%	Germany	2.90%
Others	24.10%	Others	10.03%

World market for worked cultured pearls (1997)

EXPORT		IMPORT	
Japan	48.6%	USA	33.81%
Australia	12.0%	Hong Kong	15.40%
Hong Kong	8.2%	Germany	10.03%
French Polynesia	7.6%	Switzerland	7.46%
China	7.6%	Others	33.30%
Others	16.1%		

Pearls predominately come from Japan, Australia, Indonesia, Myanmar, China, India, Philippines, and Tahiti. Japan controls roughly 80% of the world pearl market, with Australia and China coming in second and third, respectively. The waters around Australia, Indonesia, and Myanmar are renowned for their large, white pearls; Japan for their lustrous pearls; and India for their natural pearls.

China, on the other hand, produces the bulk of the world's freshwater pearls. In fact, suppliers have urged for the moderation of production lest it leads to the industry's self-destruction because of overproduction. Meanwhile, Japan's freshwater pearl industry - rendered extinct by population in 1985 - is showing signs of rebirth.

The market size of pearl jewellery in retail value in 1999 reached US\$4.5 billion. Although demand in Japan and South-east Asia has been affected by the economic crisis over the past two years, the region continued to lead in pearl jewellery sales, with a spending of more than US\$1.8 billion on pearl jewellery.

☞ page 30

PEARL . . . from page 29

The United States has grown to become the single largest pearl jewelry consumer, purchasing US\$1.47 billion, or 36% of the global pearl jewelry sales. Europe, which accounted for only a small fraction of the pearl market five years ago, is seeing its market share expand at a tremendous pace, with wholesalers reporting substantial growth year after year. The European pearl jewelry market is estimated at US\$700-900 million. Meanwhile, Tahitian cultured pearl exports are expected to exceed 7,000 kg in 2000. Annual reports of Tahitian pearls were about 5,000 kg in 1996 and 1997; and more than 6,000 kg in 1998 and 1999. The Philippines, on the other hand, continues to establish itself in the international pearl market with exports increasing 22.8% to 586,665 g or 156 kg in 1999 compared with 1998.

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IMBAO . . . from page 22

Lucinidae) that harbors symbiotic bacteria. This shell family has also been observed to live in hydrogen sulfide-rich habitats such as sewage outfalls, seagrass beds, mangrove swamps, and in organically rich sediments.

This means, researchers say, that *imbao* harbors symbiotic sulfur-oxidizing bacteria in its gills and has the mechanism within itself to use up sulfide. This capability would make *imbao* useful if raised in polyculture with shrimp. It is a fact that brackishwater pond sediments contain plenty of sulfide, particularly where the cultured animals are fed protein-rich diets. *Imbao* can very well answer this problem – and make aquaculture more environment-friendly.

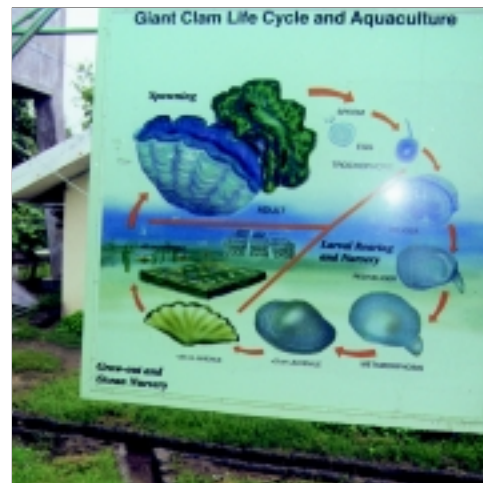
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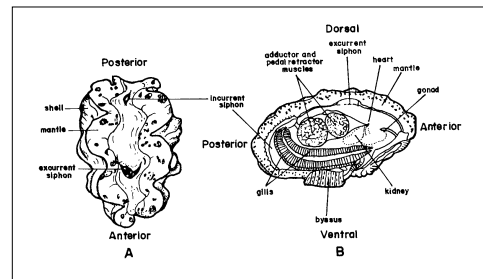
GIANT CLAMS. . . from page 19

clams are popular for export. But it is important to note that in order to produce meat biomass and supply the adductor muscle/mantle markets, time for which capital and resources are tied up prior to sales is lengthy, thus quick returns are not possible.

