ISSN 0859-600X

Volume VIII NO.3 July-September 2003

AQUACULTURE ASIA

Ornamental Fish

Breeding the Golden Arowana

Peacock eels

Ornamental fish culture in India

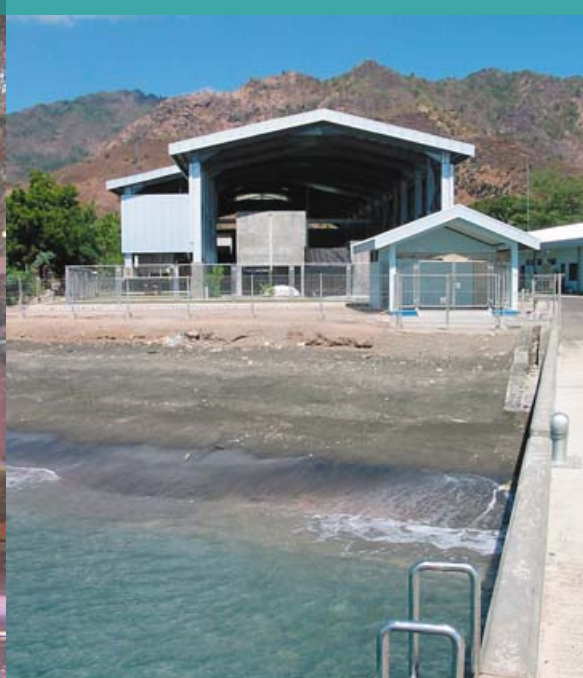
Now available on CD-ROM

New tuna hatchery in Bali

Coral trout breakthrough at Lampung

Larval rearing of mouse grouper

Shrimp health extension



AQUACULTURE ASIA

Volume VIII No. 3
July-September 2003

ISSN 0859-600X

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 naca@enaca.org
Website http://www.enaca.org

Printed by Scandmedia

From the Editor's desk

Collapse of WTO talks nothing to celebrate

Talks aimed at reforming global trade in agricultural products collapsed on 14 September in Cancun, Mexico. As expected, one of the main sticking points was the issue of agricultural subsidies and tariffs. As discussed in this column previously, these are mainly imposed by developed nations to protect their domestic industries from foreign competition – which are mainly developing nations.

A key difference in Cancun over previous talks was that developing nations banded together much more strongly than they have in the past to lobby for agricultural reform, and to oppose four new proposals about foreign investment and competition added to the agenda primarily by the US and European interests.

The collapse of talks in Cancun is a blow to the prospects of developing a global trade treaty by the end of 2004, set at a meeting two years ago in Doha. Many 'advocacy' groups celebrated the collapse as a 'victory' for developing countries. Greater solidarity among proponents of agricultural reform is a welcome development, but the collapse of the Cancun WTO talk is in no way beneficial to developing countries.

Global trade is not bad. The economic and social benefits are well documented. The real problem is that the global trading system as it exists today is not fair. It is heavily biased towards rich countries - which continue to prop up inefficient agricultural sectors with heavy subsidies (forcing their consumers to pay more tax for the privilege of buying more expensive products) while fending off imported products with quotas and tariffs.

The outcome of the failed negotiations at Cancun is that this status quo has been preserved, and so the global trading system will continue to favour rich nations. The collapse of the Cancun talks is a lost opportunity for both developed and developing countries; it's not a win for anyone. We need agricultural reform, lets hope that the negotiations are more successful next time.

On another trade related issue, if you are the owner, operator or agent in charge of a facility that manufactures, processes, packs or holds food for human or animal consumption in the US you must register your facility with the US Food and Drug Administration by 12 December 2003. This is a new requirement under the US *Public Health Security and Bioterrorism Preparedness and Response Act* of 2002. The reason ? To help the FDA protect the US food supply against actual or threatened terrorism acts and other food-related emergencies. If you don't register your facility then your exported product may be detained on arrival.

You can register through the website http://www.fda.gov/furls from 16 October onwards. You will also have to notify the USFDA prior to the arrival of your products (the timing depends on the mode of transport). Further information is available from http://www.fda.gov/oc/bioterrorism/bioact.html.

Simon Wilkinson

AQUACULTURE ASIA

In this issue

Sustainable aquaculture

Page 5

Page 7

Research and Farming Techniques

Page 14

Aquatic Animal Health

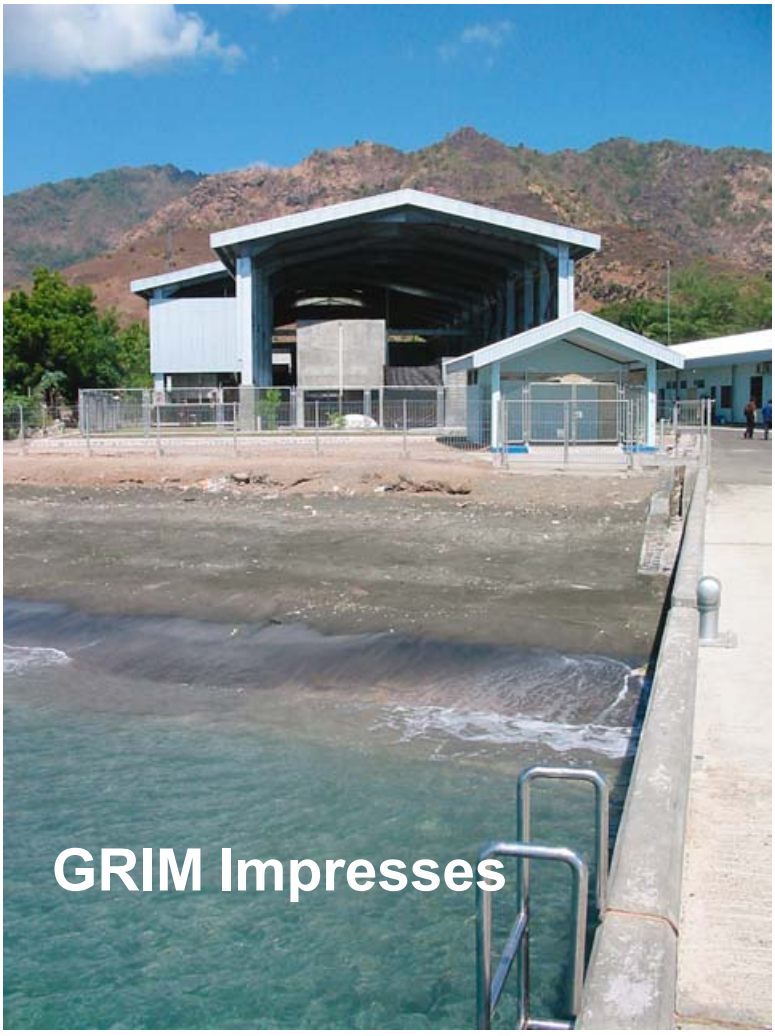
Page 24

Marine Finfish Section

What's new in Aquaculture

Page 28

Notes from the Publisher



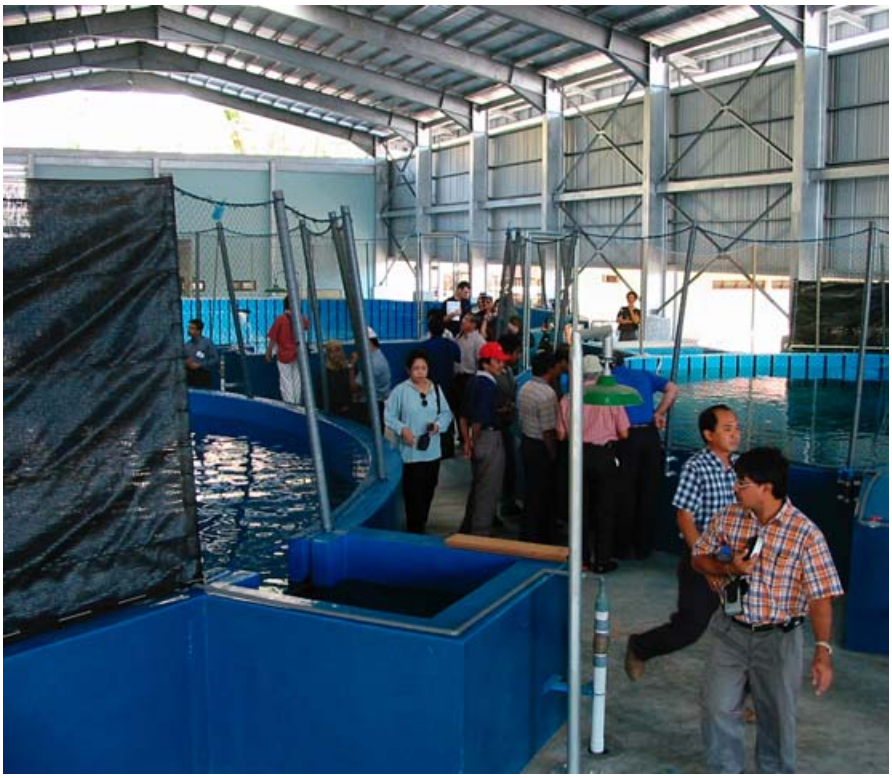
The new tuna hatchery at the Gondol Research Institute of Mariculture

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

We thank the Government of Indonesia for hosting Seventh Meeting of NACA's Technical Advisory Committee (TAC). It afforded the more than 60 participants, 40 of them from outside Indonesia, a close look at the progress that Indonesian researchers have made in mariculture. TAC 7 met in Denpasar for 2 days and motored to the northern side of the island for a study tour (and a consultation on NACA/Secretariat of the Pacific Community on cooperation in aquaculture development). The delegates toured the facilities of the Gondol Research Institute for Mariculture, which has successfully bred the humpback grouper *Cromileptes altivelis* and the Tiger grouper, *Epinephelus fuscoguttatus*, and which is producing seeds of these species for distribution to farmers in Bali and other parts of Indonesia, and even export. Local hatcheries that purchase fertilized eggs from the Centre and hatch and nurse them for grow-out by other farms are doing a thriving business. This model of a central hatchery producing fertilized eggs for smaller backyard hatcheries to hatch and nurture for eventual distribution to local farmers has proven to be a successful integrative scheme in Indonesia. (The Philippines has recently begun adopting this model for milkfish). There are 70 grouper hatcheries throughout Indonesia 52 of which are small backyard operations, and 2000 milkfish hatcheries, of which 1800 are backyard scale. (A socio-economic study on small scale marine fish hatcheries and nurseries in Bali conducted by a team of NACA, SEAFDEC AQD, and Australian researchers under the Asia-Pacific Marine Finfish R and D Network with support from APEC, is available for download from www.enaca.org/grouper).

The Centre has trained local farmers in hatchery and culture techniques of milkfish, grouper and snapper. Their experience and expertise have been extended to the region through a training program in collaboration with NACA, ACIAR and JICA. Other techniques being taught to local farmers and technicians are live food production, fish disease diagnosis and control. Other species under research and development in the Centre are swimming crabs (*Portunus pelagicus*), shrimp (*P. monodon*), red snapper (*Lutjanus johnii*), milkfish (*Chanos chanos*), artemia and very recently yellowfin tuna. A modern hatchery facility is the latest addition to the centre's impressive facilities, courtesy of a Japanese assistance. Research on fish and shrimp diseases, feed and

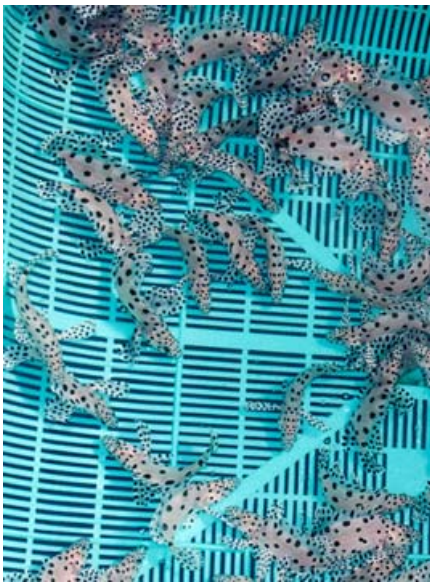
Tuna broodstock are available 'out the back' of the hatchery



Inside the tuna hatchery. The tanks are deeply inset into the ground

nutrition, probiotics, live fish production, artemia production and processing are major features to support the production technology.

Centre manpower consists of 34 researchers four with doctoral degrees and 10 with the masters degree, 27 engineers, and 64 technical and administrative support staff. Facilities include an impressive dry lab for work on diseases and parasites, nutrition, biology, biotechnology and chemistry, and a wet lab consisting of hatcheries for shrimp, mud and swimming crab, grouper, and yellow fin tuna. A mariculture station with several floating cages completes the infrastructure.



Cromileptes altevelis fingerlings

We congratulate the past leadership (Dr Ketut Sugama who is now Director of Central Institute of Fisheries Research posted in Jakarta, and current TAC Chairman) as well as the present (Dr Adi Hanafi, a quiet hardworking scientist) and staff, for the impressive development and achievements of the Centre. The same goes to the Directorate General of Aquaculture, which has given the support and allowed scientific independence to the centre. These, among other factors, have made the Gondol Research Institute for Mariculture a valuable regional resource for aquaculture development.

Side event centers on Farmer Associations

At the second meeting of FAO's Subcommitte on Aquaculture held in Trondheim, Norway on 7-11 August 2003, the Federation of European Aquaculture Producers (FEAP) and NACA convened a discussion session on the role of farmers associations in sustainable aquaculture. The purpose was to bring to the attention of the Aquaculture Subcommittee the significance of the issue so that it might recommend to the Committee on Fisheries a program to encourage the strengthening of national farmers associations and to stimulate if not assist in the formation of a regional association of aquaculture producers in Asia and other regions. Discussion papers were provided by FEAP and NACA. A comprehensive review was presented of FEAP's experiences, its history and development, role in European aquaculture development, services to members, its efforts to professionalize its ranks and operation and management, as well as making itself viable, sustainable and relevant to its members and to the industry. NACA put together a brief synthesis of a survey of 8 farmer associations in five Asian countries.

The meeting informed the Aquaculture Subcommittee Meeting that (a) farmer associations are important partners in sustainable aquaculture development; (b) enabling environments and appropriate facilities should be provided to strengthen farmers associations; and (c) provision of these would contribute to the reasons for and the creation of regional producers organizations in Asia and other regions. The Subcommittee has recommended work on enhancing the role of farmers associations in promoting sustainable aquaculture development as a priority area.

The tuna tanks are deeply inset into the ground

Breeding technique of Malaysian golden arowana, *Scleropages formosus* in concrete tanks

Mohamad Zaini Suleiman

Freshwater Fisheries Research Centre, Department of Fisheries, Batu, Berendam 75350, Melaka, Malaysia
E-mail: pppat@po.iaring.mv, homepage: www.agrolink.moa.my/dof/ppat

Golden Arowana

The Golden Arowana is the most popular and expensive ornamental fish native to Malaysia. The best quality of the crossed-back full scale Arowana is the Malaysian Golden Arowana. This variety only occurs in Bukit Merah Lake in the state of Perak, Malaysia. In its natural habitat breeding season normally occurs from August to October every year. During the season village folk from around the lake will try to collect the valuable fry at night.

There are two varieties of Arowana commonly inhabit Malaysian water bodies; a golden variety and a green variety. The green variety is more common less expensive compared to the golden variety, which sells at a premium. The crossed-back Golden Arowana commonly inhabits the Kerian River and its tributaries in Perak. In its natural habitat the fish prefer slightly acidic clean water and unpolluted natural surroundings, especially shallow and fast flowing rivers with overhanging vegetation on the river bank.

Due the high price of the golden variety the Freshwater Fisheries Research Station (FFRC) started with a few individuals of the wild catch for brood stock. The wild fish were acquired from traditional fish collectors at Bukit Merah Lake in 1990. In 1996 FFRC was fortunate to successfully breed the Malaysian Golden Arowana in concrete tanks on the first attempt.

Broodstock maintenance

Eight pieces of Malaysian Golden Dragon were reared in a bare-based concrete tank measuring 5 x 5 meters with a water depth about 0.5 meters

fenced with plastic netting about 0.75 meters high to prevent the fish from jumping out. A spawning room was built in one corner of the concrete tank and some pieces of bogwood were added to help create a natural living environment for the fish. Other decorations such as pebbles and stones were avoided because they may injure the fish and be swallowed accidentally during feeding. The rearing tank was partially shaded, away from direct sunlight and built in a quiet area. The broodstock were maintained in the rearing tank until the fish reached maturity.

Water quality management

Although the Arowana is a hardy fish the quality of water should be correspond to the pH of water in its natural habitat when reared in concrete tanks. The pH of water in the rearing tank should be maintained between 6.8 - 7.5 and 27 - 29°C. Water was partially changed at about 30 - 35% of total volume and topped up with de-chlorinated tap water. The water depth was maintained at about 0.5 - 0.75 meters.

Feeding

Broodstock were fed with a variety of food. A balanced diet is very important in helping fish to mature and spawn. The daily diet should be diverse and contain a high protein content. The fish were fed daily with meat-based live food such as wild guppy, freshwater prawn (*Macrobrachium lanchestrii*), low grade goldfish and chopped fish meat. Pellet feed containing 32% crude protein was also given as supplementary food. Total amount of food provided was approximately 2% of total body weight per day.

Maturity

The fish attain first maturity from around the 4th year onwards at which point they measure between 45–60cm in total length. The fish spawn throughout the year with the peak season occurring between July and December. In the wild the male incubates the fertilised eggs in its mouth cavity until the fry are free swimming after about 2 months.

Female Arowana have been reported to have a single ovary which contains around 20 - 30 large ova approximately 1.9cm in diameter. Our observations made by dissecting dead mature Arowana reared in earthen pond

obtained from private hatchery confirm the single ovary. However, we found around 50 - 60 ova at different stage of maturity. The mature male Arowana also possess single thread-like testis.

Sex differentiation

There are no obvious sexual differences in juvenile fish. These become apparent after maturity is reached at about 3-4 years of age.

Determination of sex is based on the body shape and the size of the mouth cavity. Male fish have a slimmer and shallower body depth, a bigger mouth and more intense colour then the females. The larger mouth and deeper lower jaw in males are for eggs incubating purposes. The size of the males' head is relatively bigger. Male fish normally seems more aggressive and leading in competing for food.

Spawning behaviour

The Arowana shows very unique behaviour during courtship. Courtship takes place from several weeks to months before the pair starts to mate. The courtship sequences usually are observed at night when the fish tend to swim closer to the water surface. The male chases the female around the perimeter of tank and sometimes the pair circle each other nose-to-tail. About one to two weeks before spawning takes place, the fish swim side by side with their bodies touching. Eventually the female releases a cluster of orange-red eggs.

The male fertilises the eggs and then scoops them into its mouth where it incubates them until the fry can swim and survive independently. The eggs are about 8 –10 mm in diameter and rich with yolk and hatch about one week after fertilisation. After hatching, the young larvae continue to live in the male's mouth for further 7 - 8 weeks until the yolk sac is totally absorbed. The fry leave the mouth and become independent when they reach about 45-50mm.

Identifying a brooding male

After mating a brooding male is can be identified by a distended operculum and its swimming behaviour. They don't seem to feed and look more placid than at other times. A brooding male can also be recognised by a remarkable brood pouch underside its mouth.

