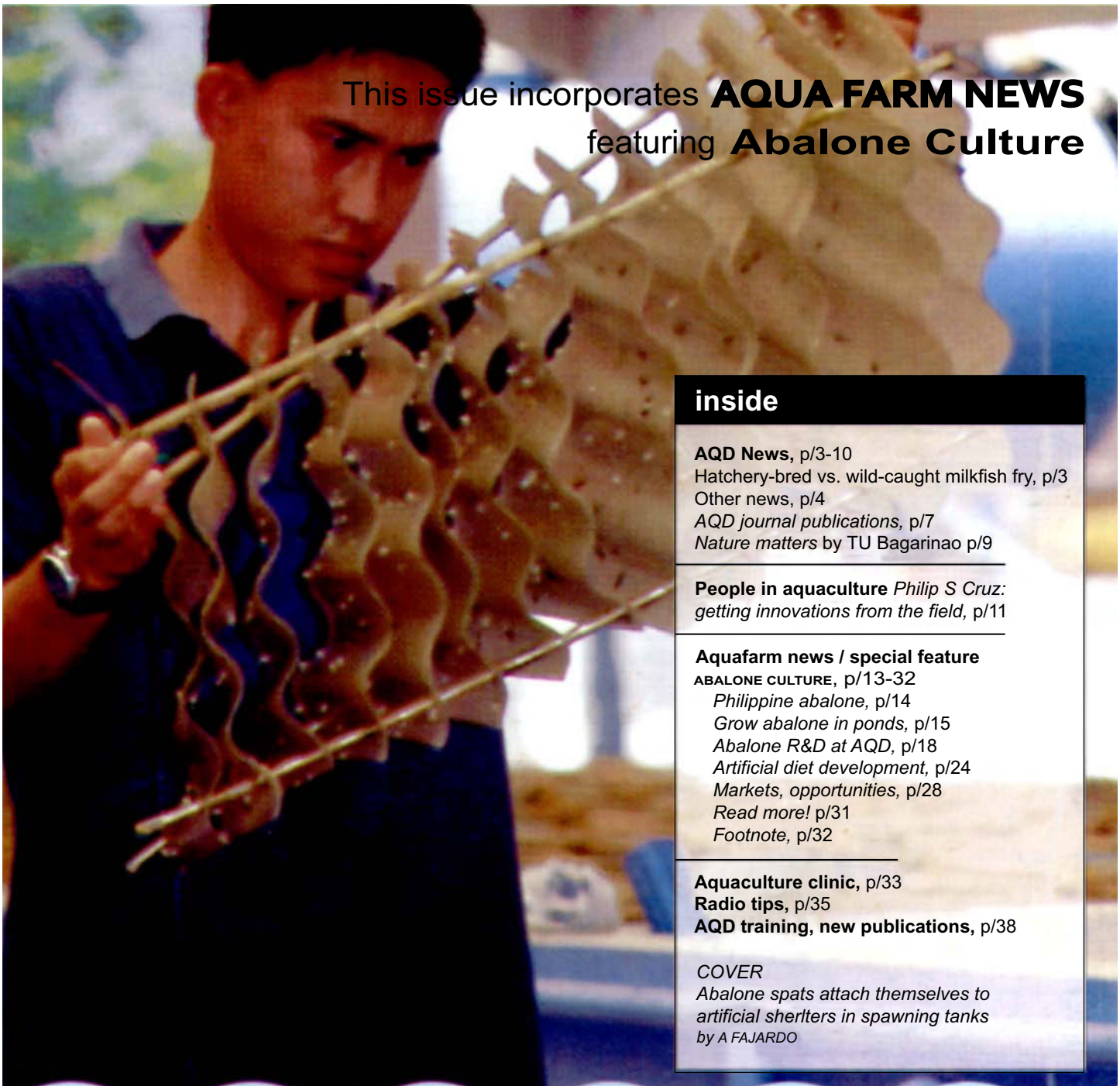
SEAFDEC Asian Aquaculture



This issue incorporates **AQUA FARM NEWS** featuring **Abalone Culture**

inside

COVER
Abalone spats attach themselves to artificial sherlters in spawning tanks
by A FAJARDO

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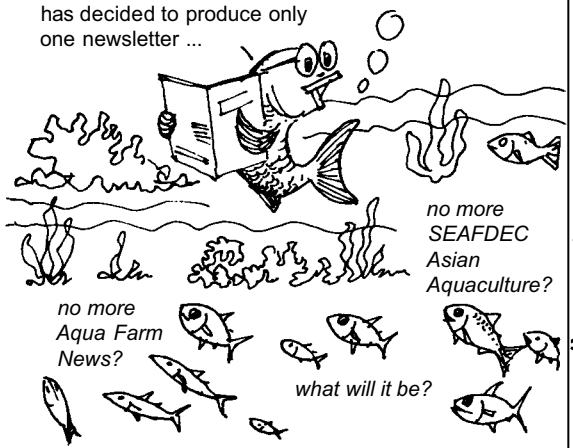
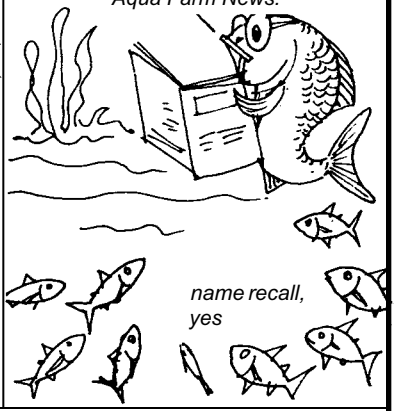
Dear readers and subscribers

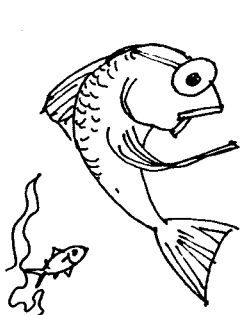
As we have previously announced, SEAFDEC / AQD has decided to produce only one newsletter ...



The merged publication will be named *SEAFDEC Asian Aquaculture* since it has been in circulation much ahead of *Aqua Farm News.*



The style, however, will follow that of *Aqua Farm News* (one special topic will be featured each issue) because it has become more popular and reader-friendly. It will be issued bimonthly.



The merged newsletter expands its coverage --

AQD News, including a regular update of biodiversity concerns

•

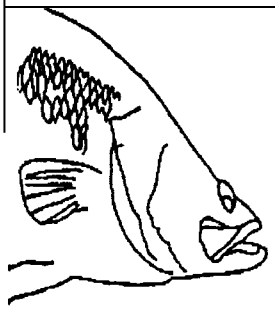
Original paper contributions from aquaculturists in southeast Asia

•

Interviews with people in aquaculture

•

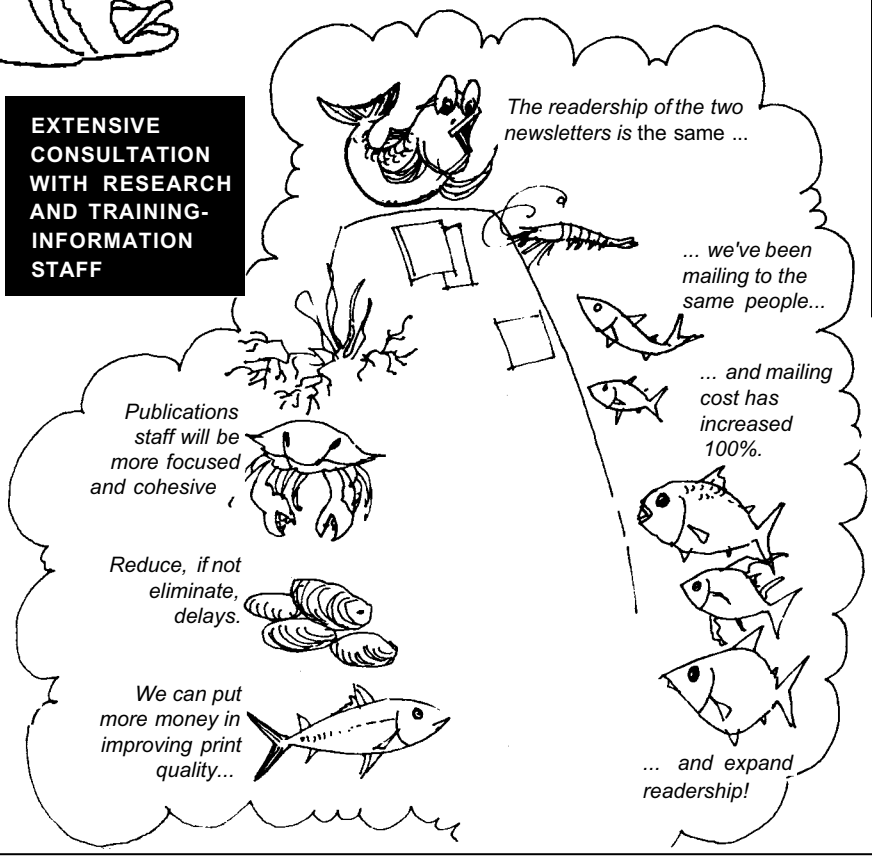
Special feature section, covering topics on economically important commodities, farming systems, among others



Before I'm tempted to eat somebody ... tell me 'why' again? Why must I read only one newsletter? ... did I or did I not pay for two?

FLASHBACK

EXTENSIVE CONSULTATION WITH RESEARCH AND TRAINING-INFORMATION STAFF



In our new masthead, the two waves represent the dynamic synergism of "research" and "development." The continuity of the wave action also suggests sustainability. The different species represent diversified aquaculture.

The new newsletter depicts the reimaging of AQD as a more relevant and "industry-friendly" institution consistent to our vision statement.

June 1997 is the target date of the first issue

sustainable aquaculture

By **M Castaños, A Surtida** and **E Ledesma**

Milkfish hatchery-reared fry as good as wild-caught say Panay fishfarmers

By **MB Surtida**

AQD's collaboration with the private sector is an ongoing research activity in line with its mandate to transfer aquaculture technology. For milkfish, the adopt-a-milkfish-broodstock scheme was launched in 1993 to enable the private sector to gain experience in maintaining breeders for commercial applications in their own facilities. An offshoot of this scheme is the sale of milkfish fry to fishfarmers with the agreement that data regarding the performance of the fry be made available to AQD researchers. Such collaborations have been made with farmers in Panay (west central Philippines). Tom Hautea Jr, Pedro Padlan, and Julieta Gaitan all work with Dr. Arnil Emata, AQD researcher in milkfish.

The Hautea family has been raising milkfish for at least five decades. Using the traditional extensive method, business has been good. Business has been handed down from father to son, and now Tom Jr. manages three ponds in Anilao and Dumangas in Iloilo and Kalibo in Aklan.

In some of his ponds from 1994-1996, Tom has been using hatchery-produced milkfish fry from AQD, partly because he wants to get around the problem of milkfish fry seasonality from the wild and partly to satisfy his curiosity. He had also wanted to find out whether wild-caught fry are more reliable than hatchery-reared ones.

In 1994, he purchased 66,000 pieces of milkfish fry reared from eggs obtained from the natural spawning of cage and tank-reared broodstock from AQD. He stocked them in his ponds and found that the fry grew as well as the wild-caught ones. He then bought 850,000 in 1995 and 900,000 in 1996. Mr. Hautea reported that on the average, he produced 750 kilograms of milkfish per ha at a stocking density of 2,000-3,000 per ha on extensive grow-out culture. The milkfish harvested were 2-5 pieces per kilo. Survival was 50 to 90%.

"Each year, I see improvement in my production from hatchery-reared fry. There's really no basis for the prejudice on hatchery-reared fry except perhaps the abnormalities. But these are manageable. They were 15, 5, and 1% for each year that I raised them," says Mr. Hautea.

He favors extensive culture. "The traditional way is much better because production input is much lower, thus, we are assured of a bigger marginal profit since milkfish market prices are vulnerable to many factors."

Similarly, Mr. Padlan has a milkfish pond in Barotac Nuevo, Iloilo. He bought hatchery reared milkfish fry from AQD in 1994. Since then, he has been using hatchery-bred fry even though his experience with wild fry dates back to 1958. "There is no difference between hatchery-reared or wild-caught fry. But

next page

I. Tendencia

Hautea harvested his milkfish crop in Dumangas last March.

the last batch that I got did not grow well. I attribute this to lack of proper nutrition and care in the nursery stage (until day 30)." To Mr. Padlan, it is not a question of whether they are hatchery-reared or wild-caught.

Abnormalities do not pose a problem. "I still make a healthy profit despite abnormalities. In our ponds, the outer covering of the gills are torn, but these are minimal," says Mr. Padlan.

Mrs. Gaitan has a different story. Since the 70's, she had been farming milkfish in her 1.5 hectare pond in Igang, Guimaras Island. She has been using hatchery-reared fry and has no cause for complaint." I have tried wild fry when I couldn't buy from AQD in 1995 (perhaps because my needs are small-scale?) but I reverted to hatchery-bred even if they are not from AQD. It isn't the performance of the wild fry. In both kinds, I made profits. They both perform equally. But I'm just not used to buying fry from traders along the coast," attests Mrs. Gaitan.

One problem is what she calls *tuko,* an abnormality when the head of the milkfish grows disproportionately bigger than the body. It is minimal but it occurs. She thinks it is caused by poor nutrition or lack of feeds. "We feed with breadcrumbs when we notice that the natural food is not as abundant during the last few weeks of culture," says Mrs. Gaitan.

These testimonies were confirmed by a recent study conducted by AQD Associate Scientist Neila Sumagaysay and colleagues. Hatchery and wild milkfish fry were grown separately in nursery ponds and transferred to rearing ponds (stocking density - 3,000 per ha). The results suggest that grow-out production of hatchery-reared fry is comparable to the wild caught as long as the abnormal fish is kept to a minimum (<30%). The researchers recommend that milkfish fry should be reared in nursery ponds for at least a month to lower the incidence of abnormality in grow-out ponds.

AQD holds techno-transfer and commercialization workshop

By **ETAIdon**

To support its present priorities on technology verification and technology packaging, AQD held a training workshop on technology transfer and commercialization for its staff and cooperators. The training workshop was conducted by the Rural-based Enterprise Foundation Inc. (REDFi) based in Los Baños, Laguna on April 24-26 and May 14-17, 1997.

"If we are to successfully convince farmers of the profitability of our technologies, we must use the participative system and processes that require the integration of sectoral services," says AQD Chief Dr. Rolando Platon. "We must also integrate environmental management as part of technology commercialization."

The training workshop aims to (1) introduce the rural-based enterprise development (RED) process in developing an integrated technology transfer program and its accompanying tools - Quick Resource Appraisal (QRA, a gap identification tool), Risk Management Process (RMP, a decision making or planning tool), and Backward Resource Inventory System (BRIS, a tool for generating basic assumptions for business planning and packaging); (2) develop a localized network of multidisciplinary cohesive teams that can provide the necessary technical and management interventions; (3) provide for a sustained intervention system to maintain the gains in implemented integrated programs; and; (4) enhance inter-agency and multi-level cooperation through the facilitative synergism of group dynamics inherent in the RED process.

The RED process is a holistic and systematic approach to enterprise building and integrated program development. It is anchored on the principles of local institution building, the integration of resources and capabilities, and the facilitative strategies of sustained intervention system. The developmental process being participative, the project beneficiaries are an integral part of the developmental process. The RED process recognizes the inherent value of incorporating local knowledge into the development perspective and resolution of problems is taken as a sound strategic developmental imperative.

The central focus of the RED process is the internalization of the team delivery system which is the key strategy for the sustained intervention in the countryside.

The training-workshop was highlighted by a field trip to Bingawan and Guimbal in Iloilo. The participants were made to gather information based on actual interviews and perceptions about the project in the locality. The tour groups then processed the information they gathered using the three tools - QRA, RMP and BRIS and came up with an integrated development program using the following components: program planning and preparation, program packaging and validation, and program implementation.

AQD's Training and Information Head Rene Agbayani led the core group in processing the Phase I output and presented a draft proposal of an integrated program on technology transfer and commercialization. Its implications on AQD's program were considered.

Phase II focused on entrepreneur building based on the QRAs and RMPs.

Expats at AQD

By **RB Buendia**

AQD invites researchers from SE Asia and other parts of the world to conduct research on AQD's priorities. Under the External Researchers Program, AQD will provide the funds for research while the visiting researchers are encouraged to get grants from international funding organizations for their travel and daily subsistence allowance.

AQD also requests consultants or experts from other countries to work with its staff.

Gaylen *played for the yellow team during AQD's 3-day sportsfest last May.*

GAYLEN ARMSTRONG

Gaylen Armstrong, 56, is **volunteer adviser** to AQD'S *Environmental Education (EE) Program for a Coastal Community.* He was sent by CIDA's Canadian Volunteer Adviser to Business (CESO International Services) upon the request of AQD. Gaylen has a BS degree in Agriculture major in Animal Science from the University of Manitoba and MS degree in Zoology major in Wildlife Management from the University of Alberta. Gaylen's expertise and extensive experience in environmental management education has brought him to projects in China, Sierra Leone, Tanzania and Uganda. Gaylen is working with AQD staff on developing an educators' guide to enrich the science curricula of elementary grades 4, 5, and 6. The guide will also serve the EE needs of community-based coastal resource management projects as it includes teaching materials for adults with low (formal) educational attainment. Gaylen visited key institutions working on EE in the country last May. He also conducted seminar-workshops on public education as a means to create environment awareness.

Gaylen is accompanied by his wife Marilyn who volunteered to teach English / literary appreciation classes at the elementary school in AQD's compound. The Armstrongs arrived last April 14, and will go back to Canada on the first week of July.

Andreas Groth

Ikuro Mitsumoto

ANDREAS GROTH

Andreas Groth, 29, is a **visiting researcher** from Germany. He is connected with the Department of Animal Nutrition and Aquaculture, Institute for Animal Production, Center for Agriculture in the Tropics and Subtropics, University of Hohenheim. He received his BS Biology from the University of Bremen in 1996. In 1994-1995, he came to AQD to conduct a study on the *Effects of L-carnitine supplementation on growth, survival and body composition of juvenile tiger shrimp Penaeus monodon.* The thesis research earned him his MS Marine Biology from Hohenheim University in 1997.

He is back at AQD for the second time to work on his PhD thesis on the development of a marker method for the quantification of natural food and supplemental feed intake of tiger shrimp in earthen ponds. The study ends September 1999.

IKURO MITSUMOTO

Ikuro Mitsumoto is a **JICA Expert on modelling (computer simulation analysis).** He is Assistant Section Chief of the Institute for Environmental Information, Shin-Nippon Metrological and Oceanographical Consultant Company Ltd, Yokohama, Japan. He received his degree in Geophysics at Hokkaido University in 1983. In 1992, he worked at IDRI Thailand on the Economic-Industry Project. He was Port Management Expert for the Philippine

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AQD trained two batches of aquaculturists in the second quarter of 1997.

E. Gasataya

The **AQUACULTURE MANAGEMENT** course has 20 participants (seven Filipinos, four Thais, three Vietnamese, two Malaysians, one each from Cambodia, People's Republic of China, Tanzania, and Micronesia). Aquamanagement aims to develop skills in project management, aquaculture planning, implementation, monitoring, and evaluation. It was conducted April 1 to 30 at AQD's Tigbauan Main Station.

E. Gasataya

The **FISH HEALTH MANAGEMENT** course has 13 participants (five Filipinos, two each from Thailand, Vietnam, and Malaysia; and one each from Sri Lanka and Indonesia). Fishhealth aims to provide theoretical and practical training for government fishery extension workers and aquaculture technicians in the etiology; isolation and identification; prevention and control of fungal, bacterial, viral, and parasitic diseases affecting aquaculture systems. It was conducted April 15 to May 26 at AQD's TMS. **(See also page 38 for AQD's regular training courses.)**

AQD Research Publications

Reprints of papers listed here may be requested from AQD authors.

Compiled by DATABANK / AQD LIBRARY

Chavoso EAJ, AQ Hurtado-Ponce. 1995. *Effect of stocking density and nutrients on the growth and agar gel of* Gracilariopsis bailinae *(Gracilariales, Rhodophyta).* The Philippine Scientist 32: 27-33.

The effect of additional nutrients and varying stocking densities (500, 1000, and 2000 g m^{-2})on the growth and physical properties of *Gracilariopsis bailinae* was determined. Growth was significantly higher (<x=0.05) at a stocking density of 500 g both in enriched (3.5% / day) and unenriched (1.9% / day) treatment, but growth was not significantly different between 1000 and 2000 g density. A decreasing growth rate was observed with increasing stocking density. Significant differences in gel strength and gelling temperatures were observed only at 2000 g m^{-2} both in enriched and unenriched treatment. Results of the study showed that additional nutrients are necessary for the growth of G. *bailinae* and its agar quality.

Dhert Ph, **RE Bombeo**, P Sorgeloos. 1993. *Use of ongrown Artemia in nursery culturing of the tiger shrimp.* Aquaculture International 1:170-177.

Juvenile and adult *Artemia* produced in a semi flow-through culture system were used as food for postlarval shrimp. The growth performance of shrimp reared on such ongrown *Artemia* live prey is identical to the growth obtained when feeding newly hatched *Artemia.* However, a significantly better stress resistance is obtained when the postlarvae are exposed to a low salinity in a stress test. Besides nutritional and energetic advantages, the use of *Artemia* biomass for feeding postlarval shrimp also results in improved economics as expenses for cysts and weaning diets can be reduced.

Duray MN, LG Alpasan, CB Estudillo. 1996. *Improved hatchery rearing of mangrove red snapper,* Lutjanus argentimaculatus, *in large tanks with small rotifer* (Brachionus plicatilis) and Artemia. The Israeli Journal of Aquaculture - Bamidgeh 48 (3): 123-132.

A hatchery rearing scheme for the red snapper, *Lutjanus argentimaculatus,* is described. The feeding regime consisted of *Chlorella, Brachionus, Artemia* and minced fish. The average survival rate at day 24 was 27% in 3-ton tanks but only 3% in 0.5-ton tanks. From an initial length of 2.15 mm at stocking, larvae grew to 8.2 mm on day 24 and 30.6 mm on day 55. Growth and survival were best when larvae were fed screened *Brachionus* (<90 um) during the first 14 days. Larvae fed *Artemia* at 1, 2 and 3 per ml per day weighed similarly on day 35 but were longer at the higher feeding levels and survived better at the lower levels. Larvae fed *Artemia* at 2 per ml had a higher survival when the ration was given four times a day rather than 1 -2 times a day.

Duray MN, CB Estudillo, LG Alpasan. 1996. *The effect of background color and rotifer density on rotifer intake, growth and survival of the* grouper (Epinephelus suillus) *larvae.* Aquaculture 146:217-224.

Rotifer intake and early growth and survival of *Epinephelus suillus* larvae were determined in terms of rotifer visibility against the background color of rearing tanks and density. The larvae were stocked at 30 1^{-1} in 200-1 fiberglass tanks with phytoplankton (green water). Larvae were fed rotifers at densities of 5, 10 and 20 ml^{-1}. Growth and survival were comparable among larvae in both tan and black tanks with green water. Rotifer intake was significantly higher in larvae in tan tanks. In black tanks, the survival of larvae at Day 14 was enhanced by the high rotifer density of 20 ml^{-1}. Rotifer intake and growth of larvae were similar at all densities.

Duray MN. 1996. *The effect of tank color and rotifer density on rotifer ingestion, growth and survival of milkfish* (Chanos chanos) *larvae.* The Philippine Scientist 32: 18-26.

The effect of tank color on rotifer ingestion, early growth and survival of milkfish larvae was assessed. The larvae were stocked at 30/L in 200-L fiberglass tanks coated black or unpainted (tan). Larvae were fed rotifers at densities of 5,10 and 15/ml. Growth and survival were higher in black tanks than in tan tanks. Rotifer ingested were also higher in larvae reared in blank tanks. In black tanks, the survival of the larvae was enhanced at high rotifer density of 15/ml. Rotifer ingestion and growth of larvae improved at higher feeding levels.

Hurtado- Ponce AQ, RF Agbayani, EAJ Chavoso. 1996. *Economics of cultivating* Kappaphycus alvarezii *using the fixed-bottom line hanging-long line methods in Panagatan Cays, Caluya, Antique, Philippines.* Journal of Applied Phycology 105: 105-209.

A socio-economic survey was conducted among the *Kappaphycus alvarezii* planters of Panagatan Cays, Caluya, Antique, Philippines to determine some social information, farming practices and costs and returns of farming the seaweed. Cultivation is dominated by brown and green morphotypes using the fixed-bottom and hanging-long line methods. Approximately 9.3 t d. wt ha^{-1} and 7.21 d. wt ha^{-1} is produced from fixed-bottom and hanging-long line methods, respectively, after 60-90 days of culture. The former method requires a working capital and total investment of P7490 and P1870, respectively, compared to the hanging-long line which requires P8455 and P25464, respectively (US$ 1=P26). A higher total rev-

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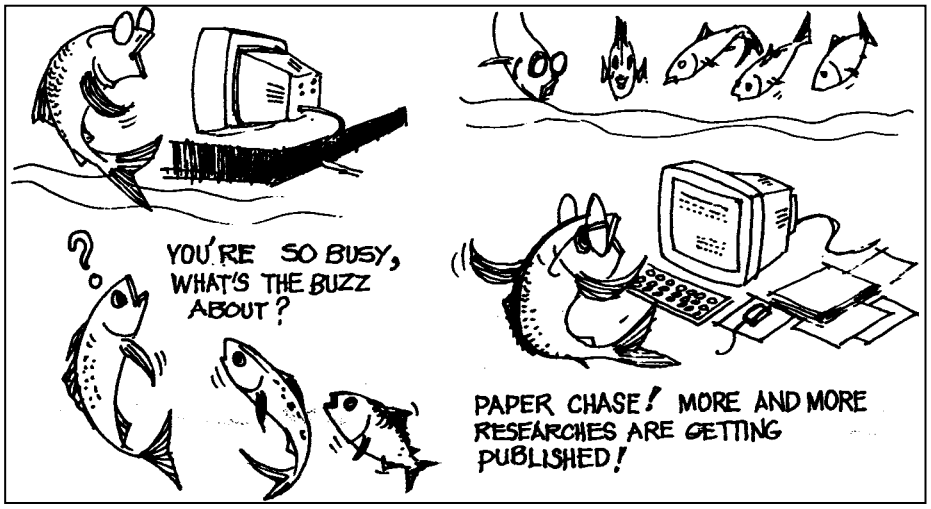

enue (P139500), net income (P187895), and return of investment 1002%), but a shorter pay back period (0.10 years) were obtained in fixed-bottom than in hanging-long line. A lower total expenses were incurred in fixed-bottom (P21354) than in hanging-long line (P24566). The farming of *K. alvarezii* in this area has brought tremendous economic impact to the marginal fishermen.

Lavilla-Pitogo CR. 1996. *Shrimp health research in the Asia-Pacific: present status and future directives.* In: RP Subasinghe, JR Arthur, M Shariff (eds). Health management in Asian aquaculture; Proceedings of the regional expert consultation on aquaculture health management in Asia and Pacific, p 41-50. FAO Fisheries Technical Paper No. 360. 142 p.

Shrimp harvests from intensive aquaculture have recently declined in areas which have been productive for many years. Because the most convenient, although not necessarily factual, explanation for these crop failures has been the occurence of infectious diseases, there is a need to consider shrimp health from a holistic point of view. The classical method used for the study of shrimp disease dealt mainly with identification of the causative organism and the search for methods of prevention and control through chemotherapy. The adverse affects resulting from the use of chemicals in aquaculture have led to a clamor for alternative approaches to disease management. For effective shrimp health maintenance and surveillance, the following components need consideration: development of rapid and sensitive methods for pathogen detection; establishment of shrimp tissue cultures for virology, immunological studies, toxicological studies and drug efficacy evaluation. The epidemiological approach to disease management should augment the classic approach to shrimp pathology, and this calls for multidisciplinary cooperation.

Lavilla-Pitogo CR, AC Emata, MN Duray, JD Toledo. 1995. *Management of fish health in broodstock and larvae of milkfish, seabass and grouper.* In: Jhain KL, Rosenthal C (eds). Aquaculture health management strategies for marine fishes; Proceedings of a workshop in Honolulu, Hawaii; 9-13 October 1996.

Historically, reports on the occurence of disease problems in milkfish, seabass and grouper were mainly on the isolation and identification of etiological agents. Studies on the tolerance of fish to chemotherapeutants were also conducted. Various species of vibrios and gill-infesting parasites have been associated with diseases in all life stages of these fish. Presently, mortalities due to diseases of unknown etiology. environmental failure and nutritional or husbandry shortfalls affect successful fry production in the hatchery. Morphological deformities in hatchery-produced milkfish fry is a major problem to be solved. In seabass fry production, swimbladder stress syndrome occasionally occurs and results in mass mortalities. In larval grouper culture, the problem of low survival is being addressed through improved husbandry and nutrition. For cage-held broodstock that naturally spawn in captivity, such as milkfish and grouper, the main problem is fouling of net enclosures in the cages. However, for fish that need hormonal manipulation to spawn, such as seabass and snapper, stressful handling procedures during sampling and hormone injection may lead to injuries and scale loss. The damaged areas become focal points for secondary bacterial infection. Future fish health management strategies in these fish should incorporate a holistic approach to include environmental monitoring, nutritional manipulation, immunostimulants and vaccine use, and biological control in addition to pathogen exclusion in the rearing system and the fish.

Leaño EM, GD Lio-Po, LA Dureza. 1996. *Virulence and production of extracellular proteins (ECP) of* Aeromonas hydrophila *associated with the epizootic ulcerative syndrome (EUS) of freshwater fish.* UPV Journal of Natural Science 1: 30-38.

Sixteen (16) isolates of *Aeromonas hydrophila* isolated from normal, apparently normal and epizootic-ulcerative syndrome (EUS)-affected fish were screened for virulence and production of extracellular proteins (ECP). Results showed that all isolates were virulent to catfish (*Clarias batrachus*) juveniles inducing dermonecrotic lesions after intramuscular injection. Lesions were characterized by necrosis of the underlying musculature that leads to erosion and sloughing-off of the locally affected tissues. Only seven of the 16 ECP preparations, however, induced similar lesions on test catfish. No clear correlation between virulence and ECP production of EUS-associated *A. hydrophila* was established.

Nature matters

the AQD Museum and Biodiversity Garden, and the Environment Action Group

By Teodora Bagarinao, PhD
AQD Scientist and Museum Curator

Biological diversity is rapidly diminishing in forest, upland, and coastal environments in the Philippines and throughout the world. The primary cause of loss of biodiversity is not direct human exploitation or malevolence, but the habitat destruction and modification that inevitably result from the expansion of human population and human activities. From an estimated 12 million hectares of old-growth forests in the 1930s, the Philippines has barely 700,000 ha at present. As a result, animal and plant species have gone extinct, including 60% of the endemic flora. The extinction of populations and species exerts its primary impact on society through the impairment of ecosystem functions, that is, the loss of the free services (such as photosynthesis, pollination, and decomposition) rendered by plants, animals, and microorganisms.

Arresting the loss of diversity will be extremely difficult. This formidable effort must begin by increasing public understanding of the importance of the loss of diversity and the urgent need for conservation. One way to popularize biodiversity and environment issues is by popularizing nature parks and biodiversity exhibits such as museums, herbariums, zoos, and botanical gardens. This non-formal environment education through immersion and recreation is part of 'the birds and the bees and the flowers and the trees' approach toward the 'greening' of the mind, the heart, and the spirit.

This article provides an introduction to the biodiversity in the Philippines, at least the flora and fauna that have been studied, and particularly those described in reader-friendly publications. This article is part of a longer paper in the journal *Ambio* that also provides information on the use, management, and conservation of biodiversity and on the location and present status of nature parks and biodiversity exhibits in the country. Additional parts of the journal paper will appear in subsequent issues of this newsletter.

A compendium of data on Philippine flora and fauna was prepared in 1977-81 by a team of biologists commissioned by the Natural Resources Management Center of the Ministry of Natural Resources. Twelve volumes of the *Guide to Philippine Flora and Fauna* were published in 1986, containing descriptions of 3,351 species (Table 1). The Philippines has 12,000 species of flowering plants, pteridophytes, bryophytes, algae, and fungi, of which 3,500 species are endemic, and a tremendous variety is grown as ornamentals. Elmer Merrill described 1,007 species (591 genera, 136 families) in his 1912 *Flora of Manila.* Eduardo Quisumbing's encyclopedic account of plants with medicinal properties was followed by several pictorial booklets. The Department of Health has approved the commercialization and popular use of four medicinal plants: lagundi *Vitex negundo* against coughs,

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AQD's mini-forest at the Tigbauan Main Station

Table 1 The groups described in the 12 volumes of Guide to Philippine Flora and Fauna published in 1986 by the Natural Resources Management Center, Ministry of Natural Resources and University of the Philippines - Diliman, Quezon City.

Vol.	Groups included	Species	Genera	Families	Orders	Total species
I.1	Zoosporic fungi	118[a,b]	60	24	10	199
I.2	Seaweeds	90[b]	34	22	12	
I.3	Mosses	80[a]	49	22	7	104[a]
II.1	Ferns	278[a] + 54[b]	(5[a])			298[a] + 54
II.3	Gymnosperms	33; 6[a]	12	6	4	33
III.1	Dipterocarps	38+9 subspp.		1		
III.2	Non-dipterocarps	299+6 subspp.	196	66		
IV.1	Bamboos	25; 7[a]		1		
IV.2	Other grasses	85; 4[a]	70	1		
IV.3	Palms	85				106
V	Corals	400	65			499
VI.1	Gastropods	297	95	48	5	
VI.2	Bivalves	91	59	26	6	
VI.3	Annelids	49	30	15	2	
VII.1	Rotifers	61	23	16		
VII.1	Cladocerans	49	28	6		
VII.1	Copepods	15	12	4		
VII.2	Barnacles	138; 23[a]; 8[b]	33	11		
VII.3	Swimming crabs	44			5	
VIII	Hemipteran insects	113; 10[a]	58	20		
IX	Fishes	429; 6[a]	293	112	21	
X.1	Amphibians	66; 42[a]	20	7		67
X.2	Reptiles	205; 127[a]	73	17		215
XI.1	Passeriform birds	70; 61[a]			1	128; 111[a]
XI.2	Mammals	75; 58[a]	58	29	19	230
XII.1	Parasitic arthropods	48	34	17		
XII.2	Poisonous animals	55				

[a]endemic, [b]economically important

hierba buena *Mentha cordifolia* as analgesic, sambong *Blumea balsamifera* as diuretic, and tsaang-gubat *Ehretia microphylla* against diarrhea and digestive problems. The vincrisin-yielding shrub *Catharanthus roseus* grows wild by the roadside as do many other medicinals. Hydrocarbon-producing plants such as peres *Pittosporum resiniferum* and lumbang oil *Aleurites mollucana* were of much research interest during the oil shortage in the 1970s. Pesticidal plants such as makabuhay *Tinospora rumphii,* manzanilla *Tagetes erecta,* and neem *Azadirachta indica* are now promoted as alternatives to synthetic agricultural poisons. Mangroves (many species of salt-tolerant trees and associated plants) have also become more widely recognized for their ecological and economic importance to the coastal zones.

Early studies on the systematics and natural history of Philippine land vertebrates were done mostly by American scientists and Filipinos like Angel Alcala and Dioscoro Rabor. There are about 975 species of tetrapods in the Philippines — 67 amphibians, 215 reptiles, 500 birds, and 194 mammals. Some 639 non-mammalian species are found in the Visayas and Mindanao, and the species endemism is very high: 50% of bird species, 64% of snakes, 76% of lizards, and 64% of amphibians. Endemic forms occupy specialized habitats, particularly in forests. On denuded Cebu Island, nine species of endemic birds have become extinct. Of the land mammals in the Philippines, 76% of the species are small (rats, mice, and bats), but many of the larger ones (flying squirrels, bats, civets, leopard cat, flying lemur, macaques, tarsier, deers, wild pigs, tamaraw) have become endangered. John Eleuthere du Pont of the Delaware Museum of Natural History published in 1971 a particularly beautiful book, *Philippine Birds,* based on his work in the Philippines since 1958.

Ichthyology was also a thriving science during the first half of the century when American and Filipino scientists at the old Philippine Bureau of Science in Manila published many illustrated descriptions of Philippine fishes. These papers have been reprinted by the Smithsonian Institution and TFH Inc. in *Philippine Bureau of Science Monographic Publications on Fishes* in 1965 and in *Philippine Journal of Science Selected Ichthyological Papers Volumes I-III* in 1969. Albert Herre's 1953 *Checklist of Philippine Fishes* includes 2,117 species, but many more have now been recorded, including 544 genera of coastal marine fishes, of which 238 species are endemic and a great many are of commercial importance. Herre also wrote delightful fish stories for non-scientists in *Philippine Fish Tales* published in 1935.

Indeed faunal diversity in the marine coastal zone of the Philippines is quite high — 1,375 genera in 499 families of chordates and six major invertebrate phyla including corals and mollusks. Springsteen and Leobrera includes 1,700 species of mollusks in their beautiful book and Chou and Aliño gives a breathtaking view of life on the coral reefs. Recently, Jose Maria Lorenzo Tan documented at least 18 species (but there may be as many as

☞ page 36

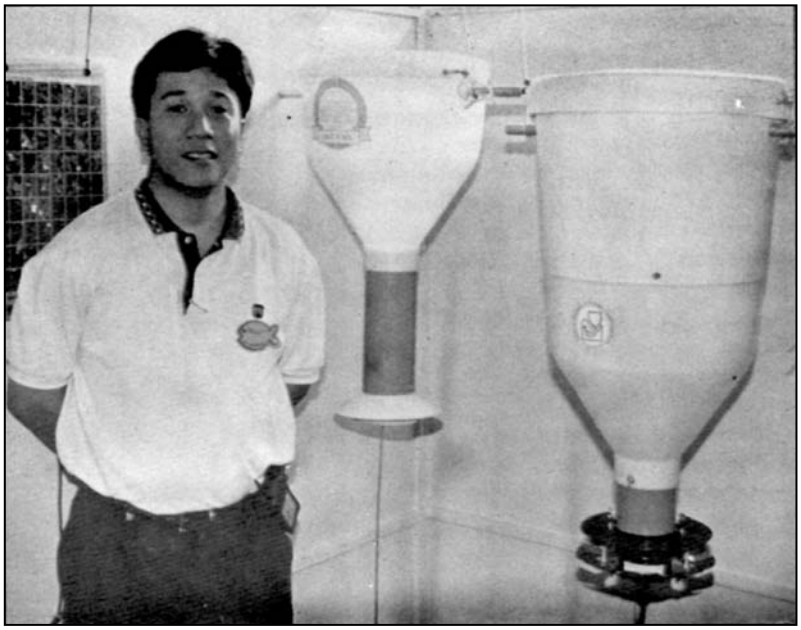
Getting innovations from fieldwork

By **MB Surtida**

On March 19, 1997, Philip S. Cruz, 32, won the National Grand Prize of the first Department of Science and Technology competition on industry and energy research. He has invented and patented the Kinetic Feeder™ for milkfish and tilapia. The grand prize carried with it a cash bonus of ₱100,000.

"This award will definitely help a lot in my R&D activities, "says Philip. He has read papers in many international and national conferences mostly on feeds and feeding management, and is also the author of the book Shrimp Feeding Management: Principles and Practices. He is a member of several professional organizations, and the founding president of U.P. Aquaculture Society, Inc.

Philip is the patent owner and applicant of various fish feeding equipments for aquaculture.



What inspired you towards inventing the Kinetic Feeder?

I was technical services manager of a shrimp feed company for nearly five years. When the shrimp industry crashed, we shifted to fish feeds. Feeding then was done mainly with the use of the feeding tray (sinking feeds), floating frame (floating feeds), or by hand feeding. I realized that the tray was not an appropriate feeding method for fish, there is just too much wastage from pellet disintegration and nutrient leaching. As for the floating frame, this actually limited feeding area to the surface and downwind and this often caused problems on uneven fish sizes. Hand feeding is effective, but when you compute the cost, it is expensive. With these constraints, I saw the challenge to try to develop a feeding device designed for the local fish farming industry.

What is the concept of your feeder?

It is a demand feeder. It releases feeds only when an actuator or "bait" rod is moved by the fish. This concept is not really new. Demand feeders have been in use in Europe and US for more than 20 years. But ironically, despite the Philippines being progressive in aquaculture, we have never successfully adopted such a valuable device. The problem basically was that there was no appropriate design suited to the feeding behavior of local species as well as to local farming conditions.

How about the foreign designed ones?

When I was still with the feed company, we imported a demand feeder from the US. We tried it on milkfish and tilapia but I wasn't satisfied. The device was eventually abandoned. When I started my own business, I did my own R&D on the feeder. After two years, I was able to make many important improvements, making the product a breakthrough in fish feeding management. The judges in the recent DOST national competition found my work novel and significant (please see cross sectional view and caption) and decided to give me the award.

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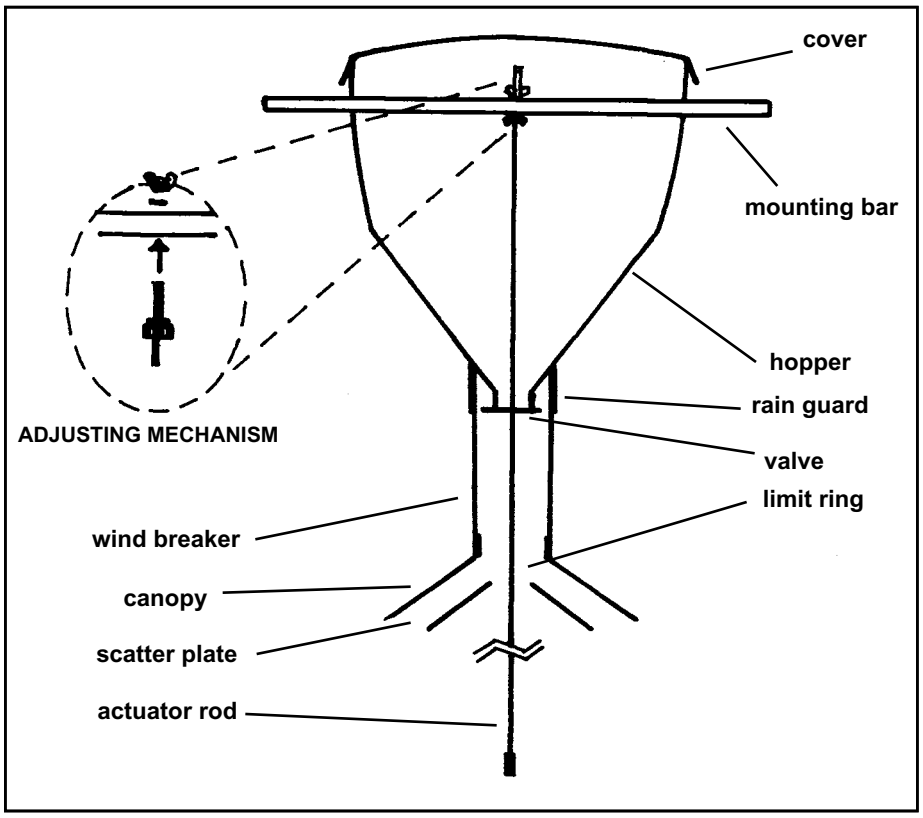

After numerous experimentations for the design of the kinetic feeder, Philip's efforts produced several important and novel improvements. These are the redesign of the valve, addition of a limit ring, addition of scatter plate, addition of wind breaker, optimization of the hopper size, and optimization of the design for transport and storage. A cross sectional view of the kinetic feeder is shown.

What are the improvements introduced by your Kinetic Feeder?

Because feeding is on demand, overfeeding or underfeeding is prevented. Second, feed pellets are immediately consumed as these drop in the water. There is thus no chance for the pellet to disintegrate and for the soluble nutrients to leach out. Pollution, in effect, is minimized allowing better water quality. With the patented scatter plate, one unit of the Kinetic Feeder is able to effectively feed 1,500-2,000 fish. These factors lead to improved growth and feed conversion, and more uniform fish sizes. Also worth mentioning is the savings on labor with the use of the feeder.

As an inventor, how would you reconcile both disciplines as a scientist (you have an MS degree) and as an entrepreneur?

When I do my R&D, I tackle a problem from the point of view of the farmer. It actually demands one to be more creative. In developing the Kinetic Feeder, making it work was just half of the problem. I had to make the product affordable yet durable, simple yet efficient, easily disassembled and assembled (being bulky), compact to transport, functional during rainy or windy days, aesthetically attractive, among many others. I try to keep a balance between being technical and being entrepreneurial although I have to admit I am more of the former. When I was marketing my feeder before, I tried to price it at a margin lower than what most business people would do. But I realized soon that if I am to remain abreast with technology, I have to spend for R&D. This decision to be profit motivated allowed me to develop, with my own resources, three other fish feeder models, an automatic feed spreader, a motor-assisted Kinetic Feeder, and a solar-powered feeder. I have a nursery feeder coming out soon.

Shouldn't these views be shared by researchers?

Many colleagues I know see research work and entrepreneurial work to be conflicting. The reason probably is that science is exacting and transparent while business tends to be otherwise. As a result, many researchers intentionally leave the economic aspect of their

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Abalone culture

The increase in demand and prices for abalone products have been steady since 1991, making abalone increasingly attractive as a financial investment to fishfarmers all over the world. Filipino fishfarmers in particular have shown interest in abalone culture, but so far, no commercial farm is operating.

Notes AQD researcher Emmanuel Capinpin: "Abalone culture is attractive to investors in the Philippines. Lucrative markets exist for live small abalone in Hong Kong, Taiwan, Singapore and other major Asian cities. There is also a strong demand in the local market for specialty restaurants. Another potential for local abalone is the canned market which represents a significant opportunity for aquaculture operations. Further, there are a lot of suitable sites for culture in the Philippines and a good quality food source, the red alga *Gracilariopsis heteroclada* is readily available." Capinpin spearheads the abalone R&D effort at AQD.

In 1991, the Philippines exported nearly 300,000 kilograms of live and processed abalone worth over US$2 million to Australia, the United States, and Asian countries. Two years later, this volume nearly doubled to 500,000 kg, worth US$3.6 million. Export countries now include Europe.

In this **special section for aquaculturists,** we discuss the abalone species of the Philippines; growing abalone in intertidal ponds, a design of submersibles in mid-term nursery of spats in the open sea; AQD's initial research on abalone spawning, nursery and cage culture; the efforts of several R&D institutions in developing artificial diets; and the abalone market opportunities as surveyed by a pioneering company in the US.

This is a wood-block print showing an ama (abalone) diver in Japan, the country that has the earliest tradition of abalone fishery (KO Hahn. 1989. Handbook of Culture of Abalone and Other Marine Gastropods. CRC Press, Florida. p. 186). The earliest reference to ama divers was during the reign of Emperor Suinin in 30 AD. Then, back in the 6th century, ama divers became exclusively female when many men were taken to serve on war ships. The women had to take care of themselves, to become self-reliant. Ama divers often pay the government with awabi as tribute.

Japan, Hahn noted, traded with foreign countries through the port of Nagasaki just before the Meiji Era (1865 to 1912). Dried abalone was the most important export, constituting about 80% of marine exports. It was in the Meiji Era that biological studies on abalone were initiated when Japan needed to generate more money from exports. Today, Japan leads the world in abalone production and consumption.

The abalone of the Philippines

About 100 species of abalone are distributed worldwide, with the larger species generally found in temperate zones whereas smaller species are found in tropical and arctic regions. Ten species are commercially important, and mainly occur in Korea, Japan, Mexico, South Africa, Australia, New Zealand, United States and China. There are two common species reported in the Philippines, *Haliotis asinina* and *H. varia.* Of the two, *H. asinina* has the potential for culture due to its larger size and body weight. *H. asinina* is one of the priority species for study at SEAFDEC Aquaculture Department.

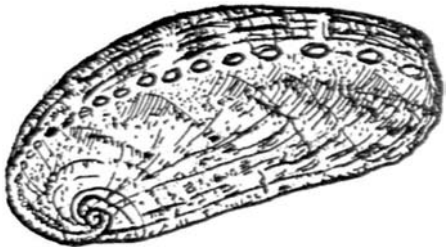
Haliotis asinina

Known as the donkey's ear abalone, ass-ear abalone or *lapas.*

Common in Tawi-tawi, Bohol, Panagatan, and eastern Samar.

Have broad, flattened asymmetrical shells, and large fleshy bodies. Its head is greenish, its marginal frill green with blotches of dark green and brown. Its foot is creamy with brown markings.

Live on the underside of corraline rocks during the day but comes out to feed at night.



Haliotis varia

Known as *lapas.*

Abundant in Cagayan and Capiz.

Shells have uneven spiral ridges, strong growth lines, radial folds and raised holes. These may also be mottled white and / or black. Heads and mantles are greenish while feet and muscles are whitish.

Found at 1 -2 meter deep water (24-30°C, 32.5-35 ppt).

Abalone live in sheltered bays with good water movement and that are far from estuaries. Fishers harvest abalone by detaching these by hand or by hooks.

Abalone have blue-gray mother-of-pearls that can be made into buttons, buckles, inlays, ornamental ash trays, jewelry. The shell is used in traditional medicine. The viscera can be made into good quality glue.

Abalone meat is a highly priced delicacy, and is about 20% protein. It is usually processed (dried, canned in brine, smoked in oil, seasoned and roasted) or eaten fresh. In Panagatan, middlemen buy abalone from farmers at P60 per kg, dry the abalone, and sell these at a much higher price. - **MTC**

REFERENCE

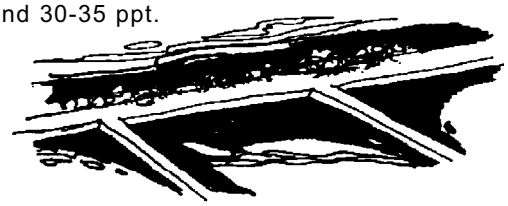
Primer on abalone: its nature and uses. 1991. Philippine Council for Aquatic and Marine Research and Development. Los Baños, Laguna. 5 pages.

Grow abalone in ponds

Culture techniques of tropical abalone are largely based on the research done on *Haliotis diversicolor supertexta,* reports Padermsak Jarayabhand[1], a researcher at the Department of Marine Science at the University of Chulalongkorn in Bangkok. Most of the published literature have dealt with temperate species. But tropical abalone culture is similar to temperate abatone culture, with slight differences in detail.

Below are the steps in growing abalone in ponds as practiced by farmers in Taiwan[2]. Taiwan has one of the most successful industries among abalone-producing countries, notes Hon-Cheng Chen of the National Taiwan University in Taipei.

1 CHOOSE A GOOD SITE. The best ponds are located on very exposed rocky shores. Check water temperature and salinity; the optimal ranges for best abalone growth are 24-30°C and 30-35 ppt.



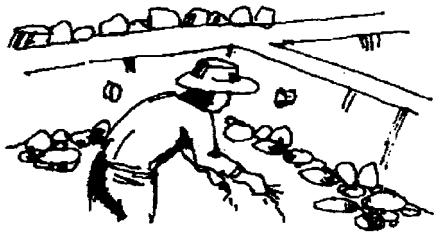
2 CONSTRUCT abalone ponds in the intertidal zone (above the low tide mark). Pond size ranges 0.1 to 0.5 ha depending on topography, available area, and investment.

Most abalone ponds have concrete offshore walls wider than 1.5 m to prevent damage from typhoon and monsoon waves. Several 300-cm plastic pipes are installed in the dikes so that incoming waves carry seawater into the pond and "used" pondwater is driven out the other end. This provides good circulation that clears away food residues and toxic substances. The pipes also regulate water level.

The pond bottom is concrete with cut rocks and oval stones neatly placed to serve as shelters for the abalone.

Some ponds may be situated onshore (at some distance from the sea). But pumps are needed to deliver clean seawater which can be expensive. Fluctuation in water temperature is extreme. Cage farming is another option, and is being studied at AQD (see page 18, this issue).

3 MAKE SURE the ponds are clean before stocking abalone juveniles. Get rid of clay sediment, fouling organisms, predators, and toxic substances.



4 STOCK abalone juveniles that are 15 mm or longer taken from the hatchery or stock sub-adults caught from the wild. (See also *Abalone R&D at AQD,* pages 18-23.) Stocking density is generally 150 to 250 per m^2. Note that very high stocking densities (500 per m^2) cause slow growth and poor survival. It takes 6 months for juveniles to reach a market size of 6 cm shell length if stocked at 400 per m^2 but only 4 months if stocked at 200 per m^2.

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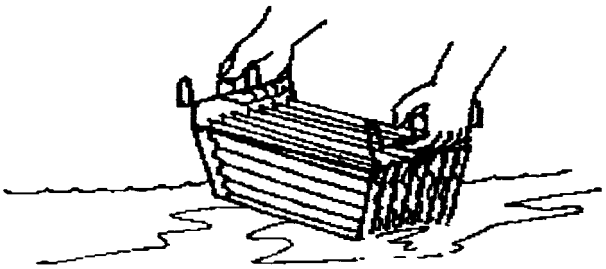

Juveniles and sub-adults may be cultured together to maximize the pond carrying capacity or pond space. The sub-adults are harvested when the juveniles need extra rearing space.

5 TAKE CARE of the abalone stock by feeding them, cleaning the pond bottom every two months, monitoring constantly and preventing predation or diseases.

For feed, *Gracilaria* sp. is the only algae abalone farmers find convenient to use. It can be purchased cheaply in bulk. Other seaweed like *Ulva* are harvested only during summer and harvest is often tedious and time-consuming.

Feed *Gracilaria* to abalone every other day by scattering it evenly in the pond. While feeding, remove the crabs hiding in the fronds to avoid predation.

Feed conversion for *Gracilaria* is quite poor, about 12:1, but this rate still satisfies farmers because feed cost is at most 8% of the market price of abalone.

The growth rate of small abalone in ponds depends on their initial size with small abalone growing faster than large abalone. For 13- and 45-mm abalone, shell growth after 6 months is 223% and 34% respectively. Small abalone grow fastest in the warmer months of April to September; slower growth occurs from October to March.

Infectious and epidemic diseases are not yet serious problems. Abalone are very hardy. Possible pathogens include *Vibrio, Pseudomonas, Flavobacterium,* and *Achromobacter,* these are endemic to shore waters. *Vibrio parahaemolyticus* has been reported to cause the death of *Haliotis discus hannai.*

Abalone would mostly die of the combined effects of stress, mantle injury when removed from the surfaces they are attached to, and lack of oxygen during air shipment. Mortality occurs often right after stocking.

About 50% of juvenile abalone have split shells. These abalone grow much slower than normal ones, reaching only 2 cm when the latter are already 5 cm. These are also vulnerable to predation. Although researchers have yet to determine exactly how or why split shells occur, they think carelessly brushing off abalone juveniles from its attachment injures the mantle. High temperatures during induced spawning and high concentrations of toxic substances in the pond may contribute. But these small splits can be healed after 2 months if rearing conditions are improved but not for large splits.

Researchers suggested the addition of calcium carbonate to speed up shell formation when they noted that split-shell abalone have lower concentrations of

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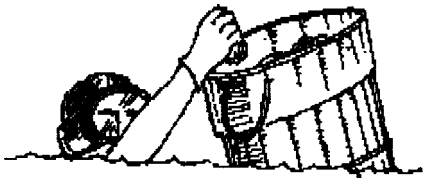
calcium in the shell than normal abalone. The use of anaesthetics or thermal shock when removing or transferring juveniles may help prevent injury.

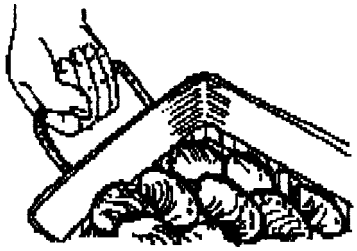
6 HARVEST abalone 4 months after stocking (for wild subadults) or after 6 months (for hatchery-produced juveniles). Ponds are either emptied or the abalone farmer goes SCUBA diving in large ponds. A diver can collect around 50 kg in 2 hours.



Survival of abalone depends on stocking density, size at stocking and pond management, but this is usually more than 70%.

Yield is usually 4.0 kg per m^2 of abalone sized 20-30 g each. However, market size varies depending on preference and season but it is usually larger than 4 cm. Farm-gate prices fluctuate all the time depending on supply and spawning season, ranging from US$30 to $40 per kg live weight. The larger the animal, the cheaper the unit price.

The annual rate of return on investment ranges 50% to 160% depending on survival, duration of operation, investment cost, and sale price. - **MTC**



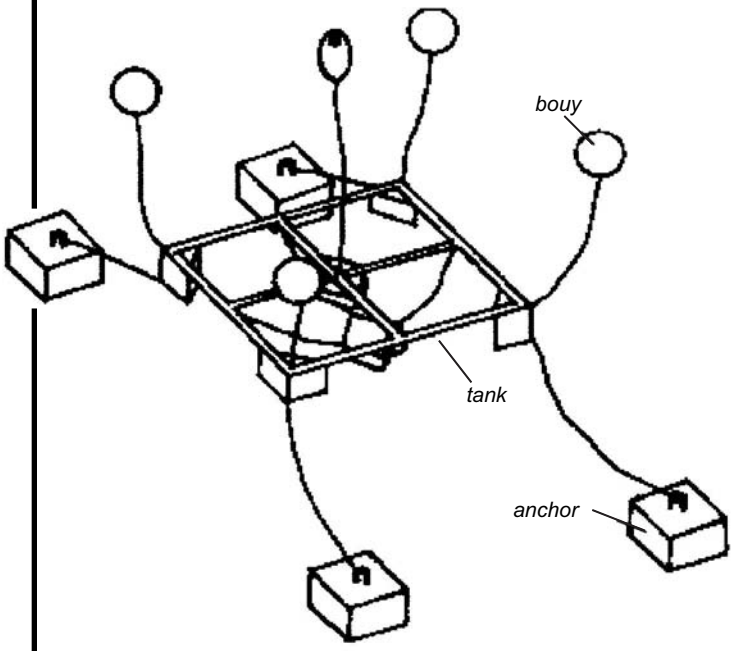
REFERENCES

[1]P Jarayabhand and N Paphavasit. 1996. *A review of the culture of tropical abalone with special reference to Thailand.* **Aquaculture** 140: 159-168.

[2]H-C Chen. 1989. Farming the small abalone, *Haliotis diversicolor supertexta,* in Taiwan. In: KO Hahn (ed). Handbook of culture of abalone and other marine gastropods. CRC Press, Boca Raton, FL. p. 265-283.

Grow abalone spats in submersible tanks

Below is a submersible tank designed by Gil Su Yoon of the Department of Ocean Engineering of the National Fisheries University of Pusan, Korea. It is ideal for raising abalone spats to 20-30 mm shell length -- also called mid-term nursing of abalone -- in the open sea. The submersible tank is easy and safe to operate, and the cost of operation is low. However, construction is expensive, but Yoon notes that the submersible tank can be modified to reduce costs.



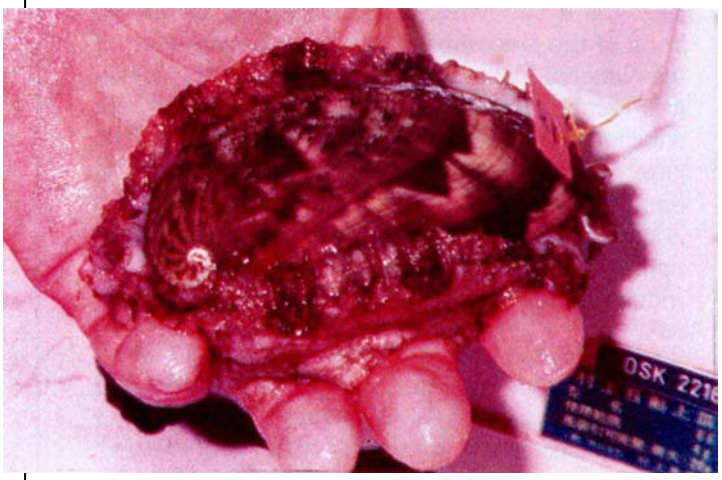
The design measures 10×10×1 m, and can be installed at 30 m depth. It can withstand 3-m waves coming every 8.5 sec and strong currents. - **MTC**

REFERENCE

Gil Su Yoon. 1995. *A preliminary study of a submersible facility for abalone spats.* **J. Korean Fish. Soc.** 28 (4): 435-442.

Abalone R&D at AQD

By **M Castaños**



Haliotis asinina

"A major factor limiting the expansion of abalone cultivation in temperate countries is the ready and economic availability of suitable algal rations," explains Emmanuel 'Manny' Capinpin, a researcher spearheading the abalone culture effort at AQD. Abalone feed on seaweed.

"There is also the environmental considerations in harvesting large quantities of macroalgae," Manny says. "In the Philippines, however, cultured seaweed is available and may be used to feed abalone. *Gracilariopsis heteroclada* has a high protein content, promotes fast growth, and can maintain growth of *Haliotis asinina* over extended periods. Moreover, this alga is abundant, farmed in drainage canals and brackishwater ponds, and available year-round."

"In other countries, better growth of abalone was observed when using mixed algal diets but in the Philippines, using a single-species algal diet is sufficient," Manny further explains. He emphasized that suitable diet is important to the success of abalone culture. Abalone grow slowly, about 2-3 cm per year. Growth is also very heterogenous (abalone seldom grow at the same rate). It all depends on the kind of food abalone eat.

"For now, farms must rely on cultured seaweeds," he says, "and there are already a number of studies done on the culture of *G. heteroclada."* But he hopes this dependence won't last long. Researchers around the world are trying to develop cost-effective artificial diets (see related article on page 24).

In addition to food quality, it is also important for farmers to use the right culture system design. Grow-out culture starts with 1.5 cm abalone. Culture systems vary, from intertidal ponds (see page 15, this issue) to land-based tanks and hanging net cages and barrels. "Farmers must be aware that an ideal culture system is one that promotes an even distribution of abalone, ready access to feed, minimum contact among abalone and feed with fecal wastes, good waterflowand exchange," Manny elaborates. "And minimum human intervention, too."

AQD is working on the abalone species with the highest aquaculture potential in the Philippines. *Haliotis asinina* was chosen because of its large size and body weight. So far, AQD researchers were able to spawn the donkey's ear abalone artificially, and raised the spats in the hatchery. Cage culture trials are underway. An artificial diet study has also been initiated by Myrna Teruel and Oseni Millamena. Researchers will also study the efficient mass culture of diatoms for larval feed in addition to settlement and survival patterns of abalone larvae.

AQD research results on abalone are presented below:

REPRODUCTIVE BIOLOGY

AQD researchers have studied reproductive biology (gonad histology, gonad indices, sex ratio, spawning period and fecundity, time interval between successive spawnings and minimum size at sexual maturity).

"Abalone may spawn throughout the year," Manny and his colleagues report. They collected their aba-

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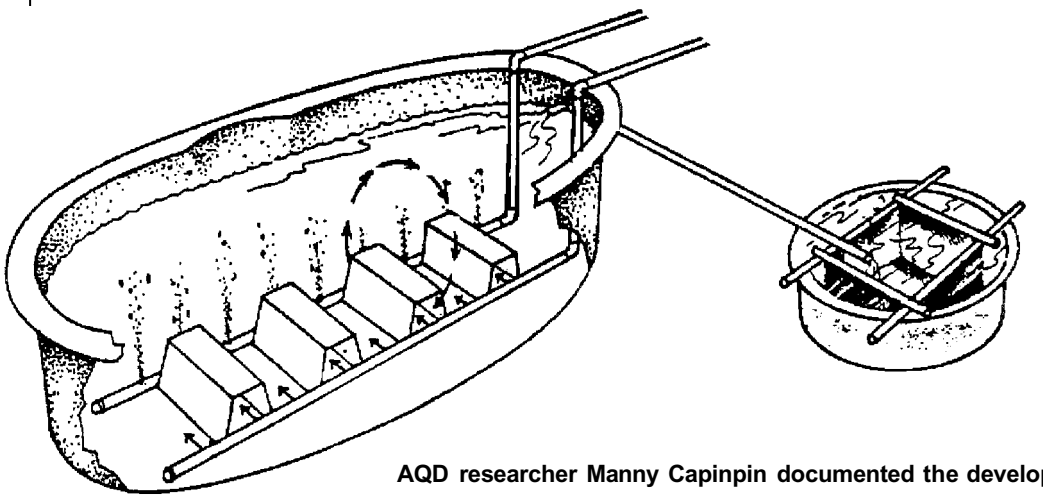
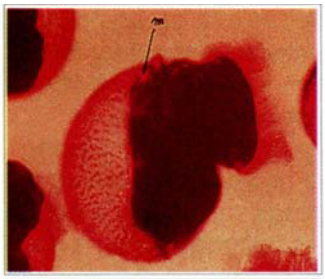


This is the 1 -ton oval fiberglass broodstock conditioning tank at AQD. This set-up is similar to the set-up at the Oyster Research Institute in Japan. It has artificial shelters, well-circulated water, and a device for harvesting newly hatched larvae.

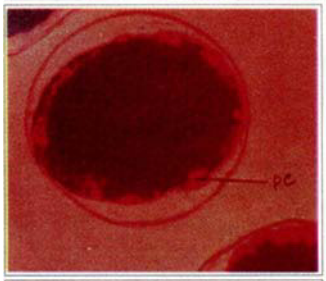
AQD researcher Manny Capinpin documented the development of *Haliotis asinina* larvae

fertilized egg 180 μm



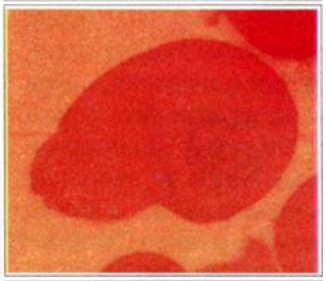
veliger larva before torsion of foot mass (m, mantle)

trocophore before hatch-out



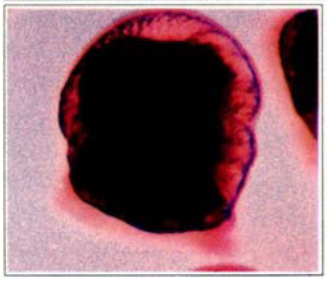
veliger larva ready for settlement

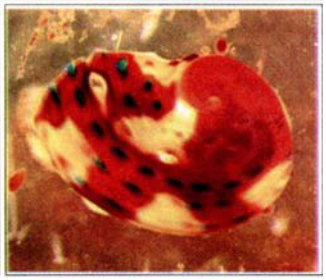
trocophore after hatch-out



creeping larva

trocophore showing larval shell secretion





juvenile with first respiratory pore

lone samples from shallow coral reefs in Panagatan Cays off Antique in west central Philippines.

They calculated gonad bulk indices and made histological cross-sections. They found that gonads of both male and female abalone become ripe in January. Abalone spawn from February to May, become spent in June to July (specimens collected were at resting stage) but rematured after that.

The smallest individual from the wild with a mature gonad is about 40 mm shell length. Hatchery reared abalone reach maturity at about 35 mm.

The sex ratio of abalone Manny and his colleagues collected from Panagatan is approximately 1:1.

"Abalone is a partial spawner with an asynchronous spawning behavior," the researchers noted. Ripe females measuring 58-70 mm shell length release about 150,000 to 600,000 eggs per spawning.

Manny also compared the reproductive performance of wild-caught and hatchery-reared abalone broodstock. Multiple spawnings occur when both groups were induced to spawn by totally draining the tank and replacing water after 45 minutes of desiccation. But wild-caught female broodstock spawn more frequently and produce more eggs than hatchery-bred broodstock. Hatchery-reared abalone have short time intervals between successive spawnings of 13-15 days.

INDUCED SPAWNING

Manny and JICA Expert Masahiro 'Mike' Hosoya noted the spawning of the abalone in the laboratory. "The abalone spontaneously spawned several days before or during the new moon and full moon," they report. "Natural spawnings seem regular, at least every two weeks following a lunar cycle. *Haliotis asinina* is known to spawn year-round with a monthly peak in October." Their broodstock (10 males and 35 females) had shell lengths ranging from 54 to 108 mm and weights ranging from 35 to 187 grams.

As a general rule, males spawn slightly earlier than the females. Abalone spawn from about 10 PM to 3 AM.

The broodstock conditioning tank at AQD is a 1-ton oval fiberglass tank (see diagram previous page). "This set-up is similar to what the Oyster Research Institute in Japan is using," Mike says. "It has artificial shelters, well-circulated water, and a device for harvesting newly hatched larvae called trocophores." The adult abalone were fed *Gracilariopsis heteroclada* ad libitum. Spawning occurred at 28-30°C and 30-32 ppt. The researchers then tracked the developing larvae (see photos, previous page).

"Our success in spawning *H. asinina* in captivity supports the strong potential of donkey-ear abalone as an aquaculture species," Manny explains, "however, more studies should be focused on laboratory-controlled conditioning (maturation) and the factors that trigger spawning. Farmers in other countries have experienced considerable mortalities up to 90-95% in the first few weeks after settlement. We observed the same at AQD, and will focus future studies on environmental and nutritional requirements of newly-settled abalone larvae."

With JICA Expert Hosoya, Manny also tried desiccation, thermal shock, ultraviolet irradiation of the seawater, and hydrogen peroxide treatment to induce abalone to spawn. This was supposed to make it easier for abalone to spawn year-round in captivity.

"We were successful only in one occasion when milt from a single male induced three females to spawn," Manny says. "The release of gametes from an abalone can induce or trigger spawning of conspecifics. We were unsuccessful because we failed to recognize ripe specimens at that time. But we can easily recognize these now and place them in separate containers. There is no need to induce them because abalone spawn naturally."

A male and a female are usually placed in one tank. Sperm density is critical to successful fertilization. "High sperm density during fertilization causes lysis of the vitelline layer of the eggs which render the eggs unviable," Manny explains. "If these eggs do hatch, there is a high percentage of abnormal trocophores." But sometimes, the eggs are unfertilized because of very low sperm concentration or the delay of the male to spawn. This phenomenon of polyspermy in abalone is well-known.

The option is separating ripe male and female abalone, and fertilizing the eggs artificially. But further basic research is needed, particularly on the factors that control maturation and spawning.

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RAISING ABALONE IN THE HATCHERY

When Manny obtained 3-month old abalone juveniles, he collaborated with AQD researcher Kaylin Corre to determine the growth rate of donkey's ear abalone if fed an artificial diet (produced by a company, Nihon Nosan Kogyo, in Japan) and cultured red seaweeds *Gracilariopsis heteroclada* and *Kappaphycus alvarezii.*

The researchers do not worry about using *G. heteroclada* and *K. alvarezii* because AQD has already very good technologies for propagating them. Farmers even raise *heteroclada* in drainage canals.

The researchers initially fed diatoms (*Navicula* and *Nitzschia*) to the abalone, and then the red seaweed after the abalone reach 10 mm in shell length. They experimented on 180 juveniles having weights of 0.48 ± 0.01 g and shell lengths of 14.52 ± 0.12 mm. The artificial diet was given to abalone at 5% body weight which was later adjusted according to consumption. Seaweed were given *ad libitum.*

"In our experiment, we stocked 20 abalone juveniles in one plastic tray (about 5 x 20 x 24 cm). The tray is perforated and enclosed in a net," Manny elaborates. "Each tray has PVC pipes as shelters, and the trays were suspended in a 1 ton oval fiberglass tank. We cleaned the tank every 2 days." The researchers maintained water flow at 300-350 liters per hour, and gently aerated the tank. Temperature was about 28-31°C, salinity 28-32 ppt.

The experiment lasted for 4 months. "The abalone fed the artificial diet and *G. heteroclada* grew faster than the abalone fed *K. alvarezii,"* Manny reports. "This did not surprise us because *alvarezii* had the lowest protein and fat content (see table above)."

"Between *G. heteroclada* and the artificial diet, the seaweed win hands down," Manny says, consulting the table on growth rates shown below. "Although it might appear that abalone grow better with artificial diets in the first 90 days, *heteroclada* still give long-term growth gains."

"Growth (in terms of shell length) slowed down after 90 days probably because the abalone were maturing then," Manny explains. "Abalone might have channelled more of its energy towards reproduction. We found that all juveniles fed artificial diet and *heteroclada* were sexually mature at the end of the experiment, but not juveniles fed *alvarezii."*

There were also shell color differences in the abalone. Those fed artificial diet have light bluish green shells, those fed the red seaweed have brown shells. The artificial diet probably contained brown algae.

Survival of abalone fed the three diets range 98-100% after 4 months.

Although their experiment ended at 120 days, Manny and Kaylin continued to monitor the growth of abalone fed *heteroclada* up to 1 year. *H. asinina* fed solely *G. heteroclada* grew well, reaching a mean of 24 g and 46 mm during its first year of growth. This is considerably faster than the 43 mm reported for the same species in Thailand. "In other countries, there is no need to feed abalone with a variety of algae to meet the preferences and nutritional requirements of cultured abalone over extended periods," Manny explains. "G. *heteroclada* can promote good growth over extended periods."

Proximate composition of the abalone diets (in %)

	Artificial diet	Seaweed	
		Gh	Ka
Crude protein	32.40%	17.32	5.35
Crude fat	3.74	1.70	1.23
Crude fiber	5.04	4.79	4.38
Nitrogen-free extract	41.99	54.45	70.08
Ash	16.83	4.74	18.96
Moisture	7.50	3.54	9.10

Gh, *Gracilariopsis heteroclada;* Ka, *Kappaphycus alvarezii*

Average daily growth of the abalone *Haliotis asinina fed* three diets

Diet	Weight (mg per day)		Shell length (μm per day)	
	0-90 days	90-120 days	0-90 days	90-120 days
Artificial diet	73.8	66.0	191.8	81.7
G. heteroclada	67.1	112.7	192.9	133.3
K. alvarezii	9.2	9.3	59.4	52.7

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CAGE CULTURE TRIALS

Manny is testing the use of hanging net cages or barrels in the grow-out culture of donkey-ear abalone. He thinks this is the more viable alternative for tropical abalone considering the lengthy culture.

He determined the effect of different stocking densities on the growth rate, feed conversion, and survival of the donkey-ear abalone. Although the details will be published in a scientific journal, Manny shared his results.

"We have conducted three trials. The first two trials used 15-20 mm juveniles, the third used 35-40 mm juveniles," Manny explains. "We know that the hatchery reared donkey-ear abalone reach maturity at about 35 mm, hence, we assume that 16-20 mm abalone have not reached maturity yet." These abalone will use the energy from its food intake to somatic (or muscle) growth and not for reproductive growth. Although Manny expects that mature abalone has a lower growth rate following sexual maturity, he wants to know this for sure.

"We would like to determine the growth characteristics of the two size groups and to find out the growth of abalone following sexual maturity," Manny says.

The net cages used in the experiment measure 40 x 40 x 20 cm and are made of PVC pipes fitted together and covered with nets. Two pieces of PVC gutter were placed inside as shelters. The cages were suspended about 1.5 m below the sea surface (see photos).

Preliminary results clearly showed that growth rate of abalone decreased as stocking density increased. "The results conform with many others concerning the inverse relationship between growth and stocking density in shellfish culture," Manny explains. "The high density in the cage makes it difficult for abalone at the bottom of the stack to move and reach the food. This restricts the feeding rates so that food availability becomes a limiting factor even though enough food was given. " The results of the study

Growth rate, feed conversion, and survival rate of two size groups of abalone cultured for 150 days in cages (mean of three replicates).

Size group	Stocking density (no./cage)	Growth rate		Feed conversion rate	Survival rate (%)
		Weight: mg per day	Length: μm per day		
15-20 mm	45	140	160	14	96
	90	113	149	14	95
	135	91	134	16	93
	180	87	124		92
35-40 mm	17	280	132	18	98
	35	225	117	17	98
	52	196	108	21	94
	70	168	89	21	94

AQD is conducting studies on the cage culture of the abalone Haliotis asinina *at its Igang Marine Substation in Guimaras Island. Another study on the use of barrels for grow-out culture is on-going. Results are promising.*

also confirm that feeding rates are higher at lower stocking densities.

The rapidly growing small juveniles measuring 16-20 mm have feeding rates of 35-40% body weight. Feeding rate decreased to about 5-10% with bigger abalone weighing more than 50 mm. Growth and survival were higher at lower stocking densities (table on page 22).

"The increased tendency of abalone to stack at higher densities due to lack of primary surface restricts movement of animals in search of food," Manny notes. "We can conclude that food limitation is one of the main factors affecting growth at higher densities."

Another factor may be the rate of water flow. The abalone were fed weekly in the study, and the cages stocked at higher densities naturally receive more loads of feeds which in turn restricts water movement.

"Water movement stimulates feeding behavior and therefore growth of abalone," Manny explains. "The design of the grow-out system should provide good water flow to stimulate abalone to feed at a higher rate. I believe that the net cage is a good design because water can flow from any direction and has a high surface-to-volume ratio."

Abalone grown in cages can reach marketable size of about 50 g body weight or 60 mm shell-length in one year. This is a shorter period compared to temperate countries where abalone grows at a rate of 2-3 cm per year and reaches market size in 3-5 years.

"This study shows the potential of abalone farming in the Philippines," Manny concludes.

SOME OF THE ABALONE RESEARCH STUDIES HAVE BEEN PUBLISHED

EC Capinpin Jr and KG Corre. 1996. *Growth rate of the Philippine abalone,* Haliotis asinina *fed an artificial diet and macroalgae.* **Aquaculture** 144: 81-89.

EC Capinpin and M Hosoya. 1995. *Spawning and larval development of a tropical abalone* Haliotis asinina *(Linne).* **The Philippine Journal of Science** 124 (3): 215-232.

Artificial diet development

[The following is based on a review paper entitled *The development of artificial diets for abalone* by AE Fleming, RJ van Barneveld and PW Hone that was published in **Aquaculture** 140 (1996): 5-53. Our writer **Eva Aldon** has simplified the presentation and deleted the citations. Full references can be found in the original paper. - *Ed.*]

The search for artificial diet for abalone aquaculture started some 30 years ago, and has intensified in recent years. To date, 28 research groups from around the world are trying to develop artificial diets. Japan has six such groups, including Nihon Nosan Kogyo KK which is probably the world's leading feed company. [The company sold 300 tons of abalone artificial feeds in 1993.] Australia and China have four research groups each; the United States, three; New Zealand, two; South Africa, three; Canada, Mexico, France, Korea, Thailand, Ireland, one each. The Philippines and Taiwan -- both with commercial fishery and taking fledgling steps towards establishing abalone aquaculture - do not have any yet. The studies at AQD, for instance, are still focused on induced spawning and larval rearing although cage farming studies have been initiated. A lone study on artificial feeds and feeding is being conducted by AQD scientists Myrna Teruel and Oseni Millamena. Abalone is just one of the 20 or so commodities prioritized for research at AQD from 1998 to year 2000.

Existing artificial diets

The artificial abalone diets in the market are similar in their proximate composition, as can be seen below:

	Range	*Average*
Protein	20-50%	30%
Carbohydrate	30-60%	47%
Lipid	1.5-5.3%	4%
Crude fiber	0-3%	
Moisture	-	12%

The capacity for abalone to digest fiber is limited. The growth of *Haliotis discus hannai* decreased as cellulose content of the diet was increased from 0 to 20%. This suggests that abalone have a poor ability to digest cellulose, despite the presence of cellulases in the gut. Some artificial diets contain fiber for binding purposes, hence the level of fiber can be as much as 6% of dry weight.

Protein sources and optimal inclusion levels

To meet the protein needs of abalone is to establish specific amino acid requirements, the most appropriate balance of dietary amino acids, and the availability of amino acids from a range of protein sources.

It was reported that incorporating fishmeal to formulate diets containing 27 and 32% crude protein produced a similar monthly growth rate of 32% of body weight. A variety of protein sources (with 30% protein content) was tested for 3-5 g abalone at 20°C.

The most commonly used protein sources in abalone diets are fishmeal, defatted soybean meal and casein. Fishmeal, however, is used extensively in aquaculture feeds, hence the high demand worldwide. But there's been a worldwide decline of fishmeal production which may increase cost. It should be noted that diets containing high levels of fishmeal are detrimental to the environment because they contain excessive amounts of phosphorus. Soybean is a potential replacement to fishmeal because its amino acid profile is close to that of fish, and its protein is highly digestible.

Mackerel silage and abalone viscera silage are cheap protein sources and reportedly gave good growth rates with a diet consisting of 20% silage, 16.8% fishmeal and 10% soybean meal. Abalone viscera silage is also a potential to enhance digestion.

All essential amino acids are available in a synthetic form and are important for supplementation in the diet. Protein quality may be improved by matching the amounts of amino acids in the diet with those in the body. The diet with DL-methionine was formulated

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using the amino acid ratios in the body rather the absolute values.

Energy / carbohydrate sources

Abalone consume a natural diet consisting of 40-50% carbohydrate and have various enzymes capable of hydrolysing complex carbohydrates. Cheap cereal sources, such as wheat and corn flour, soybean meal, maize or rice starch are frequently used as an energy source. Starches can be both an energy source and a binder in many commercial abalone feeds. The metabolic rate of abalone is low, hence, energy is also low. The energy content of feeds exceeding the requirement for tissue synthesis may be converted into glycogen. Excessive energy in the diet may lead to poor utilization of the protein which reduces feeding thus energy is wasted.

Vitamins and minerals

The requirement by abalone for vitamins and minerals were based on the requirements for carp and rainbow trout. The optimum level of the mineral mix in the diet was determined by adding graded levels between 0 and 16% into a test diet and gave a maximum growth at 8% and later 4% to improve solubility of the pellets. The effect of adding Ca and P to artificial diets was also investigated. Vitamin C is an important component of the diet.

Feed stimulants and attractants

Feed stimulants such as algae and seaweeds are added to the diet to enhance food intake and growth rate but reportedly has no effect in consumption. Abalone consumed more when supplemented with Taremel A40 while using dried kelp in diets was found unnecessary. Fishmeal is found to be more palatable than a casein diet. The leaching of soluble proteins and free amino acids from abalone viscera and fish silage attracts abalone to the feed but this was not an effective stimulant like soybean, fishmeal and kelp meals.

Palatable dietary ingredients added to the diet to enhance intake is a practical and economically viable option. Fishmeal, added as a protein source, was found to enhance intake more than a casein diet. A combination of ingredients with attraction and palatibility will improve the acceptability of the feed.

There are extensive studies on the feeding attractants of *Haliotis discus:* algae, chemical fractions extracted from algae, whole proteins, nucleic acid-related compounds, amino acids and peptides and combinations of amino acids. Combinations of some non-volatile nitrogenous bases, amino acids (as peptides) and proteins are generally more effective and attractive to abalone than when present individually. The acrid spices are potential for artificial diets as they are may be an attractant and stimulant in addition to having antiseptic properties.

Practical feed stimulants or attractants for artificial feeds may be readily identified by using feed ingredients containing high concentrations of the amino acid and fatty acid group of compounds.

Binders

Aquatic animal feeds require a binder to keep the feed intact for at least 2 days in water. Being crucial to the development of a successful feed for abalone, binders in artificial feeds are the most guarded of information and are often patented.

The majority of commercial companies use starches and gluten for binders. Although gels are frequently used to bind experimental diets, they are not considered economically viable for commercial feeds. Water solubility of a mixture of alginates and flours (rice starch, sodium alginate and gelatin) as binders were compared. A binding technique using starches and alginates was developed in Australia.

Feed stability of existing artificial diets

Pellet stability refers to the stability of the binder when immersed in seawater and is dependent on the binding ingredients, particle size and manufacturing process. The average stability of abalone feeds is about 2-3 days. A combination of agar and gelatin (1:3) forming 20% of the diet improved the stability of the feed so that only 20% was lost after 6 hours and 30% after 24 h. Further manipulations of these ratios and concentrations in the diet may improve water stability while lowering cost.

Feed stability should be tested in conditions that simulate commercial temperature, aeration and flow regimes.

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Leaching of nutrients and microencapsulation

Leaching is the loss of nutrients from the feed against the loss or breaking up of the binders which may occur without a change in feed weight. Leaching, recognized as a problem by feed formulators, can be controlled by microencapsulation, the binding technique, and heat treatment during manufacture process. Microencapsulation is a technique of enclosing dietary nutrients within a digestible capsule wall to reduce leaching and bacterial degradation. The capacity of abalone to digest the cellulose coating depends on the species.

Feed decomposition

The use of artificial feeds in culture systems causes feed decomposition and the subsequent deterioration of the water quality. Decomposition may be due to the susceptibility of the meal protein to bacterial attack or oxidation of the lipids in the meal. Inclusion of natural antiseptic substances may slow the rate of decomposition.

Feed availability in the culture system

The farmers are more concerned with accessibility of feed to animals in the tanks than nutritive quality and recognized that tank design is important to achieve feed availability and water quality. Ideally a feed should meet the following requirements:

- that the amount of uneaten feed is minimized
- that uneaten feed does not pollute the tank
- that animals are feeding to satiation
- that animals do not expend significant amounts of energy searching for feed
- that feed and faeces do not occur in the same place in the tank

Artificial feeds are buoyant to simulate the algae in the culture tank. Not all abalone will readily search for food each night hence heavier material is used during the day and lighter material at night.

Abalone performance when fed artificial diets

Intake is the product of feeding rate and duration of feeding and is different from the rate of feeding. Temperature and the light regime show a relationship between intake and the duration of darkness. The required amount of feed added to the tank to maximize growth rate is approximately twice the daily intake.

The quantity of food the abalone consumes each day varies depending on their metabolic liveweight. The amount of energy in artificial feeds is extremely high compared with the daily energy requirements of abalone, thus, abalone may cease feeding before they have consumed adequate quantities of nutrients.

Growth rate

It is difficult to compare the growth performance of abalone on various diets as abalone species differ in their capacity for growth. If a diet is deficient in a nutrient, the growth rate may decrease or cease after the abalone have exhausted its own stores.

Ideally, the temperature should be kept constant during trials or temperature data should be reported with the growth rate to determine if temperature is a factor.

Nutrient requirements of abalone for use in the formulation of artificial diets

The artificial diet of abalone should match its diet requirement for maximum efficiency and profit and minimum ecological impact. The artificial diets in the market can still be improved in terms of formulation and efficiency.

The difficulties in determining the nutrient requirements of abalone include:

- maintaining an experimental diet underwater with minimal nutrient loss
- difficulty associated with measuring slow growth rates
- the long duration of experiments
- absorption of nutrients by abalone from the aquatic environment
- maintenance of a constant experimental environment

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The first consideration when formulating feeds is to ensure that the essential amino acids and energy are supplied in sufficient quantities and proportions to meet the requirements of the animal.

Response of abalone to protein and energy intake

The first consideration when formulating feeds is to ensure that the essential amino acids and energy are supplied in sufficient quantities. Both amino acids and energy are closely interlinked in growth and development. If there is insufficient energy, the surplus amino acids (they cannot be stored) are wasted. If there is insufficient amino acid relative to energy, then the development of lean tissue is restricted. No work has yet been done to determine the optimum ratio of amino acids to energy in diets for abalone. The most valuable information in relation to the protein and energy requirements of abalone could be met by investigating the interactive effects of protein and energy intakes on protein deposition and the relationship between energy intake and protein deposition to establish a protein:energy ratio for use in diet formulations.

There are three areas that affect protein utilization:

- the quantity or proportion of dietary protein
- the quality or amino acid make-up of the dietary protein
- the ability of the abalone to utilize non-protein dietary components as energy sources

Utilizing non-protein sources is being studied in terms of absorption, storage and expenditures of energy in abalone diets with different ratios of protein, lipid and carbohydrates.

Amino acid requirements

Proteins are complex compounds of mixtures of amino acids forming various proteins in the muscles, organs, and secretions such as enzymes and hormones.

Further research is needed to establish specific amino acid requirements, the most appropriate balance of dietary amino acids, and the availability of amino acids from a range of protein sources. Most protein contain 19 or more amino acids, of which nine are essential and must be supplied in the diet.

Ideal protein ratio

A knowledge of amino acid requirements could improve the efficiency of protein use in artificial abalone diets. The concentration of amino acids in the soft tissue of abalone could indicate the balance of amino acids required in the diet.

Lysine may be the major limiting amino acid in abalone when fed a cereal-based diet.

Energy requirements

Meeting the energy requirements of abalone includes these considerations: (1) the system should be precise and simple to apply; (2) the values should be additive; and (3) the values of the feed can be easily estimated. Energy requirement is dependent on temperature and body weight.

Lipid requirements

The lipids are heterogenous group of compounds important to the diet because of their high energy value and because they are sources of essential fatty acids and fat-soluble vitamins. Fatty acids of abalone are significantly different from other animals due to differences in diet composition. The abalone's lipid requirement is very low although the abalone is highly efficient in utilizing lipid.

Vitamin and mineral requirements

There are a few studies on vitamin requirements of abalone. Digestive bacteria may significantly contribute to the vitamin nutrition of abalone implying oversupply of these nutrients.

The requirements of the juveniles

The capacity of juvenile abalone to digest various nutrients may vary according to age and size. There may be nutritional differences between juvenile and adult abalone although no comparative investigations have been done. Juveniles generally require more pro-

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Markets, opportunities

The Abalone Farm, Inc. or AFI is a big player in the abalone market, very much like Shemberg's preeminent position in the seaweeds industry in the Philippines. AFI entered the abalone market in 1982, and has since successfully marketed at least six abalone products (see tables next page). In 1993, AFI distributed cultured abalone worth US$2 million into the US, Canadian, Japanese, Hong Kong, and New Zealand markets. This value is roughly equivalent to what the whole of the Philippines exported in 1991.

The fishery statistics for abalone export-import worldwide are not well-organized into a format coherent to the industry, reports AFI's Frank Oakes. Below are the major consuming markets based on AFI's experience.

-MTC/APS

CHINA

Canned abalone

Mainland China is the largest consumer nation for abalone. Its consumption is almost entirely in the canned form which is not considered premium product in the Japanese and US markets.

The Chinese consider canned abalone as a item of prestige, often presented as a show of affluence or demonstration of respect. It is customary in banquets and feasts.

The strong traditions surrounding abalone consumption have created a stratified market," notes Frank Oakes, "and this is based on perception of the quality of brands and originating countries." At the top of the market is Mexico's CalMex brand (H. fulgens) and the South African abalone (H. midae). At the low end is the New Zealand Black Foot (H. iris). Prices of off-brands depend on the market's top brands.

The Chinese market is very compressed," reports Oakes, "with the premium canned prices limited by the buying power of the elite."

China has a commercial fishery, importing 800-1,200 tons annually to the US.

JAPAN

Premium-quality

Japan is the largest consumer of premium-quality abalone (live, fresh and frozen). But annual consumption has declined from 12,000 tons (1980-1990) to about 6,000 tons (1992). Still, interested abalone farmers can still learn about the premium abalone market from Japanese consumers.

US, Europe

Abalone steak

The traditional market is California where a commercial fishery exists until the early 1970s. It is primarily expensive, white tablecloth restaurants. Abalone meat is removed from the shell and sliced into steaks which are quite popular.

"AFI entered the market in the 1980s with abalone fillets prepared from 7.5 cm cultured abalone (H. rufescens)," Frank Oakes reports. "With the growing number of (Asian-Americans), demand has increased." This includes fresh abalone meat for sushi. Live cultured abalone also have a brisk market.

Europe is not yet a major market. Present demand arises from the traditional fishery for H. tuberculata. "The market is concentrated in France," notes Oakes, "but there is demand in the United Kingdom and the rest of Europe." The market is undersupplied and could be developed. The European abalone species are small (100 g) and aquaculturists can easily produce small abalones. Europe is a good region for future market expansion.

To these consumers, appearance is as important as taste and texture. The most prized is the black abalone, ezo awabi or Haliotis discus hannai, which is one of the eight species native to Japan and is harvested from the Ezo Prefecture. (The native fishery is historically significant and highly valued as a cultural resource.) The cultural preference is so strong that smaller abalones, like H. diversicolor supertexta or tokobushi, carry a connotation of inferiority and sell at a large discount into weak and erratic markets.

But abalone farmers shouldn't despair. Abalone species that compare favorably in appearance and taste with ezo awabi can command premium prices, too. "AFI (was able to) provide a live abalone for the premium market at US$32 per kg," reports Frank Oakes. The abalone are of more uniform size and cost lower per piece. It had reached the high-margin niches such as resort hotels and competed well with ezo awabi.

SOUTHEAST ASIA

Small abalone

The Hong Kong market is the largest and most established. (Hong Kong acts as a gateway to the mainland Chinese market.) Lucrative markets also exist in Taiwan, Singapore, Thailand, and other metropolitan centers.

"As Asian affluence increases, these markets will become more important," Frank Oakes notes. "The influence of China and southeast Asia will be significant in determining the location and product concepts best suited for future production sites."

next page

The **Abalone Farm, Inc.** PO Box 136, Cayucos, CA 93430 USA. Call Frank Oakes tel. (805) 995-2495, fax (805) 995-0236

REFERENCE

FR Oakes and RD Ponte. 1996. *The abalone market: opportunities for cultured abalone.* **Aquaculture** 140: 187-195.

Supply and price structure of major abalone-producing countries [estimated by F Oakes, Aquaculture 140 (1996): 187-195]. Roughly 80% of these abalone products are consumed by Japan, China, and some southeast Asian countries. The rest go to the US, Mexico, Europe, and Korea.

	Species	Yearly supply(tons)[1]	1993 price (US$ per ton)[2]
Japan	*Haliotis discus* *H. discus hannai*	4,000	66,000
Hong Kong	*H. diversicolor diversicolor* *H. diversicolor supertexta*	567	22,200
USA	*H. rufescens* *H. carcharoides* *H. sorenseni* *H. fulgens*	350	25,000
Mexico	*H. fulgens* *H. rufescens* *H. cracherodii*	2,000	24,000
South Africa	*H. midae*	600	25,000
Australia	*H. laevigata* *H. ruber* *H. roei*	6,300	21,850

[1]Whole body including shell. [2]Calculated as: Live weight (LW_l) × 0.38, meat weight; LW_t × 0.28, steak weight; LW_t × 0.34, canned weight; 1 can = 750 g LW_t. US$1 = Mex ₱3.1 = AUS$7.7 = HK$7.7 = ¥135

Products derived from *Haliotis rufescens* cultured at The Abalone Farm, Inc. and their target markets [by F Oakes, **Aquaculture** 140 (1996): 187-195]

Product	Size[1] (grams)	Market	Product use	Customers
Live (ezo quality)	100-110	Japan	sushi, sashimi	hotels, resorts, restaurant
Live (tokobushi)	85-100	US, Hong Kong	grilled, steamed	distributors, restaurants
Live petite	75-85	US, Hong Kong	traditional Asian cuisine	specialty seafood, distributors
Premium fillet (fresh/frozen)	85-100	US, France	traditional US restaurant cuisine	restaurants, specialty seafood distributors, retail sales
Petite fillet (fresh/frozen)	75	US, France	restaurants, traditional European cuisine	restaurants, institutional food service, retail sales
Processed whole foot (canned)	65-95	China, Hong Kong SE Asia		restaurants, institutional food service, supermarkets, retail sales

[1]Whole body weight including shell.

Read more!

There are eight excellent references describing abalone research and development, some farming techniques, and other issues important to entrepreneurs --

Handbook of culture of abalone and other marine gastropods. By KIRKO. HAHN, 1989 Published by CRC Press, Boca Raton, Florida. 348 pp.

Discusses ABALONE BIOLOGY - including gonad reproductive cycles; artificial induction of gonad maturation, spawning and fertilization; larval development; induction of settlement of competent larvae; nutrition and growth; and abalone seeding. Also discusses CULTURE TECHNIQUES - in Japan, California, an "urban environment", Korea, Taiwan, France, New Zealand, Australia and Ireland. Also notes culture of tropical top shell *Trochus* and queen conch *Strombus.*

A special issue of the scientific journal **Aquaculture**. Vol. 140, Nos. 1-2. 1996. Published by Elsevier Science Inc.

This issue features selected papers presented during **Second International Symposium on Abalone** held in Hobart, Tasmania, Australia, 7-11 February 1994. **INTRODUCES** abalone aquaculture. **CARRIES** eight papers on artificial diets and nutrition, including a review of artificial diet development; a paper on postlarval culture; 3 papers on husbandry; a paper on tropical abalone culture; 2 on system design and one on marketing. **Abalone species** covered include: *Haliotis midae, H. rubra, H. rufescens, H. kamtschatkana, H. discus hannai,* among others.

Fisheries in Japan: abalone and oyster. Vol. 9. 1980. Published by the Japan Marine Products Photo Materials Association

This is a beautiful collection of colored photographs of abalone and oyster fisheries, 164 pages in all. For abalone, the book photo-essays anatomy, larval development, rearing and rearing facilities, stocking the farm, wild fishery, landing and shipment, product development.

Seed production and culture of a tropical abalone, *Haliotis asinina* Linne. By TANIN SINGHAGRAIWAN and MASANORI DOI, 1993 Published by the Eastern Marine Fisheries Development Center, (EMDEC, Thailand) and the Japan International Cooperation Agency. 32 pp.

Introduces the **INDIGENOUS ABALONE SPECIES** in Thailand *(Haliotis asinina, H. ovina,* and *H. varia).* Outlines the seed production procedure at EMDEC. Discusses *Haliotis asinina* in detail: **MATURATION** and **SPAWNING, EMBRYONIC** and **EARLY DEVELOPMENT, LARVAL REARING** and **SPAT COLLECTION, REARING OF JUVENILES and GROW-OUT CULTURE.**

A special issue of the scientific journal **Marine Freshwater Research.** Vol. 46, No. 3. 1995. Published by the Commonwealth Scientific and Industrial Research Organisation (CSIRO Australia) and the Australian Academy of Science.

Like the special issue of the journal **Aquaculture,** this volume features selected papers presented at the **Second International Symposium on Abalone** held in Tasmania last February 1994. It includes papers on fisheries biology and ecology of abalone rather than abalone culture. CARRIES six papers on early life history; five papers on growth and ageing; five papers on general biology; and another five on stock assessment. **Abalone species** covered include: *Haliotis midae, H. rubra, H. asinina, H. mariae, H. iris, H. australis, H. tuberculata, H. discus* and *hannai.*

The issue on abalone aquaculture featured in **Fishery Journal,** August 1992, an 8-page magazine published by Yamaha Motor Co, Ltd of Japan. The issue discusses the tradition and innovation of abalone aquaculture in Japan.

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Footnote

To sum it up, abalone culture has still a long way to go towards being a commercial venture in the Philippines.

Farmers have to consider that abalone feed on seaweeds, another valuable commodity, and that their investment would necessarily be long-term because of its slow growth.

But, the market demand is definitely there, and researchers have made strides in artificial propagation, in developing artificial diets, and in the culture of abalone's natural diet, the seaweeds. In addition, not only is abalone valued for its meat, but also for its mother-of-pearl.

It's not surprising that interest in abalone culture continues among the Filipinos (the national mass media included).

More books ...

Abalone of the world. Edited by SA SHEPHERD, MJ TEGNER, SA GUZMAN DEL PROO. Published by Fishing News Books / Blackwell Science, UK. 600 pages.

CONTAINS over 60 papers / reviews presented at the First International Symposium on Abalone Biology, Fisheries and Culture held in La Paz, Mexico. DISCUSSES evolution and distribution; physiology, genetics, and reproduction; larval ecology and settlement; feeding and growth; mortality, diseases, and predators; fishery biology and modelling; case studies of fisheries; culture.

Abalone farming. By R FALLU. Published by Fishing News Books / Blackwell Science, UK. 192 pages.

INCLUDES latest developments and techniques for farmers and aquaculturists: abalone natural life cycle; acquiring and conditioning broodstock; diseases and stress; induced spawning; storing eggs and sperm, artificial insemination; genetic manipulation; fertilized eggs, larvae; spat, settlement: feeding, nutrition, natural food, seaweeds, artificial food; weaning; grow-out; ranching; live storage and transport; markets.

TALK

Growing Abalone In Cages

GROWING abalone in cages is one possible project that will suit even the small fisherfolk in many parts of the country. This is being done in Taiwan. And although it has not been done commercially in the Philippines, the possibility is there.

Manuel Casinpin Jr. of SEAFDEC showing abalone attached to a pla...

Grow abalones in pen enclosures

And now, abalone production in pen enclosures... Abalone is a large edible univalve mollusk with an ear-shaped shell. It is one of the most important marine mollusks in the country, its shell and meat fetch a high price in the local and international markets...

56 MANILA BULLETIN, Fri., Dec. 16, 1988

Businessmen go ga-ga over this sea morsel

Why the abalone will never go out of style among Filipino entrepreneurs...

By ANTONIO MA. NIEVA

BUSINESSMEN and gourmets alike go ga-ga over the sea cousin of what Filipinos know as the "kuhol" or snail, and the reason lies as much in the pocketbook as in the stomach.

For the marine snail genus called Haliotis, or abalone, implies haute Oriental cuisine and profits in hard currency.

There are various species of abalone, the most important being the California *rufescens* (red), *corrugata* (pink) and fulgens (green)...

close during growth, with the last 5 to 9 remaining open for venting waste products, according to the Technology and Livelihood Resource Center's literature on the marine snail.

Abalones have lustrous pearly shells that are manufactured into buttons or used for inlay and other ornamental purposes. But it's the meat — raw, cooked or processed — that makes a gourmet's meal especially...

* Clean by brushing or rubbing the meat with a rough stone. Trim or cut off unsightly portions. Keep the meat soaking in brine to prevent discoloration.

* Pre-cooking: steam the meat for 20-30 minutes to inactive enzymes and bacteria and to ensure moisture content.

* Drying: spread the meat drying trays and sun-dry, turning the pieces once or twice a day until hard and fully...

Aquaculture clinic

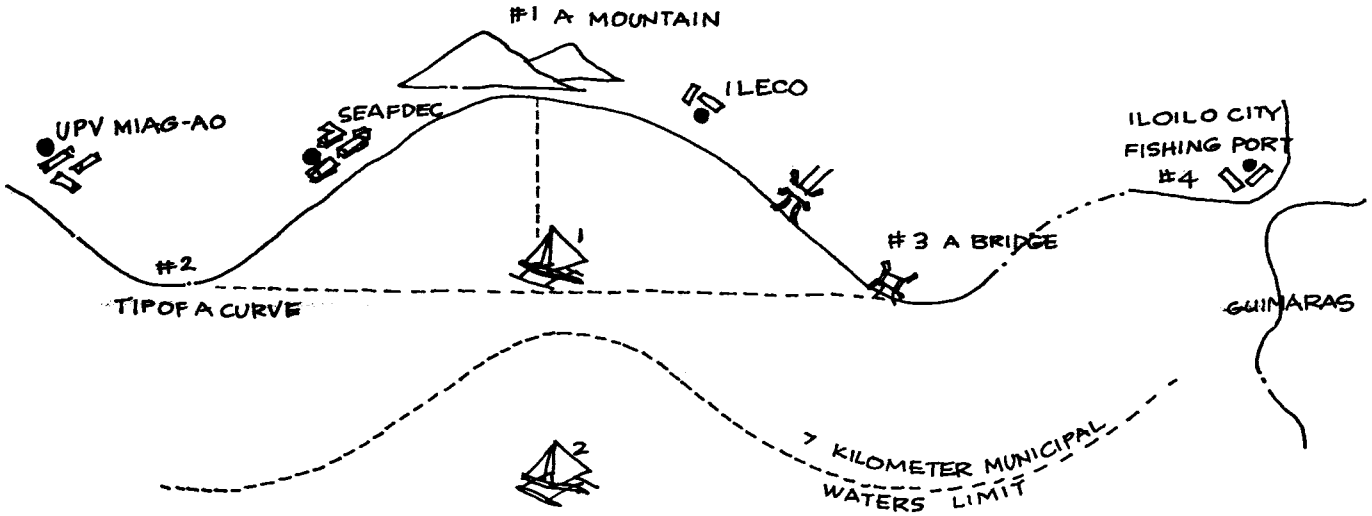
QUERY The proposed fisheries code in the Philippine Congress defines municipal waters as 7 kilometers from the shoreline from whence boats 3 gross tons or less can fish. Beyond 7 km to the 15th km is reserved for small commercial vessels whose tonnage will be determined by local government units. Beyond 15 km is for big commercial fishing vessels. How will fishers know these distances accurately? Will it be easy to police these limits?

REPLY An electronic / computerized global positioning system is the way to do it very accurately. However, this is expensive, and we doubt fishers would invest in one. Only government enforcers (the Coast Guard, the Navy) can afford it.

So, we interviewed a couple of small-scale fishers operating near AQD's Tigbauan Main Station. Salvador Gotera, 54, has been fishing for 25 years; and Severino Torreflores, 65, has been fishing for 40 years. Both explain that they **estimate** (*banta-banta*) the fishing boundaries, using **landmarks** (*tala-an*) that fishers in the area commonly use. They use additional landmarks to estimate whether they have gone beyond their fishing limit.

For instance: to determine if his position (boat 1) is within the 7-km limit, the fisher looks three-ways to find landmarks #1 -3 (sketched below). Once he finds these, he is confident he is within the limit.

Brgy. Buyu-an in Tigbauan, 25 km southwest of Iloilo City (not drawn to scale)



He'll know he has gone beyond the limit (boat 2) if he finds another marker. Landmarks include bridges, mountain peaks, tip or curve of the bay (*kurbada*), and others. For Tigbauan fishers, at least, they consider themselves definitely in commercial fishing areas when the gap between Iloilo City and the tip of Guimaras is so wide (#4) they can see the city's Fishing Port.

☞ next page

At night, the fishers locate these landmarks by their relation to the streetlights or houselights that they see. They are familiar with AQD lights which are close together, the electric cooperative lights are elevated, and lights on the mountain would be the University of the Philippines' campus in Miag-ao.

For sure, these landmarks change from town to town, from island to island. But the fisher's ability to measure fishing distances is already part of their traditional knowledge of fisheries. It can not be underestimated.

When asked if policing the fishing limits is a big problem, Salvador and Severino answer a definite yes. They felt they have to be careful about calling attention to big fishing vessels that enroach from time to time on municipal waters because the commercial operation might have powerful people behind them. But this has not stopped them from cooperating and joining the *Bantay-Dagat* (transl. 'Watch-the-Sea') operations of their community. They found that more voices calling attention to a repeated intrusion (*reklamo*) is reason enough for the Coast Guard to patrol the area or mediate a dispute.

Both fishers are empathic with commercial fishers, understanding that the latter too have families to feed and raise. Some small-scale fishers, they say, even collude with purse-seiners. Once the former finds a school of fish, they call the latter to haul the fish. The catch is divided between the two. But, Salvador and Severino point out, the price of fish will become prohibitive if commercial fishing is banned just to protect our fisheries or to protect the small-scale fishers.

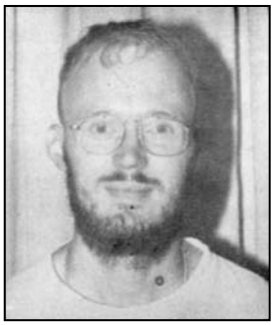
Salvador and his friends are investing in barrier net fishing (*punot*) to augment their income. They pay the municipal government more than P150,000 a year for the 3-year rights to the nearshore area. Two *punots* (with a 100-m circumference) are maintained by his 22-member fishing association. They harvest the *punot* every two months, getting all kinds of fish such as snappers, sardines, etc. *Punot* is luck, Salvador says, and they won't know how much they'll get until harvest.

Severino, an elementary graduate, is proud that he was able to send his children to school and that all have earned their bachelor's degrees. He is honored as the 'headteacher' of his community's fishers. On the other hand, Salvador, a high school graduate, is still sending his four children to school. The eldest is a high school graduate, the youngest is in third grade.

- By **M Castaños** and **L Tabigo-on Jr**

AQD EXPATS / from page 5

Ports Authority and the Indonesian Ports Authority in 1994. He has completed a study on computer-aided modelling of Laguna de Bay coastal dynamics with interest in its fisheries. The study was conducted at AQD's freshwater fisheries station in Binangonan, Rizal. Ikuro has submitted a report on *Modelling of eutrophication in Laguna de Bay as a tool for national resource management,* and conducted a research seminar about oil spill modelling last November 21, 1996.



CHRISTIAN LUCKSTADT

Christian is a **visiting researcher** from Hohenheim University in Germany. He finished his BS in Freshwater Fishery and Ecology in 1992 and MS in Ichthyology in 1996 from Humboldt University in Berlin. After his studies, he had short employment contracts at the Institute for Freshwater Ecology and Inland Fisheries in Berlin in several departments between 1993 and 1995 (pisciculture, fish pathology, biology-ecology of fishes). During study vacations, he got different kinds of practical work at the Netherlands Institute for Sea Research - Den Burg / Texel (different fishing techniques for sole) and at the Institute for Sea Research - Kiel (ICES-Fishing herring larvae project). Christian's research study under the AQD-Hohenheim collaborative project is entitled *Factors limiting the growth of milkfish* Chanos chanos F *in semi-intensive pond systems.* His study includes milkfish bioenergetics, which, Christian noted, makes it different from the usual pond studies. Christian has been at AQD since April 1996, with a PhD scholarship from the DAAD.

MYRNA KOCK

Myrna, 27, is a **visiting researcher** from the Institute for

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Radio TIPS

Radio-TV broadcasters or commentators and newswriters are encouraged to quote or rephrase, in part or in whole, all articles in this section provided due credit is given to the source of the material such as researchers, institutions or publications.

ARTIFICIAL REEF MADE OF CAR TIRE IS NOT A GOOD IDEA

Artificial reefs are used in rehabilitating a damaged reef ecosystem. These have three functions:

(1) as protection or shelter for fishes, preventing early harvest of small ones and the harvest of "pregnant" ones
(2) as a means of increasing coastal productivity in the long term by providing surfaces for growth of sessile (or attached) organisms and establishment of new food chains
(3) as a fish-aggregating device that concentrates fish for easier fishing.

Scientists led by Alan White[1] suggested that although the use of scrap materials (like car tires) in generating artificial reefs may be an economic way to solve solid waste disposal problems on land ... it may damage marine habitats.

Scrap materials can release toxic pollutants to marine food chains.

Some may even add to the already increasing debris in coastal waters.

Research on the viability of artificial reefs should be improved before moving into large-scale programs.

In 1969, a scientist warned that if we do not base a reefs construction upon proper scientific principles, it becomes at best a temporary high relief area of questionable value, or at worst an ocean junk pile whose major value has been a promotional gimmick publicizing a special interest group.

Other scientists also said that perhaps too much effort has been expended in building artificial reefs and not enough in research ... not all artificial reefs have increased fish harvest or productivity. In many areas, managers have the mistaken belief that they can proceed with large-scale programs without research.

Decisions are often made based on political expediency, absolute cost, readily available materials, navigational considerations, or solid waste disposal problems, without considering biological, economic, or social effects.

The potential exists for major mistakes which could be difficult, costly, or impossible to correct.

Many artificial reef programs have failed because waste materials have been dumped in the cheapest way possible and haphazardly.

The environmental and other costs have shown that this shortsighted approach is undesirable.

The best alternative in terms of environmental, economic, and social benefits is a carefully planned, well-managed structure.

[1] **White AT, CL Ming, MWRN de Silva, FY Guarin. 1990. Artificial reefs for marine habitat enhancement in Southeast Asia. ICLARM. MC P.O. Box 1501, Makati, Metro Manila)**

AQD EXPATS / from page 34

Animal Production, University of Hohenheim in Germany. On a DAAD and European Union grant, she is carrying out her PhD thesis research under the project *Laguna de Bay: an ecosystem approach for sustainable management.* She will work on the Influence of aquaculture on the feeding ecology of fish and macroinvertebrates. The study is for 2 years, and will end September 1997.

HARMUT RICHTER

Harmut, 32, is a visiting researcher from the Institute for Animal Production, University of Hohenheim in Germany. He studied at Eastbourne College in Sussex, England (1976-1981) and Trinity College / University of Cambridge (1982-1985). He earned his MS in Fish Ecology / Fisheries Biology from Queen's University. He was consultant to the Brachi Environment institution from June 1992 to May 1994. On a European Union grant, he will conduct his PhD thesis research under the project *Laguna de Bay: an ecosystem approach to sustainable management.* He will investigate the *Aquatic nutrient cycle and the food conversion efficiencies of natural and supplemental food sources by culture fish in the lake.* The study will be for three years, and will end February 1998. He is working at AQD's Binangonan Freshwater Station in Rizal.

NATURE MATTERS / from page 10

27) of whales and dolphins in Philippine waters. Several species of marine animals have become endangered due to habitat destruction, exploitation for commerce, or hunting out of curiosity: giant clams (*Hippopus porcellanus, Tridacna gigas, T. derasa*), the sea cow *Dugong dugon,* the estuarine *Crocodylus porosus,* marine turtles (*Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea, Dermochelys coriacea*), and sea snakes (*Hydrophis cyanocinctus, H. semperi, H. melanocephalus, H. ornatus, Laticauda colubrina, L. semifasciata, L. laticaudata, Pelamis platurus*).

The species count in the Philippines is far from complete. Several listings of terrestrial and marine flora and fauna have appeared in local science journals such as *Kalikasan,* the *Philippine Scientist,* and the *Papers of the National Museum.* Now more than ever, a comprehensive but rapid assessment of biodiversity is necessary before any more species go extinct.

The Philippines has enough laws to protect wildlife, both plants and animals, but these laws have been difficult to enforce partly because of the low environmental awareness of the general public. Angel Alcala recommends three wildlife conservation measures: (i) intensive conservation education at all school levels and of all sectors of society, (ii) establishment of more nature parks and wildlife reserves, and (iii) establishment of breeding centers for endangered wildlife. The following articles in this series will describe the developments in non-formal conservation education, and in nature parks and wildlife breeding centers in the Philippines.

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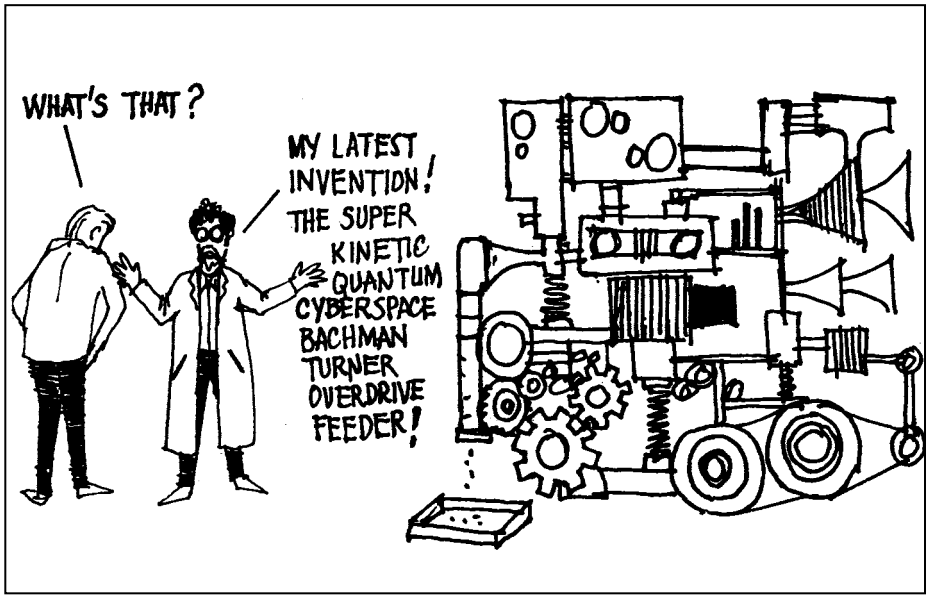
P CRUZ/from page 12

work for entrepreneurs to pursue. Many results, however, look ideal in the laboratory but are not realistic in the field. That is the sad part. And we thought we did a good job already. Take for example making low cost farm-made feeds. The seasonal availability of many raw materials actually make backyard feedmilling uneconomical during lean supply months when big commercial feed millers corner the supply. As a backyard feedmiller you buy your raw materials at the retail level which is not only more costly but must be paid in cash. Furthermore, rudimentary feed pelleting equipments produce feed pellets that have poor water stability. This leads to poor growth due to significant nutrient losses and water pollution. Thus, in actual field conditions, at least in the Philippines, making farm-made feeds is not economically viable. Research work I believe should be conceptualized and carried out up to the commercial scale where our ultimate goal of food production is realized. It is actually more challenging and fulfilling this way.

How do you view the progress of aquaculture technology generation in the country?

There is a lot of research being done but unfortunately there is little that end up in commercial use. I believe researchers should try to be more involved with the industry even if they do not share the same view with entrepreneurs. It was widely known in the scientific community that intensive shrimp farming is not going to be sustainable so many distanced themselves from conducting research in these activities. When the the industry was eventually hit by disease problems, there was little that could be done by researchers



since little was understood of the culture practices. It is only now that institutional effort is being made to save the shrimp industry but it is already quite late. High density milkfish culture is the new craze and this can very well follow the footsteps of the shrimp industry. I think by being abreast with industry, scientists are in a better position to detect early on production problems before these happen. If problems do indeed happen, rehabilitation at least will be easier. Whether we like it or not, entrepreneurs will invest where there is money. They will try to generate technology on their own if this is not available and this is not a good idea.

What do you think is the future direction of our aquaculture industry? Does the shrimp industry have a chance of being rehabilitated?

I think more and more aquaculture activities is going to be directed to marine cage and pen farming where there is large area available for expansion. We see this now for milkfish culture in Pangasinan, Davao, Leyte, Cebu, Iloilo, and Negros. Cage and pen farming is much more productive than pond culture and there is no need to spend for pumping or aeration. It is very attractive to investors. As for the shrimp industry, if the disease problems are controlled, there are still many farmers in Negros and other parts of the country that would want to come back. I am not so optimistic however because the intensification of milkfish is going to lower water quality in the coming years.

What are your plans?

I am focusing attention on cage farming. I am now experimenting on culture methodologies and all-weather cage facilities. Of course this will include the use of automatic feeders. There is much R&D I'd like to do and intend to do. My approach is not to reinvent the wheel but to adopt existing technologies to suit local farming needs and conditions, much like what I did with the Kinetic Feeder.

Abalone artificial diet / fr page 27

tein and energy per body weight than adults having higher growth rate. Also, small juveniles may require a different amino acid balance because of different growth requirement as viscera and physiological processes develop. Adults may require more lipid in the diet during gonad development. Bacterial growth which develop in the surface of the feed during prolonged storage may even improve the feed's nutritional quality. Viable bacteria in the gut of juveniles may also contribute significant quantities of nutrients to the diet and could perform metabolic activities in the gut that are highly significant to the abalone's development. Strains of these bacteria are capable of hydrolysing a variety of complex polysaccharides in algae.

Artificial diet enhances growth of hatchery-stage juveniles. It can improve survival and can aid in broodstock management. Artificial diets can be cost-effective since these improve productivity.

Nutritional value of ingredients

The best way to establish the nutritional value of ingredients for use in artificial diets for abalone is to determine the availability of the nutrients within the ingredients, i.e. the proportion of nutrients capable of being used by the abalone.

Digestive enzymes and the digestive capacity of abalone

The digestive enzymes of abalone can be purchased commercially. These are used extensively to lyse cell walls so that the protoplasts can be extracted for experimental use. Proteolytic activity of *Haliotis discus* was most active in an acidic environment. The carbohydrases have been investigated for abalone species. The abundant and com-

☞ next page

jump page

Abalone artificial diet / p37

plex composition of the polysaccharide hydrolases in these species reflects the widespread occurrence in the brown algae the abalone feed on. Cellulase is found in the gut of a number of abalone species although they differ in the levels of activity. Abalone could not easily digest cellulose but its enzymes could efficiently digest the cell walls of red and brown algae. Pre-fed algae were more efficiently digested.

Abalone can alter their enzyme composition to cope with changes in their diet. Juvenile *H. midae* fed an artificial diet had higher protease and lower amylase levels in their gut compared with abalone fed diatoms, suggesting a potential energy and protein source. The similar level of lipase between the dietary groups indicates that lipids do not play an important role in the energy metabolism of abalone.

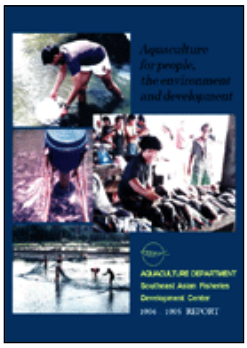
Digestibility trials

The digestibility of a food is defined as the proportion which is absorbed by the abalone and not excreted in the feces. Feces collection is impossible because they tend to disintegrate in the water, making it difficult to determine the digestibility of specific nutrients. Temperature and the light regime should be controlled as these affect digestibility.

Digestibility of the ingredients

The general observation for *Haliotis rubra, H. rufescens* and *H. laevigata* was that these can digest lipids with high efficiency. Reports on digestibility of energy in a fishmeal-based diet was about 48% for *H. rubra* and 43% for *H. laevigata,* however, this is lower than the digestibility for algae. Digestibility investigations are still required to further improve current artificial diets.

New publications, training courses NOTICES

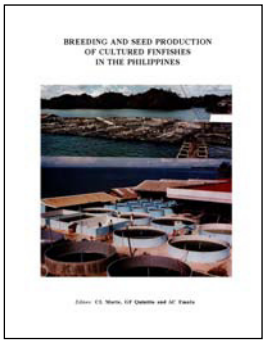


AQUACULTURE FOR PEOPLE, THE ENVIRONMENT, AND DEVELOPMENT: 1994-1995 SEAFDEC/AQD REPORT
Prepared by VT Sulit, MT Castaños, EG de Jesus, A Gonzal, EM Huervana, N Ebron. 1996. 106 pages

THIS VOLUME tracks the two-year progress of AQD since the last biennial report issued in 1993.

INCLUDES summaries of on-going research studies, research and popular publications, collaborative programs, training and extension activities, and management matters.

OF PARTICULAR INTEREST is the progress of AQD's pilot project on coastal fishery resources management at Malalison Island in Culasi, Antique. The project is development-oriented, integrating a multidisciplinary research approach. The major thrusts include the implementation of territorial use rights in fisheries, community organizing, economic utilization of resources, and co-management of fishery resources.

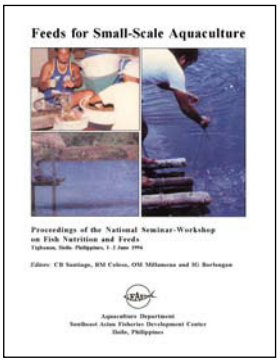


PROCEEDINGS OF THE SEMINAR-WORKSHOP ON BREEDING AND SEED PRODUCTION OF CULTURED FINFISHES IN THE PHILIPPINES Edited by CL Marte, GF Quinitio, AC Emata. 1997. 182 pages.

DOCUMENTS the proceedings of the seminar-workshop AQD hosted in 4-5 May 1993 in Tigbauan, Iloilo.

INCLUDES four review papers on:
- control of gonad growth, maturation, and spawning in teleosts (by AD Munro and TJ Lam)
- the AQD fish breeding research (by LMaB Garcia)
- mass larval rearing technology of marine fishes in Japan (by K Fukusho)
- the AQD fish seed production research (by GF Quinitio)

ALSO CONTAINS 5 full papers on breeding and 6 full papers on seed production.



FEEDS FOR SMALL-SCALE AQUACULTURE Edited by CB Santiago, RM Coloso, OM Millamena, IG Borlongan. 1996. 144 pages.

DOCUMENTS the proceedings of the *First National Seminar-Workshop on Fish Nutrition and Feeds* AQD hosted in 1-2 June 1994 in Tigbauan, Iloilo.

INCLUDES four review papers on:
- future considerations in fish nutrition research (by C Lim)
- nutritional requirements of commercially important shrimps in the tropics (by M Boonyaratpalin)
- feed formulation and evaluation for semi-intensive culture of fishes and shrimps in the tropics (by A Tacon)
- preparation, management, problems, and recommendations for farm-made feeds (by F Piedad-Pascual)

ALSO CONTAINS 7 full papers and 19 abstracts.

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The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 for the purpose of promoting fisheries development in Southeast Asia. Its Member-Countries are Japan, Malaysia, the Philippines, Singapore, Thailand, Brunei Darussalam, the Socialist Republic of Viet Nam, and Indonesia. Four departments were established in the Member-Countries; the Aquaculture Department (AQD) in the Philippines pursues aquaculture research and development.

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We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs, line drawings must be camera-ready, glossy B&W prints or colored slides.

Cut-off date for contributions considered for the issue indicated is every 1st of January, March, May, July, September, or November.

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