ISSN 0859-600X

Volume IX No. 3 July-September 2004

AQUACULTURE ASIA

Marine finfish markets, economics & trade

Genetic considerations in aquaculture

Rice-fish culture for food & environmental security

Native catfish culture in India

Now available on CD-ROM!

Babylon snail hatchery production

Women in coastal aquaculture


Research has shown that you are what they eat.
A well-balanced diet is essential for our health. Hence the saying "you are what you eat". However accurate this phrase may be, it does not cover the whole story. Because an important part of our daily diet is produced by animals. A diet for which fish and shrimp are of increasing importance. And, as you well know, their health also depends strongly on their diet.
In other words: the better the feed, the better the food. Therefore, we promote the production of prime quality fish and shrimp through improving the nutritional value and guaranteeing the safety of our feeds and concentrates. As our studies have revealed that this leads to less stress and diseases, in animals as well as in human beings. A result we always strive for. Because we care.
INVE
GROUP
INVE
Advanced Solutions
for animal rearing
www.inve.com
INVE is the proud gold sponsor of
WORLD
AQUACULTURE
2003

Aquaculture Asia
is an autonomous publication that gives people in developing countries a voice. The views and opinions expressed herein are those of the contributors and do not represent the policies or position of NACA

NACA
An intergovernmental organization that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

Contact
The Editor, Aquaculture Asia
PO Box 1040
Kasetsart Post Office
Bangkok 10903, Thailand
Tel +66-2 561 1728
Fax +66-2 561 1727
Email
simon.wilkinson@enaca.org
Website http://www.enaca.org

Printed by Scand-Media Co., Ltd.

AQUACULTURE ASIA

Volume IX No. 3
July-September 2004

ISSN 0859-600X

From the Editor's desk

Genetics in aquaculture: More attention, please

There is no doubt about the huge contribution that genetics has made in food production: Almost *all* plant and animal crops grown in terrestrial agriculture are domesticated strains. Farmers have selected them for enhanced performance through centuries of breeding. More recently, they have been improved through industrial and scientific research. The humble chicken is often cited as an example: In the 1950s it took a broiler around 84 days to reach a marketable size of 1.3kg. Today, thanks to intensive selection (and improved feeds) a broiler can reach 2kg in around 40 days.

Aquatic animals offer many advantages over their terrestrial counterparts: Their maturation times are short; they are spectacularly fecund; and they don't take up much space or feed to maintain. So why have we not seen similar productivity gains in aquaculture? Some of the explanations offered include the diversity of aquaculture practices, a poorly focused research effort that has spread itself too thinly across too many species and the lack of long-term commitment required from funding agencies to support viable breeding programmes. Consider again the development of the modern chicken: A massive and intensive research effort focused on one species for more than a century. Salmon is a similar, if more recent and less advanced story of focussed R&D, but few aquatic species have been domesticated to any meaningful extent.

By failing to address genetic issues the aquaculture industry is not just missing out on productivity gains; it is actually incurring productivity losses through distribution of poor-quality seed. Although there are many factors that determine seed quality, genetic aspects are one of the most important. As an observation I would offer that hatcheries in the region typically retain only enough broodstock to meet their seed production requirements. They do not keep enough stock to maintain the genetic diversity of their brooders. It is quite common for hatcheries to replenish broodstock from their own production, leading to increasing inbreeding depression with each generation. When the performance of the broodstock starts to become a problem they often 'buy in' more, usually with little regard for the genetic quality of the new stock, which may come from a source just as inbred as their own. Improving knowledge in genetic management for hatchery operators is an urgent need in the region.

Productivity issues aside, there may also be environmental concerns when hatchery-produced seed of dubious genetic quality are mass-released for restocking and enhancement purposes. Many freshwater species are under a lot of fishing pressure, and in some cases hatchery-produced fish now dominate the 'wild' population. In the last issue Dr Nguyen and Dr Na-Nakorn took an in-depth look at the issue of translocation, its impacts in terms of conservation genetics of aquatic species, and its implications for aquaculture. In this issue an attempt is made to suggest suitable strategies for measuring genetic diversity to assist in sustaining genetic resources of aquatic organisms.

Lastly, the Marine Finfish Aquaculture Network Magazine continues to expand at a rapid rate, so much so that we couldn't fit it all in to the printed magazine. If you would like to read additional articles about marine finfish aquaculture download the full issue from our website, you can find it at:
http://www.enaca.org/modules/mydownloads/viewcat.php?cid=114.

Simon Wilkinson

AQUACULTURE ASIA

In this issue

Sustainable Aquaculture


Page 9

Research and Farming Techniques


Page 18

Aquatic Animal Health


Page 28

People in Aquaculture

What’s New in Aquaculture


Page 31

Asia-Pacific Marine Finfish Aquaculture Network


Page 43

Notes from the Publisher

The rewards of candor, in the service of sustainable aquaculture and fisheries management

Pedro Bueno is the Director-General of NACA. He is the former Editor of Aquaculture Asia

Transparency's rewards

On NACA' latest visit to Indonesia, from 21 to 26 September we came away impressed from two events: The first was the quiet and clean presidential election (FAO's Resident Representative in Jakarta, Mr. Kimoto saw in its quietness the clear signs of a mature democratic setting). The second was a less grand but no less instructive gesture – Indonesia's transparency and speed in declaring immediately that they had Koi Herpes Virus or KHV. Dr. Rokhmin Dahuri, who was at the time of the workshop the Minister of Marine Affairs and Fisheries, revealed that debates, at times testy, preceded their conclusion that it would be in the best interest of the farmers of Indonesia - and of the Asian Region – to tell the world and their trading partners that they had a problem. As a result importers of the popular and expensive ornamental Koi carp, a multi-million dollar activity in Indonesia, cancelled all orders and declared a moratorium on imports from the country.

Former Minister Rokhmin, a Professor in Bogor Agricultural University (from which President Bambang Susilo Yudhuyono recently obtained a PhD degree in agricultural development) then looked around the table and asked, almost plaintively, what the rewards of their transparency could be? Dr. Juan Lubroth, senior FAO livestock health expert from Rome was among those in the special meeting with the Minister: He pointed out two results: The other countries were alerted and therefore had been careful that the disease does not enter their borders thus averting a widespread epizootic in the region, and, for Indonesia, it earned the confidence and goodwill of its trading partners that will surely translate to better trading relations.

How the disease – which started to be felt by Indonesian Koi and common carp farmers in the second quarter of 2002 – came into Indonesia, and how it was dealt with - basically through an FAO TCP assistance - provided the information and experiences for a regional workshop organized by FAO with NACA's collaboration and joined by the World Animal Health Organization (OIE), SEAFDEC Aquaculture Department, experts from several countries that included Australia, Canada, Japan, Malaysia, Norway, and participants from several ASEAN countries and Bangladesh. The workshop took off from the KHV experience in Indonesia to recommend a regional strategy to deal with emergency fish health situations. It had three elements - preparedness, response and a regional cooperative plan.

Aliens and the arts

Devin Bartley of FAO reminded me that it has been introductions and genetic work that have improved agriculture, enabled domestication, and raised productivity, and freed a lot of time from his hunting and gathering for man to take up the arts. That placed into a certainly higher and wider perspective my narrow concern about alien species. My concern was that alien species (whether the same species genetically improved or a different species) — introduced accidentally or with intent — can also bring in pathogens that can cause disease outbreaks on, or mess up the living space of the natives; or introduce their strange genes to the natives that might result in a future inferior population; suppress and compete with the natives; or simply eat them up. My other concern is an echo of what NACA's technical advisory committee members have been pointing out (since the first TAC meeting held in Hat Yai, Thailand in November 1992 and in every TAC meeting thereafter): That their cultured stocks are losing viability.

With partners, we have launched two initiatives that have to do with biodiversity: one on the impact of alien invasive species (on both diversity and the health of cultured and wild species), the other on the application of genetics on aquaculture and the management of fisheries resources.

The first was launched through a workshop called "Building capacity to combat impacts of aquatic invasive alien species and associated trans-boundary pathogens in ASEAN countries" in Penang, Malaysia, on the 12th-16th July 2004. The workshop was hosted by the Department of Fisheries of the Government of Malaysia and organized by the Network of Aquaculture Centres of Asia-Pacific (NACA) in collaboration with ASEAN, FAO, the WorldFish Center and the United States Department of State. The 75 participants included delegates from each ASEAN member country, resource persons with experience in aquatic invasive alien species (IAS) and aquatic animal pathogens and representatives of, regional and international organizations, research institutes, universities and private sector entities. The workshop supports the ASEAN 2020 Vision of enhancing "food security and international competitiveness of food, agricultural and forest products and to make ASEAN a leading producer of these products…".

The workshop was held to better understand the relationship of aquatic IAS and pathogens and their impacts (both positive and negative), as well as identify management and capacity building needs to reduce risks. It built on the recommendations from a 2002 Bangkok workshop organized by the Global Invasive Species Program (GISP) and a 2003 workshop of countries sharing the Mekong watershed, particularly in promoting awareness, establishing coordination mechanisms and information exchange systems and identifying management strategies and risk mitigation measures for aquatic IAS.

The workshop concluded that aquatic IAS and associated pathogens have a significant impact on the aquaculture industry in ASEAN with negative implications for aquatic biodiversity, and the social and economic well being of people in the ASEAN region. Aquatic animal pathogens in particular have caused severe damage to aquaculture industries in ASEAN. Participants also recognized the positive social and economic benefits that have come from the introduction and farming of some alien aquatic species in the region. The way forward is to minimize the risks and costs associated with negative impacts of aquatic IAS and aquatic animal pathogens whilst capturing the social and economic benefits possible through responsible aquaculture of alien species. A website has been set up and now on line (www.aapqis.org/ias/home.html)

The other initiative – on the application of molecular genetics in aquaculture development and fisheries resources management - has begun with an information site (on the enaca website and the Aquaculture Asia) to enable a wider exchange of information, expert views and opinions. A NACA research associate, Dr Thuy Nguyen, is anchoring the information exchange; she is also developing a training manual on the application of molecular genetics for a future regional training and workshop. The purpose of the workshop part will be to develop and design a regionally-coordinated project, including the national studies, that will address various aspects of the genetic biodiversity issue. The regional initiative could provide a better understanding of and more effective assistance to governments regarding the issues portrayed in the following news release:

Bangladesh workshop calls on government to help prevent aquaculture inbreeding

Delegates at an aquaculture policy workshop called "Production of Inbreed Free Aquaculture Seeds and Good Quality Feed" suggested that the Bangladesh government update their polices to save the industry from disaster caused by inbreeding. Speakers pointed out that cultured fish are currently suffering from growth retardation, increasing mortality, poor reproductive performance and diminishing immunity. The objectives of the workshop were to assess the impact of existing policy on aquaculture seed and quality of feed used and to identity and recommend suitable measures to improve them. Suggestions of how to achieve this included only using proven and tested brood fish, and the establishment of a central gene and brood bank to supply quality seed to hatcheries. *Source: United News of Bangladesh, July 17, 2004.*

Handbook of Mangroves in the Philippines – Panay

By Jurgenne H. Primavera, Resurreccion B. Sadaba, Ma. Junemie H. L. Lebata and Jon P. Altamirano

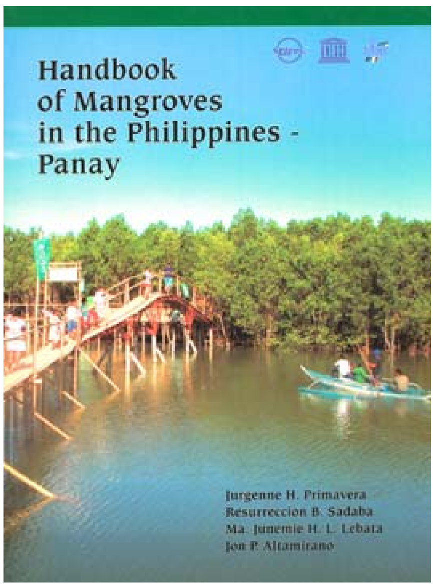
This compact handbook (106 pages) provides key information on more than 30 species of mangrove found on Panay Island and surrounding areas, together covering virtually all of the species found in the Philippines and about half of those found worldwide.

Each species is described in a two-page spread with high-quality photographs and diagrams of features useful in identification such as the leaves, flowers, fruit and roots. The description of each species contains a summary of its ecology including geographic and tidal distribution, habitat, flowering and fruiting times, co-occurring species and local names. Also included are traditional usages in food, medicine, fish poisons, dyes and importance in local industries, which is often key to understanding the underlying drivers for over-exploitation of mangrove resources.

One of the goals of the book is to assist with mangrove conservation and rehabilitation. The final chapters provide an overview of the importance of mangroves, mangrove decline and relevant legislation, conservation, mangrove-friendly aquaculture and rehabilitation.

The handbook is written for non-specialist readers and has a very clear and attractive design. I understand that it was pre-tested by students and teachers to ensure its user-friendliness, and it shows . I commend the authors for considering the needs of the end user – if only more scientists could be persuaded to do the same ! *Ed.*

Published by the Southeast Asian Fisheries Development Center Aquaculture Department, UNESCO Man and the Biosphere. ISBN: 971-8511-65-2



Topical issues in genetic diversity and breeding

Genes and Fish

Genetic considerations in fisheries and aquaculture with regard to impacts upon biodiversity

Thuy T. T. Nguyen

Network of Aquaculture Centres in Asia-Pacific, P.O.Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand

Introduction

In the previous issue of Aquaculture Asia, we wrote on the "potential impacts of translocations on genetic diversity of aquatic species". This article suggests suitable strategies for measuring genetic diversity to assist in sustaining aquaculture and inland fisheries practices. We also suggest ways to maintain genetic diversity of aquatic resources.

In most terrestrial husbanded animals, which almost entirely depend on domesticated stocks there are very few, if any, wild gene pools remaining. Therefore, for all intents and purposes, questions of wild gene pool dilution and related issues rarely arise. But this is not the case with cultured aquatic species, approximately 250 of which are thought to be affected. This situation is entirely different. In culture of aquatic species there is a highly significant dependence on natural stocks for replenishing hatchery stocks, as well as more intermingling of cultured stocks with their wild counterparts, through escapes and stock enhancement of natural and/or semi-natural waters. Consequently, and with the increasing expansion of aquaculture and culture-based fisheries in the region (Welcomme and Bartley, 1998; De Silva, 2003), there is a greater need to evaluate the interactions amongst cultured and wild stocks, particularly in relation to genetic conservation and biodiversity of aquatic resources.

Most inland fishery resources in the region tend to be common to watersheds, and therefore are often shared by countries. Also, the great bulk of cultured inland species are common to many countries in the region. In such a situation, if genetic studies are to be applied for regional conservation and maintenance of biodiversity there is an urgent need for a coordinated, cooperative approach.

Summary of genetic work in the region

Table 1 summarises the ongoing and/or planned genetic work in six countries in the region. It shows that most of the genetic work carried out is in relation to hatchery production and genetic improvement of major cultured species. On the other hand, most of these countries recognise the importance and the need for extension and application of genetic work to conserve biodiversity.

The aquaculture sector has concentrated on selective breeding of commercially important species. The most popularly known case is that of the production of the GIFT strain of Nile tilapia (Genetically Improved Farmed Tilapia), Oreochromis niloticus, utilising new germplasm of indigenous stocks in Africa, carried out under the auspices of the International Centre for Living Aquatic Resources Management (ICLARM), now the World Fish Center (WFC) in collaboration with other national institutions in the region. This was followed by the genetic improvement of major Indian and Chinese carp species and common carp, also under the leadership of the WFC, and conducted under the banner of the International Network on Genetics in Aquaculture (INGA).

From the above, it is noticeable that other aspects of genetic studies in Asia have generally lagged behind, even though the region leads the world in aquaculture production. Most of all, there has been a dearth of studies on aspects related to genetic diversity of cultured indigenous stocks, and the influence of aquaculture and other inland fishery practices on the genetic diversity of these stocks. These kinds of studies have taken back stage to those on selective breeding. This does not suggest that selective breeding of cultured species is not warranted. It indicates that it is now opportune to seriously and systematically address aspects on biodiversity, an issue that is of increasing concern throughout the world.

There can be many reasons for the dearth of genetic work related to biodiversity and conservation issues. The genetic tools used for such investigations necessarily involve molecular genetic techniques. The application of these techniques for aquatic resources management, however, is relatively recent. Second, the capacity available in the region for conducting molecular genetic research and applying the results is relatively limited. Third, most developing nations have only recently begun to pay attention to biodiversity issues and still to a limited degree. Issues of biodiversity are particularly important in aquaculture as most of the Asian nations depend on alien species for aquaculture development. The situation is further exacerbated by the fact that unplanned introductions are still common in the region.

Trans-boundary movement or translocations are still commonly carried out for aquaculture purposes in the region. Currently, the most broadly accepted guidelines used in effecting translocations/introductions are the EIFAC (European Inland Fisheries Advisory Committee) Guidelines for the Introduction of Aquatic Species, developed in 1988. These guidelines have been modified only slightly since then. The guidelines still do not incorporate any form of genetic evaluation of the stocks to be translocated, nor of the potential genetic risks on the indigenous stocks that could arise from such a translocation, the emphasis being mostly on ecological impacts and associated pathogen transfers. The genetic risks associated with translocations were discussed in the preceding issue of Aquaculture Asia, and it is not a realistic move to stop stock transfers in the region. In this light, the following suggestions provide some guidelines in measuring genetic diversity to minimise impacts of translocations, including stock enhancement and escapes from aquaculture facilities.

Useful genetic measures

Wild populations

Many approaches have been suggested to investigate influences on genetic diversity of aquatic organisms resulting from translocations. Since the existence of natural population subdivisions may imply adaptation to local conditions, genetic assessments of the degree of population sub-structuring and gene flow are necessary not only to preserve existing biodiversity, but also to preserve valuable adaptive resources (Johnson, 2000). Molecular genetic markers such as mitochondrial DNA, allozymes and microsatellites have been widely applied in studies of population subdivisions.

Patterns of population subdivisions can be used to predict the genetic risks of translocations (Johnson, 2000). In the absence of genetic variations between populations throughout the geographic distribution of a species, the interpretation would be "there are no population subdivisions (panmixia)". In such instances, genetic issues are not associated with translocations, except for problems resulting from genetic changes in captivity. However, it is also possible that the absence of genetic variation may be a result of lack of sensitivity of the genetic markers used and of geographically limited sampling. In this case, it is suggested that more than one marker be used in studying population subdivisions and that hypervariable markers such as microsatellites be employed together with extensive sampling. Johnson (2000) suggested that any interpretation of the lack of genetic structure should be based on supporting ecological evidence.

Where there is significant genetic differentiation between populations, or deep population subdivisions, translocations could threaten such diversity. In this context, Evolutionary Significant Units (ESUs) can be determined to assist conservation practices. This approach has been playing a fundamental role in the development of policy for the translocation of salmonids fishes in the United States (Waples, 1991). Moritz (1994) suggested that ESUs could be recognised as having distinct lineages of mitochondrial DNA, along with supporting evidence of divergence for nuclear genes.

Johnson (2000) also stated that between the two extremes of no population structure and deep population structure, however, prediction of risks associated with translocation is rather difficult and problematic. Molecular markers used for population genetic studies may not be directly related to local adaptation, and genetic divergence cannot be used to predict interactions between populations. There is no substitute for direct tests for variation in ecologically relevant traits and possible genetic incompatibilities among populations.

Assaying the genetic effects of cultured fish and corresponding wild stocks

The assessment of level of genetic differentiation and interaction between cultured and wild stocks should be part of any translocation or restocking program. The most basic requirements for assaying genetic effects of introduced stock to estimate the degree of genetic differentiation between the introduced and native populations are (i) to determine the population structure of the wild fish stocks and (ii) to monitor changes in the genetic make-up of this population after introduction. It is recommended that the level of gene flow between natural populations should be obtained. This information will provide a useful tool for determining the extent of the translocation/introduction to be affected (Ryman et al., 1995).

As in most genetic studies determination of relevant parameters involve mathematical calculations, which is unavoidable. The formula used for calculating gene flow is given in Box 1.

Box 1: *Gene flow can be estimated by determining the fixation index F_{ST} (Wright, 1969), which is the proportion of the total genetic diversity that results from differences among populations. F_{ST} is calculated from the formula:*

$$F_{ST} = \frac{\sigma^2(p)}{\bar{p}(1-\bar{p})}$$

Where, $\sigma^2(p)$ is the variance of the allelic frequencies in the populations and $\bar{p}$ is the mean allelic frequency. F_{ST} is related to gene flow through the formula:

$$F_{ST} = \frac{1}{4Nm+1}$$

Where, N is the effective population size, m is the rate of migration and Nm is the number of migrants per generation. The estimated number of migrants per generation (Nm) can be used as a guideline for the acceptable levels of introgression.

Box 2:
The simplest method to calculate the accumulation of inbreeding per generation with random mating is by using the equation:

$$F = \frac{1}{8xNem} + \frac{1}{8xNef}$$

Where, Nem and Nef are numbers of males and females that successfully breed, respectively.