Fry harvest

The incubation period (time from fertilisation until the fry released) is normally about 8 weeks. To shorten the period the fertilised eggs can be hand removed from the male's mouth on the 30th day after spawning. The brooding male should be carefully caught with a fine net and covered with a wet cotton towel to avoid injury and struggling.

The lower jaw of the fish is pulled backward slowly and the body is shaken slightly to release the half developed larvae from the male's mouth. The larvae are collected in a plastic basin and incubated in an aquarium. The number of the fertilised eggs collected in a single brood is usually about 20 - 35 larvae.

Larvae removed from the male's mouth

Hatching technique

Once removed from the male's mouth, the half-developed larvae are incubated in glass aquarium tanks, measuring 90 x 45 x 45 cm. Water temperature is kept around 27 - 29°C using a thermostat heater and dissolved oxygen is maintained at about 5 ppm (mg/l) through continuous gentle aeration of the water. We generally add about 2 ppm of Acriflavine solution to the water to prevent infection of any injuries suffered by the larvae during handling. Using this in vitro hatching technique, the survival rate to free swimming stage is generally about 90 - 100%.

During the first few weeks when the larvae still have a large yolk sac, they tend to remain at the bottom of the tank most of the time. The fry start to swim upward periodically when the yolk sac becomes smaller. On the 8th week the yolk sac is nearly fully absorbed and the fry start to swim horizontally. At this stage the first live food should be given to the fry. The yolk sac is fully absorbed and the fry become free-swimming at about 8.5cm in length.

Maintenance of fry

During the incubation period the fry do not need to be fed. The fry will swim freely on the 7th week. Supplementary external live feed such as young guppys or bloodworm can be given at the early free-swimming stage to prevent the fry from attacking each other. The fry are very vigorous feeders and should be provided with ample supply of feed. We recommend a partial water change of about 30% of total tank volume every 2- 3 days to maintain water quality.

Bigger fry about 10 -12cm in length can be fed with freshwater prawn or chopped fish meat to accelerate their growth rate. At 4 months in age we rear fingerlings individually in 75 x 45 x 45cm aquariums to avoid physical defects from fighting with siblings. To enhance the colour and promote the formation of chromatophores we suggest to illuminate with artificial lighting at least 10 -12 hours a day. After 6 -7 months of free-swimming the fry measure about 20 -25cm in length and are suitable for market.

Common problems during maintenance

We found few problems in maintenance of brood stock. All our fish were healthy but common diseases such as fin rot, cloudy eye and infection of anchor worm (*Lernaea*) can occur especially after transferring the fish during overall cleaning of tank.

We treat fish suffering from finrot with a saline bath (1% salt) or commercial medication. Some fish suffer cloudy eyes because of poor handling or from being kept for prolonged time in poor quality contaminated water. To overcome this problem partial water changes of about one third of tank volume every two or three days should be carried out until the fish fully recover. Common salt was

Continued on page 13

Extension in shrimp health management: experiences from an MPEDA/NACA program in Andhra Pradesh, India

PA Padiyar[1*], MJ Phillips[1], M Primphon[1], CV Mohan[1], BV Bhat[2], VS Rao[2], G Ravi Babu[1], ABCh Mohan[1], GN Murthy[3] and P Chanratchakool[4]

1 NACA, P.O. Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand
2 The Marine Products Export Development Authority, P.B. No. 4272, Panampilly Avenue, Cochin - 682 036, India
3 Sri Subrahmanyeshwara Aquaclub, Mogalthur, West Godavari District, Andhra Pradesh, India
4 Aquatic Animal Health Research Institute, Department of Fisheries, Jatujak, Bangkok 10900, Thailand
**Email arun.padiyar@enaca.org*

Asia is the major supplier of black tiger shrimp (*Penaeus monodon*) to the world seafood market. The majority of Asian shrimp farmers are small-scale holders operating low input and low output farming systems. Disease is regarded as the major bottleneck for successful and sustainable shrimp farming in many parts of Asia. White spot disease (WSD) caused by white spot syndrome virus (WSSV) alone has been responsible for significant social and economic damage to the shrimp farming sector since 1993, and is a major source of risk to the livelihoods of small-scale farmers investing in shrimp farming. Addressing shrimp disease risks among these stakeholders is essential, but much ignored requirement, to sustain the livelihoods of small-scale farming communities in many of Asia's coastal regions.

In India, a new initiative on shrimp disease control was started in 2000 by the Marine Products Export Development Authority (MPEDA), Ministry of Commerce and Industry, Government of India with technical assistance from the Network of Aquaculture Centres in Asia-Pacific (NACA). This article describes the main activities and outcomes from this 3-year "Shrimp disease control and coastal management" program.

Members of the Sri Subrahmanyeshwara Aqua Club, Mogalthur with MPEDA/NACA study team

Left: Mr. Gubbala Narayana Murthy is the active and dynamic leader of the Sri Subrahmaneshara Aqua Club

Below: Technical assistants interviewing a farmer

Shrimp disease risk factor study

Following some preliminary consultations with farming communities and planning work in 2000, a detailed study was conducted on shrimp disease problems during 2001. The study, involving 365 ponds in West Godavari and Nellore districts of Andhra Pradesh state, used an epidemiological approach to better understand the key risk factors contributing to shrimp disease outbreaks and low pond production,

with an emphasis on the economically serious "white spot disease". The outcomes of the study provided better understanding of risk factors for white spot disease outbreaks, and factors causing unusually low pond productivity, and recommended management strategies (so called "better management practices" – BMPs) to reduce the identified risks. Towards the end of 2001, results were discussed widely with farmers and other agencies in Andhra Pradesh and some consensus was reached on the study findings and their practical application to improve performance of shrimp farming systems of Andhra Pradesh.

Farm level demonstration of "better management practices"

During 2002, demonstrations were conducted on five selected private farms, involving 10 ponds, in three villages in West Godavari and Nellore. NACA and MPEDA provided technical assistance to demonstration farmers for on-farm testing of BMPs, and supported monitoring and evaluation to understand benefits and constraints. The demonstrations were also used to more widely disseminate information on risk management strategies to farmers. Although the adoption of BMPs did not completely eliminate shrimp disease problems, the outcomes as judged by participating farmers and the MPEDA/ NACA study team were very promising. Adoption of pond level risk management practices led to improvements in both profits and productivity. In demonstration farms, returns shifted from a loss in 80% of ponds in 2001 to a profit in 80% of ponds in 2002. During District level workshops in November 2002, with over 470 farmer participants from Nellore and Bhimavaram, farmers responded positively to the findings, and requested urgent support for more demonstration activities, and initiatives to extend the concept of BMPs to the wider farming community. The 2002 demonstrations further provided valuable insight into factors influencing adoption of BMPs by farmers, with farmer knowledge, willingness and capacity to adapt BMPs to on-farm conditions and

Farmers and farm types

The village demonstration was conducted in Padamattipalem area of Mogalthur village. From an initial field survey during January 2003, a total of 256 aquaculture ponds spread over 125 ha of land belonging to 98 farmers were identified. Out of these, 58 farmers with 108 ponds spread over 58 ha volunteered to work with the study team and came together to form the "Sri Subrahmanyeshwara Aquaclub" to implement BMPs through a cooperative approach. The farmers involved were mostly small-scale farmers, with on average 2 ponds of one ha water spread area. Improved traditional farming with low investment ($ 1000/ha/ crop) is practiced with an average stocking density of 25000 PLs/ha. To sustain livelihoods and maximize incomes, farmers also follow crop rotation, with paddy and/or finfish

Box 1: Mogalthur BMPs: Pond bottom and water preparation

1. Sludge removal and disposal away from pond site
2. Ploughing on wet soil if the sludge has not been removed completely
3. Water filtration using twin bag filters of 300 micron mesh size
4. Water depth of at least 80cm at shallowest part of pond
5. Water conditioning for 10-15 days before stocking

Box 2: Mogalthur BMPs: Seed selection and stocking practices

1. Uniform size and colored PLs, actively swimming against the water current
2. Nested PCR negative PLs for WSSV (using batches of 59 PLs pooled together. If test turns negative it means that the prevalence of WSSV infected PLs is less than 5% in that population at 95% confidence)
3. Weak PL elimination before stocking using formalin (100 ppm) stress for 15-20 minutes in continuously aerated water
4. On-farm nursery rearing of PLs for 15-20 days
5. Stocking during 1st week of February to 2nd week of March
6. Stocking into green water and avoiding transparent water during stocking

Box 3: Mogalthur BMPs: Post-stocking and grow-out

1. Use of water reservoirs, and 10-15 days aging before use on grow out ponds
2. Regular usage of agricultural lime, especially after water exchange and rain
3. No use of any harmful/banned chemicals
4. Using of feed check trays to ensure feeding based on shrimp demand
5. Feeding across the pond using boat/floating device to avoid local waste accumulation
6. Regular removal of benthic algae
7. Water exchanges only during critical periods
8. Weekly checking of pond bottom mud for blackish organic waste accumulation and bad smell
9. Regular shrimp health checks, and weekly health and growth monitoring using a cast net
10. Removal and safe disposal of sick or dead shrimp
11. Emergency harvesting after proper decision making
12. No draining or abandoning of disease affected stocks

Manual removal of sludge

Well prepared pond

financial resources all contributing to outcomes. Based on the findings from 2001 risk factor study and the 2002 demonstrations, BMPs were further modified and were published in a "Shrimp health management extension manual" (MPEDA/NACA, 2003). The manual is freely available for download at www.enaca.org/shrimp and www.mpeda.com.

Village demonstration

During 2003, MPEDA and NACA responded positively to the farmers requests and supported an extension of the technical assistance, for further demonstrations in one village in West Godavari. The objective was to promote adoption of BMPs across a wider number of farmers to create a visible and quantifiable impact on the village community. A further objective was to support the village to organize a "self-help group" (aquaclub) for organization among farmers in the village to collectively address common shrimp health and farm management problems.

The core NACA/MPEDA team lived in Mogalthur village during an entire cropping cycle, promoting adoption of BMPs, supporting farmers to establish the "aquaclub", facilitated weekly farmer meetings, and organised "service provider - farmer" contacts and exchange of information thus trying to build up mutual trust among the these parties. At the same time, the team established a monitoring program and at the end of the 2003 crop evaluated with farmers the outcomes of the village demonstration, to better understand the benefits and constraints to adopting better health management practices.

crops during the rainy season. The main shrimp cropping season is from March to July.

Health management practices

Shrimp health management practices were developed in consultation with local farmers, based on general BMP principles derived from the 2001 risk factor studies and 2002 demonstrations.

Pond bottom and water preparation

During January and February 2003, pond bottom preparation and water conditioning prior to stocking was strongly emphasized. The BMPs are summarized in Box 1. At this time, support was also provided in crop planning.

Seed selection and stocking

Seed quality and the pond environment at stocking has a critical influence on crop outcomes. In this area farmers had previously paid little attention to PL quality, and most had never had the opportunity to select quality seed. Farmers used to purchase seeds from traders or local nurseries, which are often poor quality. The team assisted the farmers to organise into small sub-groups of 5-10 members to visit the hatcheries and select better quality seed. PCR testing and on-farm nurseries were also promoted. The BMPs are summarized in Box 2.

After stocking

After stocking, and during grow-out a range of BMPs were promoted, as shown in Box 3. Particular attention was given to maintain healthy blooms, and exchange of water when required. Feed management was made more efficient through use of check trays

Removal of weak and dead shrimp seed while stocking

Table 1: Evaluation of BMP adoption: Criteria for grading

Grade	Criteria
A	• Good follow up, most BMPs implemented • Timely implementation
B	• Moderate follow up • Some delays in implementation
C	• Limited follow up, few BMPs implemented • Long-term delays in implementation

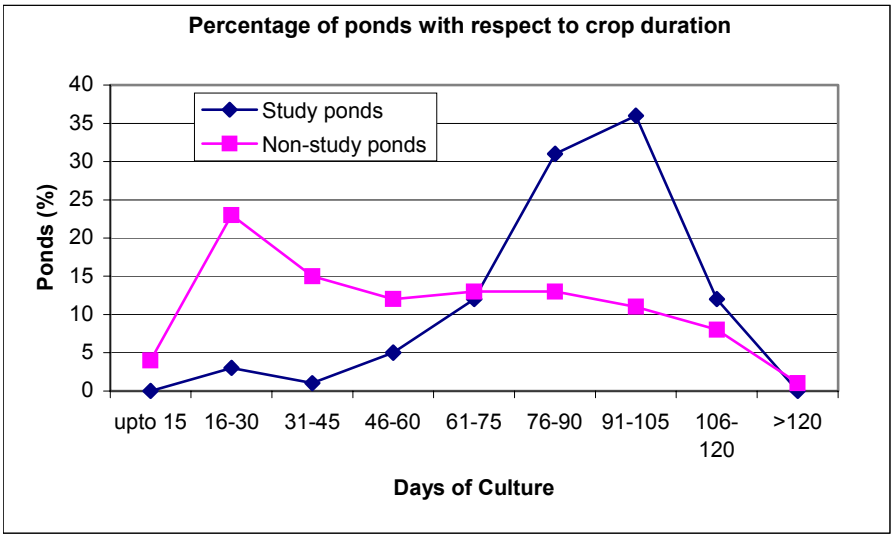


Table 2: Evaluation by study team - Percentage of ponds in each grade

Grades	Before stocking	After stocking
A	53	24
B	34	34
C	13	42

Table 3: Crop outcomes (average values)

Outcomes	Demonstration ponds	Non-demonstration ponds
Crop duration (Days)	87	63
Production (kg/ha)	318	133
Mean body weight (g)	18	12*
Survival rate (%)	58	32*
* The analysis doesn't consider 51 ponds, which were drained without any shrimp harvest		

(each more than one square feet area) to reduce FCRs, save money for farmers and reduce organic wastes leading to water quality problems and excessive pond bottom sludge. Previously, farmers were using traditional small earthern bowls (each less than half a feet in diameter) as check trays which were not effective in estimating feed consumption. After formation of the aquaclub, farmers also agreed to observe more sanitary practices after disease outbreaks.

Adoption of Better Management Practices

To assess the impact of demonstration program, BMP adoption and crop outcomes were compared in demonstration and non-demonstration ponds in nearby villages. In total, data were collected from 164 ponds in 20 villages including Mogalthur village in July 2003.

The findings show that BMP adoption rates in demonstration ponds were much higher than those in the non-demonstration ponds of surrounding villages. Adoption rates for some key BMPs like sludge removal, water filtration using twin bags of 300 micron mesh size, PCR testing, stocking on farm nursery reared seeds, demand feeding using check trays and emergency harvesting of disease affected stocks were 99%, 89%, 98%, 83%, 88% and 100% respectively. In non-demonstration ponds the adoption of these key BMPs was significantly low, at 62%, 15%, 18%, 23%, 10% and 69% of farm ponds respectively. In spite of active promotion, several BMPs were not easily adopted. For example, farmers faced difficulties in maintenance of 80 cm water depth due to land topography and the capital investment required to deepen and repair ponds. Stocking during the recommended period was followed only in 38% ponds, due to difficulties in procuring the required quantities of quality PLs, which passed initial selection process including PCR screening. Weak PL elimination and use of water reservoirs were new management approaches in the region that farmers were particularly receptive to.

To assist in evaluating outcomes, the study team gave farmers evaluation grades on an A-C scale as shown in Table 1. Evaluation grades were given at the time of stocking. Grades after stocking were given on weekly basis and then mean values for the entire crop duration was considered in a final grade.

These grades represent the skills and attitudes of farmers towards

The manual is freely available for download from www.enaca.org/shrimp or www.mpeda.com

On-farm nursery

implementation of BMPs. The results (Table 2) show that more farmers were active in adoption during pond preparation stage. Following stocking, farmers were less active in their approach, perhaps due to overconfidence, thinking they had prepared the pond very well and stocked good quality seeds. The gradings were subjective. More farmers in B and C grades after stocking was due to delayed or inappropriate follow-up of BMPs over the cropping period. For example, a farmer might have kept check trays in his pond but he may not have used it for regular feed checking and meal adjustments. For many farmers, the BMPs were new and they were in a learning stage. As crop outcomes also relate to pond management after stocking, the evaluation emphasizes the need for active adoption of BMPs through the crop cycle.

Crop outcomes

The outcome from the demonstration was very favorable, as judged by farmers and the study team. Average crop outcomes in study and surrounding ponds are given in Table 3. All the considered four crop outcomes – days of culture, productivity, shrimp size and survival - were significantly ($p < 0.05$) better in demonstration ponds than the non-demonstration ponds. Many of the non-demonstration ponds crashed with disease early in the season, whereas nearly 75% of demonstration ponds sustained the crop until 80 days. Stocking density in both the groups was on average 25,000 PLs/ha. Even though shrimp disease outbreak could not be completely prevented, with problems emerging due to poor weather in mid July, negative impacts of disease were reduced significantly leading to better harvests from demonstration ponds than non-demonstration ponds. The success of the demonstration ponds compared to non-demonstration ponds is also clear from the intense interest and requests from farmers in nearby villages to join the demonstration program.

In demonstration ponds, crop outcomes also varied depending on the extent of adoption (Tables 4 and 5). Better adoption of BMPs, both before and after stocking was significantly ($p < 0.05$) associated with higher production and higher survival rates. When the crop outcomes for different grades were compared for before and after stocking stages, it suggests that farmers who continued to actively adopt BMPs after stocking could significantly improve their crop outcomes. When the demonstration and non-demonstration ponds were compared, the average crop outcomes of even the C grade ponds (for both before and after stocking stage) were better than those from non-demonstration ponds. This indirectly suggests that adoption of even some basic BMPs like sludge removal, PCR screening, and weak PL elimination can improve crop outcomes in surrounding non-demonstration ponds.

Lessons learned

The outcome in 2003 was an active club that met regularly and promoted widespread adoption of the BMPs among its members, generating intense interest among neighboring villages. At the end of the 2003 crop, participating farmers recorded significant benefits from adopting BMPs and the aquaclub formation. Although shrimp disease was not eliminated, demonstration ponds had significantly increased production and better quality product (as reported by study farmers) compared to surrounding ponds and villages. The demonstration provided better understanding of the constraints faced by farmers in adopting BMPs.

Not all the farmers could take up all the BMPs. This is due to skills and attitude and willingness of farmers towards implementation of BMPs, traditional culture practices and experiences, some what lost faith in good crops due to many years of uncertainty, and financial and social constraints. Some simply did not have the funds to invest in pond improvements for example. The experience suggests a need to carefully develop locally specific BMPs with farmers (based on general BMP principles) tailored to the farming systems (based on stocking densities, ability to maintain water reservoirs, source water quality etc) and investment capacity of individual farmers.

The well-coordinated collective approach and positive outcome among aquaclub members has evoked keen interest amongst farmers in surrounding village and the study team has received several popular requests to bring new villages into the program during 2004.

Aquaclubs for extension?

Adopting BMPs is only one part of the Mogalthur story. The other is the formation of the aquaclub. In general, services to shrimp farmers are poor in Andhra Pradesh. The small-scale nature of shrimp farms, scattered locations across poor basic infrastructure, combined with limited existing extension capacity, make any traditional extension effort very difficult. Can the formation of self help groups, or "aquaclubs", combined with a major extension effort for the BMPs, be a model for wider improvements in farming practices?