In Australia, farm-gate price of fresh clam meat ranges from \$A3 to 7. In 1986, it was reported that Taiwan demand for adductor muscle of 100 ton/yr was at \$US 7.50 - 21.25/kg.



The giant clam life cycle shows its stages of development



The parts of the giant clam shows the adductor muscle which is the most valuable part of the clam for export purposes. The adductor muscle is highly priced in Japan for sashimi and fetches a good price

Conclusion

Experts say that the giant clams (nearing extinction in most parts of the world) are attractive to farm for economic, social, and ecological reasons because of their innate characteristics - self-feeding, sedentary habit, adult resistance to predation. Besides, technology for its mass production from breeding to harvest has been proven successful in many parts of the Indo-Pacific. But its development as an industry is difficult to appreciate considering the duration that capital is tied up to production. Perhaps its importance lies not so much on its promise for immediate profits but on its ecological importance to coasts worldwide. Resembling big trees in primary forests, their importance cannot be measured immediately but their contribution is far-reaching and simple, one fails to see it. As in most ecological issues, the profit is promised for the coming generations. ###

TROCHUS . . . from page 21

plastic panels (35,000 pediveliger larvae per 1,000 l rearing tank). When juveniles are size 5 mm dia, they are transferred to 5,000 l splasher pools. Again when juveniles reach 10 mm dia they are transferred to be reared in 10,000 l concrete raceway tanks. In 8 months, juveniles reach 26 mm dia, and in two years, they reach market size of 70 mm.

Trochus production

Countries in the South Pacific are the principal source of trochus but other producer countries are Indonesia, the Philippines, India, and Thailand. The Japanese trochus, called “Macassar” is considered the best quality shell, it serves as a standard for prices of the other quality shells. Purchase price of the “Macassar” was US\$2,000 per ton in 1982, while South Pacific trochus was US\$1,200-1,650 per ton. In 1982, Japan imported 2,069 tons. Manufacturers of trochus buttons are Japan, Korea, Indonesia, Taiwan, United States, and Italy. In northern Italy, 210 firms produce buttons. In 1997, world export price of trochus was US\$6,000-7,5000 per ton.

Demand for trochus in the world market fluctuates. A market survey of 56 designers, fashion houses, button distributors, and upmarket retailers in Italy, France, Germany, the United Kingdom, Japan and the USA in 1997 had several findings regarding trochus demand:

- (a) economic constraints and fashion trends varies by country: in the US, economic considerations are the main factors while in France, fashion trends appear to be dominant
- (b) the fashion industry anticipates a high demand
- (c) substitution of alternative materials (plastic buttons) will not produce a major shock in the industry
- (d) more than half of the market believes that direct purchases for finished buttons from producing countries would be beneficial to them
- (e) consumers’ environmental concerns would affect demand.

Conclusion

The market projections and the state of aquaculture technology show the potential of trochus as an aquaculture commodity - a dollar earner and a source of food for subsistence coastal dwell-



The inner layer of the top shell is made into buttons

ers. As a dollar earner for developing countries, however, production would be dependent on high technology foreign manufacturers because processing from other countries such as the South Pacific cannot match “the long established and vertically integrated nature of the larger Japanese, Italian, and Spanish companies.” A study of the world market and the intricacies of marketing and processing of trochus can be studied and perhaps appreciated as a potential commodity for aquaculture in the Philippines and other neighboring countries.

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WINDOW PANE . . . from page 23

rakes and dredges, dynamite fishing and compressor diving. Trawling kills recruits and broodstock of *kapis* and destroys the substrate. Mechanical rakes and dredges have the same effect, while dynamite fishing reportedly caused massive *kapis* mortalities even in deeper waters. Compressor diving is also destructive if the divers are not selective of the *kapis* they gather. Siltation caused by heavy floods and typhoons contribute to mortality. Silt covers the entire shell and clogs the mantle and gills.