Inbreeding coefficient of broodstock can also be measured using molecular markers according to the formula:

$$F = \frac{H_0 - H_t}{H_0}$$

Where, H_t and H_0 are average heterozygosities in the t^{th} generation of broodstock and founder population, respectively

Cultured stocks

(a) Inbreeding

Genetic monitoring in breeding programs that help to maintain genetic diversity of cultured populations could also help to reduce the genetic risks due to escape or release into the wild. Avoiding inbreeding and random genetic drift is critical for the maintenance of genetic variance in cultured stocks. It is a problem that inland aquaculture in the region, which is mostly based on highly fecund species, such as Indian and Chinese carps, is likely to encounter. Because of the high fecundity of these species, generally there is a tendency to use a fewer number of broodstock to meet production targets. Furthermore, as considerable volumes of fry and fingerlings are produced in backyard hatcheries, there is more likelihood for the broodstock numbers maintained and used in such practices to be less than desirable, an almost unavoidable consequence of the practices. Consequently, inbreeding has a greater probability to occur, and we are able to quantify the degree of inbreeding, thereby enabling us to take objective steps to avoid its occurrence. This is normally done through the estimation of a parameter referred to as the "inbreeding coefficient" F (see Box 2) and the objective - should be to prevent F from reaching 0.25 - the level where inbreeding depression is likely to occur in fish (Dunham, 2004).

However, it becomes difficult to estimate the "inbreeding coefficient" F when a mass spawning approach is applied. In this case, parental contribution in spawning is often unknown; as it is not always practical to count / determine the number of males and females that have successfully bred. Mass spawning could result in a substantial reduction in genetic variability often because offspring are derived from relatively limited number of potential matings. In such cases, molecular markers will be useful in the identification of the contributing number of adults to the production of offspring. Assessment of parental contributions in mass spawnings requires all potential parents to be characterised using a number of hypervariable genetic markers and the screening of an appropriate sample of the resulting progeny. Based on their multilocus genotypes, progeny are then assigned to particular parents, and the relative contribution of the adult broodstock and particular parents assessed. The inherent polymorphism of microsatellite loci, because of their high variability makes them especially appropriate for this application (Harris et al., 1991).

(b) Effective population size

Avoidance of inbreeding is often primarily resolved around population size. Maintaining effective population size (N_e) together with avoiding mating among closely related individuals of hatchery stock are important measures that are generally recommended for controlling genetic erosion in hatchery produced seed. Genetic variability decreases rapidly if the effective population size of the broodstock is small.

The effective population size can be increased in one of two ways: (1) increase the number of breeding individuals, and (2) bring the breeding population close to 1:1 sex ratio.

Effective population size is an important concept in broodstock management, as it is inversely related to both inbreeding and genetic drift. When N_e decreases, inbreeding and variance in changes of allele frequencies resulting from genetic drift increase. The relationship between inbreeding coefficient F and effective population size N_e is described below:

$$F = \frac{1}{2N_e}$$

(c) Minimal kinship selection

An extension of minimal kinship selection method was described by Doyle et al. (2001) and can be employed to increase the genetic diversity of a bottlenecked broodstock without bringing in new brooders. The mean relatedness of each potential breeder to the whole population is estimated using microsatellites, by the formula proposed by Ritland (2000). A subset of breeders is then selected to maximise the number of founder lineages, in order to carry the fewest redundant copies of ancestral genes. This approach is particularly effective when the available number of captive brood fish is small (e.g. endangered species).

To estimate relatedness between pairs of individuals, an indicator variable "d_s" ("Kronecker operator") is used. At each diploid locus, two paired individuals have four alleles, denoted by A_i and A_j for the first individual and A_k and A_l for the second individual. If allele A_i and A_j are the same then d_{ij}=1, otherwise d_{ij}=0. There are six d_s among the four sampled alleles, one for each comparison between two alleles, both within and between individuals.

The mean kinship of the i^{th} individual, mk_i, is the average kinship values for that individual with every individual in the population, including itself. A low mean kinship value indicates that an individual has few

***Box 3**: Determination of effective population size:*
In a random mating population, effective population size is calculated as follows:

$$N_e = \frac{4xNemxNef}{Nem + Nef}$$

relatives in the population, and thus is valuable in maintaining genetic diversity.

Other strategies

Apart from genetic monitoring, some other strategies can be applied to maintain genetic diversity. For example, fertilisation of a batch of eggs with sperm from several males can help to maximise N_e (= Effective population size; see Box 3). The result of mixing of sperm from several males to fertilise eggs may not be desirable as sperms from one male may be more competitive and thus dominate the fertilisation process. As such, it might be more practical to divide eggs from one female into sub-samples and then fertilise each sample with sperms from different males (Tave, 1993). Recently, cryopreservation of sperm has become routine for many species, which enables the hatcheries to use sperm from a large number of males.

It is impossible to completely avoid escapes or introductions of cultured fish into the natural waters. However, several suggestions have been proposed to minimise the genetic risks resulting from the introduction/escapes of cultured fish. These include using sterile fish after sex or ploidy manipulation for release/introduction. Stocking with natives (or supportive breeding) by choosing broodstock with similar adaptive potential enables maximum performance while minimising the detrimental effects on native populations. ESU is often used as an indicator of similarity in adaptive potential. On the other hand, one should be aware that while a common evolutionary history may suggest similar adaptive potential, it provides no direct evidence about genetic differences or similarities in ecological relevant traits (Doupe and Lymberty, 2000).

Conclusions

Information on population structure and genetic variation within cultured stocks can provide vital insights for management practice to minimise the genetic risks on biodiversity.

(*Continued on page 48*).

Table 1. A summary of genetic research in selected Asian countries. Data extracted from Gupta & Acosta, 2001; * translocated species)

Bangladesh	
• Plans for improvement of carp species	• *Catla catla*, *Labeo rohita*
• Interspecific hybridisation	• *Puntius (Barbus) sarana* and *Barbodes gonionotus**
• Genetic improvement	• *Barbodes gonionotus**
• Genetic manipulation (meiotic gynogenesis etc.)	• *Heteropneustes fossilis*
• Production of all male populations	• GIFT tilapia *
• Population genetics	• Hilsa shad (*Tenualosa ilisha*)
• Conservation genetics	• Four species identified; no work done
China	
• Genetic characterisation (aid for improving selection)	• Silver carp, bighead carp, grass carp, black carp
• Hybridisation for genetic improvement	• Common and crussian carp strains
• Genome manipulation	
Polyploid & haploid breeding	• Crussian carp, c. carp, grass carp, blunt snout bream
Sexual control	• Tilapias *
• Cell and gene engineering	• Common carp, crussian carp, blunt snout bream
• Conservation genetics	• Species top be conserved identified but no genetic work undertaken
Indonesia	
• Documentation of genetic carp resources (desk study/ literature survey)	• Common carp, *B. gonionotus*, *Osteochilus hasselti*, *Leptobarbus hoeveni*
• Establishment of synthetic base populations	• Common carp
• Gynogenesis of common carp	• Punten, Majalaya & Sinyonya strains
• Identification & characterisation	• *Pangasisus* and *Clarias* spp.
• Heritability of growth rates	• GIFT and other strains of Nile tilapia*
• Genetic variation studies using molecular genetic techniques	• *Chanos chanos*, grouper spp., *Anguilla bicolor*, *Macrobrachium rosenbergii*, shrimp spp.
Malaysia	
• Genetic relationship studies using electrophoretic markers	• *Oreochromis* spp.*, *Trichogaster pectoralis*, *M. rosenbergii*, *Penaeus* spp.
• Chromosome engineering; polyploidy, gynogenesis	• *Clarias batrachus*, *Barbodus gonionotus,*
• Hybridisation	• Tilapia spp.*
Philippines	
• Genetic improvement; selective breeding of new strains (e.g. salinity tolerant)	• GIFT tilapia*
• Endangered species planned work includes: genetic management plans, genetic assessment of stock enhancement ; estimation of inbreeding	• Four spp. identified; ludong- *Cestraeus plicatilis,* tawilis- *Sardinella tawilis*, *Puntius sirang*, pigek- *Mesopristes cancellatus*
Thailand	
• Genetic characterisation of populations/ spp.	• *Penaeus monodon*, *P. merguiensis*, *M. rosenbergii*, *T. pectoralis*, *Barbodus gonionotus*, catfish, tilapia
• Selective breeding	• Catfish, tilapias, *M. rosenbergii*
• Sex control	• Catfish, tilapias, aquarium fish
• Gynogenesis	• *B. gonionotus,* catfish spp.
• Ploidy manipulation	• Catfish spp.
• Genetic engineering (transfer of growth hormone gene)	• *Clarias macrocephalus*

Farmers as Scientists
This is a series anchored by M.C. Nandeesha. It describes farmer-driven innovations and experiences.

Rice-fish culture for food and environmental security

Dr M.C. Nandeesha is Head of the Department of Aquaculture, College of Fisheries, Central Agricultural University Tripura, India. Email mcnraju@yahoo.com

2004 has been declared the international year of rice. Like fish culture, rice cultivation has several thousand years of history. Both rice and fish are staple diets to millions of people in Asia. There are ongoing efforts to increase productivity of rice to meet the demands of growing populations. Successful demonstrations of growing rice without pesticides, and the mounting evidence of the public health and environmental hazards of their use, have paved the way for policy makers to lay greater emphasis on pesticide-free rice production. In some areas farmers have gone one step further to avoid use of chemical fertilizers and have successfully obtained impressive production using only organic manures. Examples from the organic farming systems indicate that it is possible to obtain even more than eight tons of rice per hectare. All these developments have created new hopes and opportunities to increase fish yield from rice fields.

Farmers invented the method of culturing rice and fish either concurrently or alternately with rice crops and this method has been in practice in several regions of Asia for a very long time. In India rice-fish culture has been in vogue for centuries in some of the Eastern States of the country such as West Bengal and Southern States like Kerala, Karnataka and Goa. The systems of rice–fish culture that have evolved are known to be ecologically friendly and economically viable. In the pokkali paddy fields of Kerala, even today farmers derive high economic benefits by culturing shrimp and fish. In other areas, rice fields once provided a large amount of fish and other aquatic organisms for consumption but with the adoption of improved varieties of rice for cultivation, pesticide usage became more common and the importance of fish cultivation with rice did not receive the required attention. However, now there is greater emphasis on the use integrated pest management (IPM) practices to reduce or eliminate the usage of pesticides and the new approach is gaining increasing acceptance by the scientific and farming community. Bangladesh has made substantial progress in the adoption of IPM and rice-fish cultivation practices as part of the IPM system. This article presents a description of the rice-fish system evolved and experimented widely by farmers in Bangladesh.

Evolution of IPM concept

IPM employs ecological, environmental, economic and social approaches to focus on the long term prevention on the suppression of pest problems. This is done through a combination of techniques such as encouraging biological control of pests and promotion of ecologically sound agricultural practices. The system evolved and experimented widely using the farmer field school concept, wherein emphasis is placed on learning by doing and understanding the ecosystem through a discovery process. The farmer field school concept involves adult learners in a group generally not exceeding 30 persons. They meet at a convenient time and place and learn crop productivity improvement by understanding the ecology and ecosystem of the crops. The concept was field tested on a large scale in Indonesia by FAO and it is considered to be one of the major developments that has taken place in cropping practices to eliminate or halt the increasing usage of pesticides. After the successful application of IPM practices in rice, the same approach has been tried in various other agricultural and horticultural crops.

Rice–fish farming systems have received considerable attention with the development of integrated pest management system (IPM), particularly in places where the water holding capacity of the land is good due to

Fish seed reared in rice–fish plots provide a good source of income to farmers.

CARE Staff experimenting rice-fish cultivation during the foundation training period, before advocating this approach to farmers.

topography as well as nature of the soil. Fish have been introduced as an additional food and income generating crop in locations wherein rice-fish culture is possible. Through this approach of promoting IPM through farmer field schools several thousand hectares of paddy fields have been brought under rice-fish cultivation in Indonesia. The concept of farmer field schools has been a great success and has proven that when farmers are given close follow up support and education, they can not only avoid using these dangerous pesticides but improve their crop productivity. They have even invented several new approaches.

Farmer field school concept in Bangladesh

Paddy is the major crop grown in Bangladesh with more than five million hectares under cultivation. Before the 1950's most families were able to get much of their fish requirement from paddy fields. However, with the introduction of modern varieties of rice and advice to use pesticides either as a preventive or curative measure resulted in the gradual reduction of wild fish populations in paddy fields. As an increase in rice production was viewed as the major necessity pesticide usage was thought to be an essential component of the production system. However, the success of IPM concept field trials in Indonesia encouraged the concept to be tested in Bangladesh by CARE, an international NGO working in the country. A project funded by European Union and named as "Interfish", meaning integrated rice and fish brought new hopes to farmers to revive the rice field fishery through various strategies. Initial experimentation on a small scale on the southern and northern parts of the country indicated that rice can be grown without pesticides. CARE took an interest in learning the processes invented by Indonesian farmers to eliminate pesticide usage and these were suitably modified for application in Bangladesh. The success achieved in Bangladesh through these initial efforts led to the set up of four larger projects funded by DFID and the European Union to reduce or eliminate pesticide usage in paddy cultivation and bring suitable areas under rice-fish cultivation.

Rice-fish integration trials in Bangladesh

Farmer field schools were established as part of the project activities in different parts of Bangladesh. In each school, farmers from similar economic strata involved in rice farming were brought together. The introduction of fish in to rice fields formed a major component and farmers were encouraged to identify suitable areas to undertake the activity. As not all areas are suitable for rice-fish cultivation due to variation in water holding capacity due to topography and soil type, farmers were advised to identify areas that can retain water and provide suitable aquatic environments for fish to grow. Overall, it is estimated that roughly 10% of the rice field area in Bangladesh will be best suited for rice–fish cultivation. In field schools established in different parts of the country, about 20-30% of the farmers were able to undertake rice –fish production. Areas where at least 10-20 cm of water can be retained for about 3-4 months are considered ideal for rice-fish. Clay soils are considered best in view of their low permeability. The field schools approach adopted by the project assisted immensely in the identification of suitable sites through

A large dyke for community rice-fish activity being built by a group of farmers.

Building dykes through community participation. Children and adults take part in the community effort with equal enthusiasm.

collective efforts.

Agro-ecosystem analysis in paddy fields

Farmers have been employing pesticides for the control of various insect pests. Farmers will not shift to the new way of growing crops without pesticide unless they experience the process by themselves and gain confidence. In paddy fields there are beneficial insects as well as harmful ones but pesticides destroy all of them indiscriminately. However, harmful insects population can be kept under control by following simple practices. This starts by encouraging farmers to make an analysis of the agro-ecosystem that will form the basis for them to make effective management decisions. Biological pesticides and biological control agents are recommended to use for the management of pests. Only when the pest levels cross threshold limits are chemical pesticides advocated. In well-prepared and managed plots, several common pest problems can be avoided and pesticide usage does not arise at all. Fish in rice plots are recognized as one important kind of biological agent that can reduce pest problems.

Many farmers tend to use pesticides as a preventive measure irrespective of whether there is a problem or not. Pesticide companies exploit the psychological fear of farmers through vigorous campaigns. Hence, at least one rice plot is maintained by farmers in each farmer field school and the farmers are assisted to gain confidence in growing rice without pesticide. Fish is considered to be an important component in IPM since fish help rice plants through regular movement, control various types of insects that are dangerous to rice and provide additional food and income. Farmers with fish in their plots avoid pesticides usage and can double their profit through reduced pesticide costs and additional income. This benefit has created interest among other farmers to try this new approach for themselves.

Preparation of field for stocking fish

To undertake rice-fish culture an area of about 10% is advised for creation of canals and refuge areas. It is generally suggested to build canals all around the field of about half a meter depth and width, with a few intermittent canals to help the fish to move all over the paddy field and a refuge area in a low-lying area of the field where fish can shelter even when the canal water level is reduced. Adequate preparation of the field for fish cultivation also helps to obtain the best returns from fish culture depending on the season. For example, dyke height has to be adequately raised in monsoon season to prevent the escape of fish due to flooding and this could be more than half a meter in some areas. However, in the summer period with most fields depending on irrigation small dykes of less than 30 cm will help in preventing fish to move out of the field. While no specific designs were provided to the farmers, they invariably built a refuge area for the fish to take shelter in during low water levels. Provision of a suitable inlet and outlet with screens to allow the water to pass while keeping fish in and undesirable organisms out is considered an important issue by farmers.

Cultivation season

Rice is cultivated throughout the year. While some farmers achieve three crops per year and have fish cycles underway throughout the year most

Planting of rice is generally undertaken by women in several Asian countries, but in Bangladesh the involvement of women in rice cultivation activities is still limited.

farmers restrict fish culture to the monsoon and summer seasons. The monsoon crop, which is undertaken between August and November, is the best season for rice-fish culture as the rainfall is high and there is an abundance of natural food in the rice field, and the fish can be grown to table size. During summer season when the water level in rice fields has to be maintained with canal or ground water the most common practice is fish seed nursing of common carp. Although, those farmers with good water sources continue fish culture during the intervening period between May and August and allow fish to grow in rice fields, most farmers use the fields for growing other crops or leguminous plants and incorporate them into the soil, instead of growing three crops of rice continuously.

Common carp seed produced as an income generating activity are sold to farmers for stocking in rice fields.

Species choice and stocking density

Stocking of fish seed is generally undertaken 10-15 days after rice transplantation. All major carps, silver barb and some times even tilapia are stocked for culture in rice fields during monsoon season, though larger size grass carp seed are avoided. However, common carp, silver barb and when available tilapia, are the preferred species. Bangladesh has a well-established seed production and distribution network and during the monsoon season seed availability is not a major constraint. Farmers select whatever species that are brought by seed sellers, who generally carry mixed species of carps. Some farmers nurse common carp seed during summer months either by breeding themselves or by procuring common carp eggs / fry from farmers. The fish are not generally fed with supplementary food, depending instead on natural food available in rice fields. The density of stocking is based on size of the seed used for stocking, which will be as high as 30,000 seed/ha if the seed is in early fry stage down to 5,000 seed/ha when fingerling stage seed. As the seed is easily available at relatively low cost, farmers often resort to high stocking of 10,000 seed/ha. However, survival of the seed is dependent on size at stocking, stocking density, water depth maintained and the density of predators present in the rice field. When the common carp eggs are stocked in field directly attached to water hyacinth roots only 2-5% survival is usually achieved during the two-month rearing period. However, if the eggs are hatched and spawn are stocked, survival percentage is increased to 15%. When advanced fry and fingerlings are stocked, the survival varies between 30-50%.

Farmers stock all species of carps in rice fields, but avoid large grass carp seed to prevent damage to rice plants.

Fish Production

Production levels ranging between 200-800 kg /ha are normally recorded during one crop of paddy cycle during the monsoon season and around 300 kg in the summer season. In Bangladesh there is a market for all sizes of fish at all times of the year so farmers have no problem in selling their fish. In well-managed rice fields farmers often make more money from their fish harvest than from the rice crop. With the necessary precautions in place, rice fields provide a good environment for wild fish to enter the field and their contribution to production can be substantial depending on locality of rice fields and preventive measures adopted.

Paddy production and use of dykes for vegetable cultivation

The paddy yield has been demonstrated to increase, generally up to 10%, whenever fish are stocked in the rice field. This increased yield is demonstrated during all seasons without any additional input for the fish except adequate stocking of seed.

In addition, farmers have noticed the reduced pest infestation in rice fields. Moreover, the value of the fish yield provides a strong incentive for farmers to avoid pesticide usage, since fish yield can compensate for any loss in paddy production. Dykes are efficiently used for the cultivation of various vegetables with bamboo poles commonly used to provide support for climbing plants. Long bean is the most popular vegetable grown on the dyke and farmers earn substantial income from this activity.

Application of ash to ditches and rice fields is common to increase productivity

Common carp breeding and nursing

This is the common activity undertaken by farmers whenever they have provision to raise the brood of common carp in paddy fields during monsoon season. Spawning of common carp using the hapa system or keeping water hyacinth in a pond or ditch where the fish are stocked are common practices. Water hyacinth acts as a stimulator and induces fish to spawn. This is also an activity in which women are engaged commonly in many parts of the country. Common carp eggs are hatched in the hapa and once the yolk is absorbed they are further nursed by feeding with milk powder, egg yolk and wheat bran and allowed to grow. Income earned from seed production range from 500-1000 Taka / participant. A significant innovation made by farmers is of selling water hyacinth roots with eggs attached to farmers for direct stocking into the rice fields. Most of the seed required for the hatchery and the money necessary to buy the other fish seed is generated by selling common carp seed.

Breeding of common carp using hapa and water hyacinth as a substrate is commonly undertaken by families.

In rice fields, one of the major problems confronted is the predation of spawn by insects, particularly backswimmers. Farmers apply generally kerosene over water surface to eliminate insects. Another method tried, though not popularized, is to cover the water surface with fine mesh nets and thereby prevent the insects from coming to the surface to obtain air, causing them to suffocate and die. Whenever farmers are able to eliminate insect damage to fish seed survival of spawn is better.

Farmers experimenting a new method to kill backswimmers (a kind of predatory insect) by preventing them to come to surface for breathing.

Harvesting of fish is undertaken in the ditches through draining and use of grass nets.

A good crop of fish harvested by farmers. Children get involved with fish from a very early stage.

Community rice fish culture activity

The land holdings of farmers in Bangladesh are typically small with most holding less than two acres of land. Often these small land holdings are distributed in different places and that makes it difficult to undertake rice-fish cultivation since the labor involved to prepare fields is quite high. Further, in fields located in low lying areas, the dykes have to be raised considerably to overcome the problem of floods. Hence, it is often difficult for farmers to make large investment of labor and money to undertake rice fish cultivation in small areas. In some places rice cultivation is not possible because of a high level of water stagnation. In order to overcome these problems, community rice-fish culture was initiated by some enterprising farmers. This needed special efforts to ensure that all the farmers in the locality are brought under the umbrella of this activity. Initially it proved to be a challenge to bring the entire community together, however, when the people began to witness some of the successful examples and recognized as it as a common benefit to the community, the activity began to gain acceptance.

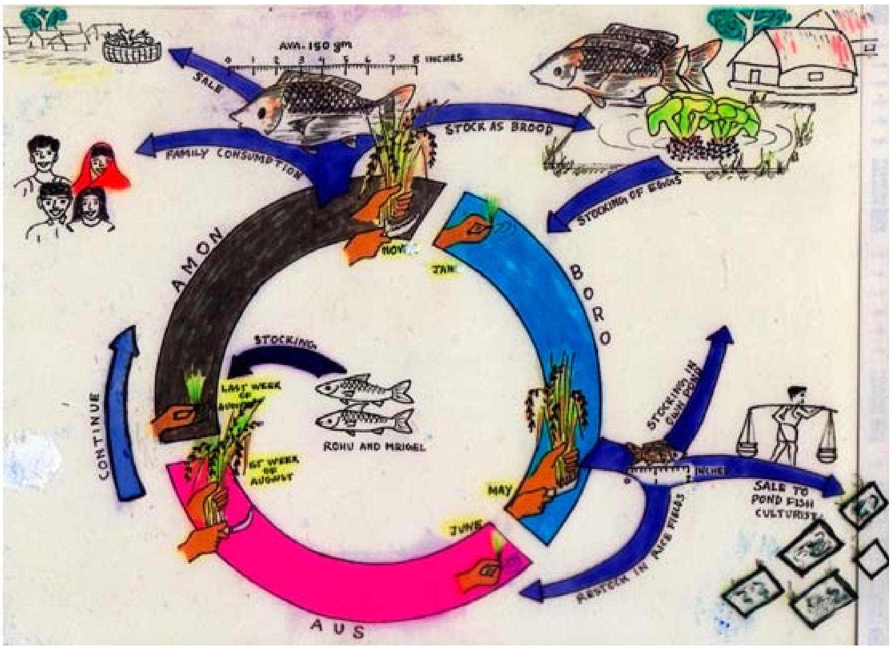
Essential steps needed to ensure success of community fish culture

Many of the areas suitable for community rice-fish culture are also generally the fishing grounds for poor and landless people to gather daily food necessities. It is necessary that those people who depend on the area for food are identified and strategies are devised to include all such dependents in the community efforts, instead of excluding them from the activity. These types of actions have helped to avoid community conflicts and poaching. In addition, it is necessary that participatory decision making process is adopted in all stages. Once the group is formed, involving all the members who will be involved in community fish culture, election of office bearers and development of clear agreement on how the activity will be carried out should be spelt out. Once the agreement is arrived, it is necessary to identify the key tasks to be performed to undertake fish culture. Most importantly all the members should agree to avoid usage of pesticides and follow the principles of integrated pest management. Community fish culture is most easily achieved during the monsoon season when pests and disease problems are less prevalent.

Once the group is formed and leaders are elected, they should be trained by professionally competent persons to ensure that they are empowered with management knowledge as well as technical information. This will help leaders to organize groups into effective bodies. Training modules developed and improved with the experience gained have served the useful purpose of creating a pool of well-trained persons.

Problems encountered in rice fish culture

Rice-fish culture in individual plots is confronted with a labor problem to prepare the field. The perceptions of farmers and the prevailing economic circumstances drive them to avoid any perceived risk to their rice productivity, sometimes compelling them to resort to pesticide application. As the women are not allowed to be involved in rice field



Year round activity of rice-fish culture as observed in Bangladesh (courtesy: Mr. Reshad Alam)

activities in conservative areas, uptake and retention of the activity in such areas is poor. In community fish culture, even with all the training provided, weak leadership has often been the major problem encountered with many of the groups formed. Under such circumstances, small conflicts within the group have often damaged the integrity of the entire group. Several of the community fish culture units created have been closed because of the conflict within the group. On the technical side, as the area under community fish culture is generally large the size of the stocked fingerlings needs to be bigger. If small seed are used, special effort has to be made to rear them using special structures like hapa or cages.

Lessons learned

Rice-fish culture has the most potential and is probably the easiest technique that can be introduced to increase fish productivity. Successful experiences by farmers, including female members of the family, is essential to ensure the continuity of the activity. The chances of the activity continuing are higher once the farmers have observed increases in rice yield. Family labor availability to undertake additional work like construction of dykes and procurement of seed also determines the acceptance of the activity. In community fish culture, unity among members is the key to success and conflicts should be resolved early through community participation. A community approach is a good tool to promote IPM and eliminate pesticide usage. The productivity of fish is higher in community rice-fish production systems as it provides a large area that helps the fish to grow rapidly. Overstocking of fish should be avoided during winter season during which epizootic ulcerative syndrome (EUS) is most common. The development of fish seed banks by undertaking production in the area during the dry season and building the stock of fish seed to save expenses would be beneficial.

Sustainability

A study conducted by CARE, few years after moving out of the project area to check on the sustainability of the introduced activities has revealed that rice fish culture activity as the most common activity sustained by farmers. Wherever farmers retained rice-fish activity, pesticide usage was eliminated. In general, it was concluded that farmers sustain the activity when an activity brings in essential food and / or income to the family and when women do not face social constraints to take part in the activity. Also, when people are provided with much needed knowledge and skills, they use these abilities to address various other problems also that are encountered in the field.

Conclusion

Thousands of farmers experience in Bangladesh clearly indicate that it is possible to grow paddy without pesticides and that the addition of fish brings a double benefit of increasing rice yield as well as adding income. To bring more farmers under rice-fish activity in new areas, it is first essential to create confidence among them that paddy can be grown without pesticides and to demonstrate the increased yields and income. Aquaculture development personnel should proactively interact with agriculture development staff and provide the required field support wherever necessary to promote rice-fish farming. Coming years will see increasing interest in rice –fish culture with increasing acceptance of the IPM concept. Even if only about ten percent of the area under rice cultivation is brought under rice-fish, with a production of only 200 kg/ha, the shortage of fish could be reduced drastically. The experience of CARE in Bangladesh demonstrates that rice-fish culture should not be promoted as a high input system, but rather farmers should be encouraged to try the system with minimal investment on fish seed and raising dykes and allow the fish to feed on the large amount of food available in rice fields.

Research and development on commercial land–based aquaculture of spotted babylon, *Babylonia areolata* in Thailand: Pilot hatchery-based seedling operation

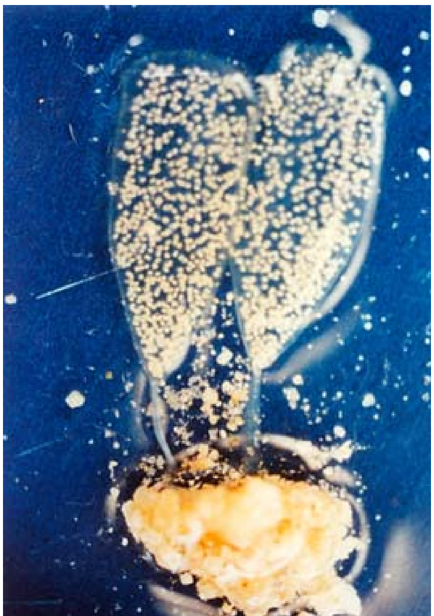
Nilnaj Chaitanawisuti[1] Sirusa Kritsanapuntu[2], and Yutaka Natsukari[3]

1. Aquatic Resources Research Institute, Chulalongkorn University, Bangkok, Thailand 10330; 2. Department of Bioproductions, Prince of Songkla University, Suratani, Thailand 84100; 3. Faulty of Fisheries, Nagasaki University, Bunkyo-Machi, Nagasaki, 852-8521 Japan

Spotted babylon, *Babylonia areolata*, is now an important marine gastropod for human consumption in Thailand. However, natural stocks vary widely from year to year and are decreasing due to continuous exploitation in various traditional fishing areas. Decreased production results in increasing in price and demand. Spotted babylon have been the subject of recent studies, particularly on their fishery and aquaculture because of their economic importance and decreasing natural stocks.

One possible solution to over-exploitation is to develop the appropriate aquaculture systems for spotted babylon as a mean of stock enhancement and increasing market supply. From an aquaculture point of view, spotted babylon has many desirable biological attributes for profitable aquaculture production, thus it is now a promising new candidate for aquaculture in Thailand. Considerable interest has been recently developed regarding the commercial aquaculture of spotted babylon in Thailand due to a growing demand and expanding domestic and export markets. The main target of this study was to develop the pilot commercial hatchery-based operations for seedling production, thereafter, the methods and techniques that have been developed are intended to transfer for the commercial land-based aquaculture operations of spotted babylon in Thailand.

Spotted babylon lay eggs naturally under hatchery conditions all year round with maximum in summer period during February.



Egg capsules are moderately transparent and vasiform in shape and each capsule possesses a short stalk (peduncle) that is cemented to the substrate.

Hatchery operations

One hundred adults of spotted babylon with average shell length of 5.0-7.0 cm were obtained from natural populations by means of baited traps in the Gulf of Thailand. These broodstock were held in 2.5 x 3.0 x 1.0 m (W:L:H) concrete spawning tanks supplied with running ambient unfiltered seawater at a rate of 10 L min^{-1}. A 10-cm layer of coarse sand was provided as substratum. The animals were fed to satiation twice daily with fresh meat of carangid fish, *Selaroides leptolepis*. The adult snails

Adult spotted babylon. These animals were photographed at the DOF Rayong Coastal Fisheries Research Centre, Thailand.

were cultured until natural egg laying occurred in the spawning tanks. Spotted babylon lay eggs naturally under hatchery conditions all year round with maximum in summer period during February – August. Egg capsules are moderately transparent and vasiform in shape and each capsule possesses a short stalk (peduncle) that is cemented to the substrate. The fertilized eggs are visible and suspended in albuminous fluid inside the capsule. Egg capsules averaged 21.43 mm in length, 9.57 mm in width, and 11.40 mm in peduncle length. An average female spotted babylon (5.7 cm in shell length) spawns around 47 egg capsules. The average egg number per capsule was 851.3, and the average egg diameter was 425.70 mm. Spotted babylon fecundity averaged 39,146 eggs per individual.

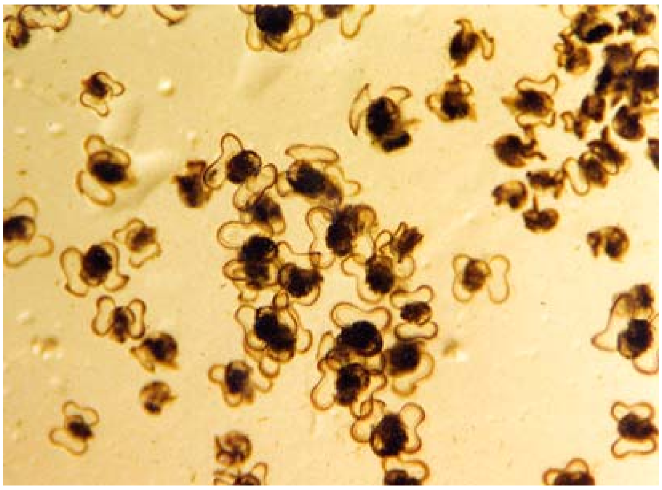
Larval rearing

After the laying of eggs, capsules were collected and rinsed with 1 mm filtered seawater. The capsules were then placed in plastic baskets of 1.0-cm mesh size and submerged in 500 liter cylindrical hatching tanks containing 1-mm filtered and gently aerated ambient seawater. Water was replenished daily until hatching. After hatching, the newly-hatched planktonic veliger larvae were collected with a 200-mm nylon mesh sieve and rinsed with 1-mm filtered, ambient seawater. These veligers were transferred to 500 liter cylindrical rearing tanks containing 1-mm filtered, ambient, continuously aerated seawater. The initial stocking density was 10,000 larvae per liter. Larvae were primarily fed twice daily with $2.0x10^5$ cells ml^{-1} of mixed unicellular microalgae consisting of *Chaetoceros calcitrans* and *Tetraselmis* sp. at a ratio of 1:1). Water was changed every two days.

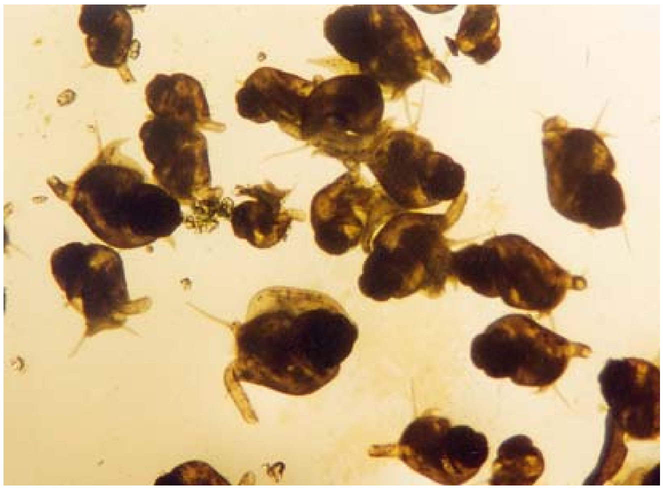
The fertilized eggs are visible and suspended in albuminous fluid inside the capsule. The trochophore larvae developed from single cell to early veliger stage inside egg capsules during the first five days. The veliger hatched out into the water column within 5 days after laying. The average hatching rate was 95.0%. The newly-hatched veliger larvae had a transparent, thin shell and two large, lobed velum. The average shell length of veligers was 720.4 mm. After hatching, veligers were positively phototactic and planktotrophic. By day 14, the presence of a foot and swimming near the bottom were the first indications that the larvae were competent to settle. Metamorphosis juvenile was completed, and the juveniles averaged 1.520 mm long and 1.160 mm wide. Larvae metamorphosed and settled in the absence of substratum.

Juvenile rearing

Spotted babylon larvae were competent to metamorphose within 16-18 days after hatching, at which time they started settling on the bottom of the rearing tanks with no particular substrate provided. After settling, the juveniles were then transferred into 500 liter cylindrical nursery tanks supplied with flow-through ambient seawater at a rate of 5 liters per minute and gently aerated. A 1-cm layer of very fine sand was provided as substrate. They were fed once daily with fresh meat of carangid fish, *Selaroides leptolepis*. Food was offered until the animals stopped eating and the uneaten food was removed. Juveniles were cultured until the average shell length was 5 – 10 mm, which was used for growing-out juveniles to marketable sizes. They



The veligers hatch out into the water column within 5 days after laying.



By day 14, the presence of a foot and swimming near the bottom were the first indications that the larvae were competent to settle. Metamorphosis of juveniles was completed, and the juveniles averaged 1.52 mm long and 1.16 mm wide.

were then harvested and counted for juvenile production, and percentage survival was calculated.

The average growth increment was 84.44 mm in shell length per day, and average survival rate of newly settled juveniles was 3.7%. The juveniles changed their behavior from being herbivorous to carnivorous and they started feeding on fish meat on the first day after settlement. During the period of settlement, heavy mortality occurred because the newly settled juveniles changed the behavior from swimming to be crawling by means of their muscular foot and they continually crawled out of the water and died of desiccation - the nursery tank needs to be designed to prevent this occurring. The newly settled juveniles have to be cultured in nursery tanks until they reached a shell length of 0.5 - 1.0 cm, and thereafter, they were collected for growing-out to marketable sizes.

Economic analysis for pilot commercial hatchery operation

Total investment requirements for construction of the hatchery was US$ 9,310. The building was the largest cost component (37%) of the hatchery. The rearing tank, land, water supply and storage tanks, and algal culture tanks are the second most expensive items in equipping the hatchery, representing 13.57%, 12.35%, 11.11% and 9.87% of total investment, respectively. These five components of the hatchery represent 83.94% of total investment requirements for production of spotted babylon juveniles. Annual ownership costs were estimated to be US$ 2,498 with annual depreciation and interest of US$ 2,153 and US$344, respectively. Annual operating cost is estimated to be US$ 5,311. The hired labor was the largest cost component (51.94%) of the operating cost, followed by electricity, feed and repairs & maintenance of 15.58%, 13.63% and 7.68%, respectively. Total annual cost for the juvenile production (hatchery) phase of spotted babylon culture was US$7,809. Annual ownership and operating costs accounted for 31.98% and 68.02% of the total annual cost, respectively. The major ownership cost item was depreciation on investment representing 27.57% of total annual cost. Hired labor was the highest operating cost items representing 35.33% of total annual cost.

The cost associated with producing juvenile spotted babylon is expressed as US$ per 1,000 juveniles (42.5 Thai Baht is approximately 1US$). The cost of producing 1,200,000 juveniles in this hatchery design was estimated at US$ 6.09 per 1,000 juveniles. However, as the total number of juveniles produced per year decreases, then cost increases. For example, if 427,000 juveniles (approximately 0.5% survival) are produced, utilizing the same level of inputs, the estimated cost of production increases to US$18.29 per 1,000 juvenile. This analysis suggests that at a 1.5% survival rate the break even point would be US$ 13.80.

The veligers were transferred to 500 liter cylindrical rearing tanks containing 1-mm filtered, ambient, continuously aerated seawater.

Thereafter, gross return and net return at these levels are US$ 17,678 and US$ 9,868 respectively. Return to capital and management, and return on investment at these levels are US$ 12,365.8 and 1.33, respectively. Under the basic assumptions in this study (juvenile production of 1.2 million/ year), a selling price of 13.8 US$ per 1,000 juveniles results in a positive cash flow by year 2. Based on juvenile production of 1.5% survival and selling price of 13.8 US$ per 1,000 juveniles production is economically feasible under the assumptions employed.

An underlying assumption in this analysis is that survival rate and market price are sensitive to farm output. The analysis assumes a constant market price, which may not be valid as the production volumes from large-scale operations are released onto the market. Investors in spotted babylon aquaculture should be aware of the potential negative effects on market prices as output levels increase. This study serves as a guideline for understanding the economics of commercial juvenile production. Costs can be lowered considerably by improving growth and survival rate. This economic analysis is intended as a guide and must be modified to reflect individual situations.

Please contact for further information and collaborations to: Dr. Nilnaj Chaitanawisuti, Aquatic Resources Research Institute, Chulalongkorn University, Phya Thai Road, Pathumwan, Bangkok 10330, Tel (662) 2188160-63, Fax (662) 2544259, e-mail: nilnajc1@hotmail.com or cnilnaj@chula.ac.th.

References

Chaitanawisuti, N. and Kritsanapuntu, A. 1997. Effects of stocking density and substrate presence on growth and survival of juvenile spotted babylon, *Babylonia areolata* Link, 1807 (Neogastropoda: Buccinidae). Journal of Shellfish Research, 16: 429-433.

Chaitanawisuti, N. and Kritsanapuntu, A. 1997. Laboratory spawning and juvenile rearing of the marine gastropod: spotted babylon, *Babylonia areolata* Link, 1807 (Neogastropoda: Buccinidae) in Thailand. Journal of Shellfish Research. 16: 31-37.

Chaitanawisuti, N. and Kritsanapuntu, A. 1998. Growth and survival of hatchery - reared juvenile spotted babylon *Babylonia areolata* Link, 1807(Neogastropoda: Buccinidae), in four nursery culture conditions. Journal of Shellfish Research. 17: 85-88.

Chaitanawisuti, N. and Kritsanapuntu, A. 1999b. Experimental culture of hatchery - reared juvenile spotted babylon *Babylonia areolata* Link, 1807 (Neogastropoda: Buccinidae) in Thailand. Asian Fishery Science. 12: 77-82.

Chaitanawisuti, N., Kritsanapuntu, S. and Natsukari, Y. 2002c. Economic analysis of a pilot commercial hatchery-based operation for spotted babylon *Babylonia areolata* Link, 1807 juveniles in Thailand. (Publishing in journal of Shellfish Research. 21 (2): (in press).

Munprasit, R. and Wudthisin, P. 1988. Preliminary study on breeding and rearing of areolata babylon (*Babylonia areolata*). Technical Paper No. 8. Eastern Marine Fisheries Development Center, Marine Fisheries Division, Department of Fisheries. 14 pp. (in Thai).

Poomtong, T. and Nhongmeesub, J. 1996. Spawning, larval and juvenile rearing of *Babylonia spirata* (L) under laboratory conditions. Phuket Marine Biological Center Special Publication. 16: 137-142. (in Thai).

Siripan, N. and Wongwiwatanawute, C. 2000. Breeding and nursing of the spotted Babylon (*Babylonia areolata* L.). Thai Fisheries Gazette. 53(4): 348-359. (in Thai).

Table 1: Initial investment requirements for hatchery production of spotted babylon juveniles.

Hatchery equipment	Hatchery equipment	Hatchery equipment	Hatchery equipment
Land		1,149.40	12.35
Building (300 m^2)	1	3,448.30	37.04
Broodstock tanks (3x3x0.7 m)	3	229.90	2.47
Larval rearing tanks (500 L)	30	689.70	7.40
Nursery tanks (500 L)	15	344.80	3.70
Algal rearing tanks (500 L)	10	229.90	2.47
Mass Algal rearing tanks (3 ton)	5	689.70	7.40
Aeration system	1	229.90	2.47
Water supply and drainage	1	574.70	6.17
Storage tanks (20 m^3)	2	459.80	4.94
Algal laboratory	1	804.60	8.65
Hatchery equipment	1	459.80	4.94
Total		9310.50	100

Table 2: Estimated annual costs for hatchery production of spotted babylon juveniles

Item	Cost (US$)`	Percent of total cost
Ownership costs		
• Depreciation	2,153.10	27.57
• Interest on investment	344.40	4.41
• Total ownership cost	2,497.50	31.98
Operating costs		
• Repairs and maintenance	408.00	5.23
• Hired labor	2,758.60	35.33
• Feed	724.10	9.28
• Broodstock purchase	413.80	5.29
• Electricity	827.60	10.59
• Interest on operating capital	179.60	2.30
Total operating cost	5,311.80	68.020
Total annual cost	**7,809.30**	**100**

Table 3: Estimated total annual cost for production of spotted babylon juveniles at selected survival rates

Survival rate* (%)	Annual production (juveniles)	Annual costs (US$)	Cost per 1,000 juveniles (US%)
0.5	426,996	7,809.3	18.29
1.0	853,992	7,809.3	9.14
1.5	1,280,988	7,809.3	6.09
2.0	1,707,984	7,809.3	4.57
2.5	2,134,980	7,809.3	3.66
3.0	2,561,976	7,809.3	3.05
4.0	3,415,968	7,809.3	2.29
Survival rate is calculated from veliger larvae to juveniles of 1.0-cm shell length with an average monthly egg capsule and veliger production of 8,180 and 7,116,600, respectively.			

Table 4: Gross return for hatchery production of spotted babylon juveniles at selected survival rates and selling prices

	Selling price (US$ per 1,000 juveniles)				
Survival (%)	**9.2**	**13.8**	**16.1**	**18.4**	**22.9**
0.5	3,928.3	5,892.5	6,874.6	7,856.7	9,778.2
1.0	7,856.7	11,785.0	13,749.3	15,713.4	19,556.4
1.5	11,785.1	17,677.6	20,623.9	23,570.1	29,334.6
2.0	15,713.4	23,570.2	27,498.5	31,426.9	39,112.8
2.5	19,641.8	29,462.7	34,373.2	39,283.6	48,891.0
3.0	23,570.2	35,355.3	41,247.8	47,140.3	58,669.3
4.0	31,426.9	47,140.4	54,997.1	62,853.8	78,225.7
Gross return was calculated for each level of survival and selling price.					

Table 5: Net return for hatchery production of spotted babylon juveniles at selected survival rates and selling prices

	Selling price (US$ per 1,000 juveniles)				
Survival (%)	**9.2**	**13.8**	**16.1**	**18.4**	**22.9**
0.5	-7,556.3	-19,168	934.7	47.4	1,968.9
1.0	47.4	3,975.7	5,940.0	7,904.1	11,747.1
1.5	3,975.8	9,868.3	12,814.6	15,760.8	21,525.3
2.0	7,904.1	15,760.9	19,689.2	23,617.6	31,303.5
2.5	11,832.5	21,833.4	26,563.9	31,474.3	41,081.7
3.0	15,760.9	27,546.0	33,438.5	39,331.0	50,860.0
4.0	23,617.6	39,331.1	47,187.8	55,044.5	70,416.4
Net return was calculated from the gross return minus total annual cost (7,809.3 US$).					

Native catfish culture – a boon to Indian fish farmers

M.A. Haniffa

Centre for Aquaculture Research and Extension (CARE), St. Xavier's College (Autonomous), Palayamkottai – 627 002, Tamilnadu

The literature on catfish culture is limited and outdated and the promise of catfish culture has yet to be fulfilled. Whereas carp culture and tilapia culture are familiar practices, catfish culture has yet to be popularised among fish farmers. Catfish culture has a number of advantages over the former; viz. greater survival in oxygen-depleted waters, tolerance to crowding, high stocking rates on artificial feeds, fewer intramuscular bones, tender flesh and delicious taste. However, the catfish culture industry needs considerable R&D input to solve its problems.

Catfishes belonging to the families Ictaluridae are widely distributed in different parts of the world and their culture is now common in the Philippines and Thailand (*Clarias macrocephalus*, *C. batrachus*), Cambodia (*Pangasius*), Africa (*C. gariepinus*), Europe (*Silurus glanis*) and USA (channel catfish *Ictalurus punctatus*, white catfish *I. cactus* and blue catfish *I. furcatus*).

Freshwater aquaculture research in Asia has mainly concentrated on propagating carps and during the past 30 years their culture and breeding techniques have been standardized and / or transferred to fish farmers. With regards to catfish, culture systems are yet to be established in many countries of Asia[1,2]. In India, culture of 'magur' catfish (*Clarias* sp.) has been given greater priority than the 'singhi' *Heteropneustus fossilis*. At present, most of the Indian fish farmers have directed their attention towards to African catfish *Clarias gariepinus* due to the opportunity for short-term profit, faster growth and cheap mode of feeding, irrespective of the potentially disastrous effects of this exotic fish escaping.

The culture of *H. fossilis* could be an alternative for farmers since they grow fast at high density. Moreover, *H. fossilis* is preferred all over India due to its taste and medicinal properties. *H. fossilis* inhabits muddy bottoms of weed infested swamps, subsisting on rich benthic fauna and detritus of decaying organic matter[3].

Captive breeding of *H. fossilis*

H. fossilis were collected from local fishermen and stocked in earthen ponds. Test fishes were maintained under ambient photoperiod and temperature and fed with chicken intestine at 5% of body weight. A few aquatic plants such as *Eichhomia crassipis* and *Hydrilla verticillata* were introduced into the ponds to provide cover for the fish. The induced breeding experiments were attempted in October-December 2002. Mature healthy males and females (200-250g) were selected. The females can be identified very easily by their bulging vent. In males, the vent is pale and a papilla-like structure is prominent, with a pointed tip. Each breeding set in our experiment consisted of two males and two females and about 20 sets were selected for seed production. Based on our previous reports[4], 0.5ml of ovaprim / kg was injected intramuscularly in the dorso-lateral region of the body. The injections were given in the late evening or early morning. Immediately after administering the hormones the breeding sets were released into cement breeding tanks (3 x 1 x 1 metre deep) provided with *H. verticillata* to provide cover. Water quality parameters recorded during the study were temperature (29 ± 1°); dissolved oxygen (5.8-6.5mg / l); and pH (7.5-8.1). *H. fossilis* spawned after a latency period of 18-24 hours and the number of eggs laid ranged between 3,000-4,000 per fish.

Culture of *H. fossilis*

After 48 hours the hatchlings were released into earthen pits (1.8 x 1.2 x 0.6 metre depth) excavated near the bank of Elanthakulam pond behind our college. Water currents were created using a flow-through system and the pits were fertilised with cow dung, urea and phosphate. The hatchlings were released into the pits and left undisturbed for about 20 days. Once they reached the fry stage, they were selected for culture. An open well (12 x 12 x 7 metres deep) in the centre of the pond was selected for *H. fossilis* culture. Mr Immanuel, a fish farmer trained in our college, attempted the culture using semi-scientific techniques.

During January 2003 the fry reared in the earthen pits were directly released into the well. Water depth in the well ranged between 1.5 metres during summer and 4 metres during the rainy season. Cow dung, thumbe plant and Indian indigo plant and tapioca leaves were cut into pieces and placed in a sack, which was added to the well and allowed to decay. After a few days the decomposing materials had completely mixed with the soil on the pond bottom. In addition, wastewater from the adjacent household was allowed to enter the well. Once per month fish waste collected from the local fish market was chopped into pieces and put in the well with waste rice collected from nearby marriage halls.

The depth of the well was about 1.5 metres during the culture period from January to August 2003. During these seven months *H. fossilis* were left undisturbed, but after which the water was removed from the well and the fish captured using a dragnet. The fish were not of uniform size, with about 400 small fish (50-75g), 350 medium fish (150-200 g) and 300 large fish (200-250g). The total weight of these fish was about 125kg, translating to a yield of around 800kg/ha over a seven month period, and the farmer sold them to the nearby market for Rs. 9,000 (US$ 200). The present culture practice clearly shows that *H. fossilis* can be cultured at a very high density of about 7,000 adults per hectare. Munshi[3] recommended an ideal stocking rate of up to 50,000 fingerlings per hectare in semi-intensive culture operations.

In the present investigation the fish farmer successfully attempted the culture of *H. fossilis* at Elanthakulam with only basic knowledge obtained from CARE. He was unaware of issues such as accumulation of metabolites in the pond, rise in ammonia concentrations or the management of algal blooms. According to Thakur and Das[4] the production potential of *H. fossilis* has been assessed by quite a number of field trials with results ranging in Assam from (900-5,000kg/ha/ year). Bihar (200-400kg/ha), Delhi and West Bengal. Huarong[6] reported a maximum production of 1.2 – 2.0 tonnes / ha for *Clarias leather*. However, the average yield of *Clarias* in Thailand is 29 – 32.6 tonnes / ha / year.

The results of this study suggest that there are good prospects that catfish can be cultured scientifically with more profit than carp culture.

Acknowledgements

We thank Rev. Dr. A. Antonysamy S.J., Principal, St Xavier's College for providing facilities to train unemployed youths for fish culture. Financial assistance was by the ICAR-NATP (NATP/Sci/2000), DST, ICAR and DBT to establish required infrastructure at the Centre for Aquaculture Research and Extension is gratefully acknowledged. Thanks are also due to Mr Immanuel for assistance.

References

1. Rao, G.R., Tripathi, S.D. and Sahu, A.K. (1994). Breeding and seed production of the Asian catfish *Clarias batrachus* (lin). Central Institute of Freshwater Aquaculture, Barrackpore pp. 47.
2. Haniffa, M.A., Jesu Arockia Raj, A. and Arul Mozhi Varma, T. (2001). Optimum rearing conditions for successful artificial propagation of catfish. NBFGR-NATP Publication No.3. Captive breeding of aquaculture and fish germplasm conservation. Paper No. 4.
3. Munshi, J.S.D. (1996). Ecology of *Heteropneustes fossilis*, an air-breathing catfish of south-east Asia. Narendra Publishing House, Delhi. Pp 174.
4. Vijayakumar, C., Sridhar, S. and Haniffa, M.A. (1998). Low cost breeding and hatching techniques for the catfish *Heteropnuestes fossiliu*s for small-scale farmers. NAGA 21 (4): 15-17.
5. Thakur, N.K. and Das, P. (1986). Synopsis of biological data on magur *Clarias batrachus*. Bulletin No. 41. Ed Halder, D.D. CIFRI, Barrackpore.
6. Huarong, C. (1996). Techniques for rice-catfish culture in zero tillage rice fields. Rice-fish culture in China: Zero tillage rice fields. IDRC.

A commodity-by-commodity guide to impacts and practices

By Jason Clay

Former US President Jimmy Carter says it is a practical, balanced guide for family farmers, giant agribusiness, and policy makers who want to meet the needs for this and future generations.

This book, a copy of which was generously given to me by the author, *informs* (there are some 400,000 shrimp producers in the world most of whom are independent; there are 1-1.5 million people employed directly by the shrimp industry who tend to be paid double or more than double the going rate for labour in their areas; another million depend on the industry for a major portion of their livelihood); *fascinates* (one of the major incentives of King Leopold of Belgium to occupy central Africa in the end of the 19th century was to access a vine that yielded latex; 3000 metric tons of zinc go into the environment a year from the wear and tear of rubber tires alone); *warns* (cutting corners has put the salmon industry at greater risk and in a place where neither government nor the industry is prepared to address, much less anticipate, future crises as they arise, a potentially explosive situation); and *provokes* (evidence suggests that smaller, more marginal producers may actually cause the bulk of environmental damage in both developing and developed countries).

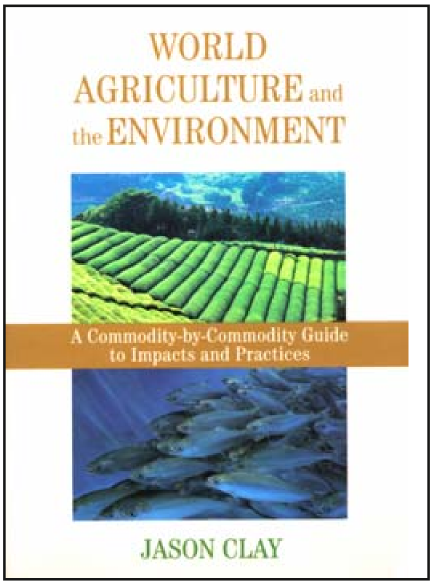
But mainly, it *describes and analyses* how the production of a variety of agricultural commodities impact on our ecosystems, and *suggests* measures that producers, consumers and policymakers can take to mitigate those impacts.

World Aquaculture and the Environment deals with 22 major commodities including shrimp and salmon (a significant amount of the information and analyses that went into the shrimp chapter came from or were based on the studies and reviews made under the Consortium on Shrimp and the Environment whose members are NACA, FAO, World Bank and WWF; Jason Clay, Vice President of World Wide Fund US, anchors the work contributed by WWF).

The book explores the main threats that key agricultural commodities pose to the environment as well as the overall global trends that shape those threats. It then identifies new practices as well as tried-and-true ones that can increase production while minimizing environmental costs. Jason Clay's position is that working with farmers directly to identify or co-develop better management practices or BMPs may be far more effective in the short term and may provide better information to inform trade and policy strategies.

The book aims to show there are new ways of thinking and acting to reduce agricultural impacts; it suggests that a better approach is not what to think in any specific circumstance but how to think. Its rich content and tight analysis provides more than enough for this mode of mental exercise. A bonus is that it is also entertaining.

Reviewer: Pedro Bueno, NACA



Advice on Aquatic Animal Health Care: Question and answer on shrimp health

Pornlerd Chanratchakool
Aquatic Animal Health Research Institute, Department of Fisheries, Thailand
Email: pornlerc@fisheries.go.th

Dr Pornlerd Chanratchakool is a shrimp health and production management expert. He lectures in the joint NACA/AAHRI annual training course on shrimp health management.

In this issue we have selected some of the many questions that Dr Chanratchakool receives from farmers in Thailand, that may be of general interest to farmers.

1. Why at present are many farmers having slow growth problems with their shrimp ? What is the cause of these problems ?

The slow growth problem in shrimp may have two main causes:

1. The stocks could have been infected with virus such as HPV (hepatopancreatic parvo-like virus) or MBV (monodon baculovirus). These infect the hepatopancreas of the shrimp, damaging their digestive system.

2. Slow growth may also result from stocking of small-sized PL in clear-water ponds that don't have adequate algal blooms and which cannot provide enough natural food. A few PL will manage to find enough food to grow but many will not.

2. After three months of culture there are a lot of shrimp that are weak and unhealthy with thin bodies and that are growing slowly, why?

This problem is related to the shrimp consuming the available natural food supply and also to seasonal pond preparation to control the water colour around day 40-70 of culture. This problem is best avoided in the first place by preparing the pond well before stocking. If it occurs, try to remove the waste from the pond using pull chains, increase dissolve oxygen with aeration and try to control plankton bloom.

3. Preparation of water colour before releasing the PL is difficult, the pond water colour only turned green for 2-3 days and after that the water became clear. How can we get an adequate algal bloom in the pond ?

Some of the possible causes of this problem are:

1. There is not enough fertilizer in the pond to support a phytoplankton bloom.

2. There is not enough sunlight on the pond.

3. There is not enough carbon dioxide in the pond.

In the first case you can fertilize the pond with cow-manure at a rate of 50-100 kg per rai and then another 5-10 kg per rai every 3-5 days. In some case can use ammonium nitrate fertilizer at a rate of 30-50 litres per rai with another 10-20 litres per rai every 2-3 days until the water colour improves in acid soil ponds. The second case is difficult to solve. In the third case, if the alkalinity is lower than 50 ppm you should add carbonate lime at the rate of 100-150 kg per rai every 3-5 days until alkalinity has reached more than 80 ppm.

If I can't make the water colour naturally, it is ok to use artificial water colourants ?

You can use artificial colourants but only for a short time. As a temporary solution apply around 1-2 bag per rai (it depends on the kind of colourant you are using, so make sure you check the manufacturers instructions carefully). The problem with using artificial colour is that, unlike a natural plankton bloom, there is no natural food for shrimp PL to feed on. It also cannot help to absorb ammonia and nitrite in water like plankton do. There is no substitute for a natural plankton bloom – it is necessary to prepare the shrimp pond to get the natural plankton.

During heavy rain, is it necessary to lime the bank of the pond ?

It is necessary in the case of newly excavated ponds in areas where there are acid soils. This can usually be determined by observing an orange colour at the soil surface or in ponds where the alkalinity is less than 50 ppm and pH lower than 7.5. Under these conditions shrimp may be not able to molt or will have soft shell.

If it is raining, does it matter if we postpone the feeding time or not ?

It depends on many factors including how heavy or frequent the rain, what kind of feed is used, the condition of the earthen pond and on water quality, particularly temperature and dissolved oxygen levels. The decision of whether or not to postpone feeding should be made considering the interaction of such factors. For example, if it rain for several days, then it is not necessary to postpone feeding but the quantity of food can be reduced by at least 20-30 %. If the water temperature is less than 23°C and it has rained in the afternoon, it can be postponed

ตอบปัญหาประมง

1. ทำไมปัจจุบันจึงมีกุ้งแคะแกรนมาก ทั้งๆที่ให้อาหารมากกว่าเดิม สาเหตุเกิดจากอะไร และแก้ไขหรือป้องกันอย่างไร

ตอบ กุ้งแคะแกรนหรือกุ้งจิ๊กโก๋เกิดจากสาเหตุที่สำคัญ 2 ประการ คือ

1. เกิดจากการติดเชื้อไวรัสเอชพีวี (HPV, Hepatopancreatic Parvo like Virus) หรือ เอ็มบีวี (MBV, Monodon Baculovirus) โดยที่เชื้อไวรัสดังกล่าวจะทำลายเซลตับและตับอ่อน ทำให้การย่อยอาหารการดูดซึมอาหารผิดปรกติ กุ้งจึงโตช้าหรือไม่โต
2. เกิดจากการปล่อยลูกกุ้งตัวเล็กมากลงไปในบ่อที่น้ำใส อาหารธรรมชาติไม่มี ตัวไหนโตอยู่แล้ว ได้อาหารกินก็โตไป ตัวที่ไม่มีอะไรกินก็จะไม่โต

2. ทำไมจึงมีกุ้งกรอบแกรบ (กุ้งผอม ตัวหลวม) เกิดมากหลังจากเลี้ยงกุ้งไปประมาณสามเดือน และกุ้งโตช้าด้วย

ตอบ ปัญหานี้จะสัมพันธ์กันในเรื่องการกินอาหารกับเรื่องฤดูกาล ตัวกรอบแกรบจะค่อนข้างสัมพันธ์กับบ่อที่มีปัญหาการเตรียมบ่อ เตรียมสีน้ำตั้งแต่ต้น คือกุ้งมีปัญหาช่วงอายุ 40 - 70 วันขึ้นไป มักจะเกิดปัญหาตั้งแต่การเตรียมบ่อ เตรียมน้ำตั้งแต่แรก ทุกวันนี้วิธี การเลี้ยงจะเปลี่ยนไปจากเดิมมาก คือ สมัยก่อนต้องทำสีน้ำ พอทำ สีน้ำเสร็จจึงปล่อยลูกกุ้ง ซึ่งใช้เวลาเตรียมประมาณ 20 วัน ปัญหา ขี้แดดสาหร่ายที่พื้นบ่อเกือบจะไม่มี ลูกกุ้งลงไปอยู่ในพื้นบ่อที่ค่อนข้างสะอาด แต่ในปัจจุบัน มีการใช้ยาฆ่าเชื้อทรีท น้ำ และสั่งลูกกุ้งไว้แล้ว จำเป็นต้องปล่อยเพราะถ้าไม่ปล่อยก็ไม่มีลูกกุ้ง ในที่สุดต้องปล่อย ลูกกุ้ง ในขณะน้ำใส จึงมีปัญหาเกิดขึ้น บ่อที่เลี้ยงกุ้งมานานที่พื้นดินก้นบ่อจะมีปุ๋ย มีสารอินทรีย์ ขี้กุ้งตกค้างอยู่มาก เมื่อแสงแดดส่องถึงพื้นสาหร่าย ตะไคร่ก็ขึ้นเคลือบพื้นบ่อ เมื่อน้ำใส สิ่งที่เกษตรกรต้องรีบจัดการก็คือ พยายามทำสีน้ำจึงใส่ปูน ใส่ปุ๋ยไปค่อนข้างเยอะมาก หลังจากนั้นประมาณ 20 วัน สีน้ำเริ่มขึ้น ขณะเดียวกันสาหร่าย ตะไคร่ที่พื้นบ่อไม่โดนแสง ก็เริ่มตาย ซึ่งเป็นจุดเริ่มต้นของการติดเชื้อของกุ้ง เมื่อพื้นบ่อเน่า ขาดออกซิเจนที่ผิวและในชั้นดิน สารอินทรีย์จะถูกย่อยโดยกระบวนการไม่ใช้ออกซิเจน สิ่งที่เกิดขึ้นคือ แอมโมเนีย ไนไตร์ท และแกสไข่เน่า ซึ่งกลไกนี้มักเกิดประมาณ 20 - 25 วัน เป็นต้นไป โดยในบ่อที่สีน้ำเกิดขึ้นเร็ว เหตุการณ์นี้ก็จะเกิดเร็ว เช่น ถ้าปล่อยกุ้งในช่วงเดือนมีนาคม เหตุการณ์นี้อาจจะเกิดขึ้นในเดือนเมษายน ซึ่งอุณหภูมิสูงมาก จะสังเกตได้ว่าปลายเดือนมีนาคม ถึงต้นเมษายน จะมีกุ้งป่วยมาก ถ้าบ่อที่มีการเตรียมการณ์ไว้ดี มีบ่อพักน้ำหากทำสีน้ำไม่ขึ้นสิ่งที่เกษตรกรทำได้คือ ระบายน้ำออกเติมน้ำใหม่เข้า ซึ่งในน้ำใหม่จะมี แพลงก์ตอน การทำสีน้ำจึงขึ้นได้เร็วหรือ ถ้าไม่สามารถจัดการเปลี่ยนถ่ายน้ำได้ แต่หากสามารถระบายน้ำทิ้งได้ ปริมาณของแอมโมเนีย ไนไตร์ท ลดลงกุ้งก็อาจจะฟื้นตัวกลับมากินอาหารได้ แต่ถ้าไม่มีการเตรียมการณ์ไว้โอกาสที่จะรอดค่อนข้างยาก เนื่องจากการย่อยสารอินทรีย์ที่เร็วมาก หากออกซิเจนในบ่อสูงมากพอก็ไม่มีปัญหา แต่ถ้ามีขี้แดดในบ่อ ออกซิเจนที่พื้นหรือในชั้นดินที่มีการย่อยต่ำก็จะทำให้พื้นเน่า เกิดแอมโมเนีย ไนไตร์ท ขึ้นซึ่งในช่วงหน้าแล้งแดดจัด พีเอชน้ำส่วนใหญ่สูงกว่า 9 ซึ่งจะทำให้แอมโมเนียเป็นพิษมากขึ้น และเมื่ออุณหภูมิสูงขึ้นถึง 34 - 35°C ความเป็นพิษจะเพิ่มขึ้นอีก โอกาสกุ้งรอดตายจึงต่ำมาก โดยเฉพาะในช่วง 40 - 70 วัน ถ้าหากผ่านช่วงนี้ไปได้นั่นแสดงว่าสภาพพื้นบ่อเริ่มดีขึ้น มีการเปลี่ยนถ่ายน้ำ ระบายของเสียทิ้งไป กุ้งอาจจะฟื้นตัว แต่พอฟื้นตัวขึ้นมา บ่อที่เคยมีปัญหาขี้แดดตั้งแต่ต้น จะมาเกิด ปัญหาอีกครั้งหนึ่งประมาณ 80 วัน หรือ 100 วัน เนื่องจากของเสีย ที่สะสมอยู่มากขึ้น เมื่อกุ้งอายุ 3 เดือนขึ้นไปจะพบกุ้งเริ่มกินอาหารน้อยลง และมีกุ้งตัวสกปรกเกาะตามขอบบ่ออยู่เรื่อยๆ โดยเฉพาะ ช่วงลอกคราบ น้ำหนักตัวไม่เพิ่มขึ้น บ่อประเภทนี้ เลี้ยงไปเลี้ยงมาแทนที่จะได้กุ้งเพิ่มขึ้น ปรากฏว่าเหลือกุ้งน้อยลงไปเรื่อยๆ เมื่อจับกุ้ง FCR มีค่าสูงมาก สรุปว่าเสียเวลาฟรีไม่มีกำไร ปัญหาดังกล่าวนี้มีสาเหตุเริ่มจากการเตรียมบ่อ เตรียมน้ำ ถ้าพลาดตั้งแต่จุดแรกปัญหาจะต่อเนื่องไปจนจับ

3. เตรียมสีน้ำก่อนปล่อยลูกกุ้งยากมาก สีน้ำเกิดขึ้น 2 - 3 วัน แล้วน้ำก็ใส ควรแก้ไขอย่างไร

ตอบ การที่สีน้ำเกิดเพียง 2 - 3-วันแล้วใส เกิดได้หลาย ๆ สาเหตุ คือ
1. ในบ่อมีปุ๋ยน้อยเกินไป
2. เกิดจากไม่มีแสงแดด
3. เกิดจากไม่มีคาร์บอนไดออกไซด์ในบ่อ

ในกรณีแรกอาจเติมปุ๋ยเพิ่มเติม โดยเฉพาะการใช้ปุ๋ยคอก เช่น ขี้ไก่แห้งในอัตรา 50-100 กิโลกรัม/ไร่ และหลังจากนั้น เติมปุ๋ยประมาณ 5-10 กิโลกรัม/ไร่ ทุก ๆ 3 - 5 วัน บางกรณีการใช้กาก ผงชูรส (อามิ-อามิ) ในอัตรา 30 - 50 ลิตร/ไร่ครั้งแรก และเติม 10 - 20 ลิตรต่อไร่ ทุก ๆ 2 - 3 วัน จะทำให้สีน้ำคงที่ได้ง่ายขึ้น โดยเฉพาะในบ่อที่เป็นดินกรด

ส่วนในกรณีที่มีแสงน้อยเกินไป คงแก้ได้ยากมาก อาจทำได้โดยพยายามใส่ปุ๋ยในบ่อพักน้ำให้เกิดสีน้ำก่อนนำเข้าบ่อเลี้ยง หรืออาจจะเติมปุ๋ยด้านท้ายลมซึ่งมักจะมีแพลงค์ตอนหนาแน่นกว่าก็จะช่วยได้พอสมควร

ในบ่อที่เป็นดินกรดหรือมีการใช้เคมีในการฆ่าเชื้อในน้ำก่อนการเตรียมน้ำ มักจะพบว่าในน้ำจะมีค่าความเป็นด่าง (อัลคาไลน์) ต่ำกว่า 50 ส่วนในล้านส่วน กรณีเช่นนี้ ควรจะเติมปูนในกลุ่มคาร์บอเนตในอัตรา 100 - 150 กิโลกรัม/ไร่ ทุก ๆ 3 - 5 วัน ให้ค่าความเป็นด่างสูงกว่า 80 ส่วนในล้านส่วน สีน้ำจะเกิดได้ง่ายขึ้น

ในทุกกรณีหากสามารถเติมน้ำเขียวจากบ่อข้างเคียง ซึ่งไม่มีกุ้งเป็นโรคเข้ามาก็จะช่วยให้สีน้ำเกิดได้เร็วขึ้น เมื่อสีน้ำเกิดแล้ว ควรตีน้ำอย่างน้อย 2 ด้านของบ่อ เพื่อให้เกิดการหมุนเวียนของปุ๋ยและแพลงค์ตอนอย่างต่อเนื่อง

4.หากสีน้ำไม่เกิด การใช้สีน้ำเทียมเติมลงไปจะมีผลด-ผลเสียอย่างไ

ตอบ ในกรณีที่สีน้ำไม่เกิด กุ้งเริ่มมีสีเข้มมากขึ้นและไม่กินอาหารที่พื้นบ่อ เนื่องจากเกิดการตายของสาหร่าย ตามพื้นบ่อหรือมีขี้แดดเริ่มเกิดขึ้น ก็สามารถใช้สีน้ำเทียมแก้ปัญหาเฉพาะหน้าได้ โดยการใช้ในอัตรา 1-2 ถุง/ไร่ (ขึ้นกับชนิด) ซึ่งจะช่วยลดการเจริญของสาหร่ายพื้นบ่อได้ แต่อย่างไรก็ตามในบ่อจะไม่มีอาหารธรรมชาติหรือสัตว์น้ำดินเกิดขึ้น และสีน้ำดังกล่าวจะไม่ช่วยในการดูดซับแอมโมเนีย และไนไตรท์จากน้ำเช่นเดียวกับแพลงค์ตอน ดังนั้นจึงยังจำเป็นที่จะทำสีน้ำจากแพลงค์ตอน ซึ่งหากมีการใช้สีน้ำเทียมเข้มเกินไป การเกิดแพลงค์ตอนธรรมชาติก็จะยากขึ้น ในกรณีที่มีซากสาหร่ายพื้นบ่อเริ่มตายมากขึ้นอาจต้องใช้โซ่ลากหรือตีน้ำให้แรงขึ้นเพื่อให้ซากสาหร่ายหลุดลอยขึ้นมา พื้นบ่อจะสะอาดขึ้น กุ้งจะลงไปกินอาหารที่พื้นบ่อได้ดีขึ้น

Women in coastal aquaculture: Performance, potential, and perspectives

D. Deboral Vimala, Ch. Sarada, P. Mahalakshmi, M. Krishnan and M. Kumaran

Women play a major role in all areas of Indian fisheries, making a substantial contribution to total income in comparison to their counterparts in other sectors[1]. Their role is not limited to fishing or farming activities, but also includes post harvest handling, processing and marketing. In brackishwater areas womenfolk were observed to involve themselves in a wide variety of aquaculture activities in addition to their well-established traditional roles. A recent project from our Institute[2] has revealed that in aquaculture, women are involved in almost all the same activities as men but on a reduced scale. In order for women to become empowered they need to become economically self-reliant and earn supplementary income for their families. This would not only improve the status of women in the family but also within the community as a whole.

Approximately 500,000 of the 1.2 million people employed in post harvest sector are women[3]. Even though the participation of women in aquaculture is currently on a limited scale there is enormous scope for their participation to increase. Only a few small studies[4,5,6,7] are available on the contribution of women in brackishwater aquaculture. A broad-spectrum perspective is available[8]. However, the literature base on this subject is still somewhat deficient so we have prepared this article to provide a brief picture of the role of women, their problems and some of their expectations with reference to brackishwater aquaculture in India.

We selected Akivedu of West Godavari district and Krishnapatnam of Nellore district of Andhra Pradesh as coastal aquaculture is a major economic activity in these areas. We surveyed 42 women engaged in brackishwater aquaculture.

Findings

In both districts, women are pivotal decision makers, making decisions in absence of their husband, brother, or father who were engaged in other economic activities. They were involved in almost all farm activities. We examined their socio-economic profiles in order to understand their standard of living (table 1), and were able to broadly group respondents as direct and indirect contributors. We classified farm owners and laborers as direct contributors, and contractors and laborers in processing plants as indirect contributors.

The age of the women we surveyed ranged between 17-50 among the four groups. Nearly 88 per cent of them were classified as youth and 58 per cent of them were married. Their literacy level ranged from primary school to post graduation and all of them were

Table 1: Differential Characteristics of the respondents

Particulars	Direct Contributors		Indirect contributors	
	Farm owners n=6	**Farm labourers** n=17	**Contractors** n=4	**Labourers in processing plants** n=15
Age	17-34	18-22	36-43	17-50
Marital Status				
Married	5	14	4	2
Unmarried	1	3	-	13
Education*	IX – Post - Graduation	III-V Std	VII - IX	V-IX
Family size	5-9	4-7	3-5	5-8
Nature of work	Segregation, pond preparation, feed reparation, feeding, sampling, monitoring, pumping, harvesting, maintaining aqua - laboratories	Pond preparation, feeding, feed mill work, harvesting	Mediator between processing plant and the labourers	Peeling, grading, deheading, packing of shrimps and deveining
Farm size	0.5-1ha	-	-	-
Farming experience (years)	1-14	3-10	3	2-16
Income	Rs 15,000-1,00,00/ha/crop	Rs 50-60/day	Rs 2000-5000	Rs 50-100/day
Level of contribution towards	50-100%	50%	60%	75-100%
Mass media exposure	Nil	Nil	Nil	Nil
Extension agency contact	Nil	Nil	Nil	Nil
No of training programme attended	1	1	-	1
No of persons attended the training	5	5	-	10

* Indian schooling system starts with class I and ends in class XII

dynamically involved in farm activities alongside other family members. With regards to farm owners, their holding were typically quite small ranging from 0.5 – 1 ha. They had between 1-16 years of direct or indirect experience in brackishwater aquaculture and their earnings per crop ranged between Rs.15, 000 – 100,000/ha. Farm laborers earn Rs 50-100/day either from the farms or the processing plants during culture seasons. There were four women who were mediators between processing plant managers and laborers working in processing plants. Neither the direct or indirect contributors we surveyed have any exposure either to mass media or extension agency support systems. The family size varied from 3-9, and more than three fourth of the people are from joint families. Their earnings typically contribute 50-100 per cent of total family revenue, highlighting their key economic role in brackishwater aquaculture activities.

Areas of Participation

Table 2 describes the activity profile of women in brackishwater aquaculture. The contribution of women in both economic and unpaid activities is obviously greater than that of the men. It appears that on-farm activities are oriented towards women and off-farm activities such as purchases, transportation, and marketing are male oriented. This trend is more pronounced in the smaller farms. This suggests that the general economic well being of the rural economy will improve where financial responsibilities related to aquaculture, both in terms of credit and revenue management rests with women.

Pond Preparation

Women are employed seasonally for renovation and preparation of culture ponds. They do manual labor such as carrying sand bags for embankment of shrimp farm and are paid Rs 50-60 per day as wages. Women were also involved in clearing shrubs and tall grasses from bunds, removal of submerged and floating weeds from the ponds and white washing of the water channels.

Feed preparation /Feeding

Women are involved in the preparation of local feed and also in dispensing the feed in the ponds at regular intervals. They told us that, due to shortage of funds for purchase of commercial feed, they prepared feed on-farm using tilapia, rice bran, and groundnut oil cake. They mix the ingredients thoroughly and make feed balls, which are then dried and dispersed in the pond. The feed is prepared on a limited scale and any left over is used the following day. This activity is restricted to small and marginal farms. Among the women we surveyed only two worked in the local feed mill and were employed year round. They were paid wages of Rs 75-90/day to dry, grind and sieve the ingredients.

Water Exchange & Monitoring

Farm owners are involved in the operational management of farm including pump operation. The women of the farmstead monitored all activities of the farm in the absence of their family members.

Table 2: Activity Profile of Women involved in brackishwater aquaculture

Activities	Adult male	Young male	Adult female	Young female
Household activity				
Cooking			***	***
Washing dishes			***	***
House cleaning			***	***
Fuel gathering		***	***	***
Water gathering	***	***	***	***
Aquaculture production			***	***
Land preparation				
Ploughing	***			
Pond preparation			***	***
Purchase of inputs	***			
Fertilising	***		***	
Cleaning of shrubs and tall grasses			***	***
Removal of floating weeds			***	***
White washing the water channels	***		***	***
Stocking	***		***	***
Feeds and feeding				
Feed preparation			***	***
Drying, grounding and sieving the ingredients			***	***
Feeding	***	***	***	***
Water pumping	***	***	***	***
Sampling			***	***
Monitoring	***		***	
Disease diagnosis	***			
Hand picking (harvest)			***	***
Deheading			***	***
Deveining			***	***
Grading			***	***
Chilling			***	***
Packing			***	***
Marketing	***			
Contractors			***	
Maintaining aqua laboratories			***	
Secondary occupations				
Petty shops				***
Tailoring				***

Harvesting

After regular harvest operations, any remaining shrimp are hand picked from the drained pond by women. While farm owners predominantly carry out wholesale and retail marketing of shrimp, women play a major and exclusive role in traditional as well as sophisticated post harvest handling of the produce. They are exclusively engaged in processing plants in deheading, deveining, grading, chilling, and packing of shrimps. In addition to fresh sale, they undertake curing on a limited scale that included drying and smoking for household consumption.

Problems encountered by women

Successful aquaculture starts with aligning the problems identified by the women in aquaculture and adopting measures suggested by them to safeguard the industry. The farm owners also face substantial problems in identifying diseases and are unable to make timely decisions since they do not have a proper understanding of the problem. The women lack technical information and are not well versed with the farming practices related to aquaculture. They indicated that they experience difficulties in obtaining loans from financial institutions, and are quite often troubled by problems with their partners including alcoholism, lethargy and lack of assistance or monetary support to bring up the family. Women working in processing plants experienced suffer occupational health problems related to humidity, cold, and standing for long periods of time while doing repetitive tasks.

Feeding the shrimps.

Collection of algal mass.

Expectations

For the first time in March 2003 women from Krishnapatnam village attended the training programme on brackishwater aquaculture for fisherwomen / rural women organized by the Central Institute of Brackishwater Aquaculture (CIBA), Chennai via special funding from the National Agricultural Technology Project. Women from Akivedu were given on the job training in a processing plant. The women we surveyed at Krishnapatnam informed us that they had also attended a one-day seminar on nutritional aspects at Muthukur Fisheries College, Nellore. Other than this, they were not aware of any other training opportunities. Women-friendly extension systems and campaigns should be organized to assist them to gain training that will help them obtain employment and enhance their economic status. Those involved in shrimp culture indicated that they have no first hand information about diseases. They would like to have opportunities to acquire knowledge, develop adequate skills and use appropriate technologies that will enable them to improve their efficiency.

The women indicated that they would like to see follow up on training programmes, greater awareness about aquaculture training opportunities, access to women extension agents, and the inclusion of women in welfare measures and study visits to research stations. They said they need access to technical information through training institutes and State Fisheries Departments. The farm owners also want to undergo training in disease diagnosis, management and culture aspects; they feel that it is necessary to address shrimp health issues become they become an urgent problem. They also feel that they have to keep abreast of information on management measures relating to keeping their stock healthy. Training in scientific management of pond preparation, fertilizer application, feeds and feeding habits, soil and water analyses, diagnosis and management of

Operation of pumps.

Working in feed mill.

diseases will help them to resolve field problems. They wish to have follow-up action and frequent discussions with the extension agencies. The farm laborers we surveyed also wished to have training in shrimp disease and culture aspects, since they expect that this would help them to gain more employment opportunities.

The Department of Fisheries of some State Governments have taken farmers on study tours to other farming areas to help them acquire first hand information. Likewise, the women were curious to visit and learn more about the recent innovations in brackishwater aquaculture from research Institutes, fisheries universities and private farms. The women depended on informal credit from relatives, moneylenders, self –help savings and credit groups of women in Krishnapattinam village of Nellore district. They require credit facilities for the culture as well as for consumption expenses.

Transfer of technology to women

Although contribution of farmwomen in aquaculture operations is well recognized, they have not been given equitable access to technology transfer programmes. In order to harness the potential of farm women in increasing aquaculture production, their access to technology, credit and input development and marketing have to be ensured without any further loss of time.

Conclusion

Gender development and women empowerment are the corner stones of any strong society. Women in aquaculture have always played a proactive role in empowering production and productivity; though with a low profile. Their contributions can be further strengthened with institutional help and effective extension management. Their role in both on-farm and off-farm activities needs to be documented and highlighted.

Aknowledgements

The authors are grateful to Dr Mathew Abraham, Director, Central Institute of Brackishwater Aquaculture, Chennai 600 028, and India for his encouragement. They are also grateful to Dr.S.M.Pillai, Principal Scientist, Crustacean Culture Division and Officer-in-Charge, Technical Cell of CIBA for his critical review and suggestions.

References

1. Krishna Srinath (2002). Women in coastal Resources Management. WomenIn Fisheries. Int Con. Women in Fisheries. M.P. Singh Kohli and Ratna Tewari (Eds) Mumbai, India, Dec., 11-12, 2002: 8-20.
2. CIBA//EXTN/03 Ex tension approaches for Sustainable Shrimp and Fish Farming, April 1999 – 2004)
3. Sathiadhas, R. (1998). Marine Fisheries in Indian Economy. 1998. Nat. Work. Advances and Priorities in Fisheries Balachandran, K.K., Iyer, T.S.G.Madhavan, P.Joseph,. Perigreen,. P.A., Raghunath, M.R. and Varghese,. M.D., (Eds) Society of Fisheries Technology Cochin, Kerala. 1998.
4. Rajyalakshmi, T. and.Pillai, S.M. 1988. Involvement of Women in gainful employment in Fisheries field- a study at Puri area. Nat. Work. Gainful Employment For Women in Fisheries Field, Cochin, Kerala,, 1988.117-122.
5. Hoon, V. and.Saleesha, A. (1995). Women's Role in Shrimp Farming Technology Needs and Mechanisms for Transfer of Technology, Nat. Work.Transfer of Technology for Sustainable Shrimp Farming, Madras, Tamil Nadu, Jan., 9-10,1995: 63-68.
6. Munawar Sultana (2002). Status of Women in Coastal Aquaculture Sector in India and Avenues for Gainful Entreneurship, Int. Con. Women in Fisheries M.P. Singh Kohli and Ratna Tewari (Eds) Mumbai, India, Dec., 11-12, 2002: 62-69.
7. Deboral Vimala,D. Ramachandran, S. Nagamani,N. Nila Rekha, P and Sophia John. (2002). Participation and Involvement of Women in Aquacultural Activities. Int. Con. Globalization and Sustainable Development: Perspectives of Digital Revolution and Environmental Management. Rajamanickam,G. Vasantha Kumaran, T. Rani Senthamarai., (Eds). Thanjavur, Tamil Nadu, Aug.,24-26, 2002: 35-43.
8. Global Sym. (2001). Sixth Asian Fisheries Forum, Women in Fisheries Williams, M.J.Chao, N.H. Choo, P.S. Matics, K. Nandeesha, M.C. Shariff,M. Tech, E and Wong, J.M.C. (Eds) Nov 29, Kaohsiung, Taiwan.

News

US slaps anti-dumping tariffs on Chinese, Vietnamese shrimp

The US Department of Commerce (DOC) issued a preliminary ruling on 7 July that China and Vietnam are dumping shrimp on the US market. Anti-dumping duties of up to 93.13 % will be applied to several Vietnamese companies and up to 112.81 % for several Chinese companies, some of which will be retrospectively applied for the past 90 days. The affected Chinese companies include the Allied Pacific Group, Shantou Red Garden Foodstuffs Co. and Yelin Enterprise Co. Affected Vietnamese companies include the Minh Phu Seafood Corporation, Kim Ahn Company, Minh Hai Joint Stock Seafoods Processing Company and Camau Frozen Seafood Processing Import-Export Corporation.

The duties have been brought about in response to petitions filed by the Southern Shrimp Alliance, a lobby group formed by members of the US shrimp fishing industry. The US industry claims to be suffering economic hardship citing the surge in imported shrimp from Asia and Latin America, allegedly at below-market prices. The industry has also cited alleged government subsidies paid to Asian producers leading to overproduction and barriers to European markets causing Asian shrimp to be diverted to the US.

Asian producers have pointed to lower production costs in Asia, arguing that they are simply more competitive and alleging US protectionism. The DOC will issue decisions on preliminary rulings for Brazil, Thailand, India and Ecuador on 28 July. Final decisions are expected on 21 November for China and Vietnam, and on 25 November for Thailand, India, Brazil and Ecuador.

Preliminary antidumping findings on shrimp from Brazil, Ecuador, India, and Thailand announced

The U.S. Department of Commerce (DOC) announced the preliminary determinations in the antidumping duty investigations on imports of certain frozen and canned warmwater shrimp from Brazil, Ecuador, India and Thailand on 29th July. DOC has found that producers/exporters have sold frozen and canned warmwater shrimp from Brazil, Ecuador, India, and Thailand in the U.S. market at less than fair value, with margins ranging from 0.00% to 67.80% for Brazil, 6.08% to 9.35% for Ecuador, 3.56% to 27.49% for India, and 5.56% to 10.25% for Thailand.

The individual and "all others" dumping margins are as follows:

- Brazil: Empresa de Armazenagem Frigorifica Ltda. (EMPAF) = 0.00%; Central de Industrializacao e Distribuicao de Alimentos Ltda. (CIDA) = 8.41%; Norte Pesca S.A. = 67.80%; All Others Rate = 36.91%.
- Ecuador: Exporklore S.A. = 9.35%; Exportadora De Alimenos S.A. (Expalsa) = 6.08%; Promarisco S.A. = 6.77%; All Others Rate = 7.30%.
- India: Hindustan Lever Limited (HLL) = 27.49%; Devi Sea Foods Ltd. (Devi) = 3.56%; Nekkanti Seafoods Limited (Nekkanti) = 9.16%; All Others Rate = 14.20%.
- Thailand: Andaman Seafood Co., Ltd., Chanthaburi Seafoods Co., Ltd., and Thailand Fishery Cold Storage Public Co., Ltd. (collectively Rubicon Group) = 5.56%; Thai I-Mei Frozen Foods Co., Ltd., (Thai-I-Mei) = 5.91%; The Union Frozen Products Co., Ltd. (UFP) = 10.25%; All Others Rate = 6.39%.

As a result of these determinations, U.S. Customs and Border Protection (CBP) will suspend liquidations of all shipments of shrimp from Brazil, Ecuador, India, and Thailand entered or withdrawn from warehouse for consumption and CBP will require a cash deposit or the posting of a bond equal to the margins shown above. DOC will now begin the process of verifying the data submitted by the respondents and will issue its final determinations in these investigation in mid-December. The U.S. International Trade Commission (ITC) is scheduled to make its final injury determination at the end of January 2005.

US shrimp tariff ruling protested by Thailand, India

Thailand will contest the US decision to impose anti-dumping (AD) duties on Thai shrimp exports, even though the rates were lower than the penalty rates imposed on the five other countries affected. Officials from the Commerce Ministry and shrimp exporters expressed confidence that they could prove that prove that their low prices were due to Thailand's efficient farming practices, not selling below cost.

The new tariffs are effective immediately and will last until Dec 17 when the department is scheduled to announce the final tariffs. US officials will visit Thailand to collect more information from Thai exporters in order to determine the final rate. In the meantime the US International Trade Commission will determine the financial impact of the alleged dumping on local producers. The results will be announced in January and if losses are deemed to be severe the US will impose an anti-dumping duty for five years. The US is Thailand's largest market for shrimp, accounting for half of the country's total shipments. In the first half of the year, shrimp exports from Thailand to the US were about 100,000 tonnes, up 4.4% year-on-year, but in value they fell 15% from 27 billion baht.

The President of the Seafood Exporters Association of India (SEAI), Mr. Abraham J. Tharakan, said, "The duties are unwarranted. We do farming that is why we are able to sell at lower prices unlike in the U.S. where the shrimps are sourced from the sea at high cost. "Moreover, the American shrimp industry meets only 10 per cent of the local demand. We will try and prove at the final stage of investigation that we are not dumping.''

Addressing a press conference at Visakhapatnam on Friday, Mr. Tharakan pointed out the SEAI was exclusively representing the entire Indian shrimp industry during the investigation, taking effective steps to the protect the interests of processors, aquaculture farmers and fishermen. The Chairman of the Marine Products Export Development Authority (MPEDA), G. Mohan Kumar, said the DoC had identified Hindustan Lever, Nekkanti Seafoods and Devi Seafoods as representatives of the Indian shrimp exporters to the U.S.

The increased duty will not only hurt Asian producers, but US consumers will also pay higher prices for their shrimp. *Source: The Bangkok Post, July 31, 2004, The Hindu, July 31, 2004.*

Aquaculture Calendar

For more events listings the NACA Events & Training page at

http://www.enaca.org/modules/extcal/

International Workshop on Culture, Fisheries and Stock Enhancement of Portunid Crabs, 20-22 January 2005, Iloilo, Philippines

The workshop will include sessions on broodstock nutrition; larval culture and nutrition; nursery grow-out; fisheries and stock enhancement; genetics and taxonomy. The proceedings will be published in special edition of a peer-reviewed journal. The workshop will be held in the Hotel del Rio, Iloilo. It is organized by the SEAFDEC Aquaculture Department, the University of Wales Bangor, the University of Can Tho, and the University of Ghent. It is supported by the European Commission. The proceedings will be published in special edition of a peer-reviewed journal. Registration fee: $150. For more information please contact INCO_CAMS@bigfoot.com.

Workshop on Antibiotic Resistance in Asian Aquaculture Environment, 24-25 February 2005, Chiang Mai, Thailand

The workshop is organized by Food and Agriculture Organization (FAO), Network of Aquaculture Centers in Asia (NACA), Department of Fisheries (DOF) and the Southeast Asian Fisheries Development Center (SEAFDEC). The workshop will address the following topics:

1. Antibiotic resistance in Asian aquaculture – the Asian perspective.
2. Antibiotic resistance in Asian aquaculture – the European perspective.
3. The antibiotic resistance problem – perceptions at the level of individual countries.
4. The EU-funded Asiaresist project.
5. Sampling of aquaculture environments for antibiotic resistance.
6. Standardized antibiotic susceptibility testing and MIC techniques.
7. Bacterial identification techniques.
8. Bacterial DNA typing.
9. Characterization and transfer of chloramphenicol resistance genes.
10. A web-based management system for antibiotic resistance in aquaculture; managing the problem.

For further information, contact Dr Supranee Chinabut, Department of Fisheries, Jatujak, Bangkok 10900, THAILAND, Tel: (66-2) 579-6803, fax: (66-2) 561-3993, email supranee@fisheries.go.th or visit: www.medinfo.dist.unige.it/Asiaresist/Workshop

International Conference on Effective Land-Water Interface Management for Solving Agriculture-Fishery-Aquaculture Conflicts in Coastal Zones, 1-3 March 2005

The objectives of the conference are to i) provide an assessment of the dependence of farmers and fishermen on coastal zone resources, and the ecological implications of resource use based on case studies and participants' experience; ii) identify processes in, and tools for managing the land-water interface for solving agriculture-fishery-aquaculture-ecosystem conflicts in coastal areas; iii) exchange the findings on land-water interface management from case studies in various countries; iv) develop concept notes on comprehensive assessment frameworks for coastal zones and identify research collaboration opportunities. Expected outputs of the conference will include publication of papers in the conference proceedings, and key messages and supporting research will form input into the Comprehensive Assessment process, identification of actions that can be taken, future research needs, and collaborative efforts to solve problems. The conference is organized by the World Fish Center, International Rice Research Institute, International Water Management Institute, People's Committee of Bac Lieu Province, Vietnam and Can Tho University, Vietnam For more information, contact Dr Chu Thai Hoanh, IWMI, email cthoanh@cgiar.org.

6th Symposium on Diseases in Asian Aquaculture (DAA VI), 25-28 October 2005, Colombo, Sri Lanka

The theme of the sixth symposium is 'Aquatic Animal Health Facing New Challenges'. A workshop, a training course, an expert consultation and the 7th Triennial General Meeting (TGM-7) of FHS are being planned in conjunction with DAA VI. Details will be made available through a dedicated website to be launched in October. Five previous Symposia (Bali 1990, Phuket 1993, Bangkok 1996, Cebu 1999 and Brisbane 2002), each brought together more than 200 aquatic animal health scientists, students, government researchers and industry personnel from some 30 countries to discuss disease related problems affecting aquaculture production and to find solutions for them. Please visit the FHS website for more detailed information about the society and DAA. Expressions of interest to participate or request for inclusion in the mailing list may be sent to Dr. Melba B. Reantaso at Melba.Reantaso@fao.org using the subject: DAA VI.

Asia-Pacific Marine Finfish Aquaculture Network

Magazine

SKRETTING

Collaborating organisations

Queensland Government Department of Primary Industries and Fisheries

CSIRO

DEPARTEMEN KELAUTAN DAN PERIKANAN

UNIVERSITAS SAM RATULANGI MANADO

SEAFDEC

Department of Fisheries Malaysia

Some insights into the live marine food fish markets in the region

Sih Yang Sim

Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand.

Marine finfish species such as groupers, snapper, seabass and other coral reef species command premium prices when sold live in seafood restaurants in the Asia-Pacific region. For example, a plate size seabass (*Lates calcarifer*), 400-700 g may cost 100-150 Baht/kg (US$1 = Baht 41) in a supermarket or wet market in Bangkok, but in local restaurants the table served prices can range from 120-250 Baht/fish or 300-357 Baht/kg. In the premium seafood places in the Central Business District of Bangkok, live seabass fetch as high as 500 Baht/kg, excluding costs of cooking and preparation.

Epinephelus coioides (green grouper or orange-spotted grouper) is the most common grouper species farmed in Thailand. At one stage during the SARS period, the price dropped to 120 Baht/kg at the farm gate but it has steadily increased to around 220-240 Baht/kg. The green grouper is priced at around 700-900 Baht/kg in most live seafood restaurants in Bangkok central business district. In Singapore, the buying price for imported live green

Network supported by:

Australian Government
Australian Centre for International Agricultural Research

APEC

grouper from Malaysia is around S$15/kg (US$8.90) as at September 2004.

In Hong Kong, live marine finfish traders expect the price for green grouper to increase toward the end of the year during the festive seasons. It is also expected that consumption of green grouper will remain high as it is the most common grouper species used for special banquets such as wedding, birthdays and company dinners.

Cultured vs wild grouper

Although many claim that the taste of cultured grouper and wild grouper cannot be differentiated by professional tasting panels, consumers from China, Hong Kong, Singapore and Malaysia still prefer wild grouper. Could this be merely the taste that consumers preferred or could it be the perception that wild products taste better and are healthier than the farmed products? As a comparison, Malaysia's "kampung chickens" or Thailand's "kai baan", native chickens that are grown in a free range condition without (or with limited) commercial poultry feed always command a higher price due to its taste and lower fat levels relative to commercially farmed chickens.

When we discussed this issue with traders from Singapore, Hong Kong and China they said that those consumers who have more cultivated "taste buds", can tell whether a grouper or other marine fish is farmed or wild caught. For example, green groupers from Thailand are considered low quality due to a muddy taste from traditional culture in mangrove creeks and earthen ponds. Similarly seabass farmed in earthen ponds or freshwater also tend to have an off flavor and can be distinguished by their darker colouration, which is a marketing problem and leads to a lower price.

They also pointed out that farmed *Cromileptes altivelis* (mouse grouper, barramundi cod) can be identified visually, as farmed mouse groupers generally have a shorter and fatter body than their wild cousins. Farmed mouse groupers are also more difficult to handle and transport as they are less hardy then the wild ones. A trader from Singapore reported that a 150kg air shipment of table size mouse groupers to Hong Kong recently turned out to be a total disaster with all of the fish dying during transit. Could the problem have been poor packing and handling, or are farmed mouse groupers genuinely less hardy ? Hong Kong traders also confirm that farmed mouse groupers are less tolerant of handling, more susceptible to stress and suffer higher mortality. Such losses would add to costs and may be one factor affecting the premium price for mouse grouper in Hong Kong and China. Farm gate prices for mouse groupers in Indonesia are US$30-40/kg, while the wholesale prices in Hong Kong and China seafood markets are around US$ 84/kg. The challenge then for aquaculture is to produce high quality, tasty, and hardy fish.

Hong Kong traders are actively looking for sources of wild caught groupers species such as *E. polyphekadion*, *E. fuscoguttatus*, and *Plectropomus* spp. Recently, a 30 ton live fish vessel was put on hold at Hong Kong due to ciguatera, which was suspected to be coming from East Timor region. Import of live coral reef fish species from the Pacific islands are also falling due to ciguatera problems. With the export quota enforced on live coral reef fish exports from Queensland, Australia in July 2004, it is very likely that species such as *Plectropomus* spp., the major species exported from Australia will be in short supply leading to an escalation in price.

Domestic vs international markets

Most farmers only focus on export markets for live marine finfish. There is no doubt that prices for markets such as Hong Kong and China are higher, but the risk is also high for sellers and buyers. For example, if an Indonesian exporter sends an air shipment of live marine finfish to Hong Kong the mortality rate on arrival may be 10%. In this case the exporter will bear the financial losses for this 10% mortality and eventually the loss may be passed on to the farmers. Dead grouper can be sold at the market but the price is generally less than one third of the live fish.

Should marine finfish farmers in the region only target Hong Kong and China live fish markets or should they also consider domestic markets for larger fish? In Malaysia, with about 30% Chinese population, the eating habits for the Chinese community are similar to those in Hong Kong or China. A visit to the local fresh market has provided an indication that groupers are also sold here as fresh fish, in addition to the live fish segment of the hotel and restaurant industries. Groupers sold in the fresh market are mostly green groupers. Most are more than 1 kg and sold as fillet or "block", priced at around RM 37/kg (US$ 9.74). Although groupers in this market only make up a very small part of the wide variety of marine finfish species sold the market demand can be considerable if every fresh market in Malaysia is selling similar quantities. Indonesia, the Philippines and Thailand might also wish to consider developing their domestic markets for grouper species. A good example is the successful replacement of the export market for *Penaeus vannamei* shrimp by domestic consumption in PR China and Thailand. A stable domestic market can absorb a portion of farmed production, reducing risk when extraordinary events in Hong Kong and China cause prices for grouper to fall. A more stable market would be a significant benefit for farmers, particularly small-scale operators, providing a buffer from financial turmoil from such events.

Focus on markets, trade and economics

Welcome to the second edition of the Asia-Pacific Marine Finfish Aquaculture Network's e-Magazine. The quarterly e-Magazine complements the fortnightly e-News by publishing full-length articles on various aspects of marine finfish aquaculture in the Asia-Pacific region.

This edition focuses on market, trade and economic issues. The rapid development of marine finfish aquaculture in the region is to a large extent in response to the strong demand and high prices for many marine finfish species, such as snappers and groupers. Information on markets and trade is valuable for farmers, aquaculture suppliers and managers.

The next issue will feature nutrition, feeds and feeding practices. We encourage the submission of articles on these topics from network participants. Send submissions to:

Asia-Pacific Marine Finfish Aquaculture Network (APMFAN).
c/o: NACA, PO Box 1040
Kasetsart Post Office,
Bangkok 10903, Thailand
Tel: 66-2-561 1728 (Ext 120);
Fax: 66-2-561 1727
Email: grouper@enaca.org
Website: www.enaca.org/marinefish/

This issue also introduces a new sponsor for APMFAN: Skretting Australia Pty Ltd. Skretting have agreed to sponsor the network for the next two years, including sponsoring this e-Magazine and the e-Newsletter. We gratefully acknowledge Skretting's contribution to the development and growth of APMFAN and look forward to continuing to work with Skretting towards the development of sustainable marine finfish aquaculture in the region.

Sih Yang Sim, Michael J. Phillips, Simon Wilkinson and Mike Rimmer.

Farming practices, market chains, and prices of marine finfish in Malaysia

Sih Yang Sim[1], Paolo Montaldi[2], Alessandro Montaldi[2] and Hassanai Kongkeo[1]

1. Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand.
2. Terre des hommes Italy (TDH). c/o Andaman Sea Fisheries Research and Development Center, 77 Sakdidej Road, Wichit, Amphur Muang, Phuket 83000, Thailand

Mr Sih Yang Sim of NACA is currently registered with Deakin University, School of Ecology and Environment, Australia, for a PhD research program on "An economic analysis of the grouper aquaculture industry in selected countries in the Asia-Pacific".

This article summarises findings from field trips to Malaysia conducted as part of a regional survey of NACA/ TDH (Terre des Hommes Foundation - Italy) in cooperation with the Asia-Pacific Marine Finfish Aquaculture Network. The surveys were conducted in March-August, 2004 facilitated by the Department of Fisheries, Malaysia

Marine finfish are widely cultured in Malaysia. This may be due to three main factors: The Malaysian government's strong promotion of aquaculture, particularly of marine finfish farming; the economic success of many marine finfish farms, and continued domestic and regional market demand for marine finfish. The annual fish consumption per-capital in Malaysia is around 50 kg.

In 2004, more than 16 marine fish species are being cultured in Malaysia either for local consumption or export, based on local hatchery produced or imported fingerlings. Species commonly found in Malaysian farms include *Epinephelus coioides* (green grouper), *E. fuscoguttatus* (tiger grouper), *E. lanceolatus* (giant grouper), *Lates calcarifer* (seabass), *Lutjanus argentimaculatus* (mangrove snapper), *L. johnii* (John's snapper), *L. stellatus* and *Trachinotus blochii* (pompano). Other marine finfish

Aerated larvae tank with newly hatch larvae and live food organisms.

Hapa system used in an open pond hatchery system in Penang.

Earthen ponds used for seabass culture in Penang.

species such as *Cromileptes altivelis* (humpback grouper), *Cephalopholis miniata* (coral hind), *Eleuthonema tetradectylum* (fourfinger threadfin), *Gnathanodon speciosus* (golden trevally), *Pomadasys unimaculatus* (red patched grunter), *Rachycentron canadum* (cobia), *Chanos chanos* (milkfish), *Caranx ignobilis* (giant trevally) are farmed but less common.

The following observations are based on field visits to three areas in West Malaysia (Penang, Kedah, and Johor) where there is substantial marine finfish farm development. Hatchery and farming practices currently being adopted in these three areas are described together with information on market chains and fish prices.

Hatchery systems for marine finfish species

There are two common types of hatchery systems in Penang; concrete tanks and earthen ponds. Hatchery systems with concrete tanks are usually roofed but not enclosed. These are high-density larviculture systems normally used for grouper species, particularly for *E. fuscoguttatus*. This system consists of a big larval rearing tank about 6 x 6 metres in size and about 1 metre in depth. Each larval rearing tank is fully aerated by air stones through a blower. Artificial diets are not commonly used; rather rotifer, copepods and *Artemia* nauplii are used extensively.

The earthen pond hatchery system is based on the open pond hatchery system traditionally used in Chinese Taipei. The ponds are aerated by both paddle wheels and blowers, averaging 0.25 hectare and are stocked with 2-3 eggs per litre. There are two methods in which the fertilized eggs are stocked into the earthen pond, either directly, or using a hapa system. The hapa system basically uses a mosquito net or canvass to enclose a small section of the pond. In this way, observation of the newly hatched larvae is easier and if the hatching rate is poor the hatchings can be removed and a new batch stocked. The hapa system is only used for a short period (i.e. five days), after which the hapa are removed to allow the fish larvae to grow in the earthen pond feeding on zooplankton.

Direct stocking basically involves releasing the fertilized eggs directly into the pond. The disadvantage of direct stocking is that hatching and survival of larvae is hard to monitor.

The natural pond productivity is supplemented with additional rotifers and copepods produced through fertilization. When problems of low copepod productivity are sometimes experienced *Artemia* biomass (either produced in tanks or imported from Thailand) is used as a supplementary food for the marine fish larvae in the pond. Marine finfish species produced using this system are mainly threadfin and snapper. Survival rates are relatively low but overall this is a simple and economical production system that can be used for producing a wide variety of species.

Grow-out systems for marine finfish species

There are two main farming systems in the three areas we visited, floating cages and pond culture. Floating cages are more widely used for a large variety of marine fish species while pond culture is normally used for species such as threadfin and seabass, although these two species are also being farmed in floating cages.

Seabass farm in Penang

Ponds for seabass culture are commonly around 6,000 m^2 in area with a rectangular shape. Paddle wheels are used to provide aeration and generally 4 to 6 long shaft paddlewheels (5 wheels per shaft) will be used per pond, each driven by a 10 hp diesel engine. The stocking density is around 45,000 fingerlings per pond (average total length 7.5cm) at the seabass farm in Penang. The cost of fingerlings is approximately RM 0.50/piece. The farm we visited imports its fingerlings from Thailand as the farmer considers importing to be cheaper than producing them locally.

The growth of fingerlings in the ponds is rapid, reaching 100 grams at two months, 500-800 grams at seven months, and more than 2 kg at 18 months. The main production target is large size seabass for export to Singapore, with fish sold ex-farm to middlemen at RM 12.00/kg who resell to

Packing of seabass at the auction area on Penang fishing pier.

300-400 g threadfin being harvested at a Penang farm and ready for market.

Long floating cage for milkfish farming in Johor.

Singaporean traders for RM 14.00/kg. The silvery colouration of the seabass produced in Malaysia is preferred by both the local and Singapore markets over the darker coloured seabass produced under lower salinity culture in Thailand. The market price for Malaysian seabass is also higher compared to the Thai seabass.

The productivity for the Penang seabass farm is around 6-10 tonnes/cycle at average 600 grams. The average survival is 60%, the lowest 30-40%. There is no significant record of disease so far.

Feeding is carried out two times per day, early morning and evening. It is common to use a mixed diet of trash fish and floating pellets to accustom fish to all-pellet diet when trash fish feeding must be discontinued because of seasonal scarcity. The farm we visited has tried several seabass feeds from Grobest and CP, but they have now found a generic "fish" feed with 38% protein content to be better in terms of performance and price, which they source from a company based in Chinese Taipei. They do not find it difficult to wean large (7.5cm) seabass fingerlings to pellets. At the beginning of weaning the pellets are squeezed into trash fish pieces and the fish is starved to accelerate acceptance.

The partial use of floating pellets seems to allow extended culture to produce large seabass as less trash fish waste accumulates on the pond bottom but the whole operation is running on tight margins. It appears that the Malaysian pond farming model for seabass allows better control over culture inputs (energy, labor, and specifically FCR) and overall farm economics.

Fourfinger threadfin

The farming of fourfinger threadfin in earthen ponds is similar to the seabass system but the stocking rate of 5 – 7.5cm fingerlings is only about 3-4 pieces per square metre. This fish is extremely aggressive and very sensitive to dissolved oxygen in the water, with low levels leading to mass mortality. Under optimal conditions the survival rate to harvest size is around 80-90%. The fish are fed with CP seabass dry feed (30% protein) and the estimated FCR is above 2. The fish can

Marine fish farm in Johor, showing workers grading tiger grouper fingerlings.

Giant grouper at a Johor marine fish farm.

Pompano fingerlings at a Johor marine fish farm.

grow to 300-400 grams within 10 months. Export to Singapore is feasible if local Penang markets (300 kg/day) have been saturated.

Farming threadfin in floating cages is also being carried out in Johor and the feed used for grow-out is also seabass feed. Threadfin are aggressive feeders.

Milkfish

Milkfish are farmed in Johor in floating cages of 6 x 60 x 3 metres in size, much larger than the normal floating cages used for marine fish. Production per cage is about 10-15 tons with average milkfish weight around 500-700 g. The production cycle is about 18 months.

The prices for milkfish range from US$1.05, US$1.20 to US$2.00 per kg depending on the size, with larger fish receiving a higher price per kilogram. Milkfish fry are all imported from either Indonesia or Chinese Taipei.

Grouper, snapper and other marine finfish

Floating cages are the most common system used for farming of grouper, snapper and other marine finfish in Malaysia. The most common net cage used for farming is 3 x 3 x 3 metres. Carnivorous species such as grouper and snapper are mostly fed trash fish. Other species such as pompano and threadfin are generally fed with floating seabass feed. Many of the floating cages in Malaysia are located in estuaries close to the river mouth. The water tends to be a bit more turbid.

Grouper species generally take more than ten months to reach marketable size, while survival rates are usually low. Some farms may even experience 30% survival rate post stocking of 5cm fingerlings. An increasing trend in grouper farming in Johor is to grow giant grouper from imported fry (from 3 cm size) to 1 kg, and sell to other farmers that will on-grow the fish to larger sizes for the market. The price for 1 kg giant grouper "fingerlings" is extremely high, around RM 80.00/kg in August 2004 mainly due to high price of small fry imported from Chinese Taipei, around US$ 1.00-1.20 per 3cm fry.

Other marine finfish species, such as pompano are considered a "cash crop" as they only take about 4-6 months to reach marketable size from 2.5cm fingerlings. The farm gate price for pompano is about US$6.50/kg in Johor (August 2004) for the Singapore market.

Fishing pier at Johor where farmed fish are being transported by 'taxi' to market.

Fresh market in Penang selling farmed snapper and grouper in fillet or block forms.

Market chains for live marine food fish in Malaysia

Generally, the farming areas for marine finfish are located close to fishing piers or fisheries landing ports. Most of these also function as a small auction ground for live or fresh seafood.

Farmers can sell their produce either at the auction floor to buyers or sell direct to exporters who come to the farm to pickup by boat or truck. Some Hong Kong buyers go direct to the farming areas and buy live marine food fish from the farmers and ship them back by boat, which normally has a capacity of 10-15 tons.

Other than grouper species, many of the marine finfish cultured in Malaysia also find their way to the Singapore market. Seabass, pompano, threadfin and snapper are some of the marine finfish that are commonly sold across the border to Singapore, live or chilled.

Although Singapore and Hong Kong markets generally command higher prices, some of the farmed marine finfish species are also sold locally in either restaurants or fresh markets. It is not uncommon to see large (more than 2 kg) farmed groupers sold in local markets as fillets or blocks.

Farm gate, retail, and restaurants prices

The following prices are based on a field survey visit conducted from 28 March-2 April, 2004. These prices are for reference only as seasonal variation in prices should also be taken into consideration. Malaysian Ringgit to US Dollar conversion rate is US$ 1.00 = RM 3.80.

Farmed snapper and grouper species are sold at a fresh market in Penang.

Table 1: Farm gate prices at Penang

Common Name	Scientific Name	RM/Kg	Comments
Giant trevally	*Caranx ignobilis*	14.00-15.00	--
Green grouper	*Epinephelus coioides*	18.00	--
Tiger grouper	*Epinephelus fuscoguttatus*	38.00-45.00	0.7-1.2 kg (live)
Fourfinger threadfin (large)	*Eleutheronema tetradactylum*	22.00	CNF Singapore (300 g/fish)
Fourfinger threadfin (small)	*Eleutheronema tetradactylum*	10.00	7 pieces/kg
Fourfinger threadfin (large)	*Eleutheronema tetradactylum*	22.00	500-700 g
Cobia	*Rachycentron canadum*	5.00	--
Seabass (small)	*Lates calcarifer*	9.00	500-700 g
Seabass (large)	*Lates calcarifer*	12.00	2 kg fish

Table 2: Sungai Udang fishing pier

Common name	Scientific name	RM/Kg	Comments
Giant grouper	*Epinephelus lanceolatus*	40.00-45.00	Cage culture, chilled
Green grouper	*Epinephelus coioides*	17.00-18.00	Cage culture, chilled
Tiger grouper	*Epinephelus fuscoguttatus*	38.00-45.00	Cage culture, chilled
Mangrove snapper	*Lutjanus argentimaculatus*	17.00	Cage culture, chilled (500 g)
Seabass	*Lates calcarifer*	13.00-14.00	Cage culture, fresh chilled
Fourfinger threadfin	*Eleutheronema tetradactylum*	22.00-23.00	Wild

Table 3: Penang retail fresh market

Common name	Scientific name	RM/Kg	Comments
Sixband grouper	*Epinephelus sexfasciatus*	20.00	Small
Green grouper	*Epinephelus coioides*	36.70	-
Mangrove snapper (large)	*Lutjanus argentimaculatus*	20.00	Large
Mangrove snapper (small)	*Lutjanus argentimaculatus*	17.50	Small
Seabass (small)	*Lates calcarifer*	13.30-23.30	Small
Seabass (large)	*Lates calcarifer*	40.00	Large -wild
Fourfinger threadfin	*Eleutheronema tetradactylum*	20.00	Small

Table 4: Live seafood restaurants in Penang (Batu Muang and Bukit Tambun)

Common name	Scientific name	RM/Kg	Comments
John's snapper	*Lutjanus johnii*	32.00	Live
Mangrove snapper	*Lutjanus argentimaculatus*	20.00-32.00	Live
Blubberlip snapper	*Lutjanus rivulatus*	35.00	Live
Seabass	*Lates calcarifer*	28.00-32.00	Live
Green grouper	*Epinephelus coioides*	50.00-65.00	Live
Humpback grouper	*Cromileptes altivelis*	260.00	Live
Giant grouper	*Epinephelus lanceolatus*	60.00	Live
Pompano	*Trachinotus blochii*	20.00	Live

Table 5: Fish prices at Carrefour-Mid Valley Megastore Kuala Lumpur

Common name	Scientific name	RM/Kg	Comments
Fourfinger threadfin	*Eleutheronema tetradactylum*	15.80	Fresh chilled, (small)
Milkfish	*Chanos chanos*	8.80	Fresh chilled, (30 cm)
Sixband grouper	*Epinephelus sexfasciatus*	15.80	Fresh chilled, (small)
Seabass	*Lates calcarifer*	12.90	Fresh chilled, (0.8-1 kg)
Mangrove snapper	*Lutjanus argentimaculatus*	19.90	Fresh chilled, (0.5-0.8 kg)
Grouper fillet	-	9.50	Frozen shelf, (300 g)
Coral trout whole	-	22.90	Frozen shelf, (600 g)

Grouper farming, market chains, and marine finfish prices in Indonesia

Sih Yang Sim[1], Paolo Montaldi[2], Alessandro Montaldi[2] and Hassanai Kongkeo[1]

1. Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand.
2. Terre des hommes Italy (TDH). c/o Andaman Sea Fisheries Research and Development Center, 77 Sakdidej Road, Wichit, Amphur Muang, Phuket 83000, Thailand

This article summarises findings from field trips to Indonesia conducted as part of a regional survey of NACA/TDH (Terre des Hommes Foundation - Italy) in cooperation with the Asia-Pacific Marine Finfish Aquaculture Network. The surveys were conducted in April-September, 2004 and was facilitated by the Directorate General for Aquaculture Development, Indonesia.

Indonesian marine finfish farming has developed rapidly over the last five years, particularly for high priced species such as grouper. Breakthroughs in grouper breeding techniques from 1999 by various research centers in Indonesia such as the Research Institute for Mariculture, Gondol; National Seafarming Development Center, Lampung; Brackishwater Aquaculture Development Sub Centre, Situbondo; together with a government focus on mariculture development, have led to major developments in grouper farming in Indonesia.

Kawahara and Ismi (2003) provided a good statistical report on the development of grouper hatcheries in Indonesia. In 1999, there were only five hatcheries producing grouper fingerlings in Indonesia located at Bali (1), Lampung (2) and East Java (2). However, by 2001 grouper hatchery development had intensified with 123 hatcheries producing grouper fingerlings in Bali (114), Lampung (5), and East Java (4). The boom in hatchery production led to overproduction and the price for grouper fingerlings dropped substantially. This drove many small hatcheries to switch to other species and by 2002 only 67 hatcheries were still producing grouper fingerling. The decline was most evident in Bali with only 55 hatcheries still producing grouper fingerlings, a 50% drop, while in Lampung (6) and East Java (7) more hatcheries were producing grouper. This may be due to the fact that the 50% of the hatcheries in Bali switched to milkfish fry production, due to market opportunities. Grouper seed production statistics for Indonesia from 1999-2002 show that the total production of tiger grouper (*Epinephelus fuscoguttatus*) fry has grown continuously from around 63,000 pieces to 2,656,000 in 2002 while humpback grouper (*Cromileptes altivelis*) fry has grown from 123,000 pieces in 1999 to 1,114,000 pieces in 2001 with a sharp decline to 698,000 in 2002.

New marine finfish species such as coral trout (*Plectropomus* spp.) and napoleon wrasse (*Cheilinus*

Live seafood restaurant in Bali with display aquaria of various marine finfish varieties.


Small quantity of coral trout fingerlings produced at RIM-Gondol.

undulatus) are being produced in captivity. The refinement of larviculture technique for these species may lead to extensive farming if fingerlings can be mass-produced in the hatchery. However, rapid market saturation may also occur.

Hatchery system for grouper species in Indonesia

The hatchery system used for grouper fingerlings production was based on the Backyard Multi-species Hatchery System (BMHS) developed in the Research Institute for Mariculture Gondol. For more details on this system refer to "Study on economics and socio-economics of small-scale marine fish hatcheries and nurseries, with special reference to grouper systems in Bali, Indonesia" by Susana v Siar, William Lee Johnston and Sih Yang Sim, 2002. A new publication "A Guide on Small-scale Marine Finfish Hatchery Technology" by ACIAR/NACA also provides details on this aspect. Check website www.enaca.org/marinefish/ for availability.

The development of grouper grow-out in Lampung

In 1999, there was only one grouper farm in Lampung with eight units (i.e. one unit is four cages measuring about 4 x 4 metres or 3 x 3 metres). With the increase in availability of grouper fingerlings and government promotion for marine finfish culture in Indonesia, the number of farms growing grouper in Lampung had escalated to 42 farms with a total of 388 units (1,552 cages) by 2002 (Kawahara and Ismi, 2003). In 2004, there are some 800 marine fish cage units (3,200 cages) in Lampung. The two main species cultured here are humpback grouper and tiger grouper, mainly based on availability of fingerlings from hatcheries. There are also some farms that obtain fingerlings of various grouper species from the wild or import from Taiwan Province of China (giant grouper) for stocking or fattening before being sold to exporters.

Most of the marine finfish farms seen in Lampung are relatively large and well constructed. The walkways are wide and allow easy movement and operations. It is common to see cages and walkways shaded with permanent netting tents and equipment such as high-pressure pumps for net cleaning. Many rafts are directly supplied with freshwater (personal use, fish treatment) delivered from land sources via pipes. Grouper farming in this area is clearly a middle- to large-scale investment and certainly not a small-scale fishermen affair.

The farming practice is a mixture of feeding artificial feed produced by commercial feed companies, or "trash" fish. Most humpback groupers are fed with artificial diet while other grouper species are mostly fed with trash fish.

Tiger grouper and humpback grouper can reach marketable size (400-700 g) within 9-12 and 16-24 months, respectively. However, if larger fingerlings are stocked it may shorten the culture period, for example 15 cm humpback grouper fingerlings will take about 9 – 10 months to reach 450 g. On the other hand, giant grouper is a fast growing species that can reach 300 g within 4 months from an initial stocking size of 4 cm.

Market chains for live reef food fish in Indonesia

The live reef food fish supply in Indonesia comes from two sources, wild caught and aquaculture. Most of the tiger and humpback groupers from Indonesia are now produced from aquaculture.

The market chains for cultured live marine finfish are rather simple, the farmers buy fingerlings from the hatchery or via traders, grow these fingerlings to marketable size in 9-24 months depending on grouper species, and sell the produces in live, mainly to local exporters, Hong Kong buyers (either by live fish vessel or by air shipment), or to local restaurants.

The market chains for wild-caught finfish are more complex. Fishermen may sell their catches through various channels (such as to collectors, fish farmers, traders, exporters, restaurants, and Hong Kong buyers) depending on the locality of the fishing area and how accessible it is to various market channels. However, most fishermen probably sell to collectors as fishing grounds are generally located in a remote area such as Eastern Indonesia and Irian Jaya and collectors are the only accessible channel to market for them.

From collectors, fish may be distributed to various channels with undersized fish going to farmers for on-growing to marketable size, and table sized fish going directly to traders, exporters, local restaurants or Hong Kong buyers.

Farm gate, retail, and restaurant prices in Indonesia

The following prices are based on a field survey visit conducted in April 11-19, 2004. These prices are for reference only as seasonal variation in prices should also be taken into consideration. All prices are converted from Rupiah to US Dollar at an exchange rate of US$1.00 = Rupiah 9,000.

References

1. Kawahara, S. and Suko Ismi, 2003. Grouper Seed Production Statistics in Indonesia (1999-2002). Research Institute for Mariculture-Gondol, Indonesia.
2. Siar, S.V., Johnston, W.L. and Sim, S.Y. (2002). Study on Economics and Socio-economics of Small-scale Marine Fish Hatcheries and Nurseries, with Special Reference to Grouper Systems in Bali, Indonesia. 36 pp., Report prepared under APEC Project FWG 01/2001 - 'Collaborative APEC Grouper Research and Development Network'. Asia-Pacific Marine Finfish Aquaculture Network Publication 2/2002. Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

Large-scale marine fish farm in Lampung growing mainly tiger and humpback groupers.

Live fish transport boat cruising around a marine floating cage farm in Bali to collect marketable size marine finfish for Hong Kong.

Wild caught Plectropomus laevis selling at a seafood market in Jakarta.

Price differentiation for wild capture species according to size, *Plectropomus leopardus*

Size	Details	US$/Kg	Comments
Large	(> 1.3 kg)	14.40	Rupiah 130,000
Medium	(0.9-1.3 kg)	12.20	Rupiah 110,000
Super	(5-9 ounces)	22.20	Rupiah 200,000
Baby	(2-5 ounces)	11.10	Rupiah 100,000
Undersized	(< 2 ounces)	5.60	Rupiah 50,000

Marine finfish prices at live reef fish exporter in Denpasar (buying prices from farmers or fishermen)

English common name	Scientific name	US$/Kg	Comments
Tiger grouper	*Epinephelus fuscoguttatus*	8.90	1.5-5 kg fish at Rupiah 80,000/kg, wild
Tiger grouper	*Epinephelus fuscoguttatus*	4.40-5.60	Rupiah 40-50,000/kg for cultured fish at marketable size
Tiger grouper	*Epinephelus fuscoguttatus*	5.60	Big size > 5 kg, Rupiah 50,000/kg
Humpback grouper	*Cromileptes altivelis*	33.30	Rupiah 300,000/kg for wild capture
Humpback grouper	*Cromileptes altivelis*	30.00	Rupiah 270,000/kg for cultured fish
Napoleon wrasse	*Cheilinus undulatus*	33.30	Rupiah 300,000/kg
Green grouper	*Epinephelus coioides*	6.70	Rupiah 60,000/kg
Camouflage grouper	*Epinephelus polyphekadion*	9.40	Rupiah 85,000/kg
Coral grouper	*Epinephelus corallicola*	10.20	Rupiah 92,000/kg
Areolate grouper	*Epinephelus areolatus*	8.90	Rupiah 80,000/kg

Fingerling prices for various marine finfish in Indonesia (April 11-19, 2004)

Details	Bali (Rupiah)	Lampung (Rupiah)	Comment
Milkfish egg	0.5/egg	-	April 11-19, 2004 (low demand)
Milkfish egg	5/egg	-	August 23, 2004
Milkfish	7-10/fish	-	1 cm fry at farm gate
Milkfish	10-15/fish	-	1 cm fry at exporter
Milkfish	500-800/fish	-	10 cm fish for tuna bait
Tiger grouper egg	1/egg	-	
Humpback grouper egg	2.5-4.0/egg	-	
Tiger grouper	700-750/cm	-	RIM-Gondol
Tiger grouper	1,000/cm	1,000/cm	
Humpback grouper	1,000-1,250/cm	-	RIM-Gondol
Humpback grouper	1,500/cm	1,000-1,250/cm	
Humpback grouper	2,000/cm	-	August 23, 2004
Giant grouper	-	40,000/fish	4 cm fingerling imported from Taiwan

Farm gate prices for marine finfish in Lampung, Indonesia

English common name	Scientific name	US$/Kg	Comments
Green grouper	*Epinephelus coioides*	5.00-6.50	Live
Tiger grouper	*Epinephelus fuscoguttatus*	7.00-10.50	Live
Humpback grouper	*Cromileptes altivelis*	15.00-40.00	Live
Mangrove snapper	*Lutjanus argentimaculatus*	3.00	Live
Areolate grouper	*Epinephelus areolatus*	6.50	Live
Giant grouper	*Epinephelus lanceolatus*	12.00-15.00	Live
Coral trout	*Plectropomus leopardus*	19.00-20.00	Live, Rupiah 175,000
Barred-cheek coral trout	*Plectropomus maculatus*	17.00	Live, Rupiah 150,000
Squaretail coral trout	*Plectropomus areolatus*	14.00	Live, Rupiah 125,000
Napoleon wrasse	*Cheilinus undulatus*	45.00	Live

Market prices at the integrated fish market & restaurant model, Jakarta

English common name	Scientific name	US$/Kg	Comments
Mix of small size grouper species	*Plectropomus leopardus; Cephalopholis sonnerati*	2.40	0.2-1.0 kg chilled fish, price is given in Rupiah 21,500
Blacksaddled coral grouper	*Plectropomus levis*	28.90	Price is given in Rupiah 7,450/ons(chilled), so per kg price in Rupiah is 260,000
Grouper fillet	-	8.90	Price is given in Rupiah 80,000, and species is not identified
Napoleon wrasse	*Cheilinus undulatus*	66.70	Live fish at Rupiah 600,000/kg
Tiger grouper	*Epinephelus fuscoguttatus*	2.40	Chilled small fish

Live reef marine finfish prices at seafood restaurant in Bali, Indonesia

English common name	Scientific name	US$/Kg*	Comments
Tiger grouper	*Epinephelus fuscoguttatus*	98.00	Rupiah 25,000/once
Coral trout species	*Plectropomus* spp.	196.00	Rupiah 50,000/once
Blackspot tuskfish	*Choerodon schoenleinii*	137.20	Rupiah 35,000/once
Reef stonefish	*Synanceia verrucosa*	98.00	Rupiah 25,000/once
Napoleon wrasse	*Cheilinus undulatus*	294.00	Rupiah 75,000/once
Green grouper	*Epinephelus coioides*	78.40	Rupiah 20,000/once
Wrasse – mixed species		137.20	Rupiah 35,000/once
*Note: These prices seem excessively high, but this restaurant is targeting the tourist market, and the prices are inclusive of cooking cost. Most species are wild caught and small sizes, less than 1 kg.			

Marine finfish markets in Hong Kong

Sih Yang Sim[1], Paolo Montaldi[2], Alessandro Montaldi[2] and Hassanai Kongkeo[1]

1. Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand.
2. Terre des hommes Italy (TDH). c/o Andaman Sea Fisheries Research and Development Center, 77 Sakdidej Road, Wichit, Amphur Muang, Phuket 83000, Thailand

This article summarises findings from a field trip to Hong Kong conducted as part of a regional survey of NACA/TDH (Terre des Hommes Foundation - Italy) in cooperation with the Asia-Pacific Marine Finfish Aquaculture Network. The survey was conducted on June 3-4, 2004 and was facilitated by the Agriculture, Fisheries and Conservation Department (AFCD) Hong Kong.

Hong Kong with a population of 6.8 million is one of the most important consumption markets for live marine finfish in the world, particular grouper species (family Serranidae). The annual per capita consumption of fish is currently around 37 kg, a decline from previous levels of 40-45 kg prior to the 1997 Asian economic crisis and the 2003 SARS outbreak.

Hong Kong is also the main entry hub for live marine finfish to China markets via Guangzhou. Hong Kong adopts a free trade policy, with some limits set by food safety monitoring and CITES. Importers are required to provide trade declarations using the Hong Kong Import & Export Classification List and its regularly revised harmonised codes.

Table 1: Major sources of live marine fish imports to Hong Kong (Source: FMO)

Country	Quantity (mt)	%	Average price (US$/kg)	Country subtotal (US$ million)
Thailand	3,182	30	4.10	13.10
China	2,605	25	1.80	4.70
Philippines	1,585	15	12.60	20.00
Australia	1,137	11	18.30	20.90
Indonesia	1,000	9	15.60	15.70
Malaysia	644	6	10.90	7.00

In 2003, the total imports were estimated at around 194,000 tons for seafood (including 80,000 tons of shellfish, 100,000 tons of marine fish and 12,000 tons of live fish). Approximately 35% (67,000 tons) of seafood was re-exported.

Although the live fish segment constitutes a relatively small volume of the total annual marine fish imports it accounted for over US$ 82 million in value with average prices ranging from US$ 4.10-18.30/kg. In the 1990s, rapid economic growth and an increase in the number of tourists led to a sharp growth in live marine fish imports to 20,000-25,000 tons. However, marine fish consumption has subsequently

Traders weighing the live marine fish in live fish transport vessel at Kwun Tong market.

declined due to the impact of the 1997 Asian economic crisis and SARS. Consumption has stabilized recently and is now starting to increase again. The 2003 Fish Marketing Organization (FMO) figures for live fish imports from major suppliers are presented in table 1.

The FMO figures highlight the differential role of the major suppliers. Thailand is historically the leader in terms of quantity, but with low average value products (mainly *Epinephelus coioides*). China is emerging as bulk supplier of lower value fish such as mangrove snappers, and is growing in terms of overall volume. Other regional sources such as Australia, Indonesia and the Philippines have higher average prices as traditional key exporters of top value, mostly wild groupers such as wrasse, humpback grouper and coral trout.

According to the FMO the bulk of the live fish imports arrives by air (64%), followed by road transport (20%), fishing vessels (12%), long distance fish carriers (4%) and river carriers (0.01%).

Local production of live marine finfish species

There are 1,160 small-scale farms covering a total of 209 hectare of water surface areas in 29 specially designated Fish Culture Zones of Hong Kong and culturing more than 18 marine finfish species. These species are mainly from family of seabream, snapper, grouper and others. The marine finfish species farmed in Hong Kong are listed in table 2. As the price for seabream has decreased through the years, farmers have shifted to culture more valuable species such as grouper. In 2003 local cultured fish production was 1,500 tons for a value of US$ 9.7 million, accounting for about 10% of the live fish consumption in Hong Kong. The remaining 90% of seafood consumed in Hong Kong is imported, and live marine fish species mainly originate from Asian countries. Green groupers (42%) accounted for the bulk of Hong Kong's 1,500 tons of production followed by snappers (28%) and others such amberjack, cobia, pompano (17%), tiger groupers (9%) and other groupers (4%). The competitive edge for local producers is their proximity to the market, which provides better survival

Ma Wan Fish Culture Zone at southern side of Hong Kong, with a cluster of small wooden rafts with floating cages.

Live fish stall at Aberdeen market using sandfilter to keep the water at the holding facility in good condition.

Wholesale trader stall at Kwun Tong with mix variety of marine fish.

Table 2: Marine finfish species recorded under culture in Hong Kong

Common English Name	Scientific Name
Gold-lined seabream	*Sparus sarba*
Yellowfin seabream	*Acanthopagrus latus*
Black seabream	*Acanthopagrus schlegeli*
Mangrove red snapper	*Lutjanus argentimaculatus*
Russell's snapper	*Lutjanus russellii*
Malabar red snapper	*Lutjanus malabaricus*
Cobia	*Rachycentron canadum*
Pompano	*Trachinotus blochii*
Greater amberjack	*Seriola dumerili*
Orange-spotted (or green) grouper	*Epinephelus coioides*
Tiger grouper	*Epinephelus fuscoguttatus*
Brown-spotted grouper	*Epinephelus chlorostigma*
Hong Kong grouper	*Epinephelus akaara*
Areolate grouper	*Epinephelus areolatus*
White blotched grouper	*Epinephelus multinotatus*
Red drum	*Sciaenops ocellatus*
Head grunt	*Pomadasys kaakan*
Japanese croaker	*Collichthys niveatus*

Table 3: Ex-farm prices for marine finfish species in Hong Kong

Species	HK$/kg	Comment
Green groupers	83.30	Size 300-500 gram/fish, original price is HK$ 50.00/cattie (1 year culture)
Green groupers	150.00	Size 1.5 kg/fish, original price is HK$ 90.00/cattie (2 years)
Tiger grouper	167.00-333.00	Size 1.2 kg/fish, original price is HK$ 100.00-200.00/cattie

Parrotfish on display at the trading floor in Aberdeen market.

in the restaurant's displayed aquarium tanks and the possibility to cater directly to restaurants.

The majority of the marine fish fingerlings used for grow-out are imported from various countries such as PR China, Thailand, Philippines, Malaysia, Vietnam, Chinese Taipei and Indonesia. Annual marine fish fingerlings imported accounted to 11 million pieces valued at around US$5 million. Only seabream fingerlings are collected from local waters. The culture period ranges from 1-3 years, depending on the species and the size of the fingerlings stocked.

Fish Marketing Organization (FMO)

The Fish Marketing Organization (FMO) is a self-financing organization, under the supervision of the Agriculture, Fisheries and Conservation Department of Hong Kong (AFCD-HK). It was established under the Marine Fish Marketing Ordinance to provide facilities and services for the seafood trade and it currently operates seven major wholesale fish markets in Kwun Tong, Shau Ket Wan, Sai Kung, Tai Po, Aberdeen, Cheung Shawan and Castle Peak. FMO markets conduct wholesale seafood trade through registered agents.

The major markets for live fish are Kwun Tong, Aberdeen and Cheung Sha Wan for a total of 35 stalls with registered agents importing live seafood from the Asia-Pacific region. However, several independent traders reportedly operate in Hong Kong with their own facilities outside the FMO. In 2003 the total trade through the FMO network was 42,000 tons of fresh seafood and 4,000 tons of live seafood, or approximately one fourth of the 251,000 tons estimated as the total consumption in Hong Kong.

Kwun Tong Wholesale Fish Market

The Kwun Tong Wholesale Fish Market is historically the main live fish trading venue and hosts the office of the Hong Kong Chamber of Seafood Merchants. Our visit to the stalls at Kwun Tong provided a visual confirmation of the broad diversity of the marine finfish species traded. The average prices quoted for common grouper species during our visit were US$ 10.00/kg for *E. coioides*, US$ 15.00-20.00/kg for *E. fuscoguttatus*, US$ 17.00/kg for large (10 kg) *E. lanceolatus.* Lower trophic level fish commonly sighted in the display tanks were scats (US$ 7.15/kg) and several species of parrotfish (*S. rivulatus*, *S. prasiognathos*, *S. ghobban*). It was reported that for some parrotfish the price could reach as high as US$20.00-40.00/kg because mortality easily occurs during shipment and storage in aquariums.

We observed more than 48 marine finfish species in the aquarium displays of the various agents at the Kwun Tong Wholesale Fish Market during our visit, listed in Table 4.

Aberdeen Fish Wholesale Market

Aberdeen Fish Wholesale Market is located on the southern side of Hong Kong island. The market is the largest in Hong Kong and was busy during our visit with several fish carrier boats moored in front of the market and live fish transport trucks moving in and out.

The main market stalls consist of batteries of aquarium tanks lined in series in the main auction building, allowing a straightforward inspection of the seafood displayed. An additional series of stalls equipped with live seafood holding tanks occupy an open area along the quay just outside the main building. The variety of the live marine finfish displayed here is similar to the species observed at the Kwun Tong market. The prices for the live marine finfish are listed in Table 5.

Market prices for marine finfish at live seafood restaurants in Hong Kong

The marine finfish diversity in the Hong Kong consumption of live marine finfish could be observed at a cluster of seafood restaurants located at Lei Yue Mun close to the Kwun Tong Wholesale Fish Market and at a large floating restaurant (Jambo) near the Aberdeen Wholesale Fish Market. The restaurant prices (cooked prices) for live marine finfish at these two areas are listed in Table 6.

Seafood sector at Wellcome Department Store, Kowloon

The fresh chilled seafood selection on display at the Wellcome Supermarket in Kowloon was very basic. All products were portion size and presented in film-sealed polystyrene trays. The main species and prices that were available are listed in Table 7.

Table 4: Species on display at the Kwun Tong Wholesale Fish Market

English Common Names	Scientific Names
Napoleon wrasse	*Cheilinus undulatus*
Triple tail wrasse	*Cheilinus trilobatus*
Blackspot tuskfish	*Choerodon schoenleinii*
Green grouper	*Epinephelus coioides*
Aerolate grouper	*Epinephelus aerolatus*
Longfin grouper	*Epinephelus quoyanus*
Malabar grouper	*Epinephelus malabaricus*
Tiger grouper	*Epinephelus fuscoguttatus*
Potato cod	*Epinephelus tukula*
Giant grouper	*Epinephelus lanceolatus*
Red grouper	*Epinephelus akaara*
Yellow grouper	*Epinephelus awoara*
Tomato hind	*Cephalopolis sonnerati*
Peacock grouper	*Cephalopolis argus*
Humpback grouper	*Cromileptes altivelis*
Coral trout	*Plectropomus leopardus*
Blue spotted grouper	*Plectropomus maculatus*
Coronation trout	*Variola albimarginata*
Slender grouper	*Anyperodon leucogrammicus*
Emperor red snapper	*Lutjanus sebae*
Mangrove snapper	*Lutjanus argentimaculatus*
Russel’s snapper	*Lutjanus russelli*
Yellow spot grunt	*Plectorhinchus cinctus*
Black porgy	*Acanthopagrus schlegeli*
Yellowfin seabream	*Acanthopagrus latus*
White seabream	*Acanthopagrus berda*
Goldlined seabream	*Sparus sarba*
Red seabream	*Pagrus major*
Cobia	*Rachycentron canadum*
Scat	*Scatophagus argus*
Spotted sicklefin	*Drepane punctata*
Spinefoot	*Siganus fusescens*
White spotted rabbitfish	*Siganus canaliculatus*
Chinese filefish	*Monacanthus chinensis*
Spotbelly batfish	*Platax teira*
Yellow scale parrot	*Scarus ghobban*
Surf parrot	*Scarus rivulatus*
Quoy’s parrot	*Scarus quoyi*
Red speckled parrot	*Cetoscarus bicolor*
Pompano	*Trachinotus blochii*
Turbot	*Scophthalmus maximus*
Flounder	*Pseudorhombus* spp.
Tongue sole	*Cynoglossus* spp.
Brown banded catshark	*Chiloscyllium punctatum*
Grey bamboo shark	*Chiloscyllium griseum*
Snake moray	*Ophichthys* spp.
Pike moray	*Muraenesox* spp.
Giant moray	*Gymnothorax* spp.

Summary

The Kwun Tong and Aberdeen markets are active in trading activities and there are many live marine food fish species being trade on daily basis. The facilities for holding the live marine food fish here are equipped with sand filter to keep the water quality at optimum level. The consumers preference for live marine food fish can be observed at various live seafood restaurants at nearby area which are stocked with a wide variety of high value and middle price species.

Table 5: Prices of live marine fish at Aberdeen Fish Wholesale Market

English Names	Scientific Names	HK$/Kg	Comment
Green grouper	*Epinephelus coioides*	166.67	Original price at HK$100.00/cattie (1.5 kg fish)
Tiger grouper	*Epinephelus fuscoguttatus*	116.67	Original price at HK$ 70.00/cattie (ciguatera fear)
Green wrasse	*Cheilinus trilobatus*	133.33	Original price at HK$ 80.00/cattie
Cobia	*Rachycentron canadum*	50.00	Original price at HK$ 30.00/cattie
Pompano	*Trachynotus blochii*	33.33	Original price at HK$ 20.00/cattie
Red snapper	*Lutjanus argentimaculatus*	58.33	Original price at HK$ 35.00/cattie
Scat	*Scatophagus argus*	80.00	Original price at HK$ 48.00/cattie
Mullet	*Mugil* spp.	20.00	Original price at HK$ 12.00/cattie
Yellow scale parrot	*Scarus ghobban*	75.00	Original price at HK$ 45.00/cattie
Red speckled parrot	*Cetoscarus bicolor*	50.00	Original price at HK$ 30.00/cattie
Rabbitfish	*Siganus fusescens*	20.00	Original price at HK$ 12.00/cattie

** 1 cattie = 600g.*

Table 6: Restaurant prices for live marine finfish at Lei Yue Mun

Species	HK$/Fish	HK$/Kg*	Price HK/pound
So mei fish (*Napoleon wrasse*)	1,800	1,327	600
Spotted grouper (*P. areolatus*)	780	664	300
Green wrasse	800	664	300
Red coat (mangrove snapper)	250	-	-
Common grouper	250	-	-
Snapper	500	425	192
Teeth parrot fish	550	531	240
Potato grouper (small size)	1,000	-	-
Dark/Big green grouper	500	-	-
Cabrilla (humpback grouper)	2,200	1,327	600
Spotted grouper (*P. leopardus*)	1,380	929	420
Parrot fish (green & yellow)	550	531	240
Red grouper	1,380	929	420
Yellow fin snapper	-	584	264
Horse head	-	584	264
Stone fish	-	531	240
Yellow fin pomfret	-	266	120
Spade grouper	-	797	360
**This is based and converted from original price in HK$/pound*			

A view of the live seafood restaurant area in Lei Yue Mun

Live fish transport vessel docking at Kwun Tong market.

Table 7: Species & prices of marine finfish at Wellcome Supermarket, Kowloon

Product	Details	HK$/kg
Nile tilapia	Whole	27.8
Seabass	*Lates calcarifer* (small size)	50.9
Coral trout	*Plectropomus leopardus*	95
Silver pomfret	*Pampus argenteus*	50

Below: Pompano on display at the trading floor in Aberdeen market.

Collaborators

The following organizations and contacts are focal points for communication in the network:

Hong Kong
Dr Jim Chu,
jim_cw_chu@afcd.gov.hk

India
Dr Mohan Joseph Modayil,
mdcmfri@md2.vsnl.net.in

Indonesia
Dr Ketut Sugama,
crifidir@indonet.id
Dr Muhammad Murdjani,
lbapstbd@radnet.id

Iran
Dr Shapour Kakoolaki,
bsh443@yahoo.com

Malaysia
Coastal marine fish culture
Mr Ali bin Awang,
ppbuk@po.jaring.my

Fish quality
Mr Ismail Ishak & Mr Hamdan Jaafar
anasofiah@hotmail.com / hamdanj@yahoo.com

Low food chain species
Mr Hussin bin Mat Ali
pppil@po.jaring.my

Philippines
Ms Prescilla B. Regaspi,
pregaspi@bfar.da.gov.ph
Ms Marygrace C. Quintero,
mgquintero@bfar.da.gov.ph

Spawning and larval rearing of coral trout at Gondol

Ketut Suwirya

Coral trout *Plectopomus leopardus* is a popular candidate for mariculture in the Asia-Pacific region. The Research Institute for Mariculture (RIM) at Gondol, Bali, Indonesia, is currently researching the development of hatchery technology for this species, known locally as sunu. Ninety wild broodstock, ranging in size from 1.3 to 3.5 kg, were collected in 2003 and 2004. Sixty broodstock were maintained in a 150 m^3 concrete tank, and the remainder in a 100 m^3 concrete tank – both tanks were supplied with flow-through seawater supply at ambient temperature. Coral trout broodstock were fed trash fish and squid (2:1 ratio). The fish commenced spawning after seven months in the broodstock tanks, and produced between 500,000 and 2,500,000 eggs/day (both tanks combined) for 3–7 days every month.

Fertilized eggs were stocked in a 5 m^3 concrete larval rearing tank. Starting on the second day of hatching, larvae were fed with rotifers at a density of 5 individuals/ml. Rotifer density in the larval rearing tank was maintained at 10–30 individuals/ml until day. From day nineteen larvae were fed *Artemia* nauplii until metamorphosis (35 days after hatch). Juvenile coral trout were fed live tiny shrimp. At the time of writing, there are still a total of 195 juvenile coral trout at RIM. These fish are being used to assess the general grow-out husbandry of this species.

A hatchery-reared juvenile Plectropomus leopardus.

Genetic considerations in fisheries and aquaculture with regard to impacts upon biodiversity

(Continued from page 8)

Most genetic measures depend largely on the use of molecular genetic markers generated by using modern molecular genetic techniques, which is relatively a new field in the Asian region in terms of its application in aquaculture and fishery management. As such, there is an urgent need to develop capacities and increase the expertise in the region in the field of molecular genetics and its practical applications, especially in development of management strategy in fishery and aquaculture development to maintain genetic integrity and biodiversity.

Acknowledgements

I am grateful to Prof. Sena S De Silva, Deakin University, Australia and Mr. Pedro Bueno, Director General of NACA for their continuing support and encouragement.

References

De Silva S.S. 2003. Culture-based fisheries: an underutilized opportunity in aquaculture development. Aquaculture 221: 221-243.

Doupé R.G., Lymbery A.J. 2000. Workshop Summary: managing translocations of aquatic species. Aquaculture Research 31: 151-156.

Dunham R.A. 2004. Aquaculture and Fisheries Biotechnology: Genetic Approaches. CABI Publishing, UK, 372pp.

Gupta M.V. and Acosta B.O. (eds) 2001. Fish Genetics Research in Member Countries and Institutions of the International Network on Genetics in Aquaculture. ICLARM Conf. Proc. 64, 179p.

Harris A.S., Bieger S., Doyle R.W., Wright J.M. 1991. DNA fingerprinting of tilapia, Oreochromis niloticus, and its application to aquaculture genetics. Aquaculture, 92: 157-163.

Johnson M.S. 2000. Measuring and interpreting genetic structure to minimise the genetic risks of translocations. Aquaculture Research 31: 130-143.

Moritz C. 1994. Application of mitochondrial DNA analysis in conservation: a critical review. Molecular Ecology 3: 401-411.

Ritland K. 2000. Marker-inferred relatedness as tool for detecting heritability in nature. Molecular Ecology 9: 1195-1204.

Ryman N., Utter F., Hindar K. 1995. Introgression, supportive breeding, and genetic conservation. In Ballou J.D., Gilpin M., Foose T.J. (eds) Population Management for Survival and Recovery, pp. 341-365. Columbia University Press, New York.

Tave D. 1993. Genetics for Fish Hatchery Managers. Second Edition. Chapman & Hall, New York. 415pp.

Waples R.S. 1991. Definition of "Species" under the Endangered Species Act: Application to Pacific Salmon. NOAA Technical Memorandum NMFS F/NWC-194. NOAA, Seattle.

Welcomme R.L. and Bartley D.M. 1998. Current approaches to the enhancement of fisheries. Fisheries Management and Ecology 5: 351-382.

WORLD AQUACULTURE 2005

May 9-13, 2005

Bali International Convention Center
Nusa Dua, Bali - Indonesia

INTERNATIONAL PEACE AND DEVELOPMENT THROUGH AQUACULTURE

The Annual International Meeting of :

WORLD AQUACULTURE Society

ASIAN PACIFIC CHAPTER WORLD AQUACULTURE SOCIETY

INDOFISH 2005 BALI

Sponsored by:

Ministry of Marine Affairs and Fisheries

Indonesian Fisheries Society

Indonesian Aquaculture Society

State Ministry of Culture and Tourism of The Republic of Indonesia

Associate Sponsors

• Asian Fisheries Society • ASEAN Fisheries Federation
• Indonesian Fisheries Federation • Aquacultural Engineering Society
• Network of Aquaculture Centres in Asia-Pacific
• Global Aquaculture Alliance • International Assoicate of Aquaculture Economics and Management
• Indonesian Coral Shell and Ornamental Fish Association
• Indonesian Shrimp and Fish Farming Association
• Indonesian Feed Milling Association
• Indonesian Pearl Culture Association
• Indonesian Seaweed Association
• Indonesian Ornamental Fish Exporter Association
• Indonesian Koi Hobbiest Association
• Indonesian Shrimp Feed Association
• Indonesian Tuna Association
• The Frozen Seafood Exporter & ProducEer Association of Indonesia
• Indonesian Fisheries Scientist Association
• Indonesian Fisheries Student Association

For more information contact:
Conference Manager
2423 Fallbrook Place, Escondido, CA 92027 USA
Tel: +1 760 432 4270 Fax: +1 760 432 4275
Email: worldaqua@aol.com

Organized by :
ROYALINDO CONVENTION INTERNATIONAL