The formation of Sri Subrahmanyeshwara Aquaclub in study area has shown several benefits to the farmers in the village. Information exchange and sharing of knowledge on BMPs among farmers within the club during weekly club meetings was a prime benefit, seen with increasing farmer numbers attending weekly meetings during the crop cycle. Many of the small-scale farmers in Mogalthur had not even visited the hatcheries over 15 years of shrimp

Measuring the water depth - at least 80cm is needed

Training the farmers on check-tray feed monitoring

Weekly farmer meeting

farming experience. The organization of the small sub-group of farmers for screening and selecting quality seeds from hatcheries was therefore a major outcome well received by farmers. One sub group of farmers went further, and organize a group "on-farm nursery" assuring themselves better quality juveniles at cheaper prices than local nurseries, where quality and infection is a major concern. There was also a good response from club farmers to cooperate in water supply and draining especially during disease outbreaks thus reducing risks of disease spread. With an organized group, better responses were observed from owners of shrimp hatcheries, processing plants, feed manufacturers, concerned government agencies to the concerns raised by the club members. Neighboring village farmers started participating in weekly club meetings to share their experiences with club farmers and have shown interest to develop similar clubs in their areas. While there is some way to go, the results show that extension through farmer clubs could be one important strategy for motivating, and bringing farmers together to disseminate extension messages and discuss solving of common problems.

Although there was no advantage for farmers in marketing their harvests during the demonstration period, considerable interests were shown by local purchasers in procuring the shrimps from club farmers, where farmers were not using any banned chemicals. Some farmers in small groups collectively sold their small quantities of shrimp together. The better organization of marketing around such aquaclubs is a potential future direction that may lead to better market incentives and access for small scale farmers.

Where to next?

The study has shown that it is possible to reduce risks of crop losses from shrimp disease and improve productivity and profitability of shrimp farms in the study areas of Andhra Pradesh through:

- Providing access to science based information on BMPs;
- Providing technical support that enables farmers to adapt BMPs to their own circumstances
- Promoting the concept of self-help groups (aquaclubs) to facilitate cooperation and communication to collectively address health management issues.

Very preliminary estimates from 2002 indicated a net improved economic return in ponds adopting BMP at Rs 30,000/ha in Bhimavaram. Even though returns in 2003 were more moderate due to lower shrimp prices, if such returns could be scaled up over time to even 50% of the ponds in this district, an economic boost of Rs 300 million in West Godavari might be achievable. Even a moderate gain in profitability spread more widely across the 120,000+ ha of active shrimp farms in India, could lead to substantial benefits to shrimp farming communities, suggesting investment in a major extension effort could be well justified. Economic returns from technical improvements also open opportunities for cost-recovery as well as for sustaining farming groups and extension systems.

One of the salient features of the BMPs is the emphasis on avoiding antibiotics, and other banned chemicals. Aquaclubs adopting BMPs therefore have a further potential advantage – they produce quality shrimp without harmful residues. This advantage could open the way for organization of trace-ability and possibly certification in line with international trends and requirements. The aquaclub approach where farmers work together indeed may be the only way of supporting small-scale farmers to access international markets, with increasingly stringent requirements for trace-ability and food safety.

Conclusion

The experiences of Mogalthur are heartening: while much remains to be done, the results clearly show that better organized farming communities, and adoption of basic health management practices have considerable potential to benefit small-scale farming communities. The challenge now is to extend this approach widely across the coastal farming communities of India, linking a better organized small-scale farming sector, perhaps organized around "aquaclubs" and better market access. The opportunity exists for a potential

Cooperation amongst farmers for grading the harvested shrimps

transformation in the sector in the coming years. Can it be done?

Acknowledgments

We thank the Chairman and the Director of MPEDA and the Director General of NACA for their support and encouragement; the Australian Centre for International Agricultural Research (ACIAR) for their technical and financial assistance; the Central Institute for Brackishwater Aquaculture (CIBA), Chennai; College of Fisheries, Mangalore and TASPARC, Vishakhapatnam, for valuable cooperation. Our sincere thanks to Dr. A Cameron, AusVet, Australia for his valuable support to the epidemiological risk factor study, and opening new approaches to shrimp disease control investigations. We are grateful to 12 technical assistants for their sincere and dedicated services during the risk factor study and particularly to the shrimp farmers and hatchery owners of Andhra Pradesh for their participation and friendship.

References

MPEDA/NACA. 2003. Shrimp Health Management Extension Manual. Prepared by the Network of Aquaculture Centres in Asia-Pacific (NACA) and the Marine Products Export Development Authority (MPEDA), India, in cooperation with the Aquatic Animal Health Research Institute, Bangkok, Thailand; Siam Natural Resources Ltd., Bangkok, Thailand; and AusVet Animal Health Services, Australia. Published by MPEDA, Cochin, India.

Central Institute of Brackishwater Aquaculture (CIBA), Chennai, organizes an *Expert Consultation on Rapid Diagnosis of Shrimp Viral Diseases* in cooperation with ACIAR and NACA

It is now well established and widely accepted that PCR screening of broodstock and/or seed for WSSV can be effective in reducing the risk of disease outbreaks and there has been a significant level of adoption of this technology for viral screening in some Asian countries, including India and Thailand. However, in many cases, disease on farms continues to impact very significantly on production, even when PCR-screened seed is used prior to stocking. There appear to be several reasons for the continued occurrence of disease on farms

During the MPEDA/NACA technical assistance on *Shrimp Disease and Coastal Management*, concern was raised about the reliability of PCR test results and the need for standard or harmonised procedures for white spot syndrome virus (WSSV) testing that would deliver a more consistent message to shrimp farmers in India. In June 2002, the Central Institute of Brackishwater Aquaculture (CIBA) of the Indian Council of Agricultural Research (ICAR) in cooperation with ACIAR, NACA and MPEDA, organised an *Expert Consultation on Rapid Diagnosis of Shrimp Viral Diseases.* The expert consultation was attended by representatives of research institutes, universities and the private sector in India and researchers from Australia and Thailand.

The objectives of the CIBA consultation were to: examine current PCR techniques and procedures (and other rapid diagnostic techniques) in use in shrimp culture in India; identify limitations and constraints in use of PCR and rapid diagnostic techniques as part of shrimp health management procedures; introduce recent regional developments in PCR and rapid diagnostic techniques and their potential application in India; develop practical recommendations for effective use of PCR and rapid diagnostic techniques in shrimp health management procedures; and to identify research needs for viral disease diagnosis and shrimp health management in India. The outcomes provide an important "road map" for effective use of diagnostic tools for shrimp viral diseases in India, and enhancing regional cooperation in development of shrimp disease diagnostic techniques. The need for more reliable PCR screening and better information for farmers was specifically identified as a priority by the consultation, as was the potential for voluntary inter-laboratory calibrations to harmonize PCR testing sensitivities with linked technical and theoretical training for PCR laboratory technicians. Further details of the outcome of the expert consultation are available at www.enaca.org or may be obtained from the Central Institute of Brackishwater Aquaculture (CIBA) at www.ciba.nic.in (ciba@tn.nic.in).

Continued from page 6

Breeding technique of Malaysian golden arowana

added at every water change (1%) until the condition improved. Infection with anchor worm parasite Lernaea causes the fish to rub its body against the side of tank and lose appetite. The parasites can be removed manually and the infected fish were also treated with Diptrex® at 0.5 ppm (mg/l).

Conclusion

Breeding of Arowana in earthen pond is commonly practised by commercial ornamental fish farms in Malaysia. To start the business the breeding operation needs a large amount of money for the cost of capital such as buying the broodstock and building new infrastructures

The FFRC Batu Berendam has developed a breeding technique for Arowana in enclosed concrete tank. To start the breeding operation requires an estimated cost of around RM 150,000-100,000. This is affordable by breeders in the Malaysian community and can be operated as concurrent activity for side income. The breakthrough achieved by FFRC shows that the technique is also suitable for small scale and backyard industry.

The technique was introduced to interested farmers in Malaysia through transfer technology programme and the responses from farmers are very promising with first harvests after two years operation. This shows that the Arowana seed production in concrete tank technique is workable and practical.

References

Mohamrnad Mohsin, A.K. and Mohd Azmi Arnbak 1983. Freshwater fishes of Peninsular Malaysia. Universiti Pertanian Malaysia.

Mohamad-Zaini,S., Saadon,K., Mansor, A & Ornar A.B (2000). Breeding of Arowana, *Scleropages formosus*, (Müller and Schlegel) In Concrete Tank. FRI Bullettin Vol.5 No: 2. December, 2000.

Scott, D.C.B and Fuller, J.D (1976. The reproductive biology of *Scleropages formosus* (Müller and Schlegel) (Osteoglossomorpha, Osteoglossidae) in In Malaya and the morphology ofits pituitary gland. J. Fish BioI. 8,pp 45-53.

Ornamental Fish Farming – Successful Small Scale Aqua business in India

Abalika Ghosh[1], B. K. Mahapatra[2] and N.C. Datta[3]

1: Department of Industrial Fish and Fisheries, A.P.C. College, New Barrackpore, West Bengal
2: ICAR Research Complex for NEH Region, Umiam (Barapani), Meghalaya 793103
3: Fishery and Ecology Research Unit, Department of Zoology, University of Calcutta, Kolkata- 700019,

Ornamental fish keeping is becoming popular as an easy and stress relieving hobby. About 7.2 million houses in the USA and 3.2 million in the European Union have an aquarium and the number is increasing day by day through out the world. Ornamental fish farming is also growing to meet this demand. The fact is that USA, Europe and Japan are the largest markets for ornamental fish but more than 65% of the exports come from Asia. It is encouraging news for developing countries that more than 60% of the total world trade goes to their economies. Although India is still in a marginal position its trade is developing rapidly. An estimate carried out by Marine Products Export Development Authority of India shows that there are one million fish hobbyists in India. The internal trade is estimated to be about U.S.$ 3.26 million and the export trade is in the vicinity of U.S.$ 0.38 million. The annual growth rate of this trade is 14%.

A rich diversity of species and favorable climate, cheap labor and easy distribution make India, and West Bengal in particular, suitable for ornamental fish culture. With Kolkata as a distribution and export center the adjoining districts have become the major ornamental fish-producing zones of India. About 90% of Indian exports go from Kolkata followed by 8% from Mumbai and 2% from Chennai. In the state of West Bengal there are more than 2000 people involved in this trade including ornamental fish breeders, growers, seed and live food collectors, traders and exporters (Fig. 1). About 150 families are involved in ornamental fish farming to maintain their livelihood. More than 500 families use it as an additional income generating business.

Series of cement cisterns are made in the backyard for ornamental fish farming.

Small-scale farmers use round portable earthen pots for rearing of juveniles

Some low-income suburban fisher folk have successfully established ornamental fish farming as a small-scale business. The general management practices followed by the small-scale ornamental fish farming of West Bengal are discussed.

Main producing districts

Most of the ornamental fish farms are located in North and South 24 Parganas, Nadia, Hoogly, Howrah districts around Kolkata so it is easy for the farmers to market their fish. The largest wholesale ornamental fish market in India is located here. Most of the fish are distributed to different states of India via train, bus or air. Some are sent abroad also.

No aerator and thermostat is used for outdoor rearing of common ornamental fish

Small-scale farmers

The distribution of the population, size of the family, education and job status of 110 families of Howrah and South 24 Parganas are given in table 1. Most of these families run small home units to earn additional monthly income of Rs. 2500- 5000 (US$ 50-100). Generally the men have other professions and they only look after the seed collection and marketing. The women and children do the everyday care like water exchange, feeding.

Fish Species

Two categories of ornamental fish are being marketed - exotic ornamental fish and native fish of India, which have ornamental value for coloration or behavior. Exotic fish dominate the domestic market. Already 288 exotic varieties have been recorded in Indian market. More than 200 species of these freshwater fish are bred in different parts of India and others still have to be imported as fry[1].

According to availability, demand, and climatic conditions the ornamental fish farmers of West Bengal are mainly engaged in breeding and rearing of common exotic live bearers and egg layers[2]. The egg layers lay sticky or non-sticky eggs on the glass wall or

Table 1: Family size, education and job status of 110 families

Population	No.	Education up to secondary	Have other job
Men	150	60%	120
Women	180	40%	25
Boys	85	70%	School education
Girls	60	60%	School education

Artificial breeding mops made up of nylon thread is used to collect the sticky eggs from cisterns

aquarium plants. Some parents show parental care and some destroy their eggs so different breeding setups are needed. Live bearers release young in batches and are easy to breed.

Among the preferred fish, there are common exotic live bearers like guppy, *Poecilia reticulata*; molly, *Poecilia latipinna*; swordtail, *Xiphophorus helleri*; platy, *Xiphophorus maculatus* and egg layers like gold fish, *Carrassius auratus*; koi, *Cyprinus carpio*; tiger barb, *Puntius tetrazona*, Siamese fighter, *Betta splendens*; serpae tetra, *Hyphessobrycon serpae* and on-growing of some imported fish like silver shark, *Balatocheilus melanopterus*; angel, *Pterophyllum scalare*, red – tailed black shark, *Labeo bicolor*; red finned shark, *Labeo erythurus*. Sometimes they are collecting the fry of native ornamental fish and selling them after rearing and domesticating them. The native ornamental fish include honey gourami, *Colisa chuna*; rosy barb, *Puntius conchonius*; zebra fish, *Brachydanio rerio*; glass fish, *Chanda nama*; Reticulate loach, *Botia lohachata*. Presently only about 52 native fish species from West Bengal have been earmarked as aquarium fish[3].

Farmers use their facilities to breed a range of species shifting with the season.

Culture tank

Cement cisterns, all glass aquaria, earthen ponds, even earthen pots are being used as culture tanks. The urban and suburban landless farmers generally use cement cistern in the backyard or on the roof. Two or three cement cistern are sufficient for a small rearing unit (around 3m x 2m x 1m). The cisterns are built above ground level for easy drainage. Indoors, all-glass aquaria are preferred for breeding purposes as heaters and aerators can be used. Farmers with small earthen tanks can use them for rearing juveniles with the food fish. Marginal farmers even use large earthen pots of 1.5m diameter for rearing the larvae and juveniles.

Aquaria are used for bath treatment of fish with medicines

Generally the area of the tank depends on the type and size of the candidate species. In the case of fresh water tropical species, generally the farmers consider that for each 1cm of fish length, 20cm^2 of surface area is sufficient.

Culture water

In the municipal areas the farmers use normal tap for farming. Before use it is aerated for few days for de-chlorination. Tube well water is also used directly in the rural areas. The average temperature of the rearing water in the area is 15- 28C and the pH is slightly alkaline. Other parameters are not so crucial. Most of the species cultured prefer soft to medium hard water.

Food and feeding

Food, especially the first food of larvae is vital for achieving good survival rates. The small-scale farmers cannot afford different readymade pellet feed or brine shrimp larvae. However, they have successfully substituted low cost alternative live feeds. Green water, water fleas, *Tubifex* or sludge worm, mosquito larvae and chopped earthworm are used. Different homemade feed like whole-wheat bread, vegetable peelings and rice are also fed. However, most farms depend on *Daphnia*, tubificid worms and mosquito larvae. The farmers collect *Daphnia* from the near by ponds by sieving through fine mesh in the early morning. Tubicid warms and mosquito larvae are generally collected from the sewage water channels. In fact there are quite a few people whose profession is to collect these live foods and sell them to the farmers.

Generally the farmers dispense the feed once daily, preferably in morning. The rate of feeding depends on species, size and season. Overfeeding is more harmful than under feeding as the excess feed destroy the water quality.

Table 2: Easily available chemicals and medicines for health management

Chemicals/ Medicines and dose	Method of use	Purpose
Common salt @ 15-30 gm/lt.	Bath treatment for 30 min	As disinfectant
Methyline blue @ 2.5 gm/lt.	Added in aquarium water	For water purification
Copper sulfate or Potassium permanganate @ 0.5-1 gm/l	Bath treatment for 1 min	As disinfectant

Health management

In ornamental fish farming, proper water quality maintenance is the primary preventive measures as they are very sensitive to temperature and pH. The common health hazards of the ornamental fish are white spot, mouth fungus, tail and fin rot. The farmers use some easily available and economic chemicals and medicines as preventive measures. These are in Table 2.

Marketing

Kolkata, the capital of West Bengal is the main distribution centre. From here the fish are sent to different states of India by air or road. A fair amount is also exported. Two parallel marketing procedures exist for exotic and native fish. In the case of exotic species, more than 99% is consumed by the domestic market and a few species like gold fish and angelfish are exported. On the other hand, 90% native ornamental species are collected and reared to meet export demand. The amount of marine ornamental fish trade is negligible in this area.

The marketing process is generally being done through the following channels:

- Firstly, the producers directly sell the ornamental fish directly to the wholesalers, but the amount is very negligible
- Secondly, there are some big middle tired men who buy large volumes of fish at very low prices from the producers, rearing the fish for 2-3 months before selling at the wholesale markets again for increased profit.
- Lastly from the wholesale markets, retailers and others purchase the ornamental fish.

For export, the Marine Products Export Development Authority has 20 registered exporters. They either have their own farm or collect the fish from different areas for export. The USA, Japan and Singapore are the main markets.

Economics

An ornamental fish production unit may be of three types – a breeding unit, rearing unit or combined breeding and rearing unit. The profit depends on the carrying capacity, candidate species and infrastructure. The marginal farmers who breed or rear the fish have to sell them earlier due to the lack of proper equipment and get less profit. On the other hand better-off farmers rear the fish to an optimum size and get more profit.

The average cost and return of a minimal breeding and rearing unit of live bearers is in Table 3.

Outlook

Ornamental fish farming can be a promising alternative for many people. It requires little space and less initial investment than most other forms of aquaculture. At the first stage of starting of an ornamental fish farm, very sophisticated or complicated equipment is not necessary. Only a clear understanding of habits and biology of the fishes basic needs is required so it can be practiced even in urban areas with little alteration of backyard or even the roof of a dwelling. As less manpower is needed, the women or the elders can run small home units. With slightly more sophisticated equipment such as heaters, aerators and power filters, and practices such as selective breeding, stock manipulation and proper feeding, large units can be maintained in urban areas also.

References

1. Mahapatra, B.K., Dutta, A., Basu, A., Dey, U.K., and Sengupta, K.K., 1999. Observation on the spawning and rearing of Angel fish, Pterophyllum scalare(Lichenstein). In: M. Sinha, Dhirendra Kumar and P. K. Kathia (eds.), Eco- friendly Management of Resources for Doubling Fish Production Strategies for 21st century. Proceedings of the National Seminar, December 22 and 23, 1999, Inland Fish. Soc. of India, Barrackpore; 102-106.
2. Mahapatra, B.K., Ghosh, A. and Datta, N.C. 2000. Breeding and rearing of ornamental fishes, Guppy, Poecilia reticulata, Peter and Gold fish, Carassius auratus (Linnaeus) for prospective entrepreneurship development. Green Technology. Vol.3. PP 26-33.
3. Ghosh, A., Mahapatra, B.K. and Datta, N.C.2000. Ornamental fish farming- an additional income generating programme for women folk with a note on its constraints and prospects, the Fifth Indian Fisheries Forum, Asian Fisheries Society, January 17-20, 2000. Central Institute of Freshwater Aquaculture (ICAR), Bhubaneswer.