But there is hope yet; there are efforts to revive the industry by reseeding formerly abundant natural beds. SEAFDEC/AQD, for example, has been helping the local government units in southern Iloilo (see boxed story on page 25).

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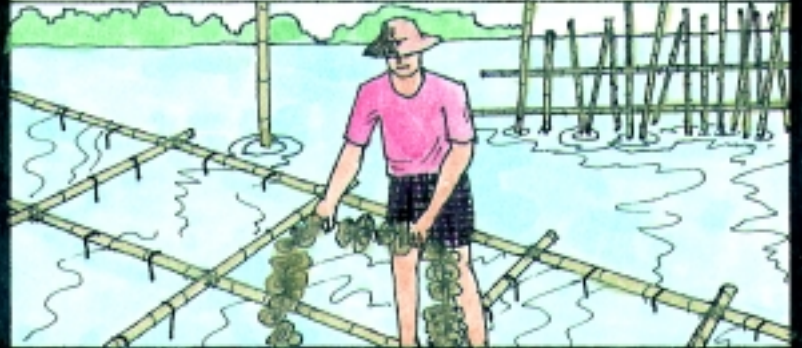
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AQUACULTURE ILLUSTRATED

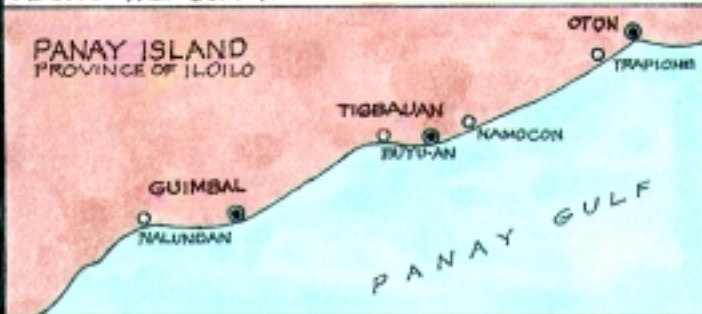
by a.p. surtida &
e.t. ledesma

BIVALVE CULTURE WHAT'S NEW?

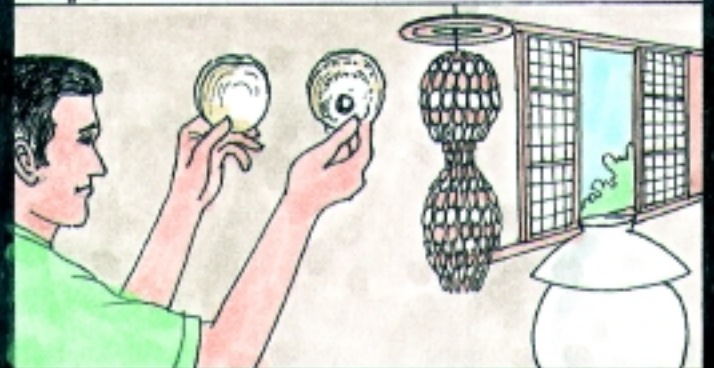
FOR YEARS SEAFDEC/AQD HAS FOUND THE SUPERIORITY OF THE HANGING RAFT METHOD FOR MUSSEL AND OYSTER PRODUCTION OVER OTHER METHODS CONSISTENTLY. THAT'S WHY IT IS BEING RECOMMENDED FOR THESE BIVALVES. AMONG ITS ADVANTAGES ARE: HIGH BIOMASS POTENTIAL, HIGHER FINANCIAL RETURNS AND LESS POLLUTION...



MORE RECENTLY, AQD EMBARKED ON THE REVIVAL OF THE KAPIS SHELL (*PLACUNA PLACENTA*), THE MAIN COMPONENT OF THE KAPIS SHELL INDUSTRY WHICH HAD SEEN BETTER DAYS IN THE LAST DECADE. TOGETHER WITH LOCAL GOVERNMENT UNITS IN THE SOUTHERN COAST OF ILOILO, AQD STOCKED KAPIZ BREEDERS ON SELECTED AREAS ALONG THE COAST.



KAPIS SHELLS ARE RAW MATERIALS FOR SHELL CRAFT PRODUCTS THAT ARE EXPORTED TO THE U.S, JAPAN AND EUROPE. IN 1991, IT RANKED FIFTH AMONG THE MAJOR FISHERY EXPORTS OF THE PHILIPPINES, RAKING IN US \$35 MILLION.



ANOTHER BIVALVE UNDER STUDY IS THE "IMBAO" (*ANODONTIA EDENTULA*) WHICH IS MAINLY FOUND IN MANGROVE AREAS FOR ITS CULTURE POTENTIAL...



ALTHOUGH NOT A BIVALVE, STUDIES ON TROPICAL ABALONE (*HALIOTIS ASININA*) CONTINUES AT AQD. THIS MOLLUSC HAS A GOOD CULTURE POTENTIAL AND IS A PROVEN WINNER IN FISHERY EXPORTS.



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Training, websites, extension materials **NOTICES**

Year 2000 AQD TRAINING COURSES

Third Country Training Program on Responsible Aquaculture Dev't (TCTP, 1st session)	January 18 to March 17
Fish Health Management	April 26 to May 31 (5 weeks)
Freshwater Aquaculture Management of Sustainable Aquafarming Systems (includes module on Aquaculture Management)	April 4 to May 3 (4 weeks) May 30 to July 5 (5 weeks)
Marine Fish Hatchery TCTP, 2nd session	June 6 to July 14 (5 weeks) Sept 5 to Nov 3 (8 weeks)

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For local applicants who wish to apply for fellowships, contact:

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

For fellowship applicants from other countries, please contact your respective SEAFDEC Council Director.

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.

SEAFDEC websites on the internet

- www.seafdec.org
maintained by the SEAFDEC Secretariat and SEAFDEC Training Department in Samut Prakan (Thailand) with contributions from the various SEAFDEC departments. Regional programs are highlighted
- www.seafdec.org.ph
all about the SEAFDEC Aquaculture Department based in Iloilo, Philippines
- www.asean.fishnet.gov.sg/mfrd1
all about the SEAFDEC Marine Fishery Research Department based in Singapore
- www.agrolink.moa.my/dof/seafdec
all about the SEAFDEC Marine Fishery Resources Development and Management based in Kuala Terengganu, Malaysia

NEW BOOKS / FLYERS / VIDEOS from SEAFDEC Aquaculture Department

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.*



Netcage 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.*

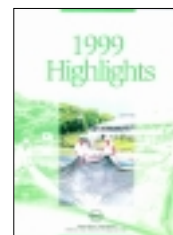
Grouper culture in floating net cages, a 10-page manual that details grow-out culture. *Price (includes postage): P80 in the Philippines, US\$ 30 other countries.*

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.

Training Module on Sustainable Aquaculture and Coastal Resource Management. Describes the new SEAFDEC/AQD training course (including course content), qualification of participants, and enrollment process.

These flyers and brochures are free upon request.

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A NEW HARVEST



This is a boatload of tiny shells known only as *agiis* in the island of Panay (west central Philippines). Notwithstanding the lack of scientific nomenclature, it is being raised in the backyard of an enterprising tiger shrimp farmer as feed for tiger shrimp and mudcrab in polyculture with milkfish.

Agiis works well as a partial substitute for the more expensive trash fish. "What is not eaten by tiger shrimp -- tougher shells -- is consumed by mudcrab," relates a Filipino farmer.

The *agiis* cultivation field is about 7-ha of intertidal zone near a river mouth where the substrate is muddy. *Agiis* are plentiful from February to October.

MORE OF THIS STORY INSIDE.



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