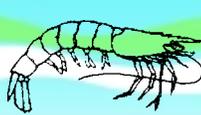
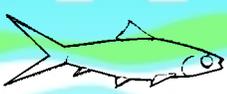


SEAFDEC Asian Aquaculture



IN THIS ISSUE
Stock enhancement



A publication of the Aquaculture Department of the Southeast Asian Fisheries Development Center
Volume XXIII Number 5-6 September-December 2001

ISSN 0115-4974

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

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

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

editor **MT Castaños**

writers **MB Surtida**
NJ Dagoon
AP Surtida
RIY Adan

editorial assistance **G Guirgen**
LM Nordista

design / layout **MT Castaños**

artwork **E Ledesma**

photography **R Buendia**

circulation **E Gasataya**
E Ledesma

editorial adviser **PL Torres Jr**

Editorial offices are located at the:
Training and Information Division
SEAFDEC Aquaculture Department
Tigbauan 5021, Iloilo, Philippines

tel. 63 (33) 335 1009, 336 2891,
336 2937, 336 2965, 511 9050
fax 63 (33) 336 2891, 335 1008
e-mail devcom@aqd.seafdec.org.ph

You may also contact the editorial staff through:

AQD Manila Office
17 Times Street, West Triangle
Quezon City 1101, Philippines
tel. 63 (2) 372 3980 to 82
fax 63 (2) 372 3983
email mlo@i-iloilo.com.ph

Contributions

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

Gifts and exchanges

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

Subscription

	FEE*
<input type="checkbox"/> 1 year / 6 issues	US\$ 9.50
<input type="checkbox"/> 2 years / 12 issues	\$12.00
<input type="checkbox"/> 3 years / 18 issues	\$15.00

*For orders in the Philippines, currency conversion is US \$1 = P 50

ADD: DELIVERY-HANDLING FEE

<input type="checkbox"/> delivery within the Philippines	US\$ 1.00
<input type="checkbox"/> delivery by Philippine Post to SEAFDEC Member-Countries	\$10.00
<input type="checkbox"/> 2-3 days delivery by special courier (all countries)	\$40.00

Please make remittances in postal money order, bank draft, or demand draft payable to **SEAFDEC Aquaculture Department**. For inquiries about **SAA** subscription and other AQD books and videos, e-mail: [<sales@aqd.seafdec.org.ph>](mailto:sales@aqd.seafdec.org.ph)

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



Our cover

Trochus, attached to a rock, are raised by a hatchery in Palawan, western Philippines. The concrete structures shown on the front cover are acclimation tanks for the shell about to be stocked in the sea.

www.seafdec.org.ph

From Around the World

Auburn U: increasing shrimp yield by increasing DO

Aquaculture would need to reduce its water use and effluent discharge if it is to minimize environmental impact. To successfully raise shrimp in less volume of water, increasing aeration would probably be the only option. Auburn University researchers advise shrimp farmers that on a practical basis, dissolved oxygen (DO) should not decline below 50% of saturation. From a study they conducted on minimum DO requirement in ponds, they found the highest yields and profits in ponds where aerators were activated at 65% saturation or 4.6 mg/l at 29°C and 15 ppt.

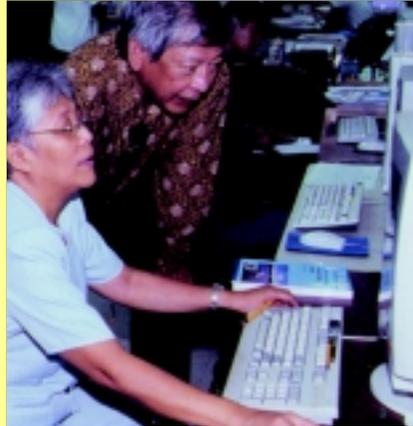
The researchers tested three DO saturation levels -- 65%, 40% and 15% -- replicated thrice. They raised *Litopenaeus vannamei* and *L. stylirostris* for five months in ponds equipped with automated temperature-DO concentration data acquisition devices, aspirator-pump aerators which activated automatically when DO falls below prescribed levels, and energy consumption watt-meters.

Researchers also note that shrimp yield, survival and profitability increase linearly with DO concentration increases, but that final shrimp weights are not significantly affected. But to maintain higher DO would mean more energy cost for the farm which can not be offset by the revenue gained. [REF: Aquaculture 1999: 311-321 (2001)]

Japan: oyster glycogen for cosmetics?

Researchers from Mie University and Mikimoto Pharmaceutical Co Ltd have found that glycogen from the pearl oyster *Pinctada fucata* is a promising candidate as a cosmetic material. Their conclusion is based on results of human dermal fibroblast cultures with crude glycogen from pearl oyster. They found 11-13% increase in cell proliferation rate and 29-61% increase in collagen synthetic ability of fibroblasts when about 0.01-0.2% glycogen was added. The recovery from ultraviolet damage for epidermal keratinocytes was also increased by 15-21% when 0.05-0.25% crude glycogen was added to the cell culture medium. [REF: kanoh@bio.mie-u.ac.jp; Aquaculture 1999: 311-321 (2001)]

☞ next page, yellow boxed text



Dr. Veravat Hongskul, assisted by the AQD librarian, checks AQD's online public access catalogue



Dr. Deb Menasveta (center) shares a joke with AQD Chief Dr. Rolando Platon and AQD mangrove expert Dr. Jurgenne Primavera

Past SEAFDEC Secretaries-General visit AQD

Two former SEAFDEC Secretaries-General visited AQD's Tigbauan Main Station in Iloilo and spoke on the past and future of SEAFDEC/AQD in a convocation on September 24.

Dr. Deb Menasveta (Sec-Gen from 1976 to 1980) and Dr. Veravat Hongskul (Sec-Gen from 1981 to 1988) shared stories of the early days of fishery development in the region. They traced the history of SEAFDEC from the establishment of the first two departments in Thailand and Singapore to the birth of AQD, which became SEAFDEC's biggest department in terms of personnel, infrastructure, and number of substations.

Dr. Deb reminded the AQD staff to learn from small scale fishers and be upfront with them, so that they (researchers) can freely have all the needed data and information. He recalled that as a young PhD graduate from the University of Washington, he was dispatched to a Thai coastal village where he learned to live with fishers and realized the importance of winning their trust. He also advised the AQD constituents to be more open to cooperation within the regional fisheries institutions.

Dr. Veravat, on the other hand, recalled the "tough days" of AQD and how it was nurtured to grow and mature. He also advised AQD to coordinate and cooperate with other institutions for a more cost-effective maintenance and operation.

About the future, Dr. Veravat would like two things to happen: first, that experts be dispatched to other countries, particularly in Asia, to teach and transfer aquaculture technologies; second, that

Transgenes can threaten natural populations

GMOs or genetically modified organisms utilize genes from other organisms (called transgenes) to increase yield or change economically important traits such as growth and reproduction. But a biologist from Arizona State University says, there could be detrimental effects on ecology and genetics if GMOs are accidentally introduced into the wild.

GMOs, for one, are much larger than non-transgenics since they follow the mating success of large males. These transgenes, which can be introduced by gene flow, may dominate natural population due to selective mating advantage but can reduce the viability of the natural population because transgenics may be less adaptable in the wild. This could lead to population extinction.

By using a deterministic model, researcher Philip Hedrick showed that in about 67% of the possible combinations of mating and viability parameters, the transgene dominates or increases in frequency; and for 50% of the combinations, it becomes fixed. The transgene increases in frequency as the mean fitness is reduced because the viability of individuals with the transgene is less than that of the wildtype. This scenario would mean negative growth rate, and if mortality increases as it tends to do, the population will become extinct.

There are assumptions inherent in Hedrick's study. One of these is that all females are assumed to be mated regardless of the presence or absence of the transgene.

But, it is still unclear whether fish transgenic for growth hormone genes will have a mating advantage or a variability disadvantage. Fitness between transgenic and non-transgenic will potentially depend on a number of factors, including the recipient and donor species of the transgene, and the ecological context. As an example: transgenic coho salmon are slower swimmers while transgenic Atlantic salmon are more active than wildtype, possibly resulting in a viability disadvantage under natural conditions.

Hedrick's study showed that there are very broad conditions in which transgenes with a large mating advantage and a general viability disadvantage may dominate natural population, reduce their fitness, and potentially cause their extinction. Researchers and resource managers should be alert to the inherent risks of accidental releases of GMOs into natural populations. [REF: philip.hedrick@asu.edu; Canadian Journal of Fisheries and Aquatic Sciences 58: 841-844 (2001)]

☞ page 6, yellow boxed text

there would be more funds available for AQD. The former Secretary-General suggested that AQD should make foreign embassies take note of what it can do to help countries in terms of poverty alleviation, food security, aquaculture technology and expertise. "There is ample money from various embassies that can be funneled to AQD, but first, we have to convince them on how we can help their countries."

Dr. Deb and Dr. Veravat are now Consultant and Senior Fishery Officer of FAO/RAP, respectively.

Mid-project workshop on mangrove-friendly shrimp culture

To assess project progress and plan the next activities, SEAFDEC conducted a mid-project workshop for the Mangrove-friendly shrimp culture (MFSC) project, a collaboration with ASEAN, September 3 and 4 in Bangkok.

Project personnel reported that Thailand's closed recirculating shrimp farming system has been successfully adopted and verified in the Philippines, particularly at SEAFDEC/AQD's Dumangas Brackishwater Station. The project will open another verification site soon in Myanmar with the involvement of the private sector.

On the other hand, the one in Vietnam has several problems including the lack of skilled technicians and set backs brought about by flooding and the reported white spot disease syndrome. Proposed to be sent on site are experts from AQD and the Department of Fisheries of Thailand.

Furthermore, a Cambodian representative proposed that the project also be extended to his country.

In addition to the verification runs, project personnel also reported on the progress of research on the use of mangroves as filters for pond effluents, and the study on nutrient cycles. The research team, led by Dr. Jurgenne Primavera and Dr. Aurelio de los Reyes showed that mangroves can be integrated as part of the whole shrimp culture system.

A study on nutrient cycles emphasized the closed recirculating shrimp culture system. This was done in a modular way with biological treatment for nutrient removal which resulted in "clean" water, thus allowing greatly reduced or zero water exchange. The study also used an improved pond design. The research team, headed by Mr. Nelson Golez, includes Dr. Anne Hurtado, Ms. Teresa Mallare, Dr. Nicolas Guanzon, Ms. Eleanor Tendencia, and Engr. Samson Jaspe.

The workshop also noted the ongoing production of information materials. This includes the project's website -- www.mangroveweb.net -- which will focus primarily on mangroves as a bigger backdrop of shrimp culture activities. Video production and translation of project manuals to Vietnamese, Bahasa Indonesia, Malay, Thai, Filipino, and Cambodian languages will follow.

A historic first for SEAFDEC *The first training ever on mangrove-friendly shrimp culture was attended by one participant each from Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, Cambodia, the Socialist Republic of Viet Nam, Union of Myanmar, and Indonesia. The training course is an output of a SEAFDEC-ASEAN collaborative project*



A trainee checks out the mangrove cover in the government recirculating shrimp farm in Chachaengsao, Thailand



AQD Deputy Chief Susumu Ito at the course's opening in Iloilo, Philippines; the course officially closed in Bangkok, Thailand after a week-long field trip by the trainees there



A training course on mangrove-friendly shrimp culture technology is ongoing at AQD's Tigbauan Main Station (see section below). Furthermore, an on-site training on responsible coastal aquaculture and coastal resource management with emphasis on mangrove-friendly aquaculture will be conducted in Myanmar November 27 to December 7, this year.

During the discussions, workshop chair Dr. Rolando Platon, the AQD Chief, noted and commended the progress of activities at project sites in the Philippines, Thailand, and Vietnam.

The two-day workshop was attended by 45 researchers and support staff from MFSC project sites in Thailand, Vietnam, and the Philippines; representatives from Myanmar and Cambodia; and the SEAFDEC Secretariat. A representative from the JICA Office in Bangkok served as observer.

Site inspection in Myanmar

The potential project sites in Myanmar have been inspected by AQD staff Mr. Dan Baliao and Mr. Neil Raphael Jamon from August 22 to 31, just prior to the mid-project workshop. Their trip was aimed at helping the Department of Fisheries of Myanmar assess the suitability of sites for shrimp culture.

Mr. Baliao observed that most shrimp farms in Myanmar are unsuitable for shrimp and are far from shorelines. Although zero salinity halts the operation for almost half of the year, the design and layout are impressive. He noted that farmers should improve their technical know-how in shrimp farming.

The two also gave lectures on environment-friendly schemes in shrimp farming. Mr. Baliao pointed out that lectures are not

enough to absorb what needs to be learned. He recommended that farmers send their technicians to Thailand or the Philippines for a complete hands-on skills development.

A well-represented training

The *Mangrove-Friendly Shrimp Aquaculture Training* at AQD, one of the activities of the MFSC project, has one representative each from SEAFDEC Member Countries. It ran from September 17 to 29, after which the trainees went on a field trip to four project sites in Thailand October 1 to 5.

The training intends to provide participants with technical knowledge and skills for the actual operation and management of the MFSC state-of-the-art technologies. It includes design and construction of ponds especially the grow-out, settling and treatment ponds, soil and water management, harvest and post-harvest methods, and socio-economics.

☞ next page

Vietnam: increasing rice and fish yields

Fish farmers have long thought that the rice field is a “temporary” aquatic environment that is not very suitable for fish production. But they continue to practice rice-fish culture because it increases rice yield, reduces weed emergence and pest growth, improves soil fertility, and provides fish protein for the family.

The above observations have been confirmed by a recently published study conducted by the Catholic University of Leuven (Belgium) and University of Can Tho (Vietnam). The specific findings are as follows:

- (1) nearly 50% of the observed changes in water parameters could be attributed to fish stocking and rice seeding rate
- (2) rice production increases with the presence of fish and higher rice seeding rate
- (3) shading by denser rice plants affects parameters related to aquatic primary productivity like chlorophyll α , dissolved oxygen (DO) concentration, and pH. But light remains the limiting factor in aquatic photosynthesis
- (4) the presence of fish increased ammonium concentration four times but decreased orthophosphate concentration. Ammonium increase has a positive effect on the density of euglenophytes and chlorophyll α at low rice-seeding rate (100 kg pre-germinated rice per ha)
- (5) fish has a significant effect on *Cladocera-Rotifera* ratio, increasing the number of rotifers as fish stimulated phytoplankton

In conclusion, the researchers note that low rice-seeding rate (100 as opposed to 300 kg pre-germinated rice per ha) seemed better for fish production than high rice-seeding rate. DO, amount of chlorophyll α and density of *Euglenophyta* remained high throughout the rice cycle.

The current rice-fish culture system in the Mekong Delta is characterized by intensive rice production (2 crops a year, pesticide use, and direct seeding) and extensive fish production (low stocking, no inputs, flow of energy and nutrients depends on natural processes). Common fish species used are silver barb *Barbodes gonionotus*, common carp *Cyprinus carpio*, and Nile tilapia *Oreochromis niloticus*. [REF: nico_vromant@hotmail.com; Hydrobiologia 445: 151-164 (2001)]

During the opening ceremonies, Dr. Platon reminded everyone that MFSC was formulated to answer issues and concerns directed at shrimp culture. These critical issues include (1) shrimp culture as unsustainable and not environment-friendly; (2) mangroves being razed to give way to shrimp ponds that discharge effluents to a fragile ecosystem; (3) shrimp's impact on capture fisheries (the use of fish meal). But Dr. Platon assured his audience that the MFSC project has produced innovations and will come up with even more refined techniques to make shrimp farming more sustainable by 2003.



AQD – NACA officials' meeting at AQD's Tigbauan home base

AQD - NACA meeting held

Officials of AQD and the Network of Aquaculture Centres in Asia-Pacific (NACA) met recently at the Tigbauan Main Station. They were joined by representatives of the major players in aquaculture development—Bureau of Fisheries and Aquatic Resources, Philippine Council for Aquatic and Marine Research and Development, University of the Philippines-Visayas, and the private sector. A representative from FAO also attended as observer.

Terms of Reference, as provided for in the Report of the 33rd meeting of the SEAFDEC Council of Directors, in line with the decision of the Government of the Philippines to reactivate the role of AQD as the regional lead center of NACA in the Philippines were agreed upon in the meeting. Officials of AQD and the Network of Aquaculture Centres in Asia-Pacific (NACA) met on July 20 in Iloilo.

The meeting also identified specific areas of collaboration among various organizations, and developed a strategy to implement the identified areas based on the NACA 5-Year Work Programme.

Sustainable aquaculture development course conducted

The Third Country Training Program (TCTP) on Responsible Aquaculture Development (RAD) sponsored by the Japan and Philippine governments was held September 6 to October 29. SEAFDEC/AQD is the implementing agency for the Philippines, while the Japan International Cooperation Agency (JICA) provides technical and funding support. Started in 1995, TCTP/RAD has had 83 participants from 18 countries in 6 sessions. The current course is now the third session in the second phase of the project.

The 15 participants for the present session came from Cambodia, Indonesia, Myanmar, and the Philippines, China, India, Kenya, Mozambique, Nigeria, Pakistan and Sri Lanka. There were also observers from Cambodia, Lao, PDR, Myanmar, and Vietnam.

Earlier at the opening ceremony, AQD Chief Dr. Rolando Platon emphasized that fish as food is tradition in the diets of Asians. Fish is consumed not as an option but rather as the only source of protein in many developing countries. Thus, TCTP/RAD is an appropriate venue of technological exchange and basis of understanding toward responsible aquaculture development.

JICA Philippine Office Asst. Resident Representative Mr. Susumu Katsumata, AQD Deputy Chief Mr. Susumu Ito, and AQD's training head Engr. Pastor Torres Jr graced the affair and gave messages.

TCTP/RAD is committed to the reconciliation of aquaculture technology and sustainability. The course envisions aquaculture technology as an instrument in rural development. Moreover, it seeks to intensify the dissemination and application of aquaculture advances alongside the protection, conservation, and enhancement of resources and its equitable allocation among people.

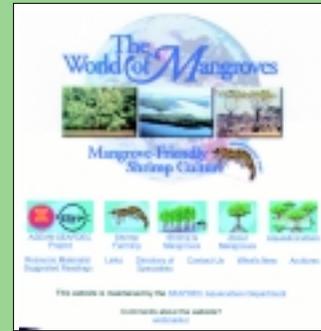


TCTP/RAD trainees in action



Fish Nutrition 2001

The Training Course on Fish Nutrition commenced on October 16. Ten participants are attending this year, representing Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Thailand, Vietnam and the Philippines. Ms. Myrna Teruel is the Technical Lead Person.



Where mangroves and shrimp come together

The ASEAN-SEAFDEC project on mangrove-friendly shrimp culture (MFSC) has a new website – www.mangroveweb.net. Written, designed, and constructed by SEAFDEC/AQD, it was uploaded to the internet on December 7. The website contains, against the backdrop of the world of mangroves, all information about the MFSC project. One can find the MFSC project sites in the Philippines, Thailand, Vietnam, and Myanmar; the project's current researches; state-of-the-art technologies; reading materials; and training sessions. There is also information on available mangrove resources and linkages to related websites.

Visit us today!



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>

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

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

Fermin AC, Buen SM. 2000. Feeding, growth and survival of abalone (*Haliotis asinina* Linnaeus 1758) reared at different stocking densities in suspended mesh cages in flow-through tanks. *Philipp. Scient.* 37 (2000): 31-41

Abstract. Feeding, growth and survival of hatchery-bred juvenile abalone, *Haliotis asinina* (mean initial shell length: 32 μ m) stocked at 25, 50 and 100 m² of shelter surface area in mesh cages suspended in indoor tanks were determined. Animals were fed the seaweed, *Gracilariaopsis bailinae*, to excess given at weekly intervals. After 250 d, average daily growth rate (mean: 122 μ m d⁻¹ shell length, 156 mg d⁻¹ body weight) was highest in abalone reared at the lowest stocking density (25 m²). Abalone stocked at 50 and 100 m² had similar growth rates that ranged from 96 to 98 μ m d⁻¹ SL and 123 to 131 mg d⁻¹ BW). Daily feeding rates of 29 and 30% were not significantly different for abalone stocked at 25 and 50 m², respectively, but were higher than abalone stocked at 100 m². The higher feeding rates of 24-28% day⁻¹ of abalone in all treatments starting day-129 until day 160 could be due to the onset of sexual maturation as most abalone are already mature at this size. Survival rates were generally high (91-98%) and were not significantly different among treatments. However, body size (range: 59.3 mm SL, 57-58.4 g BW) at harvest was bigger in animal stocked at 25 m² than those stocked at 100 m². Sexual maturation during culture did not hamper growth of abalone. *G. bailinae* proved to be a sufficient food source for abalone grow-out. A stocking density between 50-100 m² is recommended for tank grow-out of *H. asinina*.

Fermin AC. 1999. Illuminated-cage nursery of the Asian sea bass, *Lates calcarifer* Bloch (Centropomidae): effects of initial body size and stocking density. IN: Liao IC and Lin CK (eds). Proc. First International Symposium on Cage Aquaculture in Asia; 2-6 November 1999; Asian Fisheries Society, Manila, and World Aquaculture Society- Southeast Asian Chapter, Bangkok. p 267-272

Abstract. This study was conducted to determine the appropriate initial body size and the corresponding stocking density of sea bass, *Lates calcarifer*, during nursery rearing in illuminated cages. Hatchery-produced sea bass fry of different initial sizes of 7.2 (day 15), 13.2 (day 22), and 15.2 mm (day 29) were stocked at densities between 300 and 1,500 m⁻³ in decreasing order with fish size. Nylon net cages (1x1x1 m) set in a protected sea cove area were individually lit at 300 lux using incandescent bulb placed at 1 m above water surface. Artificial lights attract wild zooplankton that served as prey to young sea bass. After 42 days of culture 22-day old of sea bass fry with 13.2 mm TL initial size and stocked at 400 m⁻³ showed the highest growth (35.3 mm TL, 535.7 mg BW) and survival rates (64.4 %). At a stocking density of 800 m⁻³, the survival rate was the second highest at 43%. Although day 15-fry at 7.2 mm TL initial size showed higher specific growth rates (11 % day⁻¹) and size at harvest (29-31 mm TL, 346.2-374.4 mg BW), survival rates (11-15%) were lower than the day 22- and 29-fry (30-64%). Calanoid copepods of the genus *Calanus*, *Paracalanus* and *Acartia* dominated the diet (81-90%) of sea bass at different size groups. Percentage number of shooters ranged from 0.51-1.4 % of total stocks and were not significantly different among treatments. The present results indicate that sea bass should spend 21 days in the hatchery rearing in illuminated sea cages. Sea cages are inexpensive and more cost-effective than ordinary cage or earthen pond for sea bass fingerling production.

Hagiwara A, Gallardo WG, Assavaaree M, Kotani T, de Araujo AB. 2001. Live food production in Japan: recent progress and future aspects. *Aquaculture* 2000/1 (1-2, special issue): 111-127

Abstract. Techniques to culture rotifers at high-density (2000 to 20 000 ind/ml) have been developed by utilizing condensed phytoplankton products. Many public hatcheries in Japan have introduced automated systems for culturing and harvesting rotifers. Research has been conducted on the diagnosis of rotifer culture status and chemical treatment for reducing stress on rotifers. Preservation of the resting eggs of rotifers for an extended period or at low temperature (4°C) for a limited time has become possible. Thus, appropriately sized rotifers can be provided to fish larvae, according to fish species and growth stage. Techniques to identify the genetic status of rotifer strains have yet to be developed. Practices for culturing copepods in Japan have also been summarized.

SPECIAL ISSUE ON CRABS



Asian Fisheries Science

14 (2): 101-245

The Proceedings of the International Forum on the Culture of Portunid Crabs; Boracay, Philippines; 1-4 December 1998; the journal issue is guest-edited by OM Millamena, ET Quintito, and A Blackshaw

SEAFDEC/AQD papers appearing in this issue are as follows--

Williams MJ, **Primavera JH**. 2001. Choosing tropical portunid species for culture, domestication and stock enhancement in the Indo-Pacific. *Asian Fisheries Science* 14: 121-142

Abstract. Large and long-term investments in research, development and technology verification are required for the successful culture, domestication and coastal stock

enhancement of any species, including crabs. As more species options are sought for culture, the choice of candidate species could be guided by *ex-ante* assessments to help identify suitable species and anticipate future constraints and opportunities. Focusing on tropical Indo-West Portunidae, we propose multiple criteria for domestication and stock enhancement that include life cycle, diet and feed conversion efficiency, feeding behavior, disease resistance, growth rate, marketability, farming systems, profitability and environmental impact. The chief candidate species (four species of *Scylla*, *Portunus pelagicus*, *P. sanguinolentus*, and *Charybdis feriatus*) are considered against the criteria. Experience in the stock enhancement of *P. trituberculatus*, a subtropical portunid, is reviewed. We conclude that full domestication will not occur in the next 5 to 10 years and that the main constraints to be overcome are the aggressive behavior of the crabs, their carnivorous diet and competition for suitable coastal farm sites. We also recommend considering the tropical *Portunus* and *Charybdis* species examined here as additional or alternative option to the *Scylla* species. Stock enhancement may be feasible in some locations, provided suitable fisheries management and industry institutions are created.

Millamena OM, Bangcaya JP. 2001. Reproductive performance and larval quality of pond-raised *Scylla serrata* females fed various broodstock diets. *Asian Fisheries Science* 14: 153-159

Abstract. *Scylla serrata* females with initial body weight (BW) of 350 to 400 g were previously raised on a defined diet of 75% brown mussel meat and 25% fish bycatch in grow-out ponds at Molo, Iloilo City, Philippines for 120 days. Crabs were stocked in three units of 4 m diameter concrete indoor tanks at the Crustacean Broodstock Wet Laboratory of SEAFDEC Aquaculture Department in Tigbauan, Iloilo, Philippines. Tanks had sand substrates and were supplied with sand-filtered and chlorinated seawater in a continuous flow-through system with adequate aeration. Each female was provided with individual shelter. Before stocking, crabs were tagged on their carapace and half of the females were ablated while the other half remained intact. Broodstock were fed either T1, natural food consisting of mussel and fish bycatch; T2, a mixed diet of natural food and formulated diet; or T3, a formulated diet. Broodstock reproductive ability was measured as percent spawnings, spawnings with hatching, fecundity or number of eggs per g BW of female, egg fertilization rate and total zoea produced. Larval quality was measured as larval stage index or ability to attain the megalopa or highest larval stage. Females fed on all dietary treatments were

☞ p 11, green boxed text

Hurtado AQ, Agbayani RF, Sanares R, de Castro-Mallare MTR. 2001. The seasonality and economic feasibility of cultivating *Kappaphycus alvarezii* in Panagatan Cays, Caluya, Antique, Philippines. *Aquaculture* 199 (3-4): 295-310

Abstract. Vegetative thalli of brown and green *Kappaphycus alvarezii* were cultivated in Panagatan Cays, Caluya, Antique, Philippines, over 60- and 90-day periods using hanging-long line (HL), fixed off-bottom (FB), and hanging long line-fixed off-bottom (BL-FB) methods to determine the daily growth rate and yield. A completely randomized design experiment with six replicates of 5-m line cultivation rope was used in the study. An economic analysis was prepared to determine the viability of the culture systems used. To determine the effect of strain, culture technique, culture days and culture month on the daily growth rate and yield, a combination of these different factors was treated as a single treatment. Results show that at 60-day culture period, daily growth rate and yield in all techniques were lowest in July-August and highest in January-February. Higher growth rate (2.3-4.2% day⁻¹) and yield (3.6-15.8 fresh weight kg m⁻¹ line⁻¹) were obtained from September to February. Significant differences (P < 0.05) in growth rate and yield were determined between culture months. At 90-day culture period, there were no significant differences in growth rate and yield between culture months; however, a significant difference was found between culture techniques. The average production (dry weight kg crop⁻¹) of *K. alvarezii* when grown at 60-day culture period during lean and peak months using HL, FB and HL-FB techniques ranged from 421 to 3310 kg with HL-FB

the highest and FB the lowest. Net income, return on investment (ROI) and payback period were all positive during peak months, but negative values were obtained during lean months. Only seaweed grown on HL technique during the peak months at 90-day culture period showed positive income, ROI and payback period. The seasonality of cultivating *K. alvarezii* is shown in this present study. This paper further shows the best culture technique to be adopted at certain months of the year to produce the highest yield and income.

Leaño EM. 2001. Straminipilous organisms from fallen mangrove leaves from Panay Island, Philippines. *Fungal Diversity* 6: 75-81

Abstract. Fallen senescent mangrove leaves from three marine mangrove sites in Panay island, Philippines were collected for observation and isolation of straminipilous organisms. A total of 11 mangrove species were sampled. *Halophytophthora* species were observed on 7 out of 11 mangrove species sampled, with *H. vesicula* as the most abundant species observed. *H. epistomium* also occurred abundantly on fallen leaves of *Rhizophora apiculata* and *Sonneratia* sp. Thraustochytrids, on the other hand, were observed on all mangrove leaf samples except *Aegiceras corniculatum*. *Schizochytrium mangrovei* was the most abundant species observed. Their association and ecological role on the degradation of fallen mangrove leaves is discussed.

☞ next page

Lio-Po GD, Albright LJ, Traxler GS, Leño EM. 2001. Pathogenicity of the Epizootic Ulcerative Syndrome (EUS)-associated rhabdovirus to snakehead *Ophicephalus striatus*. *Fish Pathology* 36 (2): 57-66

Abstract. The rhabdoviruses isolated from EUS-affected snakeheads in the Philippines were tested for pathogenicity to healthy, naive snakehead *Ophicephalus striatus* fry, fingerlings and juveniles. Virus exposure of naive fry and fingerlings by bath at 20-22.5°C resulted in significant mortalities ($p < 0.01$) with no apparent lesions. Naive snakehead juveniles when injected intramuscularly (IM) with the EUS-associated rhabdovirus at ambient water temperature (28-32°C) did not develop lesion. However, similarly treated snakehead juveniles at 20-22.5°C developed dermal lesions after 3-5 days. The lesions progressed from slight to moderately advanced lesions by days 10-12 but not to deep ulcers as exhibited by naturally EUS-affected snakeheads. Mean mortalities were higher in the virus-injected fish (72%) compared to those in controls (33%). Moreover, the virus was reisolated from fish in the 20-22.5°C treatment but not from fish in the 28-32°C treatment. Virus from infected tissue filtrate and the virus passaged 3 or 4 times induced similar dermal lesions if the rhabdovirus concentration was 10(3) TCID₅₀/fish or higher. When administered orally, by bath, by intraperitoneal (IP), IM and subdermal injections to snakehead juveniles, only the latter two routes induced dermal lesions. However, IP injection of the rhabdovirus caused 75% mortalities but none in control fish. The results demonstrate the pathogenicity of rhabdovirus isolates to naive snakeheads at low (20-22.5°C) rearing water temperatures.

Millamena OM, Golez NV, Janssen JAJ, Peschcke-Koedt M. 2000. Processed meat solubles, Protamino aqua, used as an ingredient in juvenile shrimp feeds. *Israeli Journal of Aquaculture-Bamidgeh* 52 (3): 91-97

Abstract. The nutritive value of processed meat solubles, Protamino Aqua, a by-product from slaughterhouses, was examined in a growth trial with juvenile tiger shrimp *Penaeus monodon*. Experimental diets were formulated to contain processed meat solubles and/or squid meal as a partial replacement of fish meal. Dietary treatments consisted of diets (1) 5% processed meat solubles, no squid meal; (2) 2% processed meat solubles and 3% squid meal; (3) 5% squid meal, no meat solubles; (4) no meat solubles, no squid meal (control) and (5) commercial shrimp feed. The water stability of the diets was tested. Diets were fed to *P. monodon* postlarvae, PL20, with a mean body weight of 0.014 g, reared in tanks for 60 days. Results showed that survival of shrimp fed the various diets did not significantly differ ($p > 0.05$). The only significant difference in growth performance was that the weight gain of shrimp fed diet 3 was significantly better ($p < 0.05$) than that of shrimp fed the control diet. The protein efficiency ratio was best in shrimp fed diets containing processed meat solubles and poorest in shrimp receiving commercial feed. Protamino aqua has a water stability similar to that of the control diet and commercial feed and appears to be efficiently utilized by juvenile *P. monodon*. The study showed that processed slaughterhouse by-products can be a cost-effective replacement for fish meal in tiger shrimp feeds.

Murillo-Gurrea DP, Coloso RM, Borlongan IG, Serrano AE. 2001. Lysine and arginine requirements of juvenile Asian sea bass (*Lates calcarifer*). *Journal of Applied Ichthyology* 17 (2): 49-53

Abstract. Two separate experiments were conducted to determine the dietary requirements of juvenile Asian sea bass *Lates calcarifer* Bloch for lysine and arginine. Fish (average initial weight: lysine experiment, 13.12±0.12 g; arginine experiment, 2.56±0.13 g) were given amino acid test diets for 12 weeks containing fish meal, zein, squid meal, and crystalline amino acids. Each set of isonitrogenous and isocaloric test diets contained graded levels of L-lysine or L-arginine. The feeding rate in the lysine experiment was at 4-2.5% of the body weight day⁻¹, while in the arginine experiment it was at 10-4% of the body weight day⁻¹. The fish (20 per tank, lysine experiment; 15 per tank, arginine experiment) were reared in 500-L fibreglass tanks with continuous flowthrough sea water at 27°C and salinity of 31 ppt in the lysine experiment and at 29°C and salinity of 29 ppt in the arginine experiment. The experiments were in a completely randomized design with two replicates per treatment. Survival was high in fish given adequate lysine or arginine. Mean percentage weight gains were significantly different in fish fed varying levels of lysine or arginine. Fish fed high levels of L-arginine suffered high mortalities. No significant differences were obtained in the feed efficiency ratios (FER, g gain g⁻¹ feed) of fish fed graded lysine, although the values tended to increase as the dietary lysine level was increased up to the requirement level. In contrast, in the arginine experiment, significant differences in FER of fish among treatments were obtained; the highest FER was observed in fish fed the diet containing an optimum arginine level. On the basis of the growth response, survival, and FER, the lysine and arginine requirements of juvenile Asian sea bass were estimated to be 20.6 g kg⁻¹ dry diet (4.5% protein) and 18.2 g kg⁻¹ dry diet (3.8% protein), respectively. These data will be useful in the further refinement of practical diet formulations for the Asian sea bass.

Quinitio GF, Tan-Fermin JD, Nagai A. 2001. Possible application of mibolerone for induced sex inversion of grouper *Epinephelus coioides*. *Fisheries Science* 67 (2): 232-237

Abstract. Thirty immature juvenile grouper *Epinephelus coioides* (19-168 g bodyweight, BW) were randomly stocked in four units 6t tanks to determine if mibolerone can be used to induce sex inversion in groupers. After acclimatization and weaning to artificial feed, the feed given daily (4% BW/day) was supplemented with 0, 50, 100, and 200 µg mibolerone/kg feed for about 18 weeks. Thereafter, the hormone treatment was withdrawn and the experiment was terminated at Week 24. Ten fish were killed for gonad histology at stocking to serve as an initial control while about three to five fish were killed every 8 weeks. In general, ovaries of initial controls showed the presence of moderate stromal cells and gonia and few primary oocytes. At Weeks 8 and 16, ovaries of the control fish (0 µg/kg) were similar to that of the initial control except that primary oocytes increased at Week 24. Gonads of fish fed diets containing 100 and 200 µg/kg had none to moderate spermatocytes and few spermatids at Week 8 and 16, although spermatozoa were not observed, indicating that the fish were undergoing spermatogenesis. Spermatogenesis at 50 µg/kg was not as advanced since only few spermatocytes occurred at Weeks 8 followed by moderate gonia and no spermatocytes and spermatids at Week 16. However, the presence of few primary oocytes was observed when mibolerone was withdrawn suggesting that sex-inversed fish reverted back to a female condition. These results show that sex inversion in juvenile grouper can be induced by oral administration of mibolerone and may have possible application on mature females to produce functional males.



CRAB SPECIAL ISSUE ... FROM PAGE 9

capable of maturation and spawnings. However, mixed diet feeding (T2) improved broodstock performance and larval quality over those fed either natural food (T1) or formulated (T3) alone. Eyestalk ablation improved fecundity and produced higher total zoea in T1 and T3 although lower in egg fertilization rate than intact females. All zoea larvae in ablated T2 females were successfully reared to megalops. Overall improvement in larval quality of both ablated and intact females compared with previous studies on wild-caught females was attributed to their dietary history in grow-out ponds. Feeding the females with a suitable diet in ponds enabled them to fortify the reserves of nutrients needed for egg development and improve stability in larval production.

Quinitio ET, Parado-Esteva FD, Millamena OM, Rodriguez E, Borlongan EL. 2001. Seed production of mud crab *Scylla serrata* juveniles. *Asian Fisheries Science* 14: 161-174

Abstract. A protocol for the large-scale rearing of the mud crab *Scylla serrata* juveniles was developed based on the results of small-scale experiments on feeding and water management. This paper also reports the success in producing the second generation (F₂) crabs.

Pond-reared adult *S. serrata* held in 10 m³ concrete tanks with sand substrates were given fish, mussel, annelids and formulated diet. The zoeae produced were stocked in 1.5 or 10 m³ tanks at 30 to 50 ind.l⁻¹ and fed 10 to 15 *Brachionus rotundiformis*.ml⁻¹ to 5 *Artemia salina* nauplii.ml⁻¹ and 1.5 to 2.0 g shrimp larval commercial diet.m⁻³day. Water was replaced daily at 30 to 50 % of the total volume starting day 3. Megalops were nursed until crab stage either in tanks or in net cages installed in ponds. Crabs were fed mussel or small shrimps (*Acetes* sp.).

Hatching occurred 6 to 12 days after spawning at 26.5 to 30.5°C. A female produced 0.42 to 5.23 x 10⁶ zoeae at a time. Mean survival rate from zoea 1 to 3- to 5-day old megalops was 2.6 ± 0.8% and 32.8 ± 4.8% from megalops to crab stage. The development from zoea 1 to megalopa required 16 to 18 days. Cannibalism and luminescent bacteria were identified as the major cause of mortality. Highest mortality was observed during the metamorphosis from zoea 5 to megalopa and megalops to crab 1. First crab stage was obtained 23 to 25 days after hatching. Sorting the crabs during the nursery period minimized cannibalism.

Completion of the cycle in captivity was attained in 1997 and 1999 when spawns from pond-reared crabs grew to become the second-generation broodstock. The results point to a minimum age of 7.5 to 9 months at which *S. serrata* hatched their eggs after rearing from zoea 1.

Rodriguez EM, Quinitio ET, Parado-Esteva FD, Millamena OM. 2001. Culture of *Scylla serrata* megalops in brackishwater ponds. *Asian Fisheries Science* 14: 185-189

Abstract. Three- to five-day old hatchery-reared megalops (4.0 to 6.4 mg body weight) of the mud crab, *Scylla serrata*, were cultured to the juvenile stage in 20 m² net cages installed in brackishwater nursery ponds. To establish a suitable stocking density, megalops were stocked at 10, 20, and 30 ind.m⁻² in net cages. Treatments were replicated three times over time. After 30 days of culture, mean survival of juveniles ranged from 48.3 to 53.3% and did not vary significantly (P > 0.05) among the three stocking densities. Similarly, the mean final body weights of juveniles ranging from 2.91 to 3.40 g and mass weights 458.9 to 1066 g did not significantly differ among stocking densities. These results show that stocking of crab megalops directly in net cages in a brackishwater pond is feasible at any of the stocking densities tested.

Triño AT, Millamena OM, Keenan CP. 2001. Pond culture of mud crab *Scylla serrata* (Forsk.) fed formulated diet with or without vitamin and mineral supplements. *Asian Fisheries Science* 14: 191-200

Abstract. The effects of three diets (Diet 1- with vitamin and mineral supplements, Diet 2- without vitamin and mineral supplements, and Diet 3- fish bycatch) and monosex culture (male or female) on the growth, survival, feed conversion ratio (FCR), and production of mud crab *Scylla serrata* were investigated using a 2 x 3 factorial experiment with three replicates per treatment. Juvenile mud crabs were stocked at 1.0.m⁻² in 150 m² ponds and reared for 156 days. Results showed no significant interaction between monosex culture and diets (P >0.05) so that data were pooled by sex and dietary treatment. Mean final body weight of male crabs (427 g) was significantly higher (P < 0.05) than female crabs (400 g). However, crab carapace length (CL) and width (CW), specific growth rate (SGR), FCR, survival and production were not significantly different (P >0.05) between the two sexes. Regardless of

☞ next page

CRAB SPECIAL ISSUE ... FROM PREVIOUS PAGE

sex, crabs fed fish bycatch (Diet 3) gave significantly higher ($P < 0.05$) mean body weight (435 g) than those fed Diet 2 (395 g). Mean final body weight (410 g) of crabs fed Diet 1 was not significantly different from those fed Diets 2 or 3. The CL and CW, SGR, FCR, survival and production of mud crabs fed the three diets, however, were not significantly different ($P > 0.05$). The economic viability of using a diet without vitamin and mineral supplements was comparable to that of a complete diet having about the same cost of production and return on investment of 74 to 75%. The study shows that cost-effective formulated diet could be used as alternative feed for fish bycatch thus saving on feed and storage costs.

Agbayani RF. 2001. Production economics and marketing of mud crabs in the Philippines. *Asian Fisheries Science* 14: 201-210

Abstract. The current price of mud crabs in the local market is relatively higher than fish and mollusks and is projected to increase in the world market. This increasing trend in domestic and export markets is expected to step-up the demand for crab seeds. In the Philippines, the technology of mud crab grow-out culture is already being transferred to resource-poor fisherfolks for adoption as an alternative livelihood. However, buying competition among big and small crab farmers is foreseen to be disadvantageous to small farmers. There is a need to hasten the development and transfer of technology on mud crab breeding and hatchery to stabilize the supply and price of mud crab seeds. This paper discusses the economic viability of four grow-out culture methods for mud crabs namely: pond monoculture, polyculture with milkfish, culture in mangroves, and fattening in ponds. The marketing system of mud crabs covers product development, pricing, distribution channels, and promotion activities.

Triño AT, Rodriguez EM. 2001. Mud crab fattening in ponds. *Asian Fisheries Science* 14: 211-216

Abstract. Two independent experiments on mud crab (*Scylla serrata*, Portunidae) fattening were conducted simultaneously in 150m² ponds for 30 days: Expt. I – monosex male (286±1.2 g) vs. monosex female (267±0.9 g) stocked at 0.5 m⁻², and Expt. II – monosex male (338±3.1 g) or female (338±2.8 g) vs. mixed sex (338±3.4 g) stocked at 0.25 m⁻². The crabs were fed daily a mixed diet of 75% brown mussel flesh and 25% fish bycatch at 10% of the crab biomass. Intermolt male crabs weighing ≥400 g and roed females ≥350 g were partially harvested from the ponds after 20 days of culture using lift net and current method. Results of partial harvest from all treatments in both experiments showed a total yield of 51-55 % of the total initial number of stocked crabs (450 crabs in Expt. I, and 338 crabs in Expt. II). From this partial harvest, crabs in Expt. I attained a mean final body weight of 496 g, a specific growth rate (SGR) of 2.75% in males and 432 g, SGR of 2.4% in females. Expt. II gave a mean final body weight of 520 g (males), 484 g (females), and 517 g (mixed sex) and SGR of 1.1, 0.73 and 0.81, respectively. Results of total harvest showed that the overall mean body weight (372±4.5 g) of monosex male crabs in Expt. I was significantly higher ($P < 0.05$) than monosex females. However, specific growth rate, carapace length and width, survival, and production were not significantly different ($P > 0.05$)

between monosex males and females. On the other hand, growth and production of monosex crabs in Expt. II was not significantly different ($P > 0.05$) from mixed sex crabs. However survival monosex crabs (100%) was significantly higher ($P < 0.05$) than mixed sex crabs (87±1.88%).

Lavilla-Pitogo CR, Marcial HS, Pedrajas SAG, Quinitio ET, Millamena OM. 2001. Problems associated with tank-held mud crab (*Scylla* spp.) broodstock. *Asian Fisheries Science* 14: 217-224

Abstract. To support studies on the development of broodstock and hatchery technology for mud crabs under the genus *Scylla*, the SEAFDEC Aquaculture Department maintains captive broodstock in land-based tanks. Disease problems seen in broodstock after being held for three months in these tanks include shell disease due to a combination of fouling organisms and chitinoclastic bacteria, bacterial contamination of the hemolymph, parasitic infestation on gills and shell, and loss of appendages. Shell disease was manifested as off-white and black patches on the shell, that progressed and became perforations exposing underlying tissues. The hemolymph of a significant number of newly recruited crabs harbored mixed populations of sucrose-fermenting vibrios. Pedunculate cirripedes were found in large numbers both in the gill region and on the shell, boring through and creating perforations in the latter. Nematodes and other saprophytic organisms enter the crab through these perforations. The fouling problems that affect the integrity of the shell are considered to reduce the life span and reproductive potential of captive broodstock under tank conditions; therefore, regular cleaning of the shell is recommended to minimize shell fouling.

Quinitio ET, Parado-Estapa FD. 2001. Simulated transport of *Scylla serrata* zoeae at various loading densities. *Asian Fisheries Science* 14: 225-230

Abstract. Percent mortality of mud crab *Scylla serrata* zoeae was determined after 6 h of simulated transport of mobile and stationary conditions at loading densities of 10, 20, 30 and 40 x 10³ ind.l⁻¹. Mortality was not significantly different among treatments immediately after transport. Surviving zoeae were stocked in basins, fed with *Brachionus rotundiformis* and mortality was compared 15 h after transport. There was no significant interaction between loading density and condition (mobile and stationary) of transport ($P > 0.05$). However, larval mortality varied significantly among densities ($P < 0.001$) regardless of the condition. A density of 10 x 10³ ind.l⁻¹ had the lowest mortality (0.56±0.76 %) followed by 20 x 10³ (1.28±0.39 %), 30 x 10³ (4.3±0.25 %), and 40 x 10³ (4.3±0.31 %) ind.l⁻¹. In another experiment, the effect of transport duration was determined at a constant loading density of 10 x 10³ ind.l⁻¹ in control (not subjected to packing and transport), shaken and unshaken conditions. Zoea mortality did not differ significantly ($P > 0.05$) after the 6, 9, and 12 h transport. Regardless of the duration, mortality was lowest in the control (0.41±0.05 %) compared to those in the shaken (0.99±0.13 %) and unshaken (0.79±0.12 %) conditions. Likewise, the condition but not the duration of transport affected larval survival at 15 h post-transport. Mortality was lower in the shaken (1.92±0.22 %) than in the unshaken condition (2.46±0.17 %). Since mortality is low even at 20 x 10³ ind.l⁻¹, this can still be used to transport *S. serrata* zoeae for 6 h. However, loading density should be reduced to 10 x 10³ ind.l⁻¹ for transport duration up to 12 h. ####

SPECIAL REPORT



Biotechnology Research at SEAFDEC/AQD

The Nutrition Building where the biotech labs are located on the second floor

Aquaculture research will soon benefit from biotechnology facilities to be established at the SEAFDEC Aquaculture Department's main station at Tigbauan, Iloilo, Philippines. The laboratory complex will be located at the second floor of the Department's Nutrition Building. Worth more than US\$6 million, it will be largely a result of a grant from the Government of Japan, which supplemented existing laboratory facilities at AQD with additional and advanced equipment and machinery. The host government, the Philippines, will provide counterpart funds of US\$0.6 million for the improvement of the laboratories and acquisition of experimental tank systems. Proponent and recipient of the Biotech Lab is the country's Department of Agriculture (DA) while AQD and the DA-Bureau of Fisheries and Aquatic Resources will operate it.

THE LABORATORIES

Four laboratories are to be housed in the complex. These are for (1) molecular endocrinology and genetics, (2) microbiology, (3) feed technology, and (4) algal production technology.

Molecular Endocrinology and Genetics Laboratory. The laboratory's mandate is to develop strategies to enhance the reproductive and developmental potentials of cultured species. Some research problem areas AQD researchers are interested in include:

- Control of the fishes' reproductive cycles to achieve off-season maturation and spawning
- Sex inversion
- Growth enhancement
- Optimizing conditions for the use of hormones and other substances to promote larval settlement and metamorphosis

- Development of molecular markers for parental/pedigree analysis and marker-assisted selection
- Determination of the genetic variability of wild and cultured populations of marine and freshwater fishes

What has been done so far by SEAFDEC/AQD researchers is cloning the cDNA for rabbitfish *Siganus guttatus* and milkfish *Chanos chanos* growth hormone (GH). Exploiting recombinant DNA technology to produce large amounts of GH is necessary for large-scale growth enhancement applications for the species. In the future, efficient methods of incorporating the recombinant GH into larval, nursery and grow-out diets will be developed, and ways to prolong the bioavailability of the hormone will be explored. Studies on genetic variability, and molecular genetic analysis of freshwater fishes such as catfish and bighead carp are also being undertaken. The researchers aim to clone gonadotropins and gonadotropin-releasing hormones, develop protocols for off-season maturation and spawning in cultured fishes, and clone P₄₅₀ aromatase, the enzyme responsible for conversion of testosterone to estrogen, a key step in the process of sex inversion.

Molecular Microbiology Laboratory. The objectives of the facility are to:

- Establish and maintain fish cell lines for use in the diagnosis of viral diseases
- Develop rapid and sensitive techniques for the detection and identification of fish, crustacean and shellfish pathogens
- Develop vaccines and immunostimulants against potential fish, crustacean and shellfish pathogens

➡ next page



Facilities in the Biotech Lab include thermal cyclers to amplify DNA by polymerase chain reaction (PCR), refrigerators and ultra low freezers



- Develop alternatives to antibiotics
- Develop beneficial microorganisms for aquaculture wastewater treatment.

Currently available fish cell lines include the following: bluegill fry (BF-2), catfish spleen (CFS), grouper fin (GF), sea bass kidney (SBK-2), snakehead spleen (SHS), white sturgeon skin (WSSK), fathhead minnow (FHM), Epithelioma papulosum cyprini (EPC), snakehead fin (SSN-1) and white sturgeon spleen clone 1 (WSS2C1). Aside from maintaining fish cell lines, the laboratory currently conducts diagnosis using one-step and nested polymerase chain reaction (PCR) techniques of white spot syndrome virus (WSSV) and viral nervous necrosis (VNN), shrimp and fish viral pathogens, respectively. Cell culture is also being used in the diagnosis of fish viral pathogens like VNN.

The laboratory is expected to:

- Establish and maintain more cell lines
- Develop monoclonal antibody-based techniques for disease diagnosis (eg. monodon baculovirus and hepatopancreatic parvo-like virus)
- Develop PCR-based techniques for other fish and shrimp diseases
- Apply recombinant DNA technology to improve fish resistance to diseases
- Establish an effective disease control program

- Identify schemes and products to replace antibiotics as disease control agents
- Isolate microbes and develop techniques for their mass production for bioaugmentation and bioremediation.

Feed Technology Laboratory. The facility has five projects.

- Development of cheap alternative protein sources to reduce feed cost. Since imported feed ingredients are costly, the project aims to develop nutritionally effective diets with reduced costs and identify cheap alternative protein sources.
- Improve feed efficiency and growth performance of cultured species. The project's objectives are the improvement of feed ingredient quality and bioavailability through fermentation and enzyme technology and evaluation of nutrient absorption rates in cultured species.
- Reduction of losses due to diseases in aquaculture production systems. Since the use of chemotherapeutants may cause the development of drug-resistant pathogenic bacterial strains, AQD feed technology researchers are interested in finding out feed additives and nutrients that will stimulate the fish's immune system and enhance disease resistance.
- Reduction of adverse environmental impact due to inefficient feeds. The project aims to develop low polluting or "environment-friendly" feeds.
- Improved feeds for genetically superior breeds. There is yet no available feed for genetically improved strains. Since higher levels of both macro and micronutrients may be required for feed formulation, optimal levels of these nutrients must be determined.

Algal Production Technology Laboratory. The laboratory aims to

- address the problem of deterioration of seedstocks of cultured seaweeds
- maximize the utilization of algal resources for industrial and medical applications
- develop pollution control and wastewater management measures using algae.

The laboratory will conduct studies on algal physiology, genetics and chemistry. It will undertake further studies to improve algal strains by tissue culture and protoplast technology; characterize algal strains, species and populations at the DNA level; isolate, identify and characterize algal natural products of great industrial or medical use, and develop appropriate culture techniques; and explore the potential or efficiency of algae as biological filters, and in the process, study the uptake and fate of hazardous elements and compounds. ###

AQD scientists win awards

Researchers at SEAFDEC/AQD have been honored this year at separate events by the Philippine science community and the aquaculture industry.

Noteworthy are the achievements of Dr. Zubaida Basiao and Mr. Jobert Toledo who won in this year's 15th Elvira O. Tan Memorial Awards given last July by the Department of Science and Technology.

Dr. Basiao reaped the Best Published Paper in the Aquaculture Category with "Test of size-specific mass selection for Nile Tilapia *Oreochromis niloticus* L, cage farming in the Philippines." The paper, co-authored by Dr. Roger Doyle of Dalhousie University (Canada), tested the effectiveness of a low-cost, small-scale broodstock improvement procedure (collimation or the early culling of large fry) in the culture of tilapia in net cages. Dr. Basiao finished her PhD in Biology at Dalhousie University in 1994 with fish genetics as her field of specialization.

Likewise, Mr. Toledo won the Best Published Paper in the Marine Fisheries Category with the paper entitled, "Bangus fry resource assessment in the Philippines." A collaborative effort among four agencies – Bureau of Fisheries and Aquatic Resources, SEAFDEC/AQD, Philippine Council for Agricultural and Marine Resources Development and the International Center for Living Aquatic Resources Management, the study investigated the alleged scarcity of milkfish fry supply in the Philippines and provided inferences as to the likely causes. Mr. Toledo is a candidate for the doctoral degree at Hiroshima University, Japan; his dissertation is on seed production of grouper.

From the aquaculture industry, the Most Outstanding Researcher for Marine and Brackishwater Fisheries Award was given to AQD Senior Scientist Dr. Oseni Millamena. This is a category of the Fish for Every Filipino Awards 2001 launched by a consortium of the Marine Technology Foundation Inc. which includes: the Bureau of Fisheries and Aquatic Resources (BFAR), Central Luzon State University, Philippine Council for Aquatic and Marine Research and Development (PCAMRD), Philippine Aquaculture Society (PAS) and SEAFDEC/AQD. The awards recognize the Philippines' outstanding farmers and entities who have contributed significantly to the advancement of the aquaculture industry in the fields of research and production.

Dr. Millamena won for her studies on nutrient requirements and diet development for crustaceans (tiger shrimp, crab) and ma-

rine fish. Her work has increased the utilization of local materials as replacement for fish meal in the formulation of practical diets for grouper.



Dr. Zubaida Basiao, Mr. Jobert Toledo, Dr. Oseni Millamena

In another event, research papers of six AQD scientists won in the 13th National Research Symposium sponsored by the Bureau of Agricultural Research (BAR). The following were chosen for the DA Secretary's Award in the Published Research Category:

• Dr. Luis Ma. Garcia's paper "Survival of captive milkfish *Chanos chanos* (Forsskal) broodstock subjected to handling and transport"

• Dr. Oseni Millamena's "The effects of diets on reproductive performance of eyestalk ablated and intact mud crab *Scylla serrata*"

• Dr. Jurgenne Primavera's "Runt-deformity syndrome in cultured giant tiger prawn *Penaeus monodon*"

• Dr. Jurgenne Primavera's "Runt-deformity syndrome in cultured giant tiger prawn *Penaeus monodon*"

readers' corner



What shell is it, again?

SEAFDEC/AQD's FishWorld museum curator and Senior Scientist Dr. Teodora Bagarinao consulted an expert in France on the taxonomic identity of the *agihis* shell we previously featured in this newsletter.

"It is undoubtedly a member of genus *Potamocorbula*, and most probably belongs to the species group of *Corbula fasciata* Reeve, 1843. In this species group, the specimens that you sent appear very close to *Corbula faba* Hinds, 1843. Unfortunately, the taxonomic status of *C. faba* is not clear. I suppose you sent me specimens from low salinity waters (suitable to feed shrimps) for their shells are easily broken. The shell can be provisionally identified as *Potamocorbula* sp. (Family *Corbulidae* Lamarck, 1818)."

Dr. Jean-Maurice Poutiers
Muséum National d'Histoire Naturelle
Laboratoire BIMM
55 rue de Buffon
75005 Paris FRANCE
<mpoutiers@noos.fr>

AQD PUBLICATIONS ... FROM PAGE 10

Tendencia EA. 2001. Effect of iodine disinfection on the bacterial flora and hatching rate of grouper, *Epinephelus coioides* eggs at the cleavage and eyed stages. *Bulletin of the European Association of Fish Pathologists* 21 (4): 160-163

Abstract. In this study, the effect of iodine disinfection on the bacterial flora and hatching rate of grouper egg at two different stages of development were investigated. The eggs (at cleavage and eyed stages) were soaked for 10 min in sterile seawater (control) and at different free iodine concentrations -- 2.5, 5, 10, 15 and 20 ppm. Total bacterial and presumptive *Vibrio* count, as well as the hatching rate of the treated eggs were determined. Results showed that vibrios are eliminated by iodine disinfection (2.5- 20 ppm) but not by rinsing with sterile seawater. The total bacterial load and hatching rate of eggs decreased as the iodine concentration increased. Iodine concentrations of 15 and 20 ppm were effective in significantly reducing the total bacterial load of grouper egg at both the cleavage and eyed stages. However, at these concentrations the hatching rates were also significantly lower. Results also showed that grouper, *Epinephelus coioides*, eggs tolerate stress better at the eyed stage than at the cleavage stage.

Xu ZK, Primavera JH, de la Peña LD, Pettit P, Belak J, Alcivar-Warren A. 2001. Genetic diversity of wild and cultured black tiger shrimp (*Penaeus monodon*) in the Philippines using microsatellites. *Aquaculture* 199 (1-2): 13-40

Abstract. Six microsatellites were used to study (1) the genetic diversity of wild *Penaeus monodon* shrimp from four geographic regions (Palawan, Quezon, Capiz and Negros Occidental-W) in the Philippines, and (2) its association with the status of mangroves and intensity of shrimp culture systems in these regions. Two cultured populations (Negros Occidental-C and Antique) were used for comparison. All six microsatellite loci were polymorphic. A total of 184 different alleles were found over all loci. The total number of alleles per locus ranged from 6 to 54, with allele size ranging from 159 base pairs (bp) to 400 bp. The observed heterozygosity of the six loci ranged from 0.47 to 1.00. The number of genotypes per locus ranged from 5 to 70, F-st values showed significant genetic differentiation among the four wild populations. Genetic differences between wild populations were also detected by pairwise comparison based on genotypic and allelic frequencies. Genetic differentiation among wild populations exhibited a positive correlation with mangrove status and intensity of culture systems at $P=0.083$. The Negros Occidental-W population, which originated from an area with the most severe mangrove loss and the most intensive culture systems, was the most significantly differentiated population. It also showed less genotypes per locus than the other three wild populations, suggesting a decrease in genetic diversity in this population. The population from Capiz, a province with a wide area of extensive culture ponds and few remaining secondary mangroves was the second most differentiated population. The Quezon population, which originated from an area with a few extensive culture ponds and less mangrove destruction, was not genetically different from the Palawan population, which was from a pristine site with mostly primary mangroves and no major aquaculture industry. The cultured populations showed less genetic diversity and were significantly different from the four wild populations based on pairwise F, values and pairwise comparisons of allelic and genotypic frequencies.

AQD SCIENTISTS WIN ... FROM PAGE 15

- Dr. Gilda Lio-Po's "Characterization of a virus obtained from snakeheads *Ophicephalus striatus* with Epizootic ulcerative syndrome (EUS) in the Philippines," and "Pathogenicity of the Epizootic ulcerative syndrome (EUS) associated rhabdovirus to snakehead *Ophicephalus striatus*"
- Dr. Corazon Santiago's "Effect of prepared diet and vitamins A, E, C supplementation on the reproductive performance of cage-reared bighead carp *Aristichthys nobilis* (Richardson)"
- Dr. Emilia Quintio's research, "Seed production of mud crab *Scylla serrata* juveniles," earned the BAR Director's Award in the Published Research Category.

Moreover, Dr. Millamena's paper titled, "Replacement of fishmeal by animal by-product meals in a practical diet for grow-out culture of grouper *Epinephelus coioides*," received a trophy as the Agriculture and Fisheries Modernization Act (AFMA) Best R&D Paper Award in the Unpublished Research for the Fisheries and Marine Science Category.

This is the second year of the awards following the creation of AFMA, also known as Republic Act (RA) 8435. This law, signed by former President Joseph Estrada, also declared October 2 to 6 as National Agriculture and Fisheries R & D Week.

The winners received their awards during BAR's 14th Anniversary on October 4 at the BSWM Auditorium in Quezon City.

Congratulations to everyone! ###

☞ page 40

Stock enhancement

The oceans are the largest grower of seafood on this planet.

This issue is the story of efforts to bring back some of the bounty of the sea through aquaculture, sea farming and stock enhancement.

By governments and communities.

Some efforts are overwhelming successes, some are not.

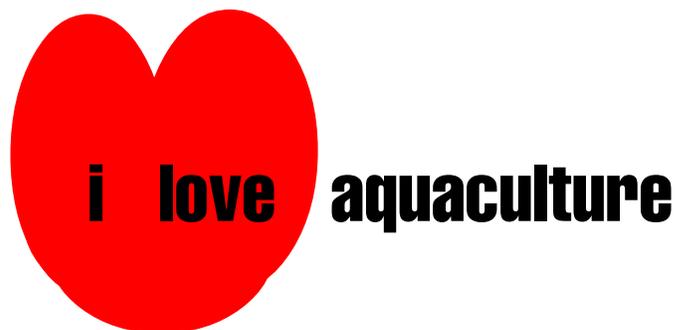
Some took centuries, some are new. Like SEAFDEC's program.

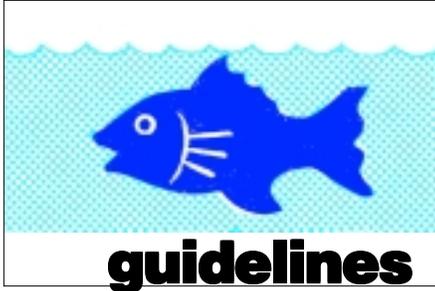
In this issue, we start with the basic considerations of a stock enhancement program, then a discussion of Japan, the most experienced in east Asia, Taiwan, and the Philippines.

We present the resources found on the internet.

We look at two community-based management efforts in the Philippines.

We hope communities and organizations learn from them.





important considerations in stock enhancement

Blankenship¹ and Leber² presented guidelines for a responsible approach to marine stock enhancement in their article titled *A responsible approach to marine stock enhancement* published in the American Fisheries Society Symposium, American Fisheries Society 15:167-175 1995. The guidelines presented are essentially applicable to any species considered for stock enhancement.

1 Prioritize and select target species. Selecting the target species for stock enhancement can be a biased exercise. To avoid this, use of a semiquantified approach (developed in Hawaii) may be better. The approach has 4 phases: (1) an initial workshop where a selection criteria are defined and ranked in order of importance; (2) a community survey, which is used to solicit opinions on the selection criteria and generate a list of possible species for stock enhancement research, (3) interviews with local experts to rank each candidate species with regard to each selection criterion, and (4) a second workshop, in which the results of the quantitative species selection process are discussed and a consensus is sought.

An important step to remove bias from the species selection process lies in the type of numerical analysis used. The relative importance of the various criteria can be used in the analysis by factoring the degree to which each fish meets each criterion by the criterion weight. This produces a score for each species. A trained facilitator who is focused on achieving results can also greatly reduce bias in the exercise.

2. Develop a species management plan that identifies harvest opportunity, stock rebuilding goals, and genetic objectives.

A management plan identifies the context into which enhancement fits into the total strategy for managing stocks. The goals and objectives of stock enhancement programs should be clearly defined and understood prior to implementation. The genetic structure of wild stocks targeted for enhancement should be identified and managed according to the objectives of the enhancement program.

¹H. Lee Blankenship, Washington Department of Fish and Wildlife, 600 Capitol Way North, Mail Stop 43149, Olympia, Washington 98501, USA.

²Kenneth M. Leber, Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, Florida 34236, USA

NOTE

The parenthetical references have been purposely omitted. Please refer to the complete paper which may be requested from library@aqd.seafdec.org.ph

3 Define quantitative measures of success. Explicit indicators of success are clearly needed to evaluate stock enhancement programs. The objectives of enhancement programs need to be stated in terms of testable hypotheses. Depending on enhancement objectives, multiple indicators of success may be needed. Numerous indicators should be identified to track progress over time. An example of such statement can be: *Hatchery releases will provide at least a 20% increase in annual landings of abalone in the area by the third year of the project.*

4 Use genetic resource management to avoid deleterious genetic effects. A genetic resource management plan should encompass genetic monitoring prior to, during, and after enhancement, as well as proper use of a sufficiently large and representative broodstock population and spawning protocols, to maintain adequate effective broodstock population size. Prior to enhancement, a comprehensive genetic baseline evaluation of the wild population should be developed to describe the level and distribution of genetic diversity.

5 Include disease and health management guidelines. Disease and health guidelines are important to both the survival of the fish being released and the wild populations of the same species or other species with which they interact. A stock enhancement program in the US requires that all groups of fish pass a certified inspection for bacterial and viral infections and parasites prior to release. Maximum acceptable levels of infection and parasites in the hatchery populations are established based on the results of screening healthy wild populations.

6 Consider ecological, biological, and life history patterns when forming enhancement objectives and tactics. Ecological factors that can contribute to success or failure of hatchery releases should be considered. Predators, food availability, environmental carrying capacity, temperature and salinity are all key variables that can affect survival, growth, dispersal and reproduction of cultured fish in the wild.

Preliminary, pilot-scale experimental releases with subsequent monitoring of culture fish can be a direct method to use in evaluating assumptions about the effects of uncontrolled environmental factors. For example, assumptions about carrying capacity in particular release habitats can and should be evaluated through pilot releases conducted prior to full scale enhancement in the sites.

7 Identify released hatchery fish and assess stocking effects.

WHAT IS STOCK ENHANCEMENT?

Stock enhancement can be defined as a process whereby the abundance of free living juveniles is supplemented by the release of juveniles reared in hatcheries or captured elsewhere (e.g., in off-shore oceanic areas). Stock enhancement aims at increasing recruitments to a fishery by supplementing the number of juvenile fish or invertebrates that survive the planktonic phase.

The terms “sea ranching” and “marine farming” are often used as synonyms for stock enhancement. Likewise, the terms “reseeding” or “restocking” are often loosely used to imply stock rehabilitation through the release of juveniles from another source because natural reproduction is not enough to sustain local stock.

Other terms that crop up in stock enhancement are: “settlement”, “recruitment”, “settlement limitation”, “culture-based fisheries” and “fisheries enhancement.”

“Settlement” refers to the addition of postmetamorphic juveniles to the stock of demersal juveniles, whereas “recruitment” refers to the addition of new individuals into life stages or size range of a population. Most often, recruitment is referenced to sexual maturity (that is, recruitment into the spawning stock). “Settlement limitation” refers to a situation in which the number of juveniles that are added to a demersal stock periodically are insufficient for the stock to fully utilize the trophic resources or the habitats that are available in the environment. “Culture-based fisheries” are those fisheries in which recruitment to the exploited stock is entirely dependent upon the release of hatchery-reared juveniles. “Fisheries enhancement” is a general term covering all aspects of the manipulation of the physical or biotic environment of a fish or

invertebrate stock in order to increase harvest, as well as supplementing natural recruitment by the introduction of new stock from an external source (Munro & Bell 1997).

Marine stock enhancement has a long history. In Japan, it dates back to 1762, when a samurai warrior named Aoto, established the Tanegawa (river of seeds) system. A fence was built in the middle of the Miomete River in northwest Honshu to prevent salmon from going upstream. During the spawning season all fisheries between the river mouth and the fence were closed to protect the breeding adults (Masuda & Tsukamoto 1998).

In the United States from the 1880s to the late 1890s, hatcheries from New England, to Gloucester and Woods Hole, Massachusetts and to Booth Bay Harbor, Maine, produced and released more than a billion fry of cod, flounder, tautog, shad and mackerel.

In Europe, the Norwegians led the way in stock enhancement in 1883. Other nations including Canada, United Kingdom, France, Australia and New Zealand also built marine hatcheries for stock enhancement during the late 1880s (Grimes 1998).

REFERENCES

- Blankenship HL, Leber KM. 1995. A responsible approach to marine stock enhancement, American Fisheries Society Symposium Vol. 15. p 167-178
- Grimes CB. 1998. Marine stock enhancement: sound management or techno arrogance? Fisheries Management Perspective - Fisheries Sept 1998
- Masuda R, Tsukamoto K. 1998. Stock enhancement in Japan: review and perspective. Bulletin of Marine Science 62 (2) 337-358
- Munro JL, Bell JD. 1997. Enhancement of marine fisheries resources. Reviews in Fisheries Science 5 (2): 185-222
- ###

Natural fluctuations in marine stock abundance can mask successes and failures. Maximization of benefits cannot be realized without the proper monitoring and evaluation system.

A few identification systems such as coded wire tags, passive integrated transponder tags, genetic markers, and otolith marks have been developed. These systems meet the requirements that identified fish are representative of the species with regard to behavior, biological functions, and mortality factors, and thus provide unbiased data. The widespread use of the coded wire tag is well known and it is safe to say that it has revolutionized the approach to stock enhancement.

8 Use an empirical process to define optimum release strategies. As preliminary releases can be used to evaluate ecological assumptions, pilot release experiments give a means of quantifying and controlling the effects of release variables and their influence on the performance of cultured fish in coastal environments. Experiments to evaluate fish size at release, release season, release habitat, and release magnitude should always be conducted prior to launching full scale enhancement programs. These studies are a critical step in identifying

enhancement capabilities and limitations and in determining release strategy. The lack of monitoring to assess survival of the fish release by marine enhancement programs early in the century through the 1940s was the single greatest reason for the failure of those programs to increase stock abundances and fishery yields.

9 Identify economic and policy guidelines. Initially, costs and benefits can be estimated and economic models developed to predict the value of enhancement. This information can be used for funding support through reprioritization, legislation, or user fees. It can also contribute to an explicit understanding with policy makers and the general public on the time frame that is needed for components such as adaptation of culture technology and pilot-release experiments before full-scale releases can begin.

10 Use adaptive management. Adaptive management is a continuing assessment process that allows for improvement over time. The key to the improvement lies in having a process for changing both production and management objectives (and

☞ page 40



stock enhancement in Japan and Taiwan

Stock enhancement has been recognized as one of the essential strategies that can sustain and increase the resources of coastal fisheries. It has been practiced for over a century, with more than 100 species released to date in worldwide programs. Among the countries in Asia, Japan and Taiwan have already established the practice of stock enhancement.

Japan

The Japanese Government has been supporting stock enhancement efforts since 1963 to improve coastal resources and ensure income of fishers. Shrimp, fish, and other juveniles have been raised in large quantities under human control, and when these acquire sufficient capability to survive, they are released into the ocean where they can grow and mature. Under this program, the Seto Inland Sea served as a model area for seafarming.

In 1979, the government created an entity, the Japan Sea-Farming Association (JASFA), to operate seafarming centers spread all over Japan and supervise stock enhancement programs in the country.

JASFA started by producing seedlings of those species already reared successfully by private aquaculture traders, such as kuruma prawn. The species for sea farming were then gradually extended to include swimming crab, red sea bream, tiger puffer (*Takifugu rubripes*) and others. It was only in the 1970s when stable production of large quantities of rotifers, the initial feed required by fish and crustacean larvae, was achieved that technical developments for the mass production of seedlings began.

There are about 90 species used for sea farming to date, including those for which seedling production techniques are presently being developed (Table 1). The commercialization of sea farming is advanced for 12 of these species, including red sea bream, Japanese flounder, kuruma prawn, swimming crab, sea urchin and abalone, and the scale of mass production has risen to over 10 million for each of these species. These large-scale sea farming operations include scallop (*Patinopecten yessoensis*) and short neck clam (*Tapes philippinarum*) based on the collection of natural spat.

At present, there are 16 national and 57 local government hatchery facilities distributed throughout the coastal area of Japan. These centers are engaged in technical developments for seedling production and release of seedlings. The regional sea farming center in each prefecture mass produces seedlings of the species for which seedling techniques have been developed. These seedlings are handed over to fisheries cooperative associations or municipal seedling

TABLE 1 The main species, number of seedstock produced and released in 1996 in Japan (Imamura 1999)

Common name	Scientific name	No. produced (x 1000)	No. released (x 1000)
Pacific herring	<i>Clupea pallasii</i>	2382	[2000*]
Black sea bream	<i>Acanthopagrus schlegeli</i>	10566	6952
Red sea bream	<i>Pagrus major</i>	30 008	22395
Sandfish	<i>Arctoscopus japonicus</i>	7574	6146
Jacopever	<i>Sebastes schlegeli</i>	1968	1481
Japanese flounder	<i>Paralichthys olivaceus</i>	30831	22626
Mud crab	<i>Limanda yokohamae</i>	4594	2793
Ocellate puffer	<i>Takifugu rubripes</i>	2409	1721
Striped jack	<i>Pseudocaranx dentex</i>	786	402
Yellow tail	<i>Seriola quinqueradiata</i>	399	197
Sea bass	<i>Lateolabrax japonicus</i>	1642	749
Kuruma prawn	<i>Penaeus japonicus</i>	457807	275192
Chinese prawn	<i>Penaeus chinensis</i>	2920	2899
Speckled shrimp	<i>Metapenaeus monocerus</i>	44435	26627
Mangrove crab	<i>Scylla serrata</i>	1142	563
Swimming crab	<i>Portunus trituberculatus</i>	61369	34919
Blue crab	<i>Portunus pelagicus</i>	3378	983
Japanese abalone	<i>Sulculus diversicolor</i>	2599	2240
Disk abalone	<i>Nordotis discus</i>	16839	5384
Yezo abalone	<i>Nordotis discus hannai</i>	18908	16377
Giant abalone	<i>Nordotis gigantea</i>	5031	3214
Spiny top shell	<i>Batillus cornutus</i>	3136	2613
Ark shell	<i>Scapharca broughtonii</i>	4339	2033
Scallop	<i>Patinopecten yessoensis</i>	2792391	2989328
Hard clam	<i>Meretrix lusoria</i>	3235	17655*
Hard clam	<i>Meretrix lamarckii</i>	2120	2246
Surf clam	<i>Spisula sachalinensis</i>	7179	6105
Sea urchin	<i>Tripneustes gratilla</i>	190	69
Red sea urchin	<i>Pseudocentrotus depressus</i>	4323	3631
Sea urchin	<i>Strongylocentrotus intermedius</i>	61851	60647
Sea urchin	<i>Strongylocentrotus nudus</i>	8994	12299*
Sea cucumber	<i>Stichopus japonicus</i>	6568	5249

*including natural seedlings

rearing facilities (intermediate rearing facilities) where they are reared for several weeks until they are large enough to be released.

Under the current basic policy on sea farming in Japan, emphasis is given to the promotion of sea farming, together with the conservation of the environment in the waters surrounding Japan, improvement of coastal fishing grounds, and proper management of fishery resources.

Taiwan

In 1982, the Tungkang Marine Laboratory of the Taiwan Fisheries Research Institute (TFRI) made the coastal waters along the south-western coast of Taiwan an experimental area for prawn releases to augment the production of its coastal fisheries. A series of ecological studies, including community structure, distribution, reproduction, recruitment, food and feeding, growth, and tagging experiments on commercially important prawns in the area was carried out. Results were used as basis for the establishment of an effective system of prawn stock enhancement.

By considering species composition and commercial value, *Penaeus monodon*, *P. semisulcatus* and *M. ensis* were selected as

candidates for stock enhancement in the coastal waters of south-west Taiwan.

Based on the data from ecological studies of penaeid prawns, the key issues identified for prawn release include: the target species; optimal seed size for release; number of seed to be released; timing of release; appropriate site for release; effective method of release; and a conservation system to protect the released animals.

According to Taiwanese researchers, restocking with juvenile prawns can enhance recruitment in open coastal waters. The released juveniles should be of a size that can acclimatize well in coastal waters as well as escape from predators. The site for restocking is also important for stock enhancement. It is assumed that the main distribution area of a species provides the best environment and a sufficient supply of food for that species. Stock enhancement sites should be near this area.

To maintain the genetic balance of a stock and avoid disease transmission, releases are only made for (1) animals that come from spawners caught from the original stock, and (2) specific pathogen-free (SPF) prawns. Taiwan's researchers have also de-

☞ page 40

TABLE 2 Species reported to be associated with success in stock enhancement and sea ranching (Liao 1999; complete reference citation for the last column can be found in Dr. Liao's paper)

Species	Common name	Release size (cm)	Country	References
<i>Atractoscion nobilis</i>	White seabass	-	California, USA	Blankenship & Leber 1995
<i>Gadus morhua</i>	Atlantic cod	-	Norway	Svåsand & Meeren 1995
<i>Lates calcarifer</i>	Barramundi	>2.5	Australia	Russel & Rimmer 1997
<i>Mugil cephalus</i>	Striped mullet	>7.0	Hawaii, USA	Leber 1995
<i>Oncorhynchus keta</i>	Chum salmon	5.0	Japan	Kitada 1999
<i>Pagrus major</i>	Red sea bream	8.0	Japan	Kitada 1999
<i>Paralichthys olivaceus</i>	Japanese flounder	7 to 10	Japan	Kitada 1999
<i>Patinopecten yessoensis</i>	Ezo-giant scallop	3.5 ¹	Japan	Kitada 1999
<i>Penaeus chinensis</i>	Fleshly prawn	1.0	China	Deng 1997
<i>Penaeus japonicus</i>	Kuruma prawn	1.5	Japan	Kitada 1999
<i>Penaeus monodon</i>	Grass Prawn	12 to 15	Taiwan	Su et al. 1990, Su & Liao 1999
<i>Sciaenops ocellatus</i>	Red drum	-	Texas, USA	Liao et al. 1997

¹Shell length



TABLE 3 Species released by the Taiwan Fisheries Research Institute (TFRI), 1976 to 1995 (Liao 1999)

Category	Number of species	Quantity (x 10 ³)	Species
Fishes	7	693	Red sea bream, black sea bream, goldlined sea bream, thornfish, gray snapper, Japanese eel, marbled eel
Crustaceans	6	29050	Kuruma prawn, grass prawn, sand shrimp, bear prawn, redbtail prawn, swimming crab
Molluscs	1	510	Small abalone



Abalone from the AQD hatchery. Note the green band, used as tag to identify hatchery-raised abalone, made by feeding the abalone with AQD's artificial feed. The feed contains seaweed pigments which, researchers say, may account for the band



The seahorse *Hippocampus kuda*, female and male, from AQD's production laboratory for marine ornamentals

SEAFDEC/AQD's stock enhancement program

SEAFDEC/AQD organized its stock enhancement program in September 2000. It is one of five programs that is focused on addressing and prioritizing urgent aquaculture issues that are important to Southeast Asia. The need for stock enhancement is addressed in the Kyoto Declaration on Aquaculture (Sections 17 and 18) and the Bangkok Declaration on Strategy for Aquaculture Development (Sections 3.9 and 3.10) which underscored the considerable potential of stock enhancement in increasing fish supply from inland and coastal waters.

AQD's stock enhancement program is anchored on the propagation of resource organisms or modification of natural habitat and environmental conditions for recovery of depleted stocks and for increased production from natural grounds.

The stock enhancement program has two research components:

- 1 Adoption and refinement of seed production techniques for
 - Abalone *Haliotis asinina*
 - Top shell *Trochus niloticus*
 - Seahorse *Hippocampus* sp.
 - Other species appropriate for stock enhancement (eg. crabs)
- 2 Development of release, monitoring, and stock enhancement strategies with several projects on:
 - Habitat protection and modification (artificial reefs, marine reserves, seaweed reforestation)
 - Release of hatchery-reared juveniles (abalone, top shell, giant clams, etc)
 - Transplantation of broodstock (window-pane shell *Placuna placenta* or "kapis")
 - Co-management of resources

Likewise, the program has training and information components such as:

- 1 Seminars and training sessions on stock enhancement for fishers, local governments and non-government units
- 2 Production of manuals, videos, posters, and flyers to enhance people awareness of stock enhancement efforts

Abalone

Abalone research at AQD has concentrated on the development of techniques for mass production of seed stock to enhance the dwindling natural population. In 1994, wild-caught abalone spontaneously spawned in the hatchery. Since then, production of juveniles in the hatchery has been achieved, followed by successful grow-out in floating sea cages, and the completion of the abalone life cycle in the hatchery in 1997. In 1998, artificial diet for juveniles was developed as well as grow-out rearing in tanks. More recently, studies focus on the development of artificial diets for broodstock maturation and spawning, and the refinement of seed production techniques. Natural spawning in tanks occurs every other week throughout the year but refinement studies are undertaken to increase egg hatching, larval settlement and postlarval survival rates to produce thousands of juveniles for release and stock enhancement. Juveniles are now "diet-tagged" and conditioned for release to their natural habitat. "Diet-tagging" is done by feeding batches of juveniles with an AQD formulated feed that produces a bluish-green shell band on the abalone. This band will serve as an identifying mark of hatchery-produced abalone that will be released to enhance wild stocks. Efforts are also being made to produce and release first generation offspring of wild spawners from the release sites to maintain genetic integrity of natural stocks.

Top shell

AQD collaborates with a top shell hatchery (Iris Hatchery) in Puerto Princesa, Palawan. More than 3,000 top shell juveniles have been provided to AQD for diet-tagging; however, AQD will eventually be producing top shell juveniles from parent stocks from Sagay Marine Reserve (Negros Occidental), the pilot site for stock enhancement. Seedstock of another top shell species, *Tectus pyramis*, will also be produced because of its need and potential for stock enhancement.

Window-pane shell

In 1990, AQD started research on the feasibility of restocking Panay



The top shell Trochus at AQD's mollusc hatchery. At far right is the giant clam

Gulf, a depleted “kapis” bed, with stocks from an abundant area. Panay Gulf still maintains the conditions necessary for the growth and development of “kapis.” Verification trials conducted in 1999 confirmed these results with the presence of juveniles, less than a year after restocking broodstock. However, gatherers collected the juveniles despite calls to allow juveniles to mature and breed several more generations. Added to this were illegal fishing activities (trawls and dredges) in the project site despite the deployment of markers and bouys. In August 2001, another batch of “kapis” breeders was stocked near the AQD station and protected by a stainless steel pen. AQD plans to hold more meetings with local officials and fisherfolk organizations to increase their understanding of the importance of the project and their role in its success.

Giant clam

AQD is collaborating with the University of the Philippines, Marine Science Institute (UP-MSI) for enhancing wild stocks of the giant clam *Tridacna gigas*. UP-MSI is distributing hatchery-produced giant clam juveniles to various areas in the Philippines in efforts to save and enhance the stocks of this endangered species. AQD is one of its partners. Recently, AQD received 500 *T. gigas* juveniles which will be initially stocked at AQD's Igang Marine Substation in Guimaras. Results will guide future stock enhancement efforts.

Seahorse

Seahorse research at AQD started in 1996 when an initial stock of 32 pairs of the spiny seahorse (*Hippocampus barbouri*) and 18 pairs of the lined seahorse (*H. erectus* or *H. kuda*) were transported from Luzon to AQD in Iloilo. Research has produced broodstock from hatchery seeds and several generations of offsprings of *H. barbouri* and *H. kuda*.

The AQD stock enhancement team

AQD researchers are now conducting resource as-

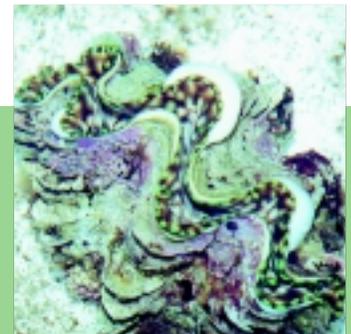
essments in preparation for the release and stock enhancement of abalone, top shell, and sea horse in some selected sites, initially the Sagay Marine Reserve, in order to establish baseline data and to prepare the local people for the stock enhancement activities.

The AQD stock enhancement group meets once a month to discuss relevant issues, review progress and identify appropriate strategies to develop the stock enhancement program.

The researchers for each species are:

- **Abalone** SEED PRODUCTION: *WG Gallardo, RSJ Gapsin, AC Fermin*; ARTIFICIAL DIET DEVELOPMENT: *MB Teruel*; DIET-TAGGING, RELEASE AND MONITORING: *WG Gallardo*
- **Top shell** SEED PRODUCTION: *RSJ Gapsin, WG Gallardo* DIET-TAGGING, RELEASE AND MONITORING: *CL Marte, WG Gallardo*
- **Giant clam** OCEAN NURSERY AND RESTOCKING: *CL Marte, WG Gallardo*
- **Window pane oyster** RESTOCKING: *JM Ladja, DD Baliao and Technology Verification staff*
- **Sea horse** SEED PRODUCTION: *GH Garcia, LMaB Garcia*
- **Artificial reefs and marine reserves:** *LMaB Garcia, YP Tirol*
- **Seaweeds and seagrasses:** *AQ Hurtado*
- **Mangroves:** *JH Primavera*
- **Socioeconomics:** *SV Siar, DB Baticados, ND Salayo*

Program Leader: *WG Gallardo* ###



SEAFDEC supports the Bangkok and Kyoto Declarations on sustainable development

*Bangkok Declaration and Strategy*¹

Section 3.9 Applying innovations in aquaculture

The technologies for sustainable aquaculture development should provide a varied and adaptable “tool box” from which people can select and design the system which most effectively meets their needs and best fits the opportunities and constraints of the local environment. The delivery of such techniques requires efficient communication networks, reliable data on the merits and drawbacks of the various approaches, and help with the decision making process through which people choose their production systems and species.

As we move into the next two decades, water and land for aquaculture will become critical issues. New opportunities for aquaculture development will also emerge through improvements in science and technology for aquaculture systems.

The potential areas for further consideration include:

- technologies for sustainable stock enhancement and ranching programmes, and open ocean aquaculture;
- increased use of aquatic plants and animals as nutrients stripping;

☞ page 25

¹ NACA/FAO. 2000. Aquaculture Development Beyond 2000: the Bangkok Declaration and Strategy, Conference on Aquaculture in the Third Millennium, 20-25 February 2000, Bangkok. NACA, Bangkok and FAO, Rome. 27 p



stock enhancement websites

We visited the web for additional information and came up with websites based in Japan, US and Europe – pioneering countries of stock enhancement. Here's our fave sites, check them out and learn more!

JAPAN SEA FARMING ASSOCIATION

www.jasfa.or.jp/english

The website traces the history of sea farming and stock enhancement in Japan, details the status and promotion of sea farming, and presents the process from seed production, nursery rearing, seed release to management of resources and catch. Some of the info are summarized in the article on page 20-21, this issue.

Visit the symposium page for details of the *Second International Symposium on Stock Enhancement and Sea Ranching* to be held January 28 to February 1, 2002 at Kobe Portopia Hotel, Kobe City, Hyogo Prefecture, Japan. This site has general information on the symposium, the program, keynote speakers, and the papers to be presented.

STOCK ENHANCEMENT AND SEARANCHING HOMEPAGE

www.efan.no/was

This homepage was established to help network people involved in conducting, researching or planning hatchery releases into aquatic environments to supplement and restore fisheries and fish populations. It highlights programs and groups working in the field, the available published information and scientific articles, and a discussion forum on all aspects of stock enhancement.

The editors of this homepage have been actively involved in stock enhancement and sea ranching research for over a decade, and have organized and conducted various symposia and meetings focused on this field. Terje Svåsand is the head of the Division of Marine Enhancement at the Institute of Marine Research in Bergen, Norway. Ken Leber directs the Center for Fisheries Enhancement at Mote Marine Laboratory in Florida, USA. Erlend Moksness is the head of the Institute of Marine Research's Flødevigen Marine Research Station in Arendal, Norway. Shuichi Kitada is an Associate Professor at Tokyo University of Fisheries, Japan whose area include evaluation of stocking impacts and statistical analyses for ecological supporting. And lastly, Ian Cowx is currently Director of the University of Hull International Fisheries Institute in the UK.

CENTER FOR FISHERIES ENHANCEMENT

www.mote.org/~kleber

The Center for Fisheries Enhancement at Mote Laboratory aims to increase knowledge on how to preserve and responsibly enhance marine and estuarine fish populations, and to advance marine aquaculture in an environmentally sustainable manner. They have

three main areas of concern or approach: hatchery releases, habitat protection and fishing regulations. As part of integrating these approaches, the center evaluates and develops (1) the science of stock enhancement to enable an effective and responsible approach to stocking cultured fishes and invertebrates, (2) how to recognize and protect essential or critical habitat for key fisheries stocks, and (3) a better understanding of life history and ecological requirements and how to use this knowledge to develop second regulations.

Their website features an excerpt of the paper *Marine stock enhancement and aquaculture R&D program/fisheries linkage with aquaculture: rationale for an experimental approach* by Kenneth Leber, the center's director.

NORTHWEST FISHERIES SCIENCE CENTER

nsfw.noaa.gov/reutd

The Resource Enhancement and Utilization Technologies Division resolves existing and developing challenges associated with captive rearing, disease control, hatchery technology, smolt quality and utilization research. The primary focus is to improve technology to better serve NOAA (National Oceanic and Atmospheric Administration) Fisheries' priority on fish enhancement/culture and full utilization of resources.

This site features the fishery enhancement program which has two main activities: salmon and marine enhancements. The marine enhancement group works on various aspects of fish husbandry specifically on salmon studies, marine fish studies and fish rearing research. On the other hand, the NOAA library (www.lib.noaa.gov/edocs/stock.html) features a list of resources for marine stock enhancement particularly recent symposia/workshops and printed resources.

NORTH ATLANTIC SALMON CONSERVATION ORGANIZATION (NASCO)

www.nasco.org.uk

Wild salmon stocks in the North Atlantic has been declining for many years. In response to this, NASCO was established under the Convention for the Conservation of Salmon in the Atlantic Ocean. It aims to contribute through consultation and cooperation to the conservation, restoration, enhancement and rational management of salmon stocks subject to the Convention taking into account the best scientific evidence available. Their website features general information about the group, the Convention, resolutions made by the group and press releases. Links to related websites are also provided.

☞ one more website
on page 41



**seafarming in japan / www.jasfa.or.jp/english
JAPAN SEA FARMING ASSOCIATION (JASFA)**



The seed fish raised in land-based tanks are transported from sea farming centers to release sites in order to acclimate them to the natural environment where they are to be released. Seed quality is enhanced. Fish undergo the process of intermediate rearing in net cages until they grow to a size suitable for release. -- JASFA photos

High quality seeds are released in appropriate sites with due consideration to the surrounding natural environment, the ecology of target organisms, and the actual state of fisheries in the area. Seeds are protected and raised in nurseries so that they will not fall prey to other organisms immediately after release. The released seeds grow under natural conditions and are recruited into fisheries stock. -- JASFA photos

BANGKOK AND KYOTO ... FROM PAGE 23

- increased emphasis on integrated systems to improve environmental performance; and
- emerging technologies (e.g., recirculating systems, offshore cage culture, integrated water use, artificial upwelling and ecosystem food web management).

Section 3.10 Improving culture-based fisheries and enhancements

Fisheries enhancements in inland and coastal waters include culture-based fisheries and habitat modifications in common pool aquatic resources, which require minimal food and energy inputs. These practices therefore provide important opportunities for resource poor sections of the population to benefit from relevant aquaculture technologies and permit efficient use of under-utilised, new or degraded resources. Culture-based fisheries in particular have considerable potential for increasing fish supplies from both freshwater and marine fisheries and generating income in rural inland and coastal areas.

The full potential of enhancements and culture-based fisheries could be achieved by:

- Creating conducive institutional arrangements to enable and sustain investment in common pool resources
- Providing appropriate research and development inputs
- Managing environmental and other external impacts and
- Promoting effective regional co-operation and information exchange

Kyoto Declaration²

Section 17. Support enhancement of fisheries in coastal marine and inland waters, when and where appropriate, by: (i) assisting in stocking of resources and restocking of depleted resources through providing suitable organisms, (ii) assisting fishers to organize themselves; (iii) promoting the use of integrated community based and/or co-management schemes; and (iv) subject to national priorities, establishing access or user rights in waters exploited under open access regimes

Section 18. Promote the use of sustainable and environmentally sound aquaculture and ranching in coastal marine and inland waters through, inter alia: (i) establishment of appropriate institutional and legal frameworks; (ii) coordination of the use of lands and waters with other activities; (iii) use of the best and most appropriate genetic material in conformity with the conservation and sustainable use of the environment and conservation of biological diversity; and (iv) application of social and environmental impact assessments

²FAO. 1976. Advances in Aquaculture. Proc. Tech. Conf. Aqua. 653 p



experiences in stock enhancement and resource management

Buttons are from a topshell

The top shell button is a luxury product, sought after by quality shirtmakers. In the mid-1900s, extraction from the natural population supplied the demand worldwide. Little was done to replace what was taken.

To sustain its remaining natural stock, *Trochus niloticus* is now a likely candidate for stock enhancement. Harvested for its many uses, the natural population has been dwindling and according to experts, dangerously near extinction. A study of its ecology and reproductive biology interspersed into management strategies and action plans would perhaps save the trochus from natural death.

What is a trochus or a top shell?

T. niloticus is a sea shell resembling a top. It is found in the tropical and subtropical waters between the eastern Indian Ocean and the western Pacific Ocean. Its natural distribution extends from Sri Lanka in the west and to Wallis Island in the east. The northern limit is the Ryukyus Island in southern Japan and New Caledonia and Swain Reef at the southern end of the Great Barrier Reef in Australia in the south. Indonesia, the Philippines, and the South Pacific countries are the three main trochus sources.

The trochus lives on reef flats formed from the debris of dead corals. Young trochus usually live on the slabs of dead coral covered with a fine film of small algae, diatoms, and foraminifers. Large trochus mainly live on the part of the reef that is exposed to wind. Their muscular foot enables them to cling firmly to the substrate and thus resist strong water turbulence. The depth range ideal for this species is the first 10 meters from the surface but it may be found 24 meters deep.

Trochus in the Philippines

It is believed that a substantial amount of trochus was extracted from the Philippines in the early to mid-1900s. It is no wonder then that today, trochus activities mostly focus on reviving the natural population.

In Palawan, a trochus hatchery has been operating since 1999 in order to produce juveniles for restocking in Bindoyan shores. Ramel Ruta, operations manager, shared some valuable information regarding the Iris Hatchery at Bindoyan, Puerto Princesa, Palawan.

In 1997, papers for the establishment of the hatchery were processed, infrastructure was completed, and by 1999, operations of the hatchery started. The year 1999 was spent in several failed

attempts to spawn trochus. After one year, on January 2000, the first successful spawning was done.

Hatchery operation

Ramel and his colleagues usually buy broodstock from the wild. Trochus shell base diameter must be between 8-15 cm; a spawning batch usually weighs 10 kg with more or less 40 individuals of varying sizes during spawning season in December-May.

For spawning, purchased broodstock (male and female) are initially packed in plastic tanks (50 l) overnight with just enough filtered seawater. The next day, trochus are placed in bigger tanks (250 l) also with filtered seawater and strong aeration and placed in a dark room. Males are next selected from the batch to manually extract the testes, which are then macerated. When females start to release eggs (early evening), they are individually placed in 30 l tanks and allowed to release eggs for 1-3 days. A 0.5 ml of the testes extract is added to the tank water to fertilize the eggs. After 3 days, in 30 l tanks, the fertilized eggs (60% hatching rate) are gathered and transferred to bigger tanks and allowed to grow until they reach the "mantle" stage (5% survival). They are then transferred to grow-out tanks (2 x 3 x 0.6 m; 6 hr aeration) where they are fed diatoms and algae. When tanks are cleaned of the diatoms, the trochus are manually transferred to other tanks with diatoms. No artificial feeds are used.

The stocks at the Iris hatchery consist of three batches: those with 2.5 and 5 cm base diameter and the much smaller ones which are placed in the diatom/algae tanks. The 2.5 and 5 cm diameter stocks are fed diatoms directly from the sea. Irregularly shaped big rocks (approximately 0.5 m dia) are manually taken from the nearby coast and placed inside the tanks. The trochus attach to and eventually feed on them. When the rocks are rendered clean, they are brought back to sea and replaced with "new" rocks with diatoms. The coast near the Iris Hatchery has about 9 acclimation tanks. Iris hatchery is able to monitor the hatchery stocks that are released because trochus are not able to cross the sand barriers. In Bindoyan, the rocky part of the coast has a sand bar as the sea gets deeper.

Collaboration with SEAFDEC/AQD

In September 2000, Iris hatchery gave 500 trochus juveniles for some feeding experiments. Results showed that trochus grow well on AQD formulated abalone diet, producing a reddish-pink banded shell. AQD researchers believe that the band could be used as an identifying mark for hatchery-reared juveniles released to natural grounds for stock enhancement. Encouraged by the results and its

usefulness, Iris hatchery provided AQD last June 26, 2001 with 3,000 trochus juveniles for diet-tagging and subsequent release for stock enhancement.

Future activities

The Iris Hatchery does not have plans of commercial production. Their sole plan is to perfect the hatchery process to increase the natural stock. Ramel estimates that 400 ha of grow-out space is needed to be able to produce more or less 10 tons (required exporting volume) per export shipment on a regular basis. Export size is a minimum of 8 cm base diameter (empty) at P90-100 per kg. “We are not ready for such production, but trochus export from the wild continues at present,” says Ramel. He observes that fisherfolk are still able to gather trochus, and when they are able to gather enough to make over a kilogram, they would sell to traders who again gather and sell them upon reaching the required volume.

Trochus as a stock enhancement species leaves more questions (like number of founder stock, survival after release, etc) than answers. Many experts admit that similar activities worldwide have remained inconclusive and specific lessons are not clear enough to learn from. Nevertheless, a beginning that is anchored on a scientific path can seldom go wrong. -- MBS & RYB



- A** Iris hatchery for trochus has four nursery-growout tanks, broodstock and larval rearing building, a power generation room, and a modest dormitory. The rocky shores of the hatchery makes it an ideal site for trochus stock enhancement
- B** The acclimation tanks of Iris along its shores are stocked with 2.5 cm base diameter trochus for subsequent release to natural waters
- C** Ramel Ruta, operations manager of Iris holds the biggest trochus broodstock gathered from the wild by local fisherfolk. Inset is the tank for overnight transport of wild trochus broodstock
- D** Rene Rafols, farm worker, reads the water temperature in the grow-out tank. “We hold 7-month old trochus in this tank. These are not fed artificial feeds yet. Trochus feed on diatoms allowed to grow in the tank (inset).”

- E** Ronulfo Cayaon, hatchery technician, lifts the trochus settling plates in one of 12 grow-out tanks
- F** SEAFDEC/AQD feed for tagging are fed to various sized trochus at Iris. With feeding, trochus are expected to develop a distinctive band to serve as tag after they have been released to the wild

Efforts to revive the kapis shell fishery ...

Kapis shell, as the window pane oyster *Placuna placenta* is also known, once thrived in the towns of Oton, Tigbauan and Guimbal along the Gulf of Panay in southern Iloilo. The area is identified as one of the 27 natural kapis beds in the country. For three decades, 1960 to 1990, kapis shell have served as raw materials of a lucrative export-oriented shellcraft industry. But because its an open access fishery, overexploitation has resulted in stock depletion.

Recently concluded studies of SEAFDEC/AQD suggests that the area still maintains the conditions necessary for the growth and development of kapis. Benthic organisms that are indicators of productive habitat are still abundant, and restocking is still feasible by using adult animals (>70 um shell length) to naturally repopulate the area. Verification trials conducted in the coast near AQD headquarters in Tigbauan, Iloilo confirm these results.

Based on these findings, AQD initiated a stock enhancement program to revive the shell craft industry along the area. It collaborated with local government units of three coastal towns who enthusiastically welcomed the program. From October to November 1999, kapis broodstock from the neighboring island of Negros were stocked in Barangays Namocon in Tigbauan, Trapiche of Oton and in Nalundan, Guimbal.

Samplings taken after a few months showed the presence of kapis larva and juveniles. AQD and local government officials appealed to the residents of the project area to be more vigilant, have more patience, and protect the young until they mature and breed several more generations.

The Gulf of Panay, however, is the fishing ground of migratory fishers from other parts of Panay and Negros island. Fishing season is October to May. Illegal fishing gears (trawl and dredges), operated at night by these migratory fishers, from time to time are hitting the project area despite the markers and bouys. Local residents and officials say these fishers do not care much because they have not invested in resource management in the marked areas. Adding to this problem is lack of fast patrol boats to guard and apprehend the intruders. Significant damage has been done as shown by the dead broodstock and their young in succeeding samplings.

With these setbacks and lesson learned, AQD is pursuing the stock enhancement program with more innovative “preservation” techniques. Kapis breeders stocked in August 2001 near the AQD station in Tigbauan were protected by a 4 x 4 x 1 meter stainless steel pen. The pen is designed and anchored to withstand monsoon weather water currents, siltation and especially uprooting by trawls and dredges. Adequate markers have been installed to warn approaching trawl fishers and for easy identification.

AQD plans to hold more meetings with local officials and fisherfolk organizations to increase their understanding of the importance of the project and their role in its success.

Recently, Tigbauan officials approved a resolution to “Preserve and protect the *Placuna placenta* locally known as ‘lampirong’ in the municipal waters of Tigbauan.” With these strong partnerships, AQD hopes for the revival of the kapis shell fishing and industry in southern Iloilo. -- RYB

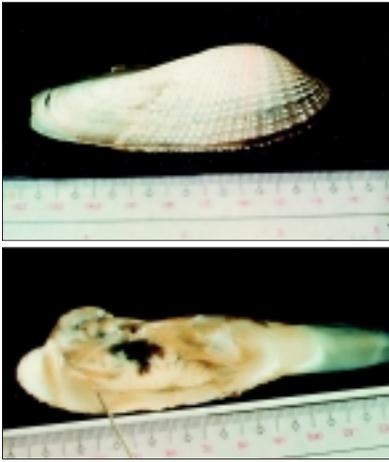
... and the angel wing clam

The University of the Philippines in the Visayas (UPV) based in Miag-ao, Iloilo was motivated to study *diwal* or angelwing clam in 1992, when the Roxas City government informed them of the rapid decline of stocks in the area. Roxas City is known to be the “seafood capital” of the Philippines, hence, the government’s alarm.

The *diwal* (*Pholas orientalis*) is indigenous to the coastal waters of Negros Occidental (Hinigaran, Pontevedra, Valladolid, and San Enrique), Iloilo (from Barotac Nuevo toward San Dionisio), and Capiz (Ivisan, Sapián, Panay, Pilar, Pontevedra, and Roxas City). It can be found in burrows of over 0.3 m in nearshore areas with muddy sand substratum. *Diwal* has a sweet, tender juicy taste. It is either marketed fresh or dried in the Philippines, Hong

Plankton sampling to evaluate the primary productivity of a kapis stock enhancement site; kapis readied for stocking; and kapis broodstock and juveniles





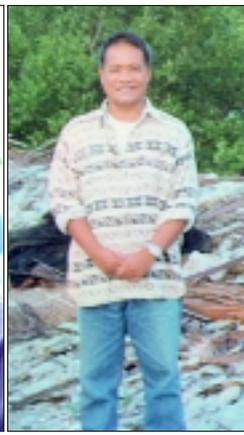
The shell and meat of the diwal *Pholas orientalis*, also known as haw chung in Hong Kong, siput selat batu in Malaysia and hoy pim in Thailand



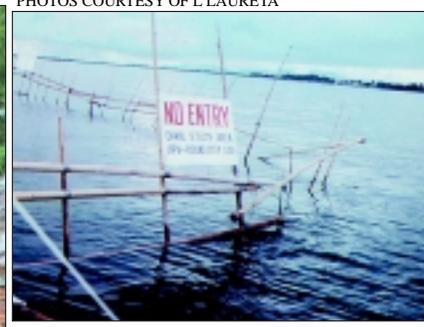
Village head Tubias Besa of Punta Cogon: "Diwal contributed a large portion to the incomes of every person in the village, and we want it back."



Councilor Vicente Martizano of Barra: "The success of the stock enhancement project will be the pride of Roxas City and of the researchers themselves."



Dr. Liberato Laureta of UPV (above); the 'no entry' signage at the site and the divers during diwal transplantation (at left)



Kong (*haw chung*), Malaysia (*siput selat batu*), and Thailand (*hoy pim*).

Diwal has been considered a tourist attraction, a good source of income, and a pride of Roxas City. In 1960s to 70s, *diwal* was harvested anywhere in the nearshore areas of Barangays Barra and Punta Cogon. One person can even harvest about 300 pieces of *diwal* a day, collected manually (without compressor) from a depth of 2 fathoms. The *diwal* was sold by piece, prices ranging from 10 to 15 centavos in 1960s to 70s, to 5 pesos in 1990s. Iloilo City is the main market of *diwal* from Roxas City with prices ranging from P 60 to 120 per kilo. However, in the 1980s to 1990s, pollution, siltation, and indiscriminate harvesting have resulted in the depletion of most of the natural beds.

To rehabilitate depleted *diwal* beds, detailed ecological information is required. To date, the only paper on *diwal* is the work of Ablan (1938). So in May of 1994, Dr. Liberato Laureta and Prof. Evelyn Marasigan of UPV's Institute of Aquaculture conducted a study on the habitat and reproductive biology of the species. The study was funded by the Department of Agriculture, and conducted in Barotac Nuevo due to the availability of stock in the area. Regular sampling and laboratory examination were done every month for about 15 months (May 1994-August 1995).

A year after, in August of 1996, the same project was done in Roxas City, particularly in Barangays Barra and Punta Cogon (the major *diwal*-producing barangays of Roxas City); at the same time, an attempt at transplantation was made. This move was supported by the government of Roxas City, as requested by the people of Barangay Barra and Punta Cogon. Prior to field research, Dr. Laureta briefed the city council and village heads on the habitat and biology of the *diwal*.

Wild stock for transplantation came from Barotac Nuevo. It was acclimatized and transported to the site, a sanctuary of about

1000 m² enclosed by bamboo stakes to prevent human intrusion. Mature *diwal* (5-12 cm in length) were planted by former *diwal* harvesters from Punta Cogon and professional scuba divers, inside and outside the enclosure (for comparison) with the aim of letting them spawn naturally. There were only ten transplantations within a 12-month study, due to shortage of stocks from Barotac Nuevo.

In Punta Cogon, the sanctuary was only about 200-300 meters away from the shore. Some of the stocks died and those that survived were gone because of uncontrollable trawling activities. "A fault on our part because we did not put lights on our enclosures," said Dr. Laureta.

In Barra, on the other hand, all stocks died and the reason was not determined. It was noted that the area is surrounded by fishponds, fish corrals, and oyster farms.

"We did our best to help," said Dr. Laureta. "We aimed to rehabilitate the stocks, but we failed. Maybe if we were able to put some lights on the enclosures, the trawlers could have noticed the area and results could have been positive."

For now, there is no existing technology for the hatchery of *diwal*. UPV was able to grow *diwal* for about six months and spawn using several techniques (manipulation of salinity, chemical method, serotonin), but 60 days after hatching, they died. More in-depth studies are needed to improve larval rearing and nursery techniques.

Stock enhancement must be complemented with hatchery technology so as not to depend on the wild for seedlings. There is a need for more detailed baseline information about the *diwal* before any transplantation or stock enhancement exercise is to be done. -- GG

☞ list of references on page 41

Giant clams ...

Giant clams are the world's largest bivalve. They sometimes reach over a meter in shell length. Locally, they are called *kabibe*, *kima*, *taklobo*, *mangleut* or *saliot*. They live in the sea, in shallow sunlit waters, among corals and limestones rocks, and in seagrass habitats.

Giant clams are described as "self-feeding" animals, and have great potential for mariculture and stock enhancement. Because they thrive in clear sunlit waters which enables the minute unicellular algae called zooxanthellae in their mantles to photosynthesize, they are able to feed themselves. On the other hand, the zooxanthellae are able to propagate and live within the host clam and utilize its waste products. This attribute along with their sedentary habit and the adult's resistance to predation makes them very attractive to mariculture. The importance of clams lies not so much on their promise for immediate products (the culture period takes years), but rather, on their ecological importance to coasts worldwide. This has far ranging implications for generations to come.

There are nine existing species belonging to this family of molluscs (Tridacnidae), and seven are found in Philippine waters. They are: *Tridacna gigas*, *T. derasa*, *T. squamosa*, *T. maxima*, *T. crocea*, *Hippopus hippopus*, and *H. porcellanus* (China clam).

Giant clams are harvested for their meat and shell. Its meat is eaten raw or as salad; the adductor muscle is dried and used in Chinese cuisine to enhance the flavor of soups. The Chinese also believe the clam to be an aphrodisiac. The shell is used in several ways, as ornament, ash tray, wash basin, jewelry, water containers, as baptismal fonts in Philippine churches, for building walls and fences. More recently, shells have been used as fashionable soap dishes and salad bowls. In Indonesia, shells are used to make floor tiles.

Bolinao, Pangasinan: 10-year old giant clam Tridacna gigas brought in from the Solomon Islands as larvae



UP-MSI Bolinao Laboratory: researcher and former director Dr. Edgardo Gomez and giant clams in a tank (inset)



Live clams are becoming popular aquarium pets (Mingoa-Licuanan & Gomez 1996).

Overharvesting has severely reduced stocks of giant clams throughout their distribution range. This could lead to the elimination of a valuable food resources, and extinction of an important component of coral reef communities. This situation has aroused international as well as national interest to conserve giant clams.

In 1983, *T. gigas* and *T. derasa* were included in the list of endangered species by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to regulate the commercial trade of these species. In 1985, all other species of giant clams appeared on the list in Appendix II of CITES due to the difficulty of distinguishing giant meat products. As signatory to the convention, the Philippines has banned the exportation of all giant clams.

According to Johann Bell of the International Center for Living Aquatic Resource Management (ICLARM), the Philippines has the most comprehensive program among nations dependent on the importation of clams to rebuild populations. For example, seven cohorts of *T. gigas* have been imported from relatively closely related stocks in Australia and the Solomon Islands. One of the imported cohorts of *T. gigas* has been reared to maturity as females and spawned four times. Progeny from this cohort together with a selection of imported cohorts have now been placed at several sites (Bell 1999).

The first institution in the Philippines working on clams is the Marine Science Institute of the University of the Philippines (UP-MSI) which was declared as the "National Center of Excellence in the Marine Sciences" by Presidential Proclamation No. 518 in December 1994 and designated



The sea urchin: adult on Sargassum (left) and seedstock produced at UP-MSI (right). Pioneering researcher Dr. Annette Juinio-Meñez (above)



as the first Center of Excellence for Marine Sciences by the Commission on Higher Education (CHED) in 1998. UP-MSI's work on giant clam mariculture started in 1985. Through collaboration with foreign and local institutions, hatchery and ocean nursery techniques have been developed at UP-MSI's 5 ha complex in Bolinao, Pangasinan, in northern Luzon. Its giant clam project has already spawned almost all giant clam species, and has reared them from larvae to adults.

UP-MSI raises giant clams to make its seed available for restocking in coral reefs. In addition, their hatchery provides a commercial alternative source of giant clams in lieu of wild stocks. Their recent efforts are directed at improving production so that community livelihood projects may be undertaken and giant clam culture commercialized.

UP-MSI's reseeded efforts are mainly concentrated in protected areas in Luzon due to lack of proper enforcement of conservation legislation. Ocean nurseries are presently found in Silaqui Island and the Hundred Island National Park (both in Pangasinan); Libaga sanctuary in San Salvacion Island (Zambales); Puerto Galera Man and Biosphere Research (Oriental Mindoro); Fortune Island, Arthurs Rock, Twin Rocks (all in Batangas); and one in Sanga-Sanga (Tawi-Tawi in Mindanao).

Other recipients of UP-MSI's *T. gigas* broodstock include Subic Bay and Hermana Mayor in Zambales and Kalayaan Islands in Palawan. Additional sites in Mindanao include Dakak (Aliguay Island) and Panguil Bay; and in the Visayas, Bohol and Samar.

Former UP-MSI director Edgardo Gomez, a pioneer in giant clam research, said that he would like to see *T. gigas* proliferate throughout the whole archipelago. He welcomes any interested party who wants to avail of UP-MSI's *T. gigas*. Write him at:

Dr. Edgardo Gomez
University of the Philippines
Marine Science Institute
1101 Diliman, Quezon City
Philippines
Email: edgomez@upmsi.ph

... the sea urchin *Triplunestetes gratilla* ...

UP-MSI is also involved in enhancing stocks of the sea urchin *Triplunestetes gratilla*. Sea urchin is widely distributed in the Indo-Pacific waters and locally, it is the most important species. Its roe or gonad is a high-value export to Japan and Korea. It is also a regular diet of many local coastal communities, and in some areas like Ilocos province, a highly prized local delicacy.

Sea urchin fishery had its heydays in Bolinao, Pangasinan in the late '80s to the early '90s. It has been reported that the total net income for sea urchin roe landed at one major landing site, in Silaqui Island, peaked in 1989 at P9.6 million (US\$348,000). But the good times did not last. Uncontrolled and non-selective harvest of sea urchin finally did it in. By 1992, the sea urchin fishery collapsed.

This led UP-MSI to formulate an alternative approach to sea urchin management which integrates culture technology and local community participation (Juinio-Meñez et al. 1998). They came up with a conceptual model focusing on family/village-managed reproductive reserves in the form of sea pens or cages where juvenile sea urchins can be grown and selectively harvested (i.e., >70 mm test diameter). Serious efforts to culture the species started in 1995, and by 1996, MSI's Bolinao laboratory closed its life cycle in captivity. Sea urchin's sexual maturity was attained in 7-8 months after artificial fertilization of 6 mm total diameter stock. Between 1999 and 2000, a moderate mass scale production of 20,000 seedstock per quarter had been achieved.

Among UP-MSI's research findings (Juinio-Meñez et al. 1998) in the hatchery and growout phases are:

- average survival rate of larvae to presettlement larvae is high (85%)
- survival rate to early benthic juveniles (= 1 cm) is still relatively low (15%)

☞ next page



Seagrass stocks are assessed using the quadrat method



Seagrass bed at low tide. Knowing the responses of seagrass to stress is vital to its ability to enhance open ecosystems



The frames of artificial seagrass (a few units are finished) used in enhancing and rehabilitating a Marinduque mine tailings bay site in 1998



Seagrasses can be big and small, thin and wide

- settlement and metamorphosis, and early juvenile nutrition are major bottlenecks
- water conditioned with *Sargassum* (a brown seaweed) enhances rate settlement and metamorphosis
- benthic diatom culture has been worked out
- factors that affect gonad yields include type of food, grow-out site, stocking density, lunar phase and season
- grow-out and harvest protocol has been developed

Grow-out culture cum mini-reproductive reserves have been established to harmonize ecological, sociocultural and economic benefits of sea urchin culture. It is noted that sites have different potential yields.

According to pioneering researcher Dr. Antonette Juinio-Meñez, UPMSI's sea urchin expert, the challenges and future direction for sea urchin studies would be in optimizing economic potential (production) for small and industry-scale culture and enhancing resource management towards sustainable fisheries through multispecies invertebrate sea ranching.

The efforts of UP-MSI to establish a viable spawning population of *T. gratilla* in Bolinao has now shown positive results. In monitoring surveys of the marine park in Balingasay, Bolinao (protected since July 1999 and reseeded with 4,000 cultured sea urchin in 1998), Dr. Meñez' team noted the presence of new recruits. This indicates the beginning recovery of sea urchin population in Bolinao.

Training and orientation on grow-out culture of *T. gratilla* as a resource management strategy has been extended to other areas as well, in western Luzon in collaboration with state colleges, the Bureau of Fisheries and Aquatic Resources (BFAR), local governments, and people's organization. The emphasis of sea-urchin culture is using the seedstock from the hatchery or the wild in enhancing the recovery of wild stocks, while providing a supplemental source of livelihood, Dr. Meñez said.

... and seagrasses

Seagrasses are the only group of submerged flowering plants in the marine environment. They thrive in shallow-water coastal habitats. Like the terrestrial grasses from which they originated, they possess erect leafy shoots and creeping stems or rhizomes which are effective for propagation. In contrast to other submerged marine plants like seaweeds or algae, seagrasses flower, develop fruit, and produce seeds.

There are only about 50 species of seagrasses worldwide and 13 species have been recorded in Philippine waters. They usually exist in enormous quantities, often forming large dense meadows in tropical areas. They are traditionally used as material for baskets, soda, mattress stuffing, roof thatch, upholstery and packing, compost/fertilizer, insulation for sound and temperature, fiber substitute for making nitrocellulose, piles to build dikes, cigars and children's toys. Their industrial uses include: as sewage filter, coastal stabilizers, paper manufacture, source of useful chemicals, fertilizer and fodder and food and medicine for humans.

Seagrasses can be viewed at two levels (Fortes 1989):

- As a community with a structural framework for plant and animal interrelationships; and
- As an ecosystem where these interrelationships are viewed as

discrete processes controlled by the interaction of biological and physico-chemical factors

In terms of economic and ecological importance, the major functions of seagrasses are to/as:

- stabilize and hold bottom sediments
- slow and retard water current and waves, promote sedimentation of particulate matter and inhibit resuspension of organic and inorganic matter through leaf action
- shelter resident and transient adult and juvenile animals like the endangered sea turtles and mammals like *dugong*
- food for grazers, epiphytes and detritus feeders
- source of organic matter as the plants attain high production and growth
- produce and trap detritus and secretion of dissolved organic matter that contribute to nutrient cycles within the ecosystem
- nursery ground for species that spend their adult lives outside the community

Again, population pressure threatens seagrass beds in the Philippines and elsewhere. Increasing human population needs extra space for food and food production, settlement, waste disposal and recreation. Thousands of hectares of seagrass beds have been lost as a result of reclamation of coastal areas for housing, airports, piers and commercial complexes, and from pollution and siltation due to deforestation.

Protecting the remaining seagrass beds by declaring certain area as reserves and marine parks continues to be a big challenge. Rehabilitation of degraded reefs using seagrass transplantation is being tried in certain limited areas (Calumpong & Meñez 1997).

A 1995 study by Dr. Miguel Fortes, a professor at UP-MSI and the country's foremost authority on seagrasses, showed that at least 30-50% of the seagrasses in east Asia had been "lost" in the last 50 years. He also found that there is five times as many fish that live over seagrass beds as over sea floors made up of mud, shells and sand. In Cape Bolinao, Pangasinan, for example, five of the 104 fish species found in the seagrass beds were residents (found all year round), while 23 were seasonal residents (residing only for a season, or life history stage), and 59 were casual species (found only occasionally). Unfortunately, the ecological role of these fairly distinct groupings is virtually unknown.

One of the techniques currently used in mitigating coastal environmental impacts, expanding seagrass areas and restoring biodiversity/productivity to degraded coasts, is the use of "restoration technology." Basically, the structure of the ecosystem is altered by applying ecological principles to redirect natural self-organizing biological processes. This means seagrass transplantation and artificial seagrass units.

In 1984, an intensive study of seagrass transplantation was undertaken. In Cape Bolinao, northwestern Philippines, Dr. Fortes demonstrated the ability of seagrasses to colonize a biologically desolate area and improve plant biomass. In Calanacan Bay, Marinduque, an area of about 0.01 km² around the mine tailings causeway has been transplanted with seagrasses. After five years, no significant growth differences were found in naturally growing

and transplanted materials of the same seagrass species.

Careful selection of transplant site is of paramount importance; if the conditions of sediment stability, light and nutrients are not favorable, the plants will not grow; if the conditions are favorable, transplanting may speed up the natural and slow process of colonization. Unfortunately, until seagrasses are better understood, it is impossible to define the precise conditions that favor particular seagrass species.

Likewise, plants to be transplanted must be chosen carefully because local populations may have limited abilities to adapt to variations in the environment. There is also a need to standardize the measurement of "success" in the transplanting procedure.

Artificial seagrass units (ASU, see picture overleaf) that are made of cement base, PVC pipes, plastic hangers and mantle strips have been used in Cape Bolinao and Calanacan Bay.

At the Cape, the number of fishes so far identified within the ASUs significantly exceeded those found in natural seagrass beds. About 62% of the species are new to the site, and only 15% is similar or overlap with the fish fauna of an adjacent seagrass bed. The results indicate active fish recruitment by ASUs, with implication of their potential in improving and rehabilitating otherwise desolate areas.

In Calanacan Bay, the 1,000 m² area "planted" with ASUs showed that the technique works in at least attracting a significant percentage of the natural fish fauna in the bay. The number of fish species found at the areas with the ASUs comprised 46% of the fauna recorded at the nearby seagrass bed and 86% of that found in transplanted seagrass areas.

With regards to legislation on seagrasses, there is a regional plan which includes country-specific policies and conservation plans aimed at managing mangrove habitat, water quality maintenance, aquaculture, coastal erosion control, inshore fisheries, sand mining and tourism. In the Philippines, the whole of Lingayen Gulf -- where there are coral reefs, offshore fisheries, seagrass beds, small islands, beaches, rivers, estuarine systems, aquaculture -- has been selected as the pilot area for an integrated management.

Dr. Fortes has some recommendations for the sustained use and development of seagrass habitats and their resources, including: (1) database development, (2) development of national plans, (3) creating awareness and research promotion, (4) sustainable management, (5) conservation of biodiversity and (6) education and training.

Dr. Fortes is pleased that today, there is a marked change in attitude with regards to a greater awareness of the vital function and intrinsic values of the seagrass ecosystem. -- **APS**

REFERENCES

-
- Bell JD. 1999. Restocking the giant clams: progress, problems and potential, p 437-450. IN: Howell BR, Moksness E, Svasand T. Stock enhancement and sea ranching. Oxford: Fishing News Books. 606 p
- Calumpong HP, Meñez EG. 1997. Field guide to the common mangroves, seagrasses, and algae of the Philippines. Makati: Bookmark Inc

☞ more references on page 40



MIKE FORTES: Point man for the Philippines' last frontier

Miguel Diño Fortes, PhD, 54, professor of marine science at the University of the Philippines (UP), has been tagged by science writer Peter Coles as the “point man in the Philippines’ last frontier.” Mike or Lens to his boyhood pals in Sorsogon City has been in the forefront of marine science research, particularly on marine plant ecology, resource inventory and resto-

ration ecology. He is the country’s leading expert on seagrasses, and has represented the country in several UNESCO initiatives. Mike earned his doctorate in botany from UP.

In 1998, UP awarded Dr. Fortes a UNESCO Chair in *Integrated Management and Sustainable Development in Coastal Regions and Small Islands*. Mike decided to use this post “as the missing link” to bring the various UNESCO initiatives, including the Coastal and Small Islands (CSI) Wise Practices Electronic Forum (<http://www.CSIWISEpractices.org>) into a dialogue with the main stakeholders -- the 6,000 inhabitants who live in the five barangays around Ulugan Bay, Palawan. The Forum case studies and comments give examples of what works or has failed elsewhere. At the same time, it is an opportunity to get international feedback on local initiatives. And this eventually filters back to grassroots level through university classes and community workshops.

The island province of Palawan, often called the Philippines’ last frontier, has a unique concentration of UNESCO coastal and small islands initiatives. In 1992, UNESCO classified the entire province as a Man and Biosphere Reserve. The island’s Tubbataha Reef Marine National Park is a World Heritage Site, and so is the Puerto Princesa Subterranean River National Park, with the world’s longest underground river (8 km). The “crown jewel” of all this, though, is Ulugan Bay, with its secluded beaches, hidden coves, pristine mangrove forests, 102 species of corals, 7 species of seagrasses, water birds and a dazzling variety of tropical fish. Ulugan Bay is a UNESCO CSI pilot project and the focus of a joint UNESCO-UNDP project on coastal resources management and sustainable tourism.

Because of its rich marine resources, and its strategic location, there are various conflicting interests in the province, particularly in Ulugan Bay. These include fishers, tourism managers and entrepreneurs, local inhabitants, conservationists and the Philippine Navy. The Navy has been laying claim to Ulugan Bay over the past 20 years. “It is the only major bay in Palawan and the South China Sea coastline,” explains Mike. “It is just 120 nautical

miles from Mischief Reef in the Spratlys, the group of islands territorially disputed with China. “The Navy wants to build a base in the bay to reinforce its national security interests.”

According to Mike, the challenge is to balance the various conflicting interests. Fisherfolks view the bay as a fish landing site and nursery ground for fish. But some in search of quick profits use disastrous techniques such as dynamite blasting and cyanide, not caring if the bay’s ecology and their livelihood are ultimately destroyed. Another threat is unregulated tourism which has wreaked havoc elsewhere. Ever the pragmatist, Mike wants an approach that will integrate and share the resources available. He explains: “Yes, the various conservation initiatives are major steps in protecting the area, but, a poor country like the Philippines does not have the resources to simultaneously manage a number of protected sites. And the concerns of these projects overlap.” Mike acts as a mediator between the community, the UNESCO biosphere reserve and the Navy over their plans to build a base in Ulugan Bay.

He is a Fellow at the National Defense College of the Philippines in charge of environmental security which makes his series of dialogues with naval officers “very positive.” The Navy would like to build a refinery, install mooring buoys, as well as barracks and training facilities. Armed with his database on various UNESCO CSI initiatives, Mike was able to get his conservation message across on what would be destroyed if the Navy went ahead with its plans.

Mike shares his UNESCO Chair appointment for a term or semester at a time with multi-disciplinary colleagues including experts on social issues: an environmental sociologist, social anthropologist, an expert on trends in coastal management and a lawyer who runs the Legal Assistance Center, an NGO that trains indigenous people in the paralegal issues of conservation. “Local people are no longer passive. They have a sense of owning what they have achieved,” says Mike.

Among Mike’s many other hats are: coordinator of the environmental science program of UP’s College of Science, current president of the World Seagrass Association, chair of the National Committee on Marine Sciences and commissioner for Science and Technology of UNESCO’s Philippine Commission.

As a wetland and coastal ecologist, he has been a member of 15 technical advisory bodies, both foreign and local, dealing with ocean research and management, policy formulation and education. He has been consultant to 35 projects since 1981, including ecological impact assessments for various private firms, allowing him to collect data for his dissertation in seagrass.

He has also written some 39 articles in international peer-reviewed journals and wrote for events proceedings and books. He has been the Head of the Philippine Delegation to the Executive Council and General Assembly for the Intergovernmental Oceanographic Commission of UNESCO since 1995.

Mike is a recipient of various awards including the International Biwako Prize for Ecology, Outstanding Young Scientist of the Philippines, and the recent Hugh Greenwood Environmental Science Award. -- **APS**



co-management and marine reserves

co-management strategies

In the marine environment, boundaries are difficult to define and defend. However, traditional fishers and other users may have established and recognized various forms of user rights. Thus, the system of property rights is “strongly defined and deeply integrated in the people’s culture and cannot be ignored. Property rights are first and foremost a definition of access, like for example, the rules that decide who is entitled to extract the resources.”

When fish are in pens, ponds, and cages, there are usually no conflicts. But when released species are no longer protected by physical means, the “successful application of enhancement techniques raises important questions about management and ownership.” An economic impact is involved as cultured organisms coming from a sea ranching project may be harvested by a fishing operation or another sea ranching operation. “At the general level, extensive mariculture will alter production possibilities in traditional marine fisheries, or as seen from the other side, traditional harvesting will affect production possibilities in mariculture.”

The law on sea ranching

One way to reduce uncertainty to access is to exclude some forms of extraction. This may be done for single species like salmon by excluding all salmon fishing at sea as in Iceland or in all rivers as in Japan. Both options are related to historical traditions. It is also an option to exclude some forms of organization, where there is a ban on private, for-profit sea ranching.

A law on sea ranching can create management uncertainty and tensions if it proposes that fishing can be regulated outside the recapture area as in regulation of pen farming or wild fish. But if sea ranching would proliferate along the coastline, management battles can burgeon. Again, the Japan experience on salmon can be worth looking into when problems on management such as these emerge because the salmon fishing operations are managed by cooperatives. They implement a rule of equality on profit and cost of operations among the members, and the system has worked well. But if net-set fisheries were managed through individuals or private companies, problems would emerge as to how profit would be distributed.

Stock enhancement in Japan

Discussion of stock enhancement in Southeast Asia would be incomplete without mention of Japan, the pioneer in stock enhancement in Asia. Japan’s stock enhancement activities started in 1876

at the initiation of Akekiyo Sekizawa after he studied hatchery techniques in the United States and conducted artificial spawning of chum salmon (*Onchorhynchus keta* Walbaum). Since then, stock enhancement of the chum salmon has subsequently been promoted by the Japan government. In the late 1950s, scallop was also used for stock enhancement in Hokkaido. Using various species (kuruma prawn, sea urchin, swimming crab, abalone, and others) from 1963, stock enhancement continues in Japan until the present time. There are 16 national and 57 local government hatchery facilities distributed throughout the country’s coasts. In these facilities, about 90 species are now under technical development for stock release.

For the past 20 years, production techniques have been developing rapidly but a comprehensive review focusing on quantitative surveys regarding the effectiveness of stock enhancement has not been done. Today, Japan’s stock enhancement program is focused on the review of stocking effectiveness, the methods of evaluation that are used in the review, and the future prospects of stock enhancement.

In fisheries management, the salmon programs are worth considering because of their organization and salmon is the longest stocked species of great economic importance. At the start of the program, the coastal fishers were integrated through the combined efforts of government, regional authorities, and fishers’ cooperatives. The costs of running the operations were divided among all parties. With more than 2000 units, the fishers’ associations were important players. The rights system, which traditionally gives exclusive rights to exploit coastal resources to the local fishing community, was included as a basis for seafarming salmon. This takes advantage of a well-established system of rights that requires all marine development activities be approved by local fishers.

Stock enhancement in Taiwan

In Taiwan, stock enhancement activities started in 1982 when the Taiwan Fisheries Research Institute selected prawn fishing grounds along the southwest coast of Taiwan as experimental area. The Institute is now engaged in a series of studies on the community structure, distribution, recruitment, reproduction, food habits, and growth of the commercially important prawns in the area. *Penaeus monodon* subadults were tagged and released along the coast of Tungkan until 1984. To date, life history models based on the above parameters have been established for several commercially important prawns.

☞ next page

P. monodon subadults (4-5 month old) were tagged and released in varying numbers on 16 separate occasions from 1983 to 1984. A modified streamer tag, made of vinyl sheeting was inserted laterally through the first abdominal segment using a sewing needle. The recapture rate of tagged prawns was 15% for those raised in saltwater ponds and 5% for those from commercial brackishwater ponds. Average growth rate was 2.97 g per week for females and 1.67 g per week for males. In addition, to evaluate the efficacy of seed release, a study on marking *P. monodon* using an automated microwire tagging system was conducted. Prawns with an initial mean total length of 27.5 mm were injected with microwire tags at the cephalothorax, the first or the sixth segment. No significant difference was observed in the growth and survival among treatments. No tag loss was found in prawns tagged at the first segment, which shows that the coded microwire tags can be used for tagging juvenile prawns.

In the rapid development of the prawn industry, supply of spawners in the waters surrounding Taiwan has been depleted. Thus, the release of pond-reared subadults of this species is expected to increase the stock in coastal waters. Assuming that subadults favor the environmental conditions and food in the spawning grounds, it is recommended that the subadults be released near spawning grounds in October to December for *P. monodon* because they may become spawners and can be harvested in the following spring.

The recapture rate of prawns released from saltwater ponds was much better than that from brackish ponds. This indicates that the physiological condition of released prawns influences the recapture rate. Based on tagging and recapture data, the growth potential was 9.37 g per week for female subadults and 3.52 g per week for male subadults. The prawns also grow faster in sea than in culture ponds. Clearly in Taiwan, restocking of subadults for cultivating broodstock is very promising. But only specific pathogen-free prawns should be released.

SEAFDEC/AQD's experience in coastal resource management

In 1991, SEAFDEC/AQD started a coastal resource management project in Malalison Island, an island off the west coast of Panay in the Philippines. Within five years, several components of CRM were successfully implemented in the island. Such components were the organization of the fishers into an association, institutionalization of initiatives in the local government level, and the granting of Territorial Use Rights in Fisheries (TURF) resulting in the establishment of a marine sanctuary deployed with concrete artificial reefs. The TURF concept was translated into policy through Municipal Ordinance No. 5-90 designating one square kilometer area for the exclusive use of the Fisherman's Association of Malalison Island.

After years of maintaining protected areas, testimonies of increased catch, and a perceivable economic progress in the island, nearby municipalities off the island adopted the Malalison way. The municipalities of Libertad, Pandan, Sebaste and Culasi, all bordering Pandan Bay grouped together to manage their coastal resources,

known as the LIPASECU Baywide Management Council Inc. LIPASECU has several projects, all related to coastal management such as resource conservation and utilization, livelihood enhancement, waste management, law enforcement and sea patrol, and research and data banking. Considered the most important component of the project is the institutionalization of initiatives in the local government level. Officers of the project believe that it is the most meaningful component of the project because any change in elective officials or pull out of funding agencies would not spell immediate change in the the legal policies or ordinances. One such initiative is the adoption of an ordinance which is spelled out in the Comprehensive Unified Ordinance Regulating the Fishing Industry, Fisheries, and Aquatic Resources.

The unified fishery ordinance would be enacted by the four member municipalities. Enforcement would cover all of Pandan Bay in conjunction with existing laws, decrees, orders, issuances, and regulations on fishing and fisheries.

The ordinance basically upholds the preferential rights of marginal municipal fisherfolks enunciated in the Philippine Fisheries Code of 1998. The general provisions start with the coverage of Pandan Bay, issuance of licenses and permits, limited entry into overfished areas, and end with the penalties of each offense cited. Other provisions provide for a Manual of Operations that governs the operations and effective implementation of the ordinance, source of fund (from municipal contribution P5000), and specific monetary and non-monetary penalties.

Conclusion

Co-management is an accepted tool in coastal management, as implemented in the SEAFDEC/AQD project. It recognizes the importance of involving user groups in the development and implementation of management policies. The creation of the Fisheries and Aquatic Resources Management Councils in every coastal barangay, municipality or city has provided the institutional setting for the emergence and enhancement of fisheries co-management at the village level.

Despite enabling legislation, documentations of projects on co-management on coastal areas are not without described difficulties, foremost of which is the expectation of fisherfolks for immediate benefits and the conflict between organizers and concerned agencies. No matter how laborious the job is, the emerging promise of the project as perceived in the empowered members' attitude towards resource rehabilitation and conservation is well worth their effort.

Except for the part on AQD experience, this story is summarized from Suchi Kitada, Effectiveness of Japan's stock enhancement programmes: current perspectives, p 103; Koji Imamura, The organization and development of sea farming in Japan, p 91; Shuichi Kitada, Effectiveness of Japan's stock enhancement programmes: current perspectives, p 103; Research and development of prawn stock enhancement in Taiwan, p 379, all from Stock enhancement and sea ranching, edited by: Bari Howell, Erlend Moksness, Terje Svasand. Fishing News Books, 1999 -- MBS

marine reserves

Marine reserves are areas protected from various forms of human or extractive exploitation, especially fishing. These were initially established for marine conservation but recent scientific evidence indicated that these also provide much needed support for fisheries.

Establishment of marine reserves is one of the management strategies relevant to marine stock enhancement. There is evidence that protecting areas from fishing leads to rapid increases in abundance, average body size and biomass of exploited stocks. Even non-target or non-fishery species benefited from protection of the area. Once an area is declared protected, fishes are safe from getting caught, live longer and grow larger. Bigger animals produce much more eggs than smaller ones. For example, a 10-kg red snapper can produce over 20 times more eggs at a single spawning compared to ten 1-kg snappers. Thus, a few very large animals are more valuable as egg producers than many smaller ones.

In addition, reserves often increase population densities. This is of great importance especially to animals that can only reproduce successfully at high population densities, such as bottom dwellers and slow moving animals like oysters, clams or abalones. As animals get further apart, fertilization rates decrease and fewer viable offspring are produced. Many of the eggs and larvae produced by fish in marine reserves will drift into adjacent fishing grounds and therefore help restock the fishery, the so-called

spillover or movement of juvenile or adult fish out of reserves.

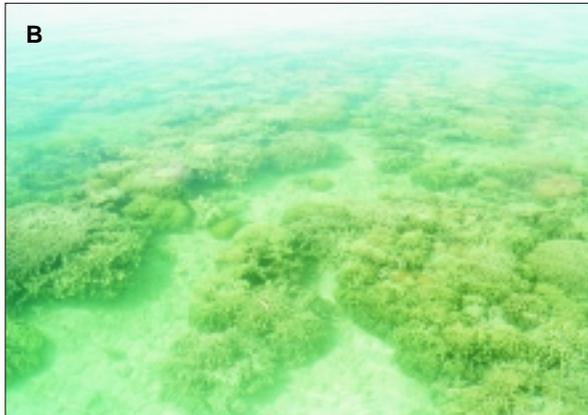
Indeed, marine reserves have a great role in fishery enhancement. Reserves can provide a refuge from fishing for vulnerable species, prevent habitat damage and promote habitat recovery, maintain biodiversity by promoting development of natural biological communities that are different from those in fishing grounds and finally, facilitate ecosystem recovery after major human or natural disturbances. These are just some of the most visible contributions marine reserves offer.

We visited two marine reserves in Misamis Occidental in northern Mindanao and in Sagay, Negros Occidental and looked at how these marine reserves were implemented.

CASE 1: BALIANGAO WETLAND PARK MISAMIS OCCIDENTAL

Danao Bay is situated in Misamis Occidental in northern Mindanao. It is shallow with a large intertidal zone dotted by mangroves, mudflats, seagrass beds and coral reefs. About 90% of the bay is located in the municipality of Baliangao while the remaining belongs to Plaridel.

Accordingly, fisheries in Baliangao were abundant in the early '40s. In fact, the name Baliangao was derived from the Cebuano phrase *balay sa langaw* which means house of flies. Folk tales



- A** Bamboo stakes serve as fence for the Baliangao sanctuary's core area to keep fishing boats from getting inside
- B** Corals and seagrasses are starting to grow back, as well as the populations of sea urchin and sea cucumber
- C** Members of the Danao Bay resource management team give testimonies about how the establishment of the sanctuary changed their outlook on the environment
- D** More than 165 ha of mangroves have been reforested since 1991

relate that the place was once literally teeming with flies living off decomposing fishes which lay on the shore. The place also has a dense mangrove forest.

Most of the people were solely dependent on the bay for their livelihood then. They were engaged in capture, processing or selling of fishery products. Exploited resources included fish, shells, sea urchins, and crabs. These activities, along with massive mangrove cutting and extensive use of illegal fishing gears, eventually resulted in the downfall of fisheries in the area.

According to a local fisher Dodong Agodolo, they noticed a decline in their fish catches by the early '80s. "Before, our catch was enough to provide for our daily needs; then came a time when we barely brought home a catch. We also noticed that several of the high-value species started to disappear," he explains.

Two resource management measures were implemented in response to this growing problem. The cutting of mangroves was prohibited and a ban period for rabbitfish was implemented. However, these regulations were not strictly enforced and the situation, in fact, became worse.

In 1991, the PIPULI Foundation Inc, a non-government organization chose Danao Bay as the site for a marine ecosystem protection program. Through the efforts of the foundation, some local fishers, the church and the local government, a 74-hectare sanctuary was established in Misom, Baliangao. This was named Misom Sea Sanctuary and later renamed Baliangao Wetland Park.

"The sanctuary was fenced off with bamboo stakes and watched over by a guard round the clock. No fishing was allowed inside the sanctuary and destructive, illegal fishing was strictly banned around the area," said Ms. Estrelita Bulatete, executive director of PIPULI.

The fishers identified and created a core area or a *lumlumay* within the sanctuary. This serves as spawning ground and a hiding place for fishes during low tide.

A fishing ban on the once thriving rabbitfish was re-enacted but strictly enforced this time. Before, rabbitfish constituted half of the catch of the fishers of Danao Bay. Local fishers' knowledge of lunar spawning rhythm of rabbitfish occurring on the 5th day after the new moon at 3-4 am reinforced the fishing ban to protect rabbitfish during spawning. A typical 48-hour ban period starts at 8 am of the 3rd day after new moon and ends 8 am of the 5th day.

Daily monitoring of catches of rabbitfish validated the period of the ban. Fish caught before the ban period had ripe gonads having eggs ready to be released. After the ban period, no ripe gonads were observed.

Sea cucumbers also thrived in the waters of Danao Bay before. Abundant on the reef in the mid '80s, the sea cucumber eventually became almost extinct in the area. Following the establishment of the sanctuary, fishers now attest to an increase in its population and individual body sizes. In fact, its abundance enticed poaching in the sanctuary.

Massive reforestation of the once dense mangrove forest of Baliangao was also implemented. The joint efforts of the people's organizations, local government units, DENR and the community are evident in the 165 hectares of planted mangroves. Seventeen

(17) mangrove species consisting mostly of the genus *Rhizophora*, *Avicennia*, *Combretia* and *Sonneratia* now grow in the area.

Bulatete explained that after the establishment of the sanctuary, PIPULI focused on organizing and educating the fishers about coastal resource management.

A participatory management group of stakeholders/fishers representatives proved effective and successful in this activity. Aside from assigning among themselves a guard to watch over the sanctuary, the organized fishers also took charge of ecotourism. A mangrove tour, coral reef and sanctuary sight seeing activities and overnight cottages are available to visitors for a minimal fee.

"One surprising and very good outcome of the establishment of the sanctuary is the change of attitude of fishers towards fishery resources and sustainable development. Illegal fishers turned their backs on destructive practices and became active advocates of resource protection," said Lilia Jumarito, PIPULI Danao Bay Program Coordinator.

"Most of us here used destructive fishing gears before. We were against the introduction of the sanctuary because it reduced our fishing area. But upon knowing and understanding the purpose of the sanctuary, we gave up our destructive practices. I am proud and happy to say that I am now militant on protecting our fishery resources," testifies Gregorio Gayola, chair of the Danao Bay Resource Management Organization (DB-REMO).

Over time, the fishing communities have become very open to the idea of improving the management of the resource through their own active involvement.

The fishers realized that if they do not take action now, their catches will continue to decline, thus worsening their livelihood. They agreed to implement the following measures to answer this growing problem: total ban on illegal or destructive fishing techniques; ban on fishing gears like drive-in nets, 3-ply trammel nets, beach seines and compressor fishing; and the change in gears to reduce the by-catch of immature fish. Moreover, only residents from Baliangao and Plaridel are allowed to fish in Danao Bay; all other resource users need to be registered.

A fish stock assessment survey conducted by PIPULI marine biologist Jade Fraser in 1997 showed higher species diversity (93 species under 25 family), abundance, and importance value (biomass and economic value) inside than outside the sanctuary. Rabbitfish, milkfish, mullet, surgeonfish, snapper, sea urchins among other species now thrive in the sanctuary.

The Marine Laboratory of Silliman University also assessed the resources of Baliangao Wetland Park in 1990s, and showed that the sanctuary has been effective in restoring degraded coastal habitats in the area.

For the fishers, the sanctuary has indeed brought good things to the entire community. They have observed a gradual increase in their fish catch, fish sizes, and fish species, which disappeared before and have now returned.

But for them, the most important contribution that the sanctuary gave is empowering the people to manage their resources well. That, in itself, will secure the future of their children. -- RIYA

**CASE 2: SAGAY MARINE RESERVE
NEGROS OCCIDENTAL**

The Sagay Marine Reserve constitutes 32,000 km² of land and seascape on the northeastern tip of Negros Island in western Visayas. Sagay's coastline and coral islets blend natural beauty with high productivity. These have supported the fishing industry of Sagay and its neighboring towns for generations. Mangroves protected the coast and islets. Likewise, seagrass meadows also covered shorelines.

But just like any other Third World setting, population pressure threatened these beautiful and rich marine ecosystems. They were exploited at a rate exceeding their carrying capacity.

Fortunately for Sagay, they have a man with a vision, strong political will and a quiet resolve to realize the need for environmental concerns. That man is erstwhile Mayor and now Congressman Alfredo Marañon Jr.

According to Congressman Marañon, even as a young man, he already dreamed of making Sagay's marine resources last for many generations. And the opportunity came to make a difference. In the late '70s, as elected mayor of Sagay, he initiated a marine conservation program with help and encouragement of Dr. Angel Alcala, then president of Silliman University in Dumaguete City. In 1983, Municipal Ordinance No. 2 formally proclaimed Carbin Reef as a fish sanctuary. Later, it extended to include Panal, Macahulom, and the fringing reefs of Molocaboc.

Law enforcement was further strengthened through the installation of a watchtower in Carbin and Macahulom, and the organization of the Bantay Dagat Program. Technical assistance was provided by Silliman University, while financial assistance came from the Philippine Council for Aquatic and Marine Research and Development.

Rehabilitation, including restocking of giant clams and mangrove reforestation was done. It was fully supported by civic groups

Pearl oysters can be found in the whole reserve; there is a ban on their harvest



and the national government's coastal environment program. Preliminary assessments of reef fish standing stock and marine flora and fauna were also conducted. Alternatively livelihood projects were introduced to displaced fisherfolk.

Recognizing the potential of Sagay's coast to contribute to the preservation of the nation's biodiversity, the Department of Environment and Natural Resources, through then Secretary Alcala recommended its inclusion in the National Integrated Area System (NIPAS). Finally, on 10 June 1995, Sagay's coastal waters were proclaimed a protected seascape by Presidential Proclamation 592. Republic Act No. 9106, dated 14 April 2001, improved it to the Sagay Marine Reserve Law.

The reserve has three component sections: resource management, social development and law enforcement.

The first conducts biological research and monitoring activities to evaluate the impact of management strategies; and initiates development projects through sustainable use of resources to improve economic conditions while enhancing environmental protection.

The second links effectively to community organizations and introduces livelihood projects that will discourage illegal fishing practices and decrease dependence on marine resources for sustenance.

The last implements laws and regulations through surveillance and monitoring of the protected areas.

See also the back cover story. -- APS

- ▶ *Congressman Marañon points to the boundaries of the reserve in a map*
- ▼ *Lush mangroves along the coasts of 3 municipalities*



CONSIDERATIONS ... FROM PAGE 19

strategies) to control the effects of enhancement. Essentially, adaptive management is the continued use of the above nine key components, to ensure an efficient and wise use of natural resource. ###

AQD PUBLICATIONS ... FROM PAGE 16

The results suggest that (a) there was a significant genetic differentiation among the wild *P. monodon* populations in the Philippines, and (b) the cultured populations were significantly differentiated from the natural populations. More replicate samples from each of the geographic regions are needed to conclusively determine the possibility of an association between genetic differentiation and the status of mangroves and/or intensity of shrimp culture systems. ###

MARINE RESERVE: BALIANGAO ... FROM PAGE 38

REFERENCES

- Alcala AC. 2001. Marine reserves in the Philippines: historical development, effects and influence on marine conservation policy. Makati City: Bookmark
- Ferrer E, de la Cruz L, Domingo MA. 1996. Seeds of Hope: Collection of Cases on Community-Based Coastal Resource Management. Manila, Philippines
- Fraser JMP, Agodolo IC. 1997. Fish stock assessment. (Unpubl report)
- . 1997. Monitoring catches of fish corral around the sanctuary
- Roberts CM, Hawkins JP. 2000. Fully-protected marine reserves: a guide. WWF Endangered Sea Campaign, University of York, UK

SEAGRASSES ... FROM PAGE 33

- Coles P. 2001. The point man in the Philippines' last frontier. Sources (131) February 2001. UNESCO
- Juinio-Meñez MA, Macawaris NND, Bangi HGP. 1998. Community-based sea urchin (*Tripneustes gratilla*) grow-out culture as a resource management tool, p 393-399. IN: Jamieson GS, Campbell A. Proc. North Pacific Symp. Invertebrate Stock Assess. Mgt. Can. Spec. Publ. Fish. Aquat. 125
- Juinio-Meñez MA. 2001. Hatchery and culture of sea urchins. Lecture presented at FISHLINK 2001, Iloilo City, 30 May 30 2001; UP Aquaculture Society Inc
- Fortes MD. 1989. Seagrasses: A resource unknown in the ASEAN region. ICLARM Education Series. 5 46 p
- Fortes MD. 1995. Seagrasses of east Asia: environmental and management perspectives. RCU/EAS Technical Reports Series No. 6. UNEP and UP-MSI
- Mingoa-Licuanan SS, Gomez ED. 1996. Giant clam culture, p 281-299. IN: de Silva SS (ed). Perspectives in Asian Fisheries. Manila: Asian Fisheries Society, p 281-299
- Mingoa-Licuanan SS, Dumale DT, Gomez ED. 2000. Giant clam culture / how to grow giant clams in the ocean. Quezon City: Marine Science Institute, University of the Philippines
- Oliva ELG. 2001. Up close with a seagrass man. Science Profiles, INQ Net. 10 May 2001
- Oliva ELG. 2001. RP scientist cited for seagrass study. Science Profiles, INQ Net. 6 May 2001

JAPAN AND TAIWAN ... FROM PAGE 21

veloped monitoring and assessment techniques, especially the use of an effective tag for sub-adult and a coded microwire tag for juvenile prawns. It appears that the prospects for restocking with sub-adults to augment prawn broodstocks in nature are promising. Taiwan's prawns have joined a growing list of successful stock enhancement programs (Table 2).

In addition to prawns, TFRI has experimentally released fingerlings, sub-adults and adults of seven fishes, six crustaceans, and one mollusc from 1976 to 1995 (Table 3). Most released animals were fingerlings except for the Japanese eel (*Anguila japonica* Temminck and Schlegel) and grass prawn (*P. monodon* Fabricius).

Taiwan considers the provision of artificial reefs an effective approach to building a good habitat for fishery resources. Since 1973, both the central and prefectural governments have put more emphasis on constructing artificial reefs to provide fish habitats or substrates.

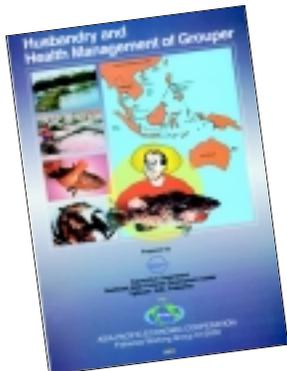
In addition, a total of 25 fisheries resource protective zones have been set up for fish (anchovy), crustaceans (lobster, kuruma prawn, redbtail prawn, grass prawn), molluscs (small abalone, hard clam, *Tapes* spp., purple clam, blood cockle, top shell, pearl shell), echinoderm (sea urchin) and seaweeds (*Porphyra*, *Gelidium*, *Meristotheca*). -- RIYA

REFERENCES

- Fukumoto S. 1989. Mariculture and stock enhancement in Japan. SEAFDEC Aquaculture Department, Philippines
- Imamura K. 1999. The organization and development of sea-farming in Japan, p 91-102. IN: Howell BR, Moksness E, Svåsand T (eds). 1999. Stock Enhancement and Sea Ranching. Oxford: Fishing News Books. 606 p
- Kitada S. 1999. Effectiveness of Japan's stock enhancement programmes: current perspectives, p 103-131. IN: Howell BR, Moksness E and Svåsand T (eds). 1999. Stock Enhancement and Sea Ranching. Oxford: Fishing News Books. 606 p
- Liao IC. 1997. Status, problems and prospects of stock enhancement in Taiwan. Hydrobiologia 352: 167-180
- Liao IC. How can stock enhancement and sea ranching help sustain and increase coastal fisheries, p 132-150. IN: Howell BR, Moksness E and Svåsand T (eds). 1999. Stock Enhancement and Sea Ranching. Oxford: Fishing News Books. 606 p
- Su MS, Liao IC. 1999. Research and development of prawn stock enhancement in Taiwan, p 379-392. IN: Howell BR, Moksness E and Svåsand T (eds). 1999. Stock Enhancement and Sea Ranching. Oxford: Fishing News Books. 606 p

www.mangroveweb.net

new website on *The World of Mangroves and Mangrove-friendly Shrimp Culture* online as of 7 December
MAINTAINED BY SEAFDEC/AQD



Husbandry and health management of grouper

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

The project team writers from AQD -- ER Cruz-Lacierda, CR Lavilla, JD Toledo, NV Golez -- is joined by NJ Ogburn of AJ

Aqua Intercon Pty Ltd Australia.

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

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

It should be noted that APEC and the Network of Aquaculture Centres in Asia-Pacific (NACA) formed a grouper working group in 1999 (1) to develop a strategy to increase collaboration between countries and institutions and (2) to develop an action plan to extend research and development outcomes to the industry. The group, also known as FWG 1: Production Technology - Research, Extension and Industry Development, identified the immediate need to develop a practical guide on husbandry and health management of grouper for fish farmers.

ON THE WEB ... FROM PAGE 24

OCEANIC INSTITUTE

www.oceanicinstitute.org/techtransfer/coastalconsulting.html

Oceanic Institute's integrated coastal resource management program provides expertise for stock enhancement and environment consulting. OI is recognized for its initiatives in marine stock enhancement particularly in hatchery technology and tag and recovery protocols. Custom built hatchery and release technologies, founded on the use of appropriate species, habitat selection and consideration of environmental, genetic and health variables make OI's work uniquely suited to stock enhancement and habitat restoration projects in coastal areas anywhere in the world. Moreover, OI also has strong capabilities in applied oceanographic studies, especially as they relate to fisheries and environmental impact. The programs are under OI's technology transfer efforts. -- RIYA

10th International Congress of Parasitology (ICOPA X)

4 to 9 August 2002

Vancouver Conference and Exhibition Centre

Vancouver, Canada

Under the auspices of the World Federation of Parasitologists; sponsored by the Canadian Society of Zoologists (Parasitology Section) and the American Society of Parasitologists

Final call for abstracts (March 1, 2002 deadline) and registration is announced.

The scientific program includes 5 plenaries, 15 sub-plenaries, sessions, invited lectures, oral and poster paper presentations, workshops. Topics to be covered include: immuno-pathology, molecular biology, morphology and ultrastructure, biochemistry and proteomics, ecology.

The honorary president Z. Kabata said that the conference "comes at a time when parasitology, always a wide-ranging discipline, is being further enlarged by new fields of research, such as those at the cellular or molecular level ..."

Visit www.venuewest.com/ICOPA

support responsible aquaculture

ANGELWING ... FROM PAGE 29

REFERENCES

- Ablan GL. 1938. The diwal fishery of Negros Occidental. Philippine Journal of Science 66 (3): 379-385
- Amornjaruchit S. 1988. Economically important molluscan shellfish of Thailand. IN: McCoy EW, Chongpeepien T (eds). Bivalve Mollusc Culture Research in Thailand. ICLARM Tech. Rep. 19. Department of Fisheries, Bangkok, Thailand: International Center for Living Aquatic Resources Management, Manila, Philippines; and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, Federal Republic of Germany, p 1-8
- Davidson A. 1976. Seafood of South-East Asia. Federal Publications, Singapore, 366 p
- Laureta LV, Marasigan ET. 2000. Habitat and reproductive biology of angelwings, *Pholas orientalis* (Gmelin). Journal of Shellfish Research 19 (1): 19-22
- Suraya A. 1982. Thailand. In: Davy FB and Graham M (eds). Bivalve Culture in Asia and the Pacific, Proc. Workshop held in Singapore, 16-19 February 1982. Int. Dev. Res. Center, Ottawa, Ontario, Canada, p 73-78
- Torkisana R, Tugsinavisuiti S, Muangkoe M, Kao-ian S. 1985. Marketing system of shellfish products. Asian Fish. Soc. Res. Network Thailand and Dept. Agric. Econ., Kasetsart University, Bangkok, 263 p
- Young A, Serna E. 1982. Philippines, p 55-68. In: Davy FB and Graham M (eds). Bivalve Culture in Asia and the Pacific, Proc. Workshop held in Singapore, 16-19 February 1982. Ottawa: IDRC of Canada

Training, websites, **EXTENSION MATERIALS**

Year 2002 AQD TRAINING COURSES

Health Management in Aquaculture, March 19 to April 22 (4 weeks)
Freshwater Aquaculture, April 2 to 30 (4 wks)
Marine Fish Hatchery, May 28 to June 26 (4 wks)
Management of Sustainable Aquafarming Systems (includes module on Aquaculture Management), July 2 to 31 (4 wks)
Responsible Aquaculture Development (Third Country Training Program funded by JICA), by invitation, August 6 to October 4 (8 wks)

DISTANCE LEARNING

Principles of Health Management in Aquaculture, April 2 to July 30 (17 wks)
Basic Principles of Aquaculture Nutrition, August 6 to December 3 (17 weeks)

For application forms and further information, please contact

SEAFDEC Aquaculture Department
Tigbauan 5021, Iloilo, Philippines
Tel/fax: 63 (33) 336 2891, 335 1008
E-mail: training@aqd.seafdec.org.ph

For local applicants who wish to apply for fellowships, contact

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

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

NEW!

Regional guidelines for responsible fisheries in Southeast Asia: Responsible aquaculture, prepared by the SEAFDEC Aquaculture Department, 94 p



Use of chemicals in aquaculture in Asia, edited by JR Arthur, CR Lavilla-Pitogo and RP Subasinghe, 235 p

Responsible aquaculture development, edited by LMaB Garcia, 275 p



Conservation and ecological management of Philippine lakes in relation to fisheries and aquaculture, edited by CB Santiago, ML Cuvin-Aralar and ZU Basiao, 187 p

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

An assessment of the coastal resources of Ibaday and Tangalan, Aklan: implications for management, edited by LMaB Garcia, 60 p



The farming of the seaweed *Kappaphycus*, written by AQ Hurtado and RF Agbayani, 25 p

PRICE LIST and ORDER FORM

Publication code (Please check) Price US \$*

() Newsletter	SEAFDEC Asian Aquaculture, published since 1978	9.5
<input type="checkbox"/> 1-year subscription (6 issues)		12
<input type="checkbox"/> 2-year subscription (12 issues)		15
<input type="checkbox"/> 3-year subscription (18 issues)		2
() Manual #16	Diseases of Penaeid Shrimps in the Philippines, 2000	2
() Manual #18	Seabass Hatchery Operations, 1998	2
() Manual #21	Feeds and Feeding of Milkfish, Tilapia, Seabass, Shrimp, 1994	1
() Manual #22	<i>Pagpaparak o Pagpaparami ng Tilapia</i> , 2001	1
() Manual #23	<i>Pagpapalakti ng Tilapia</i> , 2001	1
() Manual #24	Group Culture in Brackishwater Ponds, 1998	2
() Manual #25	Milkfish Pond Culture (The Modular Method), 1999	1.5
() Manual #26	Pen Culture of Mudcrab in Mangroves, 1999	1.5
() Manual #27	Mudcrab, 1999	6
() Manual #28	Mudcrab <i>Scylla</i> Production in Brackishwater ponds, 1999	2
() Manual #29	Group Culture in Floating Net Cages, 2000	2
() Manual #30	Net Cage Culture of Tilapia in Dams and Reservoirs, 2000	2
() Manual #32	The Farming of the Seaweed <i>Kappaphycus</i> , 2000	6
() Manual #33	Induced breeding of bighead carp <i>Aristichthys nobilis</i> , 2001	1
() Textbook	Health Management in Aquaculture, 2001	9
() Monograph	Ecology and Farming of Milkfish, 1999	13
() Monograph	Biology and Culture of Siganids, 1998	1.5
() Proceedings	Breeding and Seed Production of Fishes, 1996	2
() Proceedings	Mangrove-Friendly Aquaculture, 2000	2
() Proceedings	Use of Chemicals in Aquaculture in Asia, 2001	Free
() Proceedings	Responsible Aquaculture Development, 2001	7
() Proceedings	Conservation and ecological mgt of Philippine lakes, 2001	Free
() Report	An Assessment of the Coastal Resources of Ibaday & Tangalan, Aklan: Implications for Management, 2001	3
() State-of-the-Art	Environment-friendly Schemes in Intensive Shrimp, 2000	2
() State-of-the-Art	Closed-Recirculating Shrimp Farming System, 2000	2
() Poster 1	Important Prawns in the Philippines, 1984	2
() Poster 2	Life Cycle of Prawn <i>Penaeus Monodon</i> , 1989	2
() Video, VHS	Culture of Oyster and Mussel Using Raft Method, 1999	7
() Video, VHS	Milkfish Hatchery Operations, 1999	7
() Video, VHS	Conserving our Mangrove Resources, 1997	7
() Video, VHS	Group Culture in Brackishwater Ponds, 1999	7
() Video, VHS	Group Cage Culture, 1999	7
() Video, VHS	A CFRM Experience: Malalison Story (Antique, Phil), 1999	7
() Flyer	Mangroves and Community Aquaculture, 2000	Free
() Flyer	Group Culture, 1999	Free
() Flyer	R&D: Abalone Seed Production and Culture, 2000	Free
() Flyer	Seed Production of Catfish <i>Clarias macrocephalus</i> , 1999	Free
() Flyer	Mudcrab Culture, 1999	Free
() Flyer	Netcage Culture of Tilapia in Freshwater Reservoirs, 1999	Free
() Flyer	The Farming of the Seaweed <i>Kappaphycus</i> , 1999	Free
() Flyer	Milkfish Breeding and Hatchery Fry Production, 1999	Free

PRICE LIST and ORDER FORM

Publication code (Please check) Price US \$*

() Flyer	Milkfish Breeding / Hatchery Technology at AQD, 1999	Free
() Flyer	Commercialization of AQD's Milkfish Fry Tech, 1999	Free
() Flyer	Training on Sustainable Aquaculture and CRM	Free
() Brochure	Aquaculture Training Program, 1999	Free
() Report	Group Training on Responsible Aquaculture Dev't, 2001	Free
() Report	AQD's Biennial Report 1998-1999	Free
() Report	AQD's 2000 Highlights	Free
() Report	Promoting Appropriate Aquaculture Technologies for More Fish in Southeast Asia, 1999	Free

SUB-TOTAL US\$

ADD DELIVERY-HANDLING FEE

Please check () delivery within the Philippines	1
() delivery by Philippine Postal Service (SEAFDEC Member Countries)	10
() delivery by Philippine Postal Service (non-Member Countries)	12
() 2-3 days delivery by special courier (all countries)	40

TOTAL CHARGES US\$

*For orders in the Philippines, currency conversion is \$1=P50

3 easy ways to order



sales@aqd.seafdec.org.ph



(63-33) 335 1008, 336 2891



Sales/Circulation, SEAFDEC/AQD, Tigbauan 5021, Iloilo, PHIL

inquiries



(63-33) 511 9050, 336 2891, 335 1009, 336 2965

MODE OF PAYMENT

- () Payment enclosed: Bank Draft, Demand Draft, or Postal Money
- Order payable to **SEAFDEC Aquaculture Department**
- () Payment deposited: To SEAFDEC/AQD account # 307 112877 9 at UCPB. Attach photocopy of bank receipt with your order. *This option is for orders in the Philippines only*

SEND BOOK ORDER TO

Name _____

Complete Address _____

Tel/fax/email _____

Ecotourism at Sagay Marine Reserve central Philippines

Sagay boasts of scenic marine coastlines whose aesthetic value is but a faint reflection of its biodiversity and productivity. It is one of the richest fishing grounds that significantly contribute to the fishing industry of the Visayas.

in brief

PROTECTED ECOSYSTEMS

Coral reefs, seagrass beds, mangrove forests

PROHIBITED ACTIVITIES

All forms of illegal fishing (dynamite/poison use) and commercial fishing

COVERED AREAS

Islands of Molocaboc, Diutay, Matabas, and Suyac, including their surrounding reefs and the reefs of Carbin, Macahulom, and Panal

LEGAL BASIS

Republic Act 9106

(Sagay Marine Reserve Law, 24 April 2001)

Presidential Proclamation No. 592 (1995)

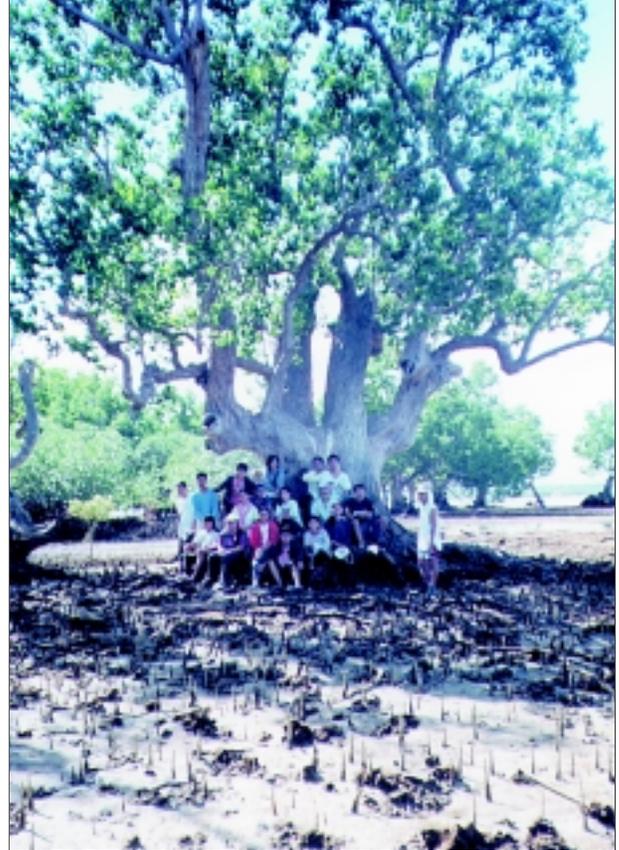
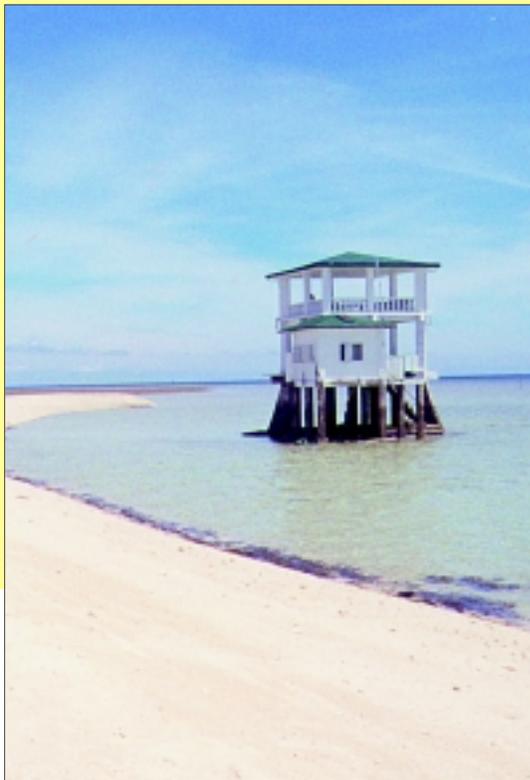
Municipal Ordinance No. 2 (1983)

ENFORCEMENT

Bantay Dagat Task Force /
Philippine National Police (PNP)

FACILITIES

Concrete watchtowers powered with solar energy, motorized patrol crafts, communications and camping gears



areas to see

CARBIN REEF

Sagay's 200 ha marine sanctuary where the earliest conservation efforts of the local government were implemented. A concrete watchtower stands as a marker and refuge for fishers navigating at night. Amenities for picnic, snorkeling boating, among others are available for a minimal fee.

MACAHULOM REEF

This 1,000 hectare reef/shoal is the habitat of abalone and winged strombed, locally known as "saang" shells. Surrounding waters teem with gamefish such as sailfish and mackerel. On certain months, migratory birds can be seen on the reef. A watchtower similar to that of Carbin's stands also as a marker, and has the same purpose. Amenities are similar to Carbin's.

MANGROVE WILDLIFE

Remnants of the oldest mangroves line the coastal Barangays of Vito, Bulanon, and Tabao where several bat and bird species abound, including the migratory ones. Facilities such as boardwalk viewing stands will soon line the area for better visual appreciation of the habitat. The DENR's Coastal Environment Program plot site for mangrove reforestation is also found in the area.

MOLOCABOC ISLANDS

Widespread seagrass meadows connect the three islands of Molocaboc. These islands are famous for shells, rabbitfish (*danggit*), and squid. Extensive mangrove reforestation can also be found in the area.