Table 3: Average cost and return of a breeding and rearing unit of live bearers

Capital cost (Rs.)		
2 glass aquarium (2.5 x 2 x 1) m each with lids and fittings	@1400.00	2,800.00
3 cement cistern (5 x 3 x 2) m	@1200.00	3,600.00
3 aerator	@200.00	600.00
Other equipments like hand net, buckets, pipes		1000.00
		8000.00
Culture cost (Rs.)		
200 hundreds female	@1.00	200.00
50 male	@3.00	150.00
Feed for one year		3,600.00
Others		1,000.00
		4,950.00
Total cost (Rs.)		**12950.00**
Production Monthly production of 5,000young Yearly production of 60,000 young 40% male = 24,000 60% female = 36,000		
Sale		
24,000 male	@1.25	30,000.00
36,000 female	@0.30	10,800.00
Total sale		40,800.00
Annual profit = (40,800.00 - 12,950.00) = 27,850.00 **Monthly profit = Rs. 2,320.83**		

Captive Breeding of Peacock Eel, *Macrognathus aculeatus*

S.K.Das and N. Kalita

Assam Agricultural University, College of Fisheries, Raha, Nagaon,Assam,India 782 103

World trade of ornamental fishes has reached more than one billion dollars and is growing rapidly at around 10% per year.

India currently exports only around Rs. 30 million (US$650,000 million) of ornamental fish. However, the northeast of India has many species of fish that have great potential in the ornamental trade and many of which are attractive to foreign markets. There is great potential to expand the local industry.

In Assam there are several native species suitable for the ornamental fish trade. These include *Botia dario*, *Channa stewartii*, *Channa barca*, *Gagata cenia*, *Hara hara*, *Garra* species, *Mystus* sp. *Somileptes gongata*, *Nemacheilus botia*, *Macrognathus aculeatus*, *Mastacembelus pancalus*, *Rasbora* species, *Danio* species and many others. In Assam there is no organized trade at present. Only a very few people are supplying these fishes to the exporters in places such as Kolkata and Chennai. Since, they are not directly involved in exporting they are always deprived of the actual price prevailing in the global market. Those who are supplying ornamental fishes endemic to this region normally collect the fish from the wild through their contact fishermen. Therefore, there is always an uncertainty in the availability of a particular species of ornamental fish. A preliminary survey on the export of ornamental fish reveals that about 20 different varieties of ornamental fish of this region are exported annually.

Considering their potential, a few fish species have been recently short-listed for research on captive breeding under a National Agriculture Technology project in the Assam Agricultural University at College of Fisheries, Raha. The project has so far been successful in captive breeding of 5-6 local species of ornamental fishes of Assam. However, more research activities are required in this direction to conserve our natural resources and fish bio-diversity. It is expected that in near future, the dependency on nature for ornamental fish collection will decline.

The peacock eel (M.aculeatus) broodstock

Captive Breeding of Peacock Eel

The "standard" spiny eel, *Macrognathus aculeatus*, is commonly referred to as the porthole eel or the peacock eel. The species belongs to family Mastacembelidae. The body is long and eel-like with a long fleshy snout and a rounded tail fin that is separated from dorsal and anal fins. The body color is brownish to yellowish ventrally and marked with two long dark bands on either side. There are 3-11 ocelli (false 'eye' spots) at the base of dorsal fin. Both the dorsal and caudal fins have several fine streaks. During our survey in Assam we have so far recorded a maximum size of 24.5 cm weighing 56 grams.

Peacock eels are distributed in India, Pakistan, Sri Lanka, Bangladesh, Nepal and Myanmar. It is locally known as Tourah or Tora or mud eel in Assam and Ngaril in Manipur. They have a medium food value and fetch about Rs.120-140 per Kg (US$2.50-3.00) in the local markets of Assam. The IUCN list this fish in the 'lower risk-near threatened' category. It is in high demand as an ornamental fish in the export market due to its beautiful body shape, coloration and playful behavior.

A preliminary survey conducted by the Marine Products Export Development Authority under Ministry of Commerce, Government of India found that *M. aculeatus* is increasingly being exported in greater numbers as an ornamental fish.

We collected peacock eels from the wetlands of Assam and reared them in captivity for 3-4 months until they matured. Peacock eels seem to have nocturnal feeding habits, prefering to hide by burying themselves in the substrate or under rocks during the day. They come out at night and early morning to feed. We feed them on a mixture of *Tubifex* worms, mosquito larvae and boiled egg yolk. Since they prefer to hide, We provide shelters such as pieces of bamboo of diameter 4 cm and 25 cm long, submerged aquatic weeds and pebbles to create a congenial environment for breeding.

Determining sex

Al Castro (2003) in Aquarium Fish Magazine reported that the peacock eel grows to about 33cm, but spawns after it has reached about 18cm in length. We have found that a size of around 16-20 cm in length is suitable for induced breeding. It is difficult to determine the sex of the fish when they are young. In general the females are slightly larger than males of the same age. During the breeding season the females develop a swollen abdomen with a greenish tinge, while the males will ooze milt when gentle pressure is applied to their abdomen.

Induced spawning

In Assam, the breeding season starts with the onset of monsoon in the month of April and lasts till August with peaks in June-July. We conducted our breeding trials in April and May. We provided 4cm thick layer of small marble stones on the bottom of the tank and about half a kilogram of cleaned water hyacinth as substrate for spawning. Both male and female *M. aculeatus* received a small dose of Ovaprim hormone (0.025-0.05 ml).

We conducted our breeding trials in a small glass aquarium (75cm x 30cm x 45cm) with a water depth of 10 cm. We maintained the water temperature between 28-30C, pH 7.6-7.8, dissolved oxygen 8-9 mg/L and hardness of about 1.5 mol/L. The water should be completely iron free. We maintained a mild flow of water with the help of an electrical filter and also used an aerator and water heater.

Courtship behaviour

Spawning response varied from 8-10 hours. Courtship begins with the male chasing the female and swimming in a tight circle. Later, the pair encircle each other around the water hyacinth for spawning. The eggs stick to the roots of the water hyacinth. The male releases sperm as the eggs are laid. The eggs are round, green in color, adhesive in nature and about 1.25 mm in diameter.

Larval rearing

The yolk is fully absorbed in around 96 hrs. The free-swimming fry hide among pebbles, plants and in other substrate. The results of the experiment have been summarized in Tables 1, 2 and 3. Larval feeding is very crucial. Once the yolk is absorbed we fed fry at liberty with infusoria, zooplankton and boiled egg yolk.

Spiny eel larvae are very susceptible to bacterial and fungal infections. We find the highest mortality of the larvae during the second week. The poor survival of the larvae in our trials was primarily due to fungal attack and lack of appropriate larval food.

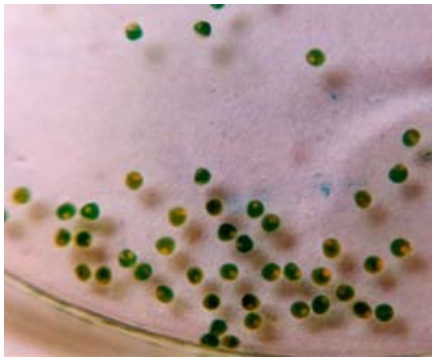
This fish can be reared in community aquarium tank as they are generally peaceful in nature. Initially, we had problems in feeding the fish under captive conditions. However, once acclimated in the glass aquarium, they slowly started feeding on tubifex worms and egg yolk. and attained full maturity in the month of early April.

There is little information on captive breeding of spiny eel. This was our first attempt to breed this fish under captive conditions. More trials are required to refine the larval rearing techniques to improve the survival of the young.

Acknowledgement

We are grateful to the PIU, National Agriculture Technology Project, New Delhi for financial assistance and National Bureau of Fish genetic resources- the lead center, ICAR, Lucknow, UP, India for support and cooperation. The study was conducted under a captive ornamental fish breeding project funded by the NATP on Germplasm, inventory, evaluation and gene banking of fresh water fishes.

The Adhesive eggs attached to roots of water hyacinth.



The green colour eggs of M.aculeatus.

The Hatchlings of M.aculeatus.

Larval measurement of *M. aculeatus*

Life Stages	Size Range (mm)
Hatchling	2.9-3.1 mm
5-day old	3.8-4.2 mm
7-day old	6.0-6.5 mm
10 –day old	7.0-7.5 mm
21-day old	9.2-9.6 mm
30-day old	10.4-10.8 mm

Continued on page 21

The status and treatment of serious diseases of freshwater prawns and crabs in China

Yang Xianle and Huang Yanping

Fishery Pathogen Collection of the Ministry of Agriculture, Shanghai Fishery University, Shanghai 200090, China

Chinese mitten-handed crab (*Eriocheir sinensis*), Giant river prawn (*Macrobrachium rosenbergii*) and Oriental river prawn (*Macrobrachium nipponense*) are important high-quality freshwater products in China. Their culture began in the 1970s and the total output of these products had reached 700 thousand tons by the end of 1999. However, disease issues have become increasingly serious. Every year the economic losses caused by diseases amount to thousands of million Yuan; in 2000 losses due to trembling disease in crab were 2-3 thousand million Yuan while 60-70 percent farmers in Guangdong, Guangxi, Jiangsu and Zhejiang great losses totaling hundreds of million Yuan due to white body disease of *M. rosenbergii*.

The diseases of fresh water prawns and crabs are caused by a combination of pathogenic, nutritional, physiological, and environmental factors. In this article I would like to outline the general characteristics of these diseases and their corresponding treatments.

Disease features

As crustaceans, freshwater prawns and crabs grow quickly and have short life cycles. Owing to differences in their physiology and ecology, these animals differ from other aquatic animal in terms of their pathogens, infections and treatment. Realizing these features is very beneficial and helpful.

Fresh water prawns and crabs are highly sensitive to pathogens. The reasons are:

- Prawns and crabs are lower aquatic animals with simple organ structure and function. Their immune system is inferior to that of vertebrates and higher animals does not appear to have the ability to 'remember' pathogens in the same way (though there is some recent evidence to suggest they may have other mechanisms).
- Prawns and crabs are highly sensitive to pathogens during the molting period when they cannot feed, have a week body and poor mobility.
- The gills of prawns and crabs are easily infected as they lie in the base of the thoracic limb or even their appendix, and are in direct contact with the pathogen-bearing water.
- The shorter life cycle and faster metabolism of these animals results in weaker resistance to enemies.

Prawns and crabs need good water quality. They like to live in a place where there is clean water and plant life. The incidence of disease is higher in low quality water, particularly if oxygen levels are low. For example, black gill disease generally follows an increase in levels of organic detritus, and both black gill and trembling disease in crabs tend to occur where there is a lack of plants.

The worse the water quality, the higher the occurrence of diseases because of their poor low-oxygen tolerance. For example the outbreak of black gill disease usually follows an increase in organic detritus in the water; if there is a lack of plants freshwater crabs will often become infected by black gill and trembling disease.

Diseases generally progress quickly and result in high mortality. The circulatory system of prawns and crabs is open so pathogens can easily reach target organs and the whole body through the plasma lymph. For example, in several days *Torulopsis mogii* disease can cause broodstock of *Macrobrachium rosenbergii* to die group by group; prawns and crabs larvae can be completely wiped out by Vibiosis; it is only 15 days from initial observations of trembling disease to mass mortalities of 80-100 percent.

Complications and succession with one disease leading to another are common. To illustrate this with examples, sessilinasis infection is usually an omen of impending bacterial and virus disease; the initial cause of trembling disease in fresh water crab is a bacteria but it is often followed by viral infections, and 30 different kinds of pathogenic bacteria have been isolated from focus of black-spot disease.

Different conditions and animals require different treatments. For instance, splash dosage of lime powder to fresh water prawn and crab is 15-20mg/l, while for fish a more suitable dosage is 25-30mg/l and 60-70mg/l for turtles. Caution should be exercised with chemical treatments – some are dangerous for the stock, or illegal to use in animals destined for human consumption. If chemotherapeutants are used then appropriate withholding periods should be strictly observed before market.

Most of these animals require brackish water during their early life stages, adapting to freshwater later on. Most require an adaptation period and salinity has an important influence on their growth and development. The animals are vulnerable to infection during this period as it is stressful. Great care should be exercised not to stress the animals any further or disease may result.

Serious diseases of fresh water prawns and crabs

Sessilinasis

This is a very common and harmful condition caused by a number of pathogens including *Zoothemnium* sp., *Vortscella* sp., *Carchesium* sp., *Epistylis* sp., *Gastrionauta* sp. and *Intranstylumpalaemoni* sp. all of which belong to Peritrichida. Sessilinasis and animals are symbionts. Once infected, cotton wool-like growths appear attached to the gill, spawn and body surface. The gills turn black and rotten which reduces respiration and excretory capacity, and making feeding difficult. This disease is more serious in the breeding season. Once these parasites get into the breeding ponds they will quickly reproduce and cause heavy mortalities of juveniles. The mortality rate is often 60-80 percent. The main cause of this disease is elevated nutrient and organic matter content in water.

Vibiosis disease

Vibiosis disease is very harmful to freshwater prawn and crab. The death rate of prawn is often 30-50 percent and greater for post-larva, zoea-larva and megalopa-larva. If the juveniles are infected in the breeding season, there will be heavy or complete losses. Frequently application of antibiotics is not a solution as it can induce the appearance of antibiotic-tolerate bacterial strains.

The pathogens include *V. anguillarum*, *V. alginolyticus*, *V. parahaemolyticus*, *V. mimicus* and others. Plasma lymph is the main target organ. High stocking density, mechanical damage or infection, infestation with parasites, too much feeding and polluted water all can induce this disease.

Some infected adult animals have no obvious symptom, while others show mucus secretion and discoloration, erratic swimming, loss of appetite, poor phototaxis, reduced growth and metamorphosis, crawling beside ponds with rotten abdomen and appendages. Bacteria and plasma cell gather into opaque white clots in the gill and other tissue. The dying animals have a dark hepatopancreas, turbid muscle, with a lot of blood clots, and die en masse.

White-body disease

This condition is also called white tail disease, muscle necrosis disease and white spot disease. The main susceptible species is *Macrobrachium rosenbergii*. This pathogen was brought to China with prawn seed from Thailand. It first appeared in Guangdong and Guangxi province but has now spread to the south of Jiangsu, Zhejiang and the other provinces with an attack rate 60-90 percent and mortality rate above 50 percent in 2-8cm *Macrobrachium rosenbergii*. Outbreaks occur from April to June every year, yet the main target is prawn larvae. In Jiangsu the prawn was completely wiped out. Heavily infected prawn are recognized by white spots, which are initially a trace of spots in the tail, followed by a halt in moutling, decreased appetite, reduced mobility, a turbid abdominal muscle, white body (excluding the head) and necrotic muscle without elasticity.

Possible causes of this condition include parasites in the muscle, bacteria and malnutrition. Poor environmental conditions can induce the disease.

Trembling disease

This condition is also called limb-trembling disease, wide-claw disease, numb-claw disease or circle-leg disease. It affects fresh water crabs. Although bacteria have been isolated from diseased prawns one or more virus may be responsible. A spherical RNA virus with no capsule has been reported to be the pathogen, which normally lives in intestine and becomes harmful once invading the central nervous system (Lu Hongda, 1999). A spherical reovirus-like virus with no capsule and 55nm size is also believed to be one of the pathogens (Xue Renyu, 2001). Another virus has been observed growing into cyporyctes in the endoplasmic reticulum. In addition, vibiosis and *Aeromonas hydrophila* have been isolated from diseased crabs. Contaminated water, mingling of varieties, in breeding, high stocking and irregular sizes, and poor nutrition can all serve as inducing factors. The main targets are two-year old and adult crabs with an incidence rate above 30 percent and mortality of 80-100 percent. The epidemic season is from May to October and peak period is from August to October. This disease is very harmful along the Yangtze River especially in Jiangsu and Zhejiang province.

Principal countermeasure

Traditional methods are not always effective in treatment of serious diseases of fresh water shrimp and crab. The author believes that only when we change our idea to new ones will we make progress. Specifically, following ideas are helpful:

- The traditional strategy of "stamping out the pathogens" is difficult to apply in the aquatic environment, particularly once a pathogen has become endemic to an area. A more practical approach is "combined control and prevention". The presence of pathogens doesn't usually lead to significant disease in itself – there are normally a number of contributing factors that lead to an outbreak, such as poor nutrition, water or environmental quality. These factors weaken the resistance of the host or disturb the balance in favor of the pathogen.
- We should therefore consider how to utilize beneficial and neutral microbes or inactive pathogenic microbes to compete with and restrict the activity of other pathogens, maintaining a state of balance and peaceful coexistence with the host. Such a preventative approach better than traditional medical 'treatment' of disease outbreaks – which are only effective after disease has occurred and losses have been sustained.
- We can directly apply micro-ecological preparations (probiotics), feed additives to nourish beneficial microbes, or use highly specific anti-microbial drugs to restrict harmful microbes to help beneficial and neutral microbes compete for and occupy living space. We can also improve the farming environment and make greater use of artificial feeds, which help to keep the pond environment suitable for stock and

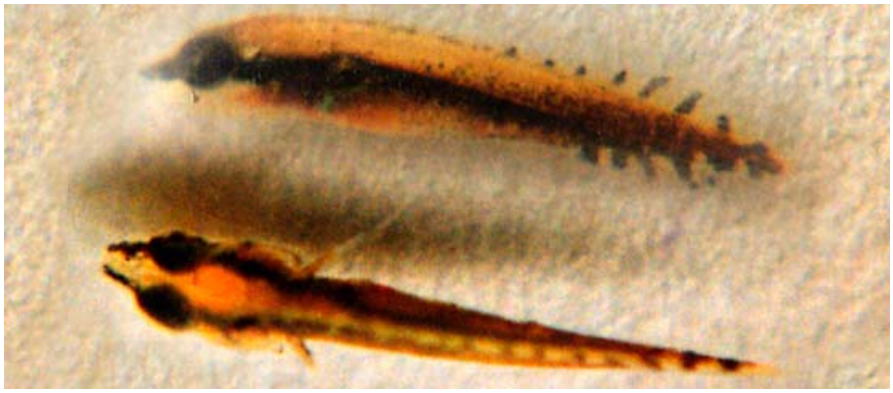
beneficial microbes. The presence of a small quantity of pathogenic microbes in the water and animals is normal and acceptable. If we try to totally eradicate pathogens we will disrupt the micro ecological balance, which may induce loss of physiological balance of the stock, leading to proliferation of pathogens and disease.

- Controlling farm volume and implementing rotational farming practices with fallowing of culture areas is a highly effective disease control measure. As the number of farms in an area grows more disease problems are experienced. Limiting the number and area of farms helps to prevent major disease problems and provides the best benefit and consistent development of freshwater shrimp and crab aquaculture. Since some pathogens are specific to a particular host, allowing farming areas to rest between crops can keep pathogen numbers down and maintain the safety of products, quarantine risk and impact on the environment.
- Implement health management centered on disease prevention and protection of the environment, while not rejecting responsible drug usage as a useful tool. At present, "health management" is a resounding slogan in aquaculture and key to successful culture. Health management includes scientific breeding, farming, water usage, and feeding and drug usage.
  Appropriate drug usage requires the following: A diagnosis must be made in order to select an appropriate drug and treatment regime. Other factors contributing to the disease, such as environmental conditions or nutrition must be addressed simultaneously. Drugs that are potentially harmful to humans or the environment should not be used, withdrawal periods must be applied to allow drug residues to be eliminated.
- Effectively apply disease quarantine procedures and monitor in order to bring large-scale epidemics under control. Emphasis should be placed on investigating disease epidemiology including season, area and condition in order to identify important factors and times. Quarantine measures should be established and their effectiveness monitored; and appropriate regulatory and institutional controls implemented.
- Develop and make use of biological products and techniques. Biological products include vaccines and toxoids, high-immune serum, interferon, antitoxins and other treatment products. Recent developments in these areas have great potential for aquaculture.

Continued from page 18

About the Authors

Dr S.K.Das is an Associate professor of Assam Agricultural University at College of Fisheries, Assam, India, e-mail: skdas01@yahoo.com. The second author is a senior research fellow working under the project.



The 3 weeks old young fry of M.aculeatus

Captive breeding of *M.aculeatus*

Set	Size of Brood Fish	Water	Spawning	Survival
1.	Male: 17.5cm (15.4 g) 19.2 (17.0g) Female: 18.0cm (19.50g) 20.30cm (21.20g)	29.5^{0}C pH 7.9	Fertilization: 88% Hatching: 48% Incubation time: 30-33 hrs.	12 % (at 30 days)
2.	Male: 18.5cm (16.6g) 18.3cm (16.0g). Female: 20.0cm (20.90g) 19.10cm (19.50g)	29^{0}C pH: 8.2	Fertilization: 92% Hatching: 35% Incubation time: 36-38 hrs.	9 % (at 30 days)
3.	Male: 17.3 cm (10.60g) 16.50cm (8.0g) Female: 18.50cm (13.5g).	28.3^{0}C pH: 7.6	Fertilization: 85% Hatching:60% Incubation time: 40- 42 hrs.	14 % (at 30 days)

Fecundity and Gonado-somatic Index of *Macrognathus aculeatus*

Fish (g)	Ovary (g)	GSI ratio	Sample (g)	No.of eggs	Eggs/g fish
11.9	1.40	1:8.50	0.40	164	48
16.6	1.80	1:9.20	0.20	75	40
15.9	1.70	1:9.30	0.40	179	47
35.0	3.30	1:10.60	0.40	320	75
25.8	2.80	1:9.20	0.30	172	62
21.0	**2.20**	**1:9.36**	**0.34**	**182**	**54.40**

Topical issues in genetic diversity and breeding

Genes and Fish

Graham Mair

Graham Mair is a research fellow at the University of Wales Swansea, on secondment since 1997 to the Aquaculture and Aquatic Resources Management Group at the Asian Institute of Technology, Bangkok. Based in Asia for the past 14 years, he has been coordinating and conducting research projects under DFID's fish Genetics Research Program, focusing on the appropriate application of genetic technologies to species for low-input aquaculture systems. Email gcmair@ait.ac.th

Tilapia: A species for Indian Aquaculture?

A few years back when I was just starting out on a collaborative project to evaluate and initiate improvements to the genetic status of carps used for aquaculture in Southern India, I was asked to give a talk to District DOF officials and hatchery managers on the topic of broodstock management in carps. When I was introduced my host made mention of my background in tilapia genetics. The participants listened attentively to what I had to say about the potential impacts of poor management on the genetic quality of cultured carp stocks and to recommendations on how management can be improved. When it came to the question and answer phase of the presentation, I recall that virtually every one of the questions related not to carp but to tilapia and we basically got completely side tracked into a fairly heated debate on the pros and cons of the introduction of tilapia (we were talking principally about the Nile tilapia *O. niloticus*) for aquaculture in India. I seem to remember the consensus opinion among the participants was generally negative towards tilapia but the reasons for this poor opinion of the species were not clearly defined. I suspect that there were two main reasons for the negative reaction to the introduction of tilapia.

Firstly, as is almost universally the case, the ubiquitous *O. mossambicus* was the first tilapia to be introduced into India and was already widespread. It had quickly gained a reputation of being a pest, commonly occurring in quite large numbers in carp polyculture systems where it was perceived to compete with one or more of the carps, limiting the productivity of the systems. Due to overpopulation and stunting the *O. mossambicus* did not reach a large size and therefore had minimal economic value although in communal water bodies they may have been a resource for the poor.

The second major factor acting against tilapia was the doubts over whether there was a significant market for the fish. In a society that is very familiar with carps as the major inland aquaculture species, typically being sold at sizes of around 1kg or more, the size and form of the tilapia would be considered quite a departure from the norm.

Concerns were also expressed, although not well elucidated, over the effect that the introduction and spread of tilapia might have on the environment and particularly on the diversity of indigenous species.

At the time I was very familiar with the success stories of tilapia where introductions had led to the development of very significant inland aquaculture production, nowhere more so than in the Philippines, where I was then based, where tilapia is synonymous with inland aquaculture. I was then less familiar with the situation of the predominantly carp-based aquaculture that dominates in the sub-continent, about which I have since learned a lot (that's not to say there is not much more to learn). Thus, at the time, I sat on the fence and neither recommended nor rejected the idea that the Nile tilapia should be widely introduced for aquaculture in India, limiting our discussion to the pros and cons.

With the benefit of more experience of the issues and given that the interest in tilapia aquaculture in India is steadily rising, I thought it would be timely to revisit some of the issues that were raised during that meeting many years ago.

The main potential disadvantages of the widespread adoption of *O. niloticus* for aquaculture remain the same as outlined above, namely the risk that the fish would suffer the same problems evident with *O. mossambicus* and that there would be no significant market for the product.

It is my view that the uptake of *O. niloticus* into Indian aquaculture is unlikely to be beset by the same problems associated with *O. mossambicus*. The species matures at a larger size and is less fecund and thus less prone to overpopulation and stunting. Also evidence from other introductions throughout the region is that *O. niloticus* aquaculture is commonly sustained where initial introductions of *O. mossambicus* have failed. Tilapia is used extensively in both monoculture and polyculture and it likely that it will be used for both forms in India. The phytoplankton filtering and periphyton grazing tilapia do not compete directly with any of the Indian major carps although there may be some overlap in feeding niches. Tilapia then is likely to enhance the productivity of polyculture systems in ponds and tanks (reservoirs) as evidenced by its adoption in such systems in other countries such in northern Vietnam. It is also probable that some farmers will initiate monoculture of tilapia in ponds and

Tilapia have enhanced productivity of polyculture systems, making a significant proportion of harvest as seen here in a sewage-fish systems in northern Vietnam

cages and there may even be some development of more intensive tilapia culture targeting export markets. Provided that good quality tilapia feeds become available at reasonable cost (and commercial feeds are already available for other species), there is no obvious reason why entrepreneurial Indian producers cannot compete in the international marketplace.

Tilapia culture will not flourish however without the establishment of local markets, both urban and rural. Indian fish consumers are very familiar with the major carps and the methods of cuisine have evolved to suit these species. However, tilapia has become popular among fish consumers in other south Asian countries. The tilapia that are currently available in Indian markets (either from fisheries or "informal" aquaculture) are considered as a poor man's fish and it may take time and some targeted marketing for the species to become popular amongst the higher castes, particularly if it is priced at the same level as carps.

The issue of the potential deleterious environmental impact of the introduction of Nile tilapia is more difficult to assess and should be properly addressed with the conduct of environmental impact assessments prior to any changes in legislation over introductions taking place. The main problem with conducting such assessment is that there is very little published information on the impact of introductions of Nile tilapia as an exotic species, on which to base any predictions. The few studies that have been made cite isolated examples of competition with indigenous species, possibly leading in some cases to local extinctions, although it is difficult to determine whether the tilapia is the main factor is such extinctions. Overall, the numbers of negative environmental impacts recorded from the introduction of tilapia are very few and undoubtedly more would have been recorded if more impacts had indeed occurred.

It must be accepted that adoption of the Nile tilapia for aquaculture will lead to the formation of feral populations of the species in natural and man made water bodies where the climate is suitable for year round survival and reproduction of the species. This may be lessened to some extent by the adoption of monosex culture but this is unlikely to effectively eliminate colonization. The Nile tilapia will thus qualify as an invasive species as has already happened with *O. mossambicus* throughout large parts of the country. *O. niloticus*, however, may well be less successful a colonizer than *O. mossambicus* due to the higher fecundity and wider environmental tolerances of the latter species.

The environmental risks of the introduction of carnivorous species such as the African catfish are quite easy to appreciate, even among those who are not conservation minded. However, the impact of omnivores or herbivores such as the Nile tilapia, which could still be very significant particularly where it invades environments lacking major predators or competing species, is more difficult to appreciate. Even if local extinctions are avoided significant changes in the population dynamics of fish species in many water bodies is likely. In purely economic terms such changes may have positive or negative implications with regard to yields from associated fisheries.

Cage culture could be an option for commercialized monoculture of tilapia in some states of India with rich water resources

One of the main arguments that could be made by a pro-tilapia lobby, given that *O. mossambicus* is already widespread (and indeed *O. niloticus* itself can already be found in many locations), is the question of whether there is really any significant further risk from the wider formalized introduction of another closely related tilapia species? Set against the productivity and economic and livelihood benefits that tilapia culture has brought to many Asian countries, pro tilapia lobbyists would argue that localized and small scale impacts on indigenous diversity, usually on species with limited economic importance, are a relatively small price to pay?

Whether a relaxation in legislation on introduction and culture of the Nile tilapia in India (or indeed other tropical or sub-tropical countries outside its natural range where it is not yet ubiquitous) is a good idea or not depends mainly one's position on conservation and the interpretation of the extent of the threat posed by invasive colonization by a new tilapia species. The case for Nile tilapia is perhaps rather easily made by pointing to the significant economic and food security benefits that its culture has brought to many other countries in the region. The counter case is more difficult to make due to the paucity of information available on the key issues of environmental impact. It may be time for the relevant authorities to actively consider the topic and to encourage open debate among stakeholders on both sides. It will be important in this debate is well informed by access to available information and involvement of appropriate expertise.

Farmers as Scientists

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

Substrate based aquaculture systems

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

Farmer innovation withstands scientific scrutiny and proves robust

Use of substrates to aggregate fish in the natural environment has been in practice for several centuries in different parts of the world. Scientific evidence to the existence of this type of system has begun to emerge from Africa and Asia. The application of this technology evolved by farmers have resulted in the generation of new technologies that are likely to benefit the poor who always have difficulty in obtaining pond input resources. Welcomme (1972) made the pioneering efforts to record the Acdja-based fisheries prevalent in West Africa. In the Acdja system, dense clusters of branches are placed in lagoons to attract fish. The tree branches are known to promote the growth of periphyton, which is an excellent food for many different species of fish. In addition, tree branches also provide shelter for the fish by creating a protective environment. After nearly two decades of the pioneering work by Dr. Welcomme, which showed that farmers could get a high production (ranging from 4-20 tones /ha), scientists from France explored the possibility of applying the basic principles of Acdja system to aquaculture in West Africa. The results with tilapia culture, showed the possibility of increasing production of tilapia up to 8 tones /ha by addition of bamboo as a substrate. This created a lot of interest to test this technique to enhance the productivity of different aquaculture systems.

Asian fishers experience

In Cambodia, brush parks, commonly known as "Samarahs" are used as fish aggregating devices in many river stretches. The tree branches are submersed in rivers and the surface is covered with floating aquatic vegetation. Fish begin to inhabit these structures after about two months. Fishers encircle the area with a net, the branches are removed and the fish are harvested. Brush park fisheries similar to those in Cambodia are also seen in several other Southeast Asian countries.

Adequate number bamboo poles fixed in the pond would provide good amount surface area for the growth of periphyton

In Sri Lanka brush park fisheries are also prevalent in the shallow coastal waters with more than 3000 brush parks established during the season to attract fish and shrimp. In other South Asian Countries such as Sri Lanka, different forms of fish aggregating devices are used. In Bangladesh, "Katha fisheries", which employ the same principle have been prevalent for centuries. Farmers submerge different types of woody branches in the river stretches and after two-three months, the area is encircled with the net and the aggregated fishes are collected.

In the state of Manipur on the Northeastern part of India, substrate-based aquaculture systems are widely prevalent in the Lok Tak Lake. This lake, which is the lifeline of Manipur supplies a large part of the fish needs of the state. Floating islands formed through the dense growth of aquatic weeds and grasses are spread throughout the lake and are used as the natural fish aggregating devices. These floating islands, which are constructed by trimming the fronds of weed mats to a width of 1-2 meters and these trimmed fronds are bent in a circular format to give a diameter of 10 to 30 meters. The two ends are held together with bamboo and ropes. Once the circular ring is formed, they are moved to the desired place in the lake and they are anchored using the bamboo. The inside of the weed ring is filled with other aquatic vegetation. The dense network

Jute sticks, which also has been found to be as a good substrate, though commonly available, has not gained popularity with farmers

Bamboo branches, which are commonly used in ponds to prevent poaching are also found to be effective as substrates in promoting fish growth.

Tilapia has shown excellent growth in the presence of substrates in fish ponds

of the weeds act as floating platforms and as centers for the trapping of nutrients and their subsequent release in to the environment through death and decay. These circular weed mats are locally called "Phums". Fishers even build houses on the weed masses and there are about 500 families living on such masses on the lake. The phums are harvested at an interval of one to two months. Several strategies are adopted by farmers to increase productivity from the phum like fixing feedbags in the area to attract fish in the early stages of phum establishment and increasing productivity by regulating weed density inside the weed ring. Production obtained from these phum areas are reported to be very good (estimates indicate 300 to 1000 kg / phum). Some fishers own 3-4 phums and the income earned through fishing them is reported to be good. As the number of phums are increasing in the lake and affecting the ecology of water body, Government is exploring various ways to regulate the number of phums inside the lake to safeguard the ecology and fisheries of the lake as there are many who are dependent on it to meet their livelihood necessities.

More scientific research results support the novel invention of farmers

A recently concluded research project with the funding support of the European Union and through the twin partnership work between the Asian and the European scientists added very valuable scientific information to support the benefits of these traditional systems evolved by the farmers. The two institutions from Asia (the Fisheries Faculty, Bangladesh Agricultural University, Mymensingh the College of Fisheries, Mangalore in India and) and the two institutions in Europe (the Institute of Aquaculture, University of Stirling, UK and the Fisheries Faculty, Wageneningen Agricultural university, Netherlands) worked over a period of three years. Some of the interesting results obtained are highlighted here to encourage others to explore this simple and efficient technology to increase productivity from aquaculture systems. E-mail contact addresses are also provided to enable those interested to

contact the person with expertise to get more information.

Mangalore findings

Research in Mangalore focused more on the use of degradable substrates and their benefits in promoting fish growth. This followed the earlier work of Dr. Shankar (kalkulishankar@rediffmail.com) and his group that biologically degradable substrates, rich in C:N ratio will result in higher periphyton production and the growth of fish. Further detailed studies by Dr. Keshavanath (perarkeshavanath@yahoo.co.in) and his group have shown the benefit of easily degradable biological substances like water hyacinth, bagasse and paddy straw in enhancing fish productivity. Growth comparison of fishes on these substrates with bamboo, which has longer shelf life and is known to provide good surface area for the growth of periphytic organisms was impressive. The results obtained at Mangalore under the field conditions also demonstrate clearly that it is possible to obtain 46% higher profit just by the addition of bagasse as substrate, as compared with the control treatment.

Mymensingh findings

The work carried out in Bangladesh by Dr. Wahab (wahabma@bdonline.com) and his group at the Bangladesh Agricultural University has revealed good lot of information on the use of substrates that are not easily degradable. Bamboo poles, bamboo branches, bamboo mats, jute sticks, etc, have been evaluated for their benefits as substrates in fish ponds. In addition, the growth performance of different species of carp has also been evaluated. Rohu and calbasu have shown to grow rapidly in presence of the above substrates. The growth of these species has been found to be several folds higher (60-80%) as compared to control treatment. These results are very important in view of the benefits one would derive in terms of growth with species like rohu, which has very high market demand.

The European Institutions with Dr. Malcolm Beveridge (m.beveridge@marlab.ac.uk) from

A farmer with the harvested from a family fish pond provided with substrates

Phums (weed aggregated areas) have demonstrated to be excellent areas to promote the growth of fish and also serve as good spots to aggregate the fishes

Among carps, rohu is known to grow rapidly in the presence of substrates and this species also has the highest market demand

Stirling and Marc Verdegeham (marc.verdegem@wur.nl) from Wageningen have played major in planning the experiments and data processing including human resource training at various levels. Dr.M.E. Azim from Bangladesh completed Ph.D. program from the Wageningen University. The thesis produced by him is considered as one of the best thesis, with many publications emerging from the study appearing in widely read journals like "Aquaculture" and "Aquaculture Research " (azim@post.saitama-u.ac.jp).

From lab to land

Inspired by the good results that were obtained in the research station, some field trials were carried out by the farmers in a CARE supported project in Bangladesh. I had the opportunity to be associated with this work along with my other colleagues like Mr. Manjurul Karim (manjurul@stir.ac.uk) who led the field investigation. Early trials carried out with jute sticks as a substitute to Bamboo, although demonstrated benefits, small size of the sticks and the amount of labor involved in fixing these sticks in water did not encourage farmers to explore large scale adoption of the technology, though the jute stick is commonly available in many parts of the country. Discussion with farmers revealed that they would use different types of substrates that are commonly used by the fishers in rivers along with whatever amount of bamboo that they can obtain. A field trial conducted with a group of 31 Farmers over a period of one culture cycle revealed that all the farmers used bamboo as a substrate and this supplemented with two other tree branches namely, saora (*Streblus asper*) and Mango (*Magnifera indica*) tree branches. The results indicated that even the sparse addition of these substrates resulted in the significant increase in production. While quantitative analysis of the data showed a significant increase in production from 1411 kg/ha to 1876 kg/ha, qualitative analysis indicated that 79% farmers were happy with the production, while rest of the farmers were moderately happy as compared to the baseline year when 56% were unhappy, 36% were moderately happy and remaining 8% were very happy with the production obtained.

Growth performance of high value species

Preliminary studies conducted in Bangladesh and detailed investigations carried by Tidwell and his group in USA have also demonstrated the benefits of substrates in enhancing the growth and yield of freshwater prawn *Macrobrachium rosenbergii*. These results are significant in view of the commercial value of the species and easy possibility of introducing substrates in to promote the growth of these high value species.

Availability of commercial mats

Different types of mats have begun to appear in the market, which employ the same principle of augmenting the availability of periphyton in the water. It is reported that usage of mats in some experimental areas has resulted in a reduction in feed usage of almost 50% without any effect on production. In Ghana, a new project using the principle of "substrate based growth promotion" has been initiated between Ghana Artisinal Fisheries Development and exporters Organisation (GAFDEO) and Fair Trade Seafoods (UK). Acdjamat, which has been developed using polymer composite materials and registerd in UK will be used with fishers to promote the growth of tilapia in cages. The fish cultured will be processed and exported.

Opportunities for further experimentation

In several places, bamboo poles and tree branches are placed in ponds as a device to prevent poaching. It would be useful, if the farmers could increase the amount of substrate to a level taking in to consideration of the surface area that would be available and ensure that the substrate added would contribute to additional increase in surface area almost to the same level. It bamboo poles could be fixed at 8-10 / m^2, it appears that, it will provide good surface area for the production of periphyton. So far, efforts have not been made to combine rapidly degradable substances like sugarcane bagasse, paddy straw and water hyacinth along with bamboo poles or tree branches, which have longer shelf life in water. Water productivity is an important criterion in determining the abundance of plankton, including periphyton. Hence, addition of biologically degradable substrates with slowly degrading materials like bamboo and woody branches might result in the best growth of fish. Filling of bamboo poles with manure and provision of holes for the slow release of nutrients through these holes also likely to promote the good growth of periphyton.

It appears that not all species may perform well with the addition of substrates. Tilapia, rohu and calbasu have shown very good growth in the presence of substrates, particularly bamboo. Rohu has the highest market demand in the whole of South Asia. Farmers in Andhra Pradesh have proved that it is possible to obtain more than 10 ton/ha /year with rohu comprising more than 90% of the stock. It may be possible to further step up the production of rohu by employing the substrate-based system.

In eastern and Northeastern part of India, rice and fish are the staple food items of the population. While bamboo is grown widely in the region, paddy is the common agricultural crop cultivated. Usage of bamboo along with biologically degradable substances like paddy straw or water hyacinth might help in increasing productivity from carp culture ponds. Field trials are necessary to evolve technologies that are appropriate to the farming practices noticed. Partnership with farmers in carrying out field trials under the actual farming conditions would result in generating more useful information.

Marine Finfish Section

The Grouper Section has taken on a new and broader name: It has become the Marine Finfish Section to take account of other species. This section is almost wholly based on the Marine Finfish Aquaculture Newsletter which is prepared by Sih Yang Sim (Editor), Michael Phillips (NACA Environment Specialist) and Mike Rimmer (Principal Fisheries Biologist of the Queensland Department of Primary Industries). Visit www.enaca.org/grouper for more information on the network or email sim@enaca.org.

Coral trout: World First Breeding Success in Indonesia

The National Seafarming Development Centre (NSDC) in Lampung, Indonesia, has succeeded in breeding the bar-cheeked coral trout *Plectropomus maculatus*. Around 100 healthy and active 10cm fingerlings have been produced from 50,000 fertilized eggs. Although at an early stage of development, the result is very promising and further refinement of the hatchery techniques should enable improved survival rates of this new species for hatchery rearing.

In Bahasa Indonesia language NSDC is also known as Balai Budidaya Laut (BBL). BBL has been working on grouper hatchery mass production technique since 1999. It has had success in production of several grouper species, including Tiger grouper *Epinephelus fuscoguttatus*, Green grouper *E. coioides*, Malabar grouper *E. malabaricus* and Hump-back grouper *Cromileptes altivelis*. The hatchery now produced large quantities of all four species, and the evidence of this success can be seen in the increasing number of commercial grouper grow-out farms in the Lampung area.

NSDC was established in 1982 and its development supported through a FAO/UNDP Technical Assistance Project. It is a NACA Seafarming Centre.

For further information, contact Mr Sudjiharno (Director of BBL) at asts@indo.net.id. The Asia-Pacific Marine Finfish Aquaculture Network also welcomes further information and experiences on the aquaculture of this and other marine finfish species. Please send contributions to grouper@enaca.org.

Report of the Grouper Hatchery Production Training Course, May 2003

The second regional grouper hatchery production training course was held in May 2003 with 14 participants from Australia, Brunei Darussalam, India, Malaysia, Singapore and Vietnam.

The course covered twelve topics: Broodstock management; egg collection, quality checking and treatment; larviculture and hatchery management; cleaning of culture tanks; harvestinglive feed and feeding larvae; harvesting lavae, grading and sorting sizes; packaging and transportation; disease laboratories; PCR testing; and artificial feed production. The full report of the training course, which is illustrated with many photographs, is available for free download from: the MFAN website, http://www.enaca.org/Grouper/.

NACA has been following the 2002 participants with interest. Three of last year's participants have since reported successful larval rearing trials of species. In Thailand, green grouper (*Epinephelus coioides*) was the only grouper species that has been regularly produced in government hatcheries. However, in August 2002, Krabi Coastal Aquaculture Development Station of Department of Fisheries Thailand produced tiger grouper (*E. fuscoguttatus*) seed for the first time. In Vietnam, green grouper fingerlings were successfully produced in June 2002. Around 100,000 fingerlings were reared and sold to fish farmers by the Cat Ba Research Centre for Mariculture of Research Institute for Aquaculture No 1 (Ministry of Fisheries Vietnam). In Malaysia, Mr Lu Kien Chee and Mr Yazid Bin Sahjinan of the Department of Fisheries Sabah reported that they were able to produce tiger grouper fingerlings (6 cm TL and above) in January 2003, and 1,200 fish were sent for grow-out trials. These success stories, following the training course, are a welcome development, and a credit to the staff at the Research Institute for Mariculture - Gondol in Bali, Indonesia, who put significant effort into delivering this well received course.

The training course was organised by the Asia-Pacific Marine Finfish Aquaculture Network under the coordination of Network of Aquaculture Centres in Asia-Pacific (NACA) in cooperation with Northern Fisheries Centre, Queensland, Australia (QDPI) and Research Institute for Mariculture - Gondol. Support for the training course came from the Ministry of Marine Affairs and Fisheries, Indonesia, NACA, the Australian Centre for International Agricultural Research (ACIAR), the Asia-Pacific Economic Cooperation (APEC) and the Japan International Cooperation Agency (JICA). The training course

was conducted in the Research Institute for Mariculture at Gondol, northern Bali, Indonesia.

Joint DPI / JCU Project Targets Captive Spawning of Barramundi Cod / Humpback Grouper (Cromileptes altivelis)

The Department of Primary Industries' (DPI) Northern Fisheries Centre (NFC) in Cairns, Queensland, Australia, is conducting research into the captive breeding of barramundi cod / humpback grouper (*Cromileptes altivelis*). The research focuses on resolving the issues of poor performance and spontaneous sex reversal of male broodstock in captive culture systems. Newly acquired broodstock are being held at the new Aquaculture and Stock Enhancement Facility at NFC, Cairns in 30 and 60 m^3 fibreglass tanks fitted with recirculating biofiltration systems. Current research is investigating the differential response between male and female sex steroids levels (testosterone, 11a-ketotestosterone and 17a-estradiol) to various hormonal treatments. To date, DPI has successfully achieved the sex inversion of females to males (masculinisation) using methyltestosterone implants. Implanted females responded to treatment within 6 days by significantly reducing 17a-estradiol production, with significant proliferation of testicular tissue and viable milt production observed after 35 days. Exogenous hormone implants are being used to artificially induce sex change from female to male (inversion) and male to female (reversal) in order to identify the mechanisms involved in sex change. Future research will focus on prolonged hormonal manipulation to control the sex ratio of captive spawning populations. In conjunction with this work, a quantitative real-time PCR assay to study the gene expression of the enzyme aromatase is being developed, using the facilities at DPI's Bribie Island Aquaculture Research Centre and James Cook University. Aromatase converts the precursory steroid testosterone to feminising oestrogen steroids and is the primary enzyme involved in the sex change process. The down or up regulation of aromatase gene expression in protogynous fishes signals the onset of sex inversion or reversal respectively. In in vivo studies expression of aromatase gene will be assessed using gonad biopsies during induced sex change. In addition, specific *C. altivelis* brain and gonadal cell lines have been developed to study the regulation of aromatase gene expression. This in vitro research will study the response in gene expression to specific stimulatory and inhibitory compounds in isolation. Subsequent research (in 2004) will focus on developing a successful delivery system to induce spawning behaviour in broodstock, utilising existing procedures and prostaglandins. The projected outcomes of this research are to increase our current knowledge of the mechanisms controlling sex change in *C. altivelis* and development of techniques to ensure functional reproductive males in captive populations. This research is funded by the Queensland Government's Aquaculture Industry Development Initiative. For further details contact: Adam Reynolds (adam.reynolds@dpi.qld.gov.au); Elizabeth Cox (elizabeth.cox@dpi.qld.gov.au) or Abigail Elizur (abigail.elizur@dpi.qld.gov.au)

Philippines Working on Becoming Self-Sufficient in Milkfish Fry

A program to make the Philippines self-sufficient in bangus (milkfish) fry in a few years is on target, the Bureau of Fisheries and Aquatic Resources (BFAR) recently said. Westly Rosario, Chief of the Dagupan-based National Integrated Fisheries Technology Development Center (NIFTDC) of the BFAR, said since the program was launched in October 2002, some 16 million good milkfish eggs had already been produced. P10 million (US$188,000) has been made available from Countrywide Development Fund for the establishment of the central bangus hatchery. The target of the program is the production of 200 million milkfish eggs for distribution to 18 satellite breeding centers and private hatcheries across the nation. Rosario said that Dagupan is known for its tasty bangus. Through the program, the proper technology in raising bangus, the way they do it in the aquaculture farms of Dagupan, is being disseminated all over the country. At least 6.5 million eggs have already been delivered to private satellite hatcheries in Labrador, Pangasinan; and Damortis, La Union. These private hatcheries will raise the eggs until they grow into fry, for sale to fish-farmers who are in short supply of this commodity in their respective provinces. Rosario said in later months, the central hatchery here will also supply fish eggs for the other satellite hatcheries in Cabangan, Zambales; Bais, Negros Occidental; and the BFAR satellite hatcheries in Tiwi, Albay; Naujan, Occidental Mindoro; Guian, Eastern Samar; Dumangas, Illoio; and Calape, Bahol. To date, bangus fry being used by the country's fish-farmers are coming from Taiwan and Indonesia, draining the country of its much-needed dollar reserves, Rosario said. Source: Asia Pulse, April 8, 2003.

Enhancing Reef Recovery in Komodo National Park, Indonesia: Coral Reef Rehabilitation at Ecologically Significant Scales

Fox H.E, Mous P.J. Muljadi A., Purwanto & Pet J.S.*

Illegal fishing with homemade bombs or dynamite is rampant throughout Southeast Asia and has devastated many coral reefs in the region. In addition to fish and other organisms being indiscriminately killed, coral skeletons are shattered by the blasts, leaving fields of broken rubble. This rubble shifts in the current, abrading or burying any new coral recruits, thereby slowing or preventing reef recovery. Due to effective management, blast fishing has decreased in Komodo National Park (KNP), Indonesia, making restoration efforts worth investigating. Based on 4 years of pilot data testing three different methods (rock piles, cement slabs, and netting pinned to the rubble) rocks were selected for large-scale rehabilitation. Many more corals per square meter grew on the rock piles compared to untreated rubble. Rocks also provided the most natural, complex substrate, were easiest to scale up, and are relatively inexpensive compared to reef rehabilitation methods being investigated elsewhere. Mid-scale rock piles were installed in 2000; cover by hard corals on the rocks continued to

increase as of this most recent visit (March 2003). In 2002, rehabilitation efforts in KNP were further scaled up, testing four rock pile designs at each of four different rubble field sites, covering more than 6,000 m^2 total. If the rubble fields have adequate source coral larval supply from nearby live coral, using rocks for simple, low-cost, large-scale rehabilitation could be a viable option to restore the structural foundation of the reefs, thereby facilitating the return of coral, fish, and other reef-associated life. For further information contact: Dr. Peter J. Mous Science, Training and Partnerships Manager The Nature Conservancy Coastal and Marine Program Indonesia E-mail: pmous@TNC.ORG The complete report in pdf format (1.3 Mb) is available for download from: http://www.komodonationalpark.org/downloads/foxetal2003.pdf

SPC Live Reef Fish Information Bulletin, Number 11 – April 2003

Articles that are of interest in this issue:

- Aquaculture suitability of post-larval coral reef fish
- Market and industry demand issues in the live reef food fish trade
- Live reef food fish trade – Pacific awareness materials project
- Developing industry standards for the live reef food fish trade
- Protecting and managing reef fish spawning aggregations in the Pacific

There are many more interesting articles listed on this issue, for direct connection to these articles visit SPC website at www.spc.int/coastfish/.

LiveFish HK

A new venture, LiveFish HK, has been established in Hong Kong, the biggest demand center in the world for live reef food fish. The company provides services to sectors interested in the trade in live reef fish, including the fishing industry, mariculutrists, governments, multi-governmental agencies and non-governmental and environmental organizations. For more information go to the website www.livefishhk.com.

Fish Health Abstracts

Intervet Aquatic Animal Health Newsletter, March 2003

Characterisation of a Pathogenic Virus Isolated from Marine Threadfin Fish (*Eleutheronema tetradactulus*) during a Disease Outbreak

An unknown virus was isolated from massive mortality of cultured threadfin (*Eleutheronema tetradactulus*) fingerlings. The virus replicated in BF-2 fish cell line and produced a plaque-like cytopathic effect. Electron micrographs revealed non-enveloped, icosahedral particles approximately 70-80 nm in diameter composed of a double capsid layer. Viroplasms and subviral particles approximately 30 nm in diameter and complete particles of 70 nm in diameter were also observed in the infected BF-2 tissue culture cells. The virus was resistant upon pH 3 to 11 and ether treatment. It is also stable to heat treatment (3 h at 56C). Replication was not inhibited by 5-iododeoxyuridine (5-IudR). Acridine orange stain revealed typical reovirus-like cytoplasmicinclusion bodies. Electrophoresis of purified virus revealed 11 segments of doublestranded RNA and five major structural polypeptides of approximately 136, 132, 71, 41 and 33 kDa. Based on these findings, the virus isolated was identified to belong to the genus Aquareovirus and was designated as threadfin reovirus. This virus differed from a majority of other aquareovirus by its increase in virus infectivity upon exposure to various treatments such as high and low pH, heat (56C), ether and 5-IudR. The RNA and virion protein banding pattern of the threadfin reovirus was shown to differ from another Asian isolate, the grass carp hemorrhage reovirus (GCV). Artificial injection of the threadfin fingerlings resulted in complete mortality, whereas seabass (*Lates calcarifer*) fingerlings infected via bath route showed severe mortality within a week after exposure. These results indicate that the threadfin virus is another pathogenic Asian aquareovirus isolate that could cross-infect into another marine fish, the seabass. Original published in Aquaculture 214: 1-18, 2002. Seng K, Fang Q, Chang SF, Ngoh GH, Qin QW, Lam TJ, Sin YM (Singapore, China).

Nodavirus Infection in Hatchery-reared Orange-spotted Grouper Epinephelus coioides: First Record of Viral Nervous Necrosis in the Philippines

Mass mortality occurred in 34-day old larval orange-spotted grouper *Epinephelus coioides* reared at a hatchery in the Philippines with clinical signs such as anorexia and abnormal swimming behavior. Histopathology of moribund fish demonstrated marked vacuolation of the brain, spinal cord and retina. Cytopathic effects were observed in SSN-1 cells inoculated with the tissue filtrate of affected grouper. Electron microscopy revealed non-enveloped virus particles measuring 20 to 25 nm in diameter in the cytoplasm of degenerated SSN-1 cells. Piscine nodavirus (betanodavirus), the causative agent of viral nervous necrosis (VNN), was detected in the affected tissues and SSN-1 cells inoculated with the tissue filtrate of affected fish by RT-PCR. This is the first record of VNN in the Philippines. Original published in Fish Pathology 37: 87-89, 2002. Maeno Y, de la Pena LD, Cruz-Lacierda ER (Japan)

Tuna News and Abstracts

Tuna – The New Goldrush

The development of Bluefin tuna (*Thunnus thynnus*) in aquaculture has been given a boost by the recent success in two crucial areas of tuna aquaculture. The first is the success in closing the lifecycle of bluefin tuna by Japanese researchers in 2002, which enable fingerlings to be produced in hatchery rather than rely on wild caught juveniles. The second being able to produce commercial pelleted diet for tuna grow-out is also on the way and the result has been encouraging based on grow-out trial with southern bluefin. The full article is available from *Fish Farming International, May 2003, Volume 30, No. 5.*

Multi-national Bluefin Study

An EU project on "Reproduction of the Bluefin Tuna in Captivity, A Feasibility Study for the Domestication of *Thunnus thynnus*" (REPO-DOTT) started in 2003. This is a three years project brings researchers from seven countries to work on bluefin reproduction in captivity. The aims of the project are:

- Improving knowledge of the reproductive biology of bluefin tuna in the wild as well as in captivity;
- Assessing the capability of broodstock to mature and spawn in captivity; and
- Determining the feasibility of obtaining and hatching viable eggs from breeders.

Tuna farming is still relatively new so researchers need to develop skills such as handling techniques, transport system, eggs collection methods, etc. The full article is available from *Fish Farming International, May 2003, Volume 30, No. 5*.

Genetic Monitoring for Spawning Ecology of Captive Yellowfin Tuna (*Thunnus albacares*) using Mitochondrial DNA Variation

Y. Niwa, A. Nakazawa, D. Margulies, V.P. Scholey, J.B. Wexler, S. Chow-2003 Aquaculture, 218(1-4): 387-395
Mitochondrial DNA genotypes of captive broodstock of yellowfin tuna (*Thunnus albacares*) were compared with those of their offspring in order to monitor spawning frequency and periodicity. Among 38 broodstock individuals, 27 genotypes were observed, 18 of which established a single individual's identity. Spawned eggs and hatched larvae were collected on 48 sampling days over a period of 1 year. Among 538 eggs and larvae analyzed, 10 genotypes were observed; eight of them established a single female's identity, and two females shared two types. The spawning profiles of these females were determined by observing the occurrence of these genotypes in the offspring. Based on the dates when genotypes first occurred and on growth trajectories estimated for individual fish, the size of a female at first spawning was estimated to be 12–28 kg and 75–112 cm. Usually, multiple females spawned on a given date. The same genotypes were observed on almost any sampling day throughout the year. The results indicated that some individual females were capable of spawning almost daily for extended periods of time as long as they remained in the appropriate range of water temperatures and had sufficient food. (INTEM Consulting, Inc., 7-22-18-K201 Nishi-shinjuku, Shinjuku-ku, Tokyo 160-0023, Japan, email of S. Chow: chow@affrc.go.jp)

Grouper Research Abstracts
Transport of hatchery-reared and wild grouper larvae, *Epinephelus* sp

Ch.B. Estudillo, M.N. Duray-2003 Aquaculture, 219(4): 279-290
Optimum packing conditions for the transport of hatchery-reared and wild grouper larvae were investigated under simulated condition or actual air transport. Simulation of transport motion was done through the use of an electric orbit shaker to identify the best packing conditions for the transport of grouper larvae at various ages. Simulated transport was conducted in hatcheryreared grouper larvae at day 35 (mean TL=14.73 mm), 45 (mean TL=15.23 mm) and 60 (mean TL=28.16 mm) at packing densities of 50, 100 and 200 larvae l-1 and at high (28 °C) or low (23 °C) temperatures. Packing density of 50 larvae l-1 was best for 45- and 60-day-old larvae 8 h transport at low temperature. However, packing density could be increased to a maximum of 100 larvae l-1 8 h transport at 23 °C with mortality rates ranging from 2.3% to 5.3%. The increase in total NH_3 level was dependent on temperature, packing density and size of larvae. High packing density (100–200 larvae l-1) and temperature (28 °C) resulted in increased NH_3 level and mortality rates during transport. In addition, regardless of the temperature, NH_3 levels were consistently higher for 60-day-old larvae. Day-60 grouper larvae displayed strong resistance to handling/mechanical stress compared to 35-day-old larvae probably because most are already fully metamorphosed at this stage. Based on these results, a packing density of 50 larvae l-1, a temperature of 23 °C and larval age of 60 days were considered as the best transport conditions for hatchery-reared grouper larvae. When these transport conditions were used in experiment 2, for 26-day-old hormone-metamorphosed, 60-day-old naturally metamorphosed or 60-day-old pre-metamorphosing hatchery-reared grouper larvae, a 100% survival rate was attained in all treatments. Seven days of hormone (T3) treatment did not accelerate metamorphosis of wild-caught transparent grouper larvae (tinies) significantly. Survival rates of hormone-treated transparent tinies (H-tinies), untreated black tinies (B-tinies) and untreated transparent tinies (T-tinies) were also similar after 8–9 h air transport (experiment 3). The results of the current study suggest that T3 treatment did not affect the performance of hatchery-reared and wild-caught transparent tinies/larvae during transport. In addition, mass mortalities of these transported tinies during the nursery phase were associated with nutritional aspect and the sudden confinement of these undomesticated wild-caught grouper to small space rather than transport or hormone treatment effects. Source: *Southeast Asian Fisheries Development Center, Aquaculture Department (SEAFDEC/AQD), 5021, Tigbauan, Iloilo, Philippines, e-mail: chonae@aqd.seafdec.org.ph.*

Induction of Ovulation in Captive-reared Dusky Grouper, Epinephelus marginatus (Lowe, 1834), with a Sustained-release GnRHa Implant

G. Marino, E. Panini, A. Longobardi, A. Mandich, M.G. Finoia, Y. Zohar, C.C.
Mylonas-2003 Aquaculture, 219(4): 841-858 Captive-reared dusky grouper were induced to ovulate using a sustained-release delivery system (implant) loaded with gonadotropin-releasing hormone agonist [D-Ala6, Pro9, NEt]-GnRH (GnRHa). Thirteen females were implanted at doses ranging from 30.5 to 68.3 µg kg-1 during three experiments between late June and early September. Of the injected females, 85% responded positively to the GnRHa implant and ovulated between 60 and 238 h after treatment, whereas none of control fish showed any sign of maturation. No spontaneous spawning was observed, and the eggs were manually removed

from the females using gentle abdominal pressure. The mean number of ovulations per fish was 3.8, with a maximum of nine for one female. Overall, a total of 42 ovulations were obtained, resulting in the production of more than 5 million eggs. The average relative fecundity was 118.3±16.0×103 eggs kg-1 BW, with a maximum of 202.2×103 eggs kg-1 BW. Mean percentage fertilisation and hatching were 48.2% and 52.2%, respectively. The results demonstrate that GnRHa administration via controlled delivery systems is an effective method for producing good quality eggs in captive dusky grouper. (ICRAM Istituto Centrale per la Ricerca Scientifica e Tecnologica Applicata al Mare, 300 Via Casalotti, 00166, Rome, Italy, e-mail: g.marino@icram.org)

Morphometric Prediction of Cannibalism in Larviculture of Orange-spotted Grouper, *Epinephelus coioides*

J.-R. Hseu, H.-F. Chang, Y.-Y. Ting-2003 Aquaculture, 218(1-4): 203-207.
This study developed a linear regression model to predict the occurrence of cannibalism in larviculture of orange-spotted grouper, *Epinephelus coioides*. Based on measurements of mouth width (MW), body depth (BD), and total length (TL), a model of prey length (mm) to cannibal length was constructed: TLprey=0.80 TLcannibal-1.50. According to the equation, we suggest that 30% is a threshold for TL differences to use in grading grouper fry, and that beyond the threshold, potential cannibals should be removed. (Institute of Fisheries Science, National Taiwan University, 1 Roosevelt Road, Section 4, Taipei 106, Taiwan, e-mail; jrhseutfri@pchome.com.tw)

The Effects of Exogenous Androgens on Ovarian Development and Sex Change in Female Orange-spotted Protogynous Grouper, Epinephelus coioides

S.-L. Yeh, Ch.-M. Kuo, Y.-Y. Ting, Ch.-F. Chang-2003 Aquaculture, 218(1-4): 729-739
The efficacy of various doses of an androgen mixture, containing testosterone (T), 17-methyltestosterone (MT), and testosterone propionate (TP) in equal ratios, for induction of sex change in protogynous orange-spotted grouper, *Epinephelus coioides*, was examined. The androgen mixture, with doses from 1 to 20,000 µg/kg BW, was implanted into each fish (body weight 1.7 kg) in July (post-spawning season), and gonadal stage and plasma T were monitored at various time intervals for a period of 90 days. Gonadosomatic (GSI) and hepatosomatic indices (HSI), gonadal histology, sex steroids (T, 11-ketotestosterone=11-KT, and estradiol=E2) in plasma were determined after 90 days of implantation. The implanted T was released to plasma for 60 days. All androgen mixtures at doses higher than 1000 µg/kg BW were capable of inducing a sex transition and completion of spermatogenesis up to the functional male phase. Low doses of androgens induced ovarian development and higher GSI and HSI indices than in the control and other groups. Significantly higher plasma T levels were found in the developing and spermiating males as compared to the females and intersextransitional fish. No significantly difference of plasma levels of E2 and 11-KT was found in the control and all the androgen-treated groups (during the nonreproductive season). Therefore, it is concluded that the stimulation of sex change or ovarian development is dependent on the dose and time course of implanted androgens. Plasma T levels were correlated with the development of controlled male phase in protogynous grouper, *E. coioides*. (Department of Aquaculture, National Taiwan Ocean University, Keelung 202, Taiwan, ROC, email of CH.-F. Chang: b0044@mail.ntou.edu.tw).

Induced Sex Change, Spawning and Larviculture of Potato Grouper, Epinephelus tukula

Shinn-Lih Yeh, Quen-Chai Dai, Yeong-Torng Chu, Ching-Ming Kuo, Yun-Yuan Ting and Ching- Fong Chang Aquaculture, In Press*
The potato grouper (*Epinephelus tukula*) is a new aquaculture species with high economic potential. This is the first report of induced sex change, reproduction and larval rearing in this species. The smallest body size at which mature females were observed was 90 cm in total length and 16 kg in body weight. The diameter of tertiary yolk globule stage of oocytes was 505±10 mm for 16-24 kg individuals. Larger oocytes (552±13mm) were obtained from individuals. (Department of Aquaculture, National Taiwan Ocean University, Keelung 202, Taiwan, ROC, email of CH.-F. Chang: b0044@mail.ntou.edu.tw)

Grouper Nutrition Abstracts

All the grouper nutrition abstracts in this section are obtained from Department of Fisheries, Thailand and most of these articles were published in Thai language with English abstracts.

Effect of Ash and Inoganic Phosphorus in Diets on Growth and Feed Performance of Orange-spotted Grouper, *Epinephelus coioides*

Mali Boonyaratpalin and Atra Chaimongkol
Juvenile grouper (*Epinephelus coioides*) initial weight 5.62 g were fed with low-ash diets (diets 1-4) and high-ash diets (diet 5-8) supplemented with mono-sodiumphosphate containing phosphorus at 0, 0.25, 0.50 and 1.0 %, respectively. Fish were fed to satiation twice daily for 12 weeks in a flow-through system; 40 liter aquarium. The effect of dietary treatments on growth, survival, feed intake, feed efficiency ratio, protein efficiency ratio, protein retention, phosphorus retention, Ca, P, and Zn in vertebrae, protein digestibility coefficient, energy digestibility coefficient, dry matter digestibility coefficient and phosphorus absorption were evaluated. The result showed that no significant difference on growth and survival among dietary treatments. While feed efficiency ratio was highest in diet 2 for low-ash diets and diet 6 for high-ash diets. Phosphorus retention and phosphorus absorption in low-ash diets range from 26.81-93.78% and 87.16-91.94%, respectively. In contrast, phosphorus retention and phosphorus absorption in high-ash diets slightly low, 14.78-24.25% and 44.88-65.73%, respectively. There were interactions between ash content and supplemented P level for phosphorus

retention and phosphorus absorption. From this experiment can be concluded that low-ash and high-ash diets without supplemented phosphorus satisfy the needs of the fish for growth. Unfortunately, the utilization of low-ash diets is less polluting than high-ash diets.

Effect of Fishmeal Source in Diets on Growth. Feed Efficiency and Body Composition for Orange-spotted Grouper, *Epinephelus coioides*

Atra Chaimongkol, Mali Boonyaratpalin, Chusak Borisut and Sujin Boonchuy

Fishmeal produced from pelagic fish (catch by purse seine: diet 1), ground fish (catch by trawl net: diet 2), by-product of surimi fishery processing (diet 30, and by-product of tuna fishery processing (diet 4) were used as single protein source in grouper diet. Experiment diets were fed to satiation twice a day to juvenile grouper (initial body weight 1.33 g) in 30 liter aquaria for 10 weeks. From the experiment, fish fed diet 1 showed significantly highest growth among dietary treatments. Feed conversion, feed intake and survival rate were not significantly different between fish fed diet 1 and diet 2, but significantly higher than fish fed diet 3 and 1. Protein and ash content in whole body of fish fed diet 1 and 2 slightly lower than fish fed diet 3 and 4. Based on these results, fishmeal that is produced from pelagic fish was suitable for use as protein source in grouper diet. Further investigations should e conducted to determine effect of fishmeal source for large grouper.

Effect of Dietary Protein to Lipid Ratio on Growth and Body Composition for Orangespotted Grouper, *Epinephelus coioides*

Atra Chaimongkol, Mali Boonyaratpalin, Chusak Borisut and Sujin Boonchuy

The suitable protein to lipid ratio for juvenile orange-spotted grouper was determined using practical diets in a factorial experiment. Fish (initial weight 6.2 g) were fed with nine formulated diets that contain protein : lipid (%) ratio as 43:13, 43:17, 48:13, 48:17, 48:21, 53:13, 53:17 and 53:21, respectively. Fish were fed to satiation for 10 weeks in a 40 liter aquarium. The effect of dietary treatments on survival, growth, feed conversion, feed intake, protein efficiency ratio and whole body composition of the fish were evaluated. Best growth was observed in fish fed diets contain protein : lipid ratio of43:17 (diet 2), 48:17 (diet 5), 48:21 (diet 6), 53.13 (diet 7), 53.17 (diet 8) and 53.21 (diet 9). Feed conversion ratio ranged from 0.98 to 1.32, the highest value was obtained in fish fed diet 1 (43% protein and 13% lipid). Protein efficiency ratio ranged from 1.76-2.34 and was highest in fish fed diet 2 (43% protein and 17% lipid). Whole body lipid content was correlated positively to dietary lipid. Dietary treatments did not effect on survival and feed intake. There was no interaction between dietary protein and lipid except for growth. From this experiment can be concluded that dietary protein : lipid ratio of 43:17 appeared to be suitable fro juvenile orange-spotted grouper.

Effect of feeding 3-17 Day Grouper Larvae, Epinephelus coioides with omenga-3 HUFA Enriched Rotifer, *Brachionus rotundiformis*

Mavit Assavaaree, Tida Pechmanee and Paiboon Boonliptanon

Grouper larvae age 1-day-old was used in this study. The larvae were put in six 500 Liter plastic tanks (culture volume was 450 L) at 25 ind./L. The larvae were fed with rotifer until 17-days old. We started feeding rotifer to larvae when they were 3-days old. After the first three days of experiment (larvae 3-5 days old) small sized rotifer filtered through 120 micron net were fed to larvae at density of 5-10 ind./ml. Larvae 6-17 days old were fed with all sized rotifers at 10-15ù he result showed that the larvae fed enriched rotifer had significantly higher survival (4.77%) than larvae fed rotifer without enrichment (2.59%). However, total length and body weight did not show significant differences between with and without enrichment. The culture conditions during experiment were, temperature 27-30 C, salinity 30-31 ppt, pH 7.6-8.1 and dissolve oxygen 5.6-6.6 ppm. It could be concluded that feeding enriched rotifer to grouper larvae will increase essential fatty acid at early stage and can improve their survival and health.

Fish Identification Cards

The Secretariat of the Pacific Community (SPC) has published a set of 16 waterproof identification cards for fish commercially taken for the live reef fish trade, mostly covering groupers but also several species of wrasse. Each card provides the English and Hong Kong names, a description and a clear photograph. The reverse of the card has notes on the biology, reproduction maximum size, distribution, commercial importance and IUCN conservation status.

Available from: SPC Information Section, BP D5, 98848 Noumea, New Caledonia, Email cfpinfo@spc.int.

Weekly Live Marine Fish Prices – Hong Kong

A new service – average wholesale prices in the Hong Kong market are published for a range of live reef fish species. Updated weekly. http://www.enaca.org/Grouper/FishPrices/FishPricesIndex.htm

Improvement of larval rearing technique for Humpback grouper, *Cromileptes altivelis*

Ketut Sugama[1], Suko Ismi[2], Shogo. Kawahara[3] and Mike Rimmer[4]

1: Gondol Research Institute for Mariculture. Present Address: Central Research Institute for Aquaculture, Indonesia, Jl. KS Tubun Petamburan VI Jakarta, 3. Japan International Cooperation Agency, 4. Queensland Department of Primary Industries.

Introduction

Breeding of humpback grouper, *Cromileptes altivelis* has been underway in Gondol Research Institute for Mariculture Indonesia since 1995. Techniques for mass seed production of this fish were successful in late 1998 under research collaboration with JICA on the Multi-species Hatchery Project and the ACIAR Improved Hatchery Technology for Groupers Project and transferred to private hatcheries including backyard hatcheries in 1999. The techniques, which are based on natural spawning in captivity and the intensive rearing of larvae in tanks, are described in detail by Sugama et al. (2001). About one million juveniles (4-5 cm TL) were produced in 2000 and more than three million juveniles in 2001. Egg production is no longer a constraint since private hatcheries routinely produce billions of eggs from domesticated broodstock. In the research result carried in Research Institute, Sugama et.al. (2001) reported the highest known survival of 53.9 % in 10-ton tank on day 50 for this species. However, in recent times survival has been highly variable (low and irregular) due to various factors, chiefly due to infection with Viral Nervous Necrosis (VNN) infection (Koesharyani et.al.2001)

This paper summarize the larval rearing techniques that has been practicing in grouper hatcheries within Indonesia.

Broodstock management, maturation and spawning

Broodstock

At present, all of existing humpback grouper hatcheries are using wild caught fish as broodstock. This species is a protogynous hermaprodite, meaning that it is first sexually mature as a female and later on changes to be male. The smallest mature female is 1 kg body weight and only among broodstock more than 2.5 kg can males sometimes be found. In some cases, females do not change the sex even if their body weight is more than 3kg.

Broodstock Tank

The recommended volume of broodstock tanks can range from a minimum of 20 to a maximum of 200 tons. However, considering biological and management factors, the ideal volume of tank is 50-100 tons with 2.0-2.5 deep. The ideal shape of maturation tank is circular, with a flat bottom and 5-10 % gradient toward the central drain. The broodstock tank is equipped with a water inlet and outlet (over-flow) pipes and egg collection tank with a fine net (400mm) that is connected with the outlet pipe, and an aeration system.

Broodstock Care

The techniques for the capture, transportation, handling, sexing, sampling and acclimation of humpback grouper broodstock have been adequately developed. Prophylaxis using freshwater, antibiotics and quarantine is necessary before introducing broodstock into the maturation tank. A detailed description of prophylaxis and quarantine techniques is available in work by Sugama et.al.(2001). Recent advances have led to improved handling to reduce stress coupled with improved broodstock nutrition and good water quality and could increase overall egg quality. This leads to higher first feeding success rate and subsequent higher survival throughout the early developmental stages.

Maturation and spawning

Following quarantine and acclimation, broodstock fish are stocked in a maturation tank. The tank system is a flow-trough, achieving 200-300% water exchange daily. Generally, 30 fish are stocked in 100-ton tank with sex ratio of two females and one male. Fish are fed with mixed fresh or frozen trash fish (avoid using only *Sardinella* sp.) and squid mixed with 1% vitamin mix at 2-3 % of body weight per day.

Six to eight months after stocking in tank, the fish spawn naturally in captivity. The spawning usually occurs every month 7-10 days before and after the new moon phase and spawning takes place from midnight to early morning.

Early Cromileptes fry produced at Gondol

A closer view of the fry

Egg selection

Collected eggs are transferred into a transparent polycarbonate tank filled with filtered seawater, debris mixed with the eggs is removed using a 1.0 mm mesh net. In the tank, the eggs separate into three groups namely, floating, suspended and sinking eggs. Only floating eggs are recommended for further use in larval rearing. Floating eggs are soaked in 20 ppm iodine for 10 minutes or washed with UV treated sea water for 30 minutes to prevent a possible contamination of bacteria or other micro organism that may cause disease. In water temperatures of 28-29oC, the eggs hatch after 18-20 hours of incubation. Eggs from broodstock fed with fresh and mixed trash fish four times and squid three times a week with 1 % vitamin mix result in good quality larvae. The newly hatched larvae incubated without feeding can survive until seven days after hatching, while eggs from broodstock fed with sardine only mixed with 1% vitamin mix had completely died five days after hatching. I recommend using good quality eggs for seed production of this fish (Fig 1).

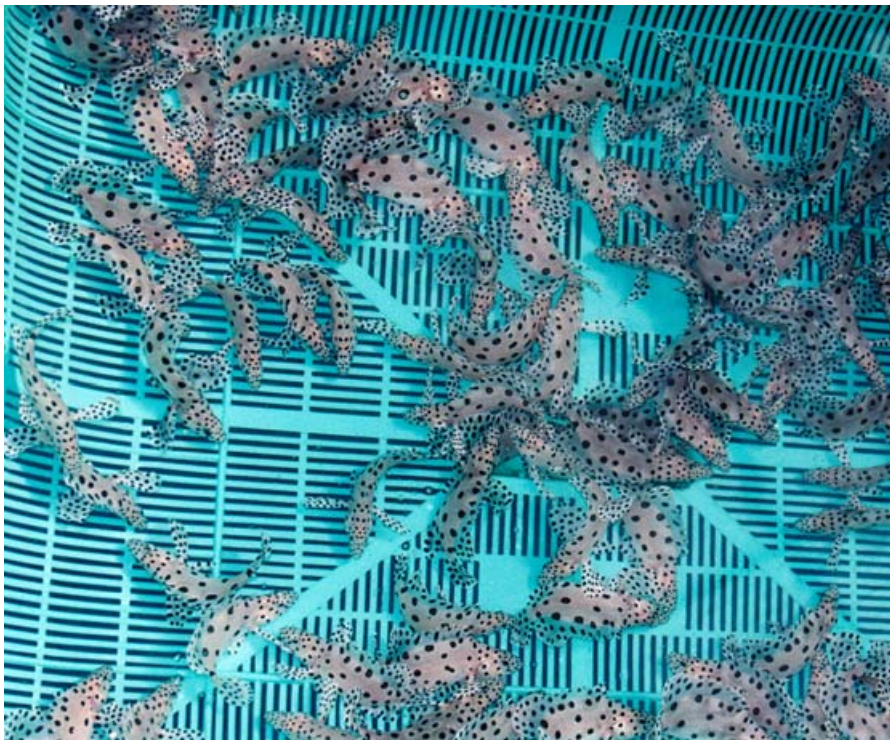
Larval rearing

Larval Rearing Tank

A particular feature of grouper hatcheries in Indonesia is use of the indoor method. The recommended size for larval rearing tanks is 10 ton with 1-1.2 metre depth. Both circular and rectangular tanks with flat bottoms can be used for larval raring. The tank should be painted with a light blue or yellow colour. For backyard hatcheries, the larval rearing tank should be roofed to avoid direct sunlight and rainwater. In order to minimize water temperature fluctuation, it is recommended to cover the tank with a transparent plastic sheet. The sheet is partially opened during the day and closed at night. The larval rearing tank should be filled with sand filtered sea water on the day of egg inoculation.

Feeding and Water Management

The eggs are generally added directly to the larval rearing tank with a density of 5-10 eggs/litre. Occasionally these are placed in hatching tanks and then the newly hatched larvae are transferred to the rearing tank, this process enables larval density to be estimated more accurately. The larval rearing is undertaken using green water techniques. The algal density (*Nannochlosopsis*) used for green water culture ranges from 300,000 to 500,000 cell/ml. Variables such as algal density are measured only in research hatcheries, commercial hatcheries and backyard hatcheries just add algal cells until the desired shade of green is reached. Two-day-old larvae are fed small rotifer (SS-strain, size 120-140m) usually for three days at density of 5-7



Fingerlings being graded for sale to local nurseries and farms

individuals/ml and followed by S-strain rotifer (180-200m) at density of 8-10 individuals/ml until day 20-24. Rotifers are enriched using a commercial fatty acid booster (DHA protein Selco) or by using concentrated *Nannochloropsis* before supply to the larval rearing tank. Commercial compound feed is used as an artificial diet introduced from day 17 onward and enriched *Artemia* is supplied from day 20 onward at density of 0.5 individuals/ml. A detailed feeding scheme and water management is presented in Table 1.

Survival rate

In 1999-2000 during five trials, the survival rate ranged from 2.65 to 5.13 % with total production of 22,000 juveniles (Sugama et.al 1999). At that time most mortality of the larvae occurred during the initial 2-5 days after hatching. Larval mortality was mainly due to poor quality of the newly hatched larvae. The newly hatched larvae were very weak, hence, easily trapped at the water surface by water tension. As well, the trapped larvae would be stressed and produce mucus that would accelerate the trapping of other larvae. In the 2000 trials, improvement of broodstock feed produced better quality of eggs and larvae. Furthermore, spreading squid oil on the surface of larval rearing water seemed to reduce such mortality.

Beginning on day 10-11, larvae have an elongated dorsal and pelvic fin spines, which often entangle larvae, especially when they swim to a common place in the tank wall near the water surface, probably in response to the light. Here they aggregated and clump together, which may be accelerated by the mucus and eventually die. Consequently, a high mortality (20-30 %) frequently occurred between day 10-25. To prevent total aggregation, a fluorescent tube lamp (40 watt) was hung above the larval rearing tank with minimum light intensity of 800 lux. The light intensity was adjusted as evenly as possible on the water surface. The colour of larval rearing water was maintained green through inoculation of *Naanochloropsis* at a density of 300-500 x 103 cell/ml. This might reduce larval aggregation.

Gradual larval mortality was usually observed after day 25, which was suspected to be due to nutritional deficiency. To prevent this problem, early weaning of larvae onto artificial diets that have sufficient nutritional value is recommended. In 2000-2001 trials, artificial diets were introduce at day 15 prior to feeding *Artemia*, and this minimized the demand of *Artemia* as food. The remaining Artemia in the larval rearing water should not be kept for more than one day. With this feeding management, mortality could be reduced and resulted in absence of lordosis. Based on our observation cannibalism was not the main factor of mortality in humpback grouper.

Figure 1. Survival of larvae without feeding from eggs that spawned by different broodstock

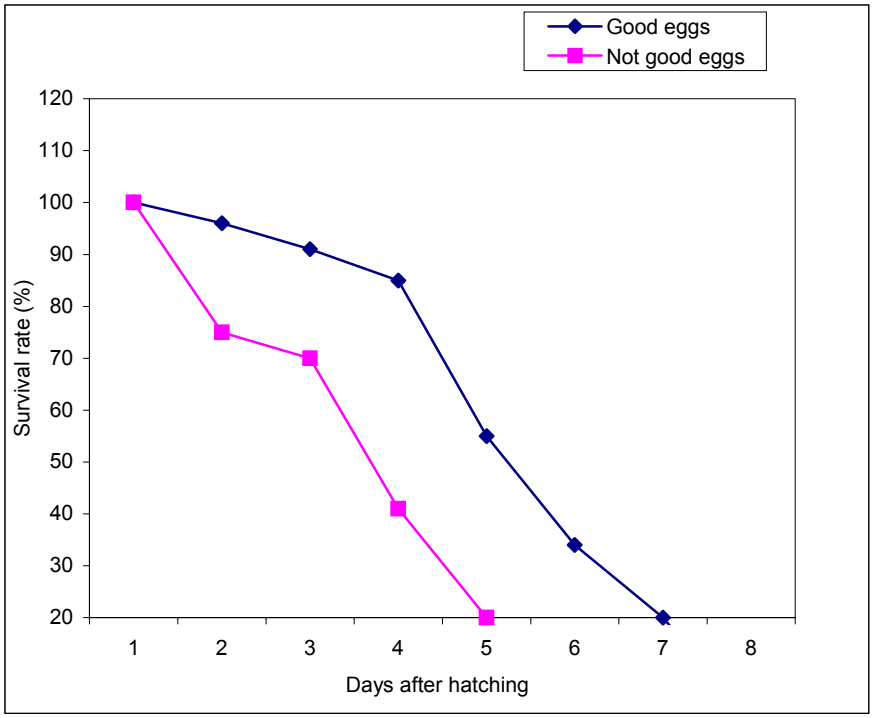


Table 1. Feeding scheme and water management in larval rearing of humpback grouper *Cromileptes altivelis*

Feeding scheme		
Day 2-25	*Nannochloropsis* (3-5 10^5 cell/ml	Control at 8:00 AM and 5 PM
Day 3-5	SS-strain rotifer (5-8 ind/ml)	Control at 8:00 AM and 5 PM
Day 5-25	S-strain rotifer (8-10 ind/ml)	Control at 8:00 AM and 5 PM
Day 15-31	Artificial diet (200-400µ)	1.5 g. each, four times daily
Day 20- 45	Artemia (0.5-1.0 ind./ml)	Supply at 5 PM
Day 28-39	Artificial diet (400-600µ)	2-5 g each, five times daily
Day 36 onward	Artificial diet (600-800µ)	5-10 g each, 7- 12 times daily
Water management		
Day 2-5	Spread squid oil in water surface	1 ml each, 10 AM and 15 PM
Day 11-17	10 % water exchange	Bottom siphoning at 9 AM
Day 18-30	20 % water exchange	Bottom siphoning at 9 AM
Day 30-35	50 % water exchange	Bottom siphoning at 9 AM
Day 35 onward	Running Water	Exchanged rate 100 %/day

The success of larval rearing depends on the control of Virus Nervous Necrosis (VNN). Once VNN broke out during larval rearing, most if not all larvae died within 2-3 days (Koesharyani et.al.2001). No treatment method is presently available. To avoid VNN infection, use only VNN-free broodstock by checking sperm and oocyte by PCR. In 2001-2002, an effort was made to reduce larval stress by decreasing the stocking density, improve nutritional quality of live feed (rotifer and *Artemia*) by enrichment and early weaning of artificial diet. In 2001-2002 data have shown that in Government hatcheries the survival at day 50 ranged from 23.4-53.9% in four commercial hatcheries ranged from 3.1-51.4 % and in 15 farmers backyard hatcheries ranged from 7.0-35.01 %.

Production

In 2001-2002, more than one million juveniles have been produced by hatcheries within Indonesia. At present, two Government, seven commercial and more than one hundred farmer backyard hatcheries are actively producing juveniles.

References

Sugama Ketut, Trijoko, Wardoyo, J. H. Hutapea and S. Kumagai, 1999. Natural spawning and larval rearing of Cromileptes altivelis. Report the APEC-NACA Cooperative Grouper Aquaculture Workshop, 7-9 April Hat-Yai, Thailand. 91-98 pp.

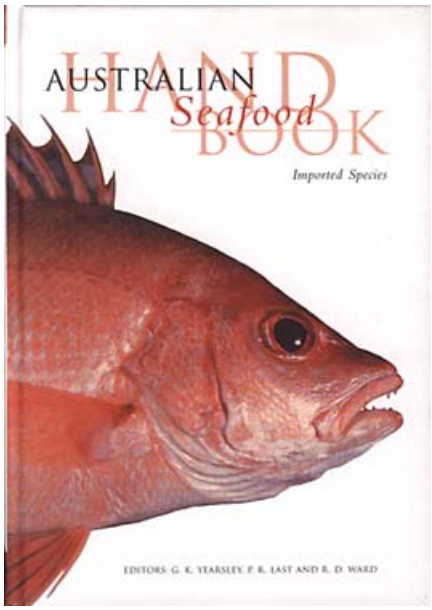
Sugama, Ketut, Trijoko, B. Slamet, S. Ismi, E. Setiadi and S. Kawahara. 2001. Manual for the seed production of Humback grouper Cromileptes altivelis, GRIM-JICA, Agency for Marine and Fisheries Research of Indonesia 37 p.

Koesharyani, I, D. Roza, K. Mahardika, F. Johnny, Zafran and K. Yuasa. 2001. Manual for fish diseases diagnosis II. 2001. GRIM-JICA, Agency for Marine and Fisheries Research of Indonesia 48 p.

Australian Seafood Handbook – an Identification Guide to Imported Species

This is the companion volume to a previously released (and also excellent) publication, the *Australian Seafood Handbook – an Identification Guide to Domestic Species*. The main purpose of the book is to help identify and standardize the naming of imported seafood products and link them with their official marketing name on the 'Australian Seafood Names List'.

Seafood marketing names have been an issue in Australia for some time. Consumers often pay a premium for certain species and there have been some high-profile product substitution rackets along with a lot of genuine confusion over interchangeable local names. Sometimes identical imports are sold side-by-side in the supermarket under different names. The Australian Seafood Names List was introduced standard marketing names to increase consumer confidence in the names used by vendors and to reduce mislabeling.



The guide is beautifully illustrated. Each of the 350 species of fish, crustaceans and shellfish covered is documented with color photographs of the whole animal and a representative fillet. Descriptions include identifying features, size, habitat, distribution and important marketing/trade notes.

A 'protein fingerprint' (electrophoresis gel) is also provided for each species to help confirm the identity of fillets since most imported product is imported in processed form. Regulatory and policing authorities can use these 'fingerprints' as a forensic test to detect product substitution or misrepresentation. The fingerprints depend on genetic variation between species and can be conducted outside the laboratory with only a small sample.

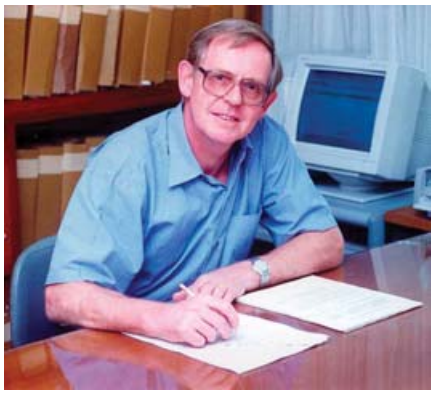
Price: AUD$ 49.95 + $35.00 for international freight. Available from CSIRO Publishing, PO Box 1139, collingwood, VIC 3066, Australia. Fax +61 (3) 9662 7555, email publishing.sales@csiro.au, www.publish.csiro.au.

Conclusion: Highly recommended for all involved in the Australian seafood trade. A very useful and beautifully presented book. Edited by G.K. Yearsley, P.R. Last and R.D. Ward. 480 pages.

Peter Edwards writes on

Rural Aquaculture

Peri-urban food production in Southeast Asia



Peter Edwards is Professor of Aquaculture at the Asian Institute of Technology where he founded the aquaculture program. He has 25 years of experience in education and research relating to small-scale inland aquaculture based on extensive travel throughout the region. Email pedwards@ait.ac.th.

The reason for another column devoted to peri-urban aquaculture so soon after the one on Kolkata in the special India issue (Volume 8, number 2) is I recently attended an inception meeting for PAPUSSA, acronymn for the project Production in Aquatic Peri-urban Systems in Southeast Asia. However, it is justified also by the growing interest in the subject. I am co-editing the first volume to be devoted to the subject, entitled "Urban Aquaculture", which is to be published by CABI Publishing towards the end of the year.

According to Deelstra and Girardet in a book entitled Growing Cities, Growing Food edited by Nico Bakkar et al., "the cities of the 21st century are where human destiny will be played out, and where the future of the biosphere will be determined". This statement is based on the fact that we are becoming an "urban species" : more people are expected to inhabit cities than rural areas in about 10 years time. This is leading to major changes between humanity and ecosystems upon which we depend. It is unlikely that planet earth will be able to support an urbanized humanity that uses increasing amounts of resources from ever distant areas and disposes of wastes, mostly without treatment in the environment. Clearly the challenge is for cities to become sustainable - socially as well as environmentally.

The main objective of PAPUSSA is better understanding of the role of peri-urban food production systems (PAFPS) in Southeast Asia. The project will:

- Develop a detailed holistic analysis of the situation at four sites in Southeast Asia; namely the Red River Delta, Vietnam and the environs of Ho Chi Minh City, Vietnam, Phnom Penh, Cambodia and Bangkok, Thailand;
- Conduct pilot studies to test appropriate interventions;
- Monitor impacts on systems, producers, consumers and institutions; and
- Develop dissemination and communication strategies with and for stakeholders.

Activities will relate to production and livelihood systems, public health, and institutional issues and policy:

- Multidisciplinary situation appraisal of PAFPS;
- Assessment of the risks of existing PAFPS and opportunities for enhanced management;
- Analysis of social characteristics of PAFPS, identification of environmental tensions; definition of marketing and consumption patterns;
- Characterization of occupational and consumer health hazards;
- Design of improved systems, monitoring of health, livelihoods and social and institutional dynamics;
- Interaction with stakeholders to ensure active participation.

The project is coordinated by the University of Stirling, UK and involves the Research Institute for Aquaculture No.1 and the University of Agriculture and Forestry in Vietnam, the Royal University of Agriculture in Phnom Penh, and Kasetart University in Bangkok. The National Institute of Hygiene and Epidemiology, Vietnam, in association with the Royal Veterinary and Agricultural University, Denmark are leading the project with respect to public health. The University of Durham, UK will focus on social/spatial issues surrounding development of PAFPS. Outcomes from this integrated approach will feed into a balanced

dialogue with stakeholders as dissemination and feedback activities.

AIT is providing technical support to the project. The following outcomes are expected:

- Knowledge of current roles and risks associated with different types of PAFPS developed and disseminated through contacts with local stakeholders and globally through the project website. This will be coordinated through both international and regional fora for dissemination i.e., the Resource Center on Urban Agriculture and Forestry (RUAF) and Support to Regional Aquatic Resources Management (STREAM), respectively;
- Improved PAFPS strategies developed and tested with stakeholders, such as urban planners and policy makers, public health strategists, municipal sanitation and flood relief specialists in each country;
- Raised awareness of the status and potential of PAFPS among a diverse range of stakeholders indicated through changes in public dialogue and behavior.

Various issue were discussed at the inception meeting. Considerable time was devoted to trying to define peri-urban aquaculture and to discussing the types of PAFPS. It was agreed that it is necessary to determine how important PAFPS are to people's livelihoods in the rapidly changing peri-urban zone from a consideration of producers through marketing channels to consumers i.e., from "production to plate". How diverse are the livelihoods of people involved and in particular how poor are they? What will be the future trajectories of change and how will people's livelihoods be affected by urban development? What are the pertinent institutional and legal frameworks influencing peri-urban aquaculture ?

Definition of peri-urban aquaculture eluded the participants. However, it was agreed that it should not be defined by city boundaries. Ho Chi Minh City, for example, has large areas of rural as well as coastal areas, the latter with mollusk, prawn and shrimp culture with limited connection to urban areas; and an extended metropolitan area that spreads into adjacent provinces such as Dong Nai and Long An. A useful discussion of the difficulty of defining urban ("in/within" the city) and peri-urban ("around" the city) agriculture is in the above mentioned book: Growing Cities, Growing food.

One definition presented in the book appeals because it is both concise and holistic : "Urban agriculture (aquaculture) is integrated into the local urban economic and ecological systems". Determining what is meant by "integration" would presumably distinguish urban (peri-urban) agriculture, *sensu lato* to include aquaculture, from its counterpart in rural areas (note I avoided use of the term rural aquaculture as it is defined narrowly with regard to only poverty alleviation and food security). Much peri-urban aquaculture is distinguished, at least by scale, from aquaculture in rural areas by (re)use of city wastes, including wastewater as illustrated by the photographic examples from the four areas being studied.

Most urban agriculture in developing countries is reported to be carried out by poor farmers who grow food largely for home consumption, on small plots they do not own, with little to no official sanction or support i.e., poverty and food insecurity are major driving factors. Our limited knowledge of peri-urban aquaculture indicates that poverty may be a significant factor but there are large scale systems that produce seed (fingerlings) as well as food primarily for sale on local markets. Clearly it is necessary to define peri-urban (urban) aquaculture so that it can be differentiated from aquaculture in coastal and rural areas. Only then will the concept be of use from

Advice on Aquatic Animal Health Care Title

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.

แนวทางในการปรับปรุงคุณภาพ และปริมาณน้ำในฟาร์มกุ้ง

(Guidelines for improvement of water quality and volume in shrimp farm)

พรเลิศ จันทร์รัชชกูล, สถาบันวิจัยสุขภาพสัตว์น้ำ

(Pornlerd Chanratchakool, Aquatic Animal Health Research Institute)

ปัญหาคุณภาพน้ำที่เสื่อมลงในทุกๆแหล่งที่มีการเลี้ยงกุ้งกันอย่างหนาแน่นได้ถูกหยิบยกขึ้นมาพิจารณาหาทางแก้ไขในระยะยาว โดยกลุ่มผู้ที่เกี่ยวข้องกับธุรกิจฟาร์มเพาะเลี้ยงกุ้ง ทั้งทางภาครัฐบาลและเอกชนกันมาตลอด เพื่อหาทางแก้ไขและวางมาตรการการป้องกันมลภาวะอันอาจจะเกิดขึ้นอีกในแหล่งที่มีการพัฒนาการเลี้ยงกุ้งแหล่งใหม่ๆ อีกทั้งยังหาแนวทางในการปรับปรุงคุณภาพน้ำในแหล่งเสื่อมโทรมให้สามารถนำมาใช้เลี้ยงกุ้งได้อีกครั้งหนึ่ง ปัจจุบันเราจะเห็นว่าในบางพื้นที่ที่สภาพแวดล้อมยังถูกทำลายไม่มากนัก และคุณภาพน้ำยังอยู่ในเกณฑ์ปานกลาง ก็ยังสามารถที่จะผลิตกุ้งได้อย่างดี โดยจะต้องอาศัยเทคนิคหรือวิธีการต่างๆในการปรับปรุงและควบคุมดูแลกัน อย่างใกล้ชิด ซึ่งในที่นี้จะได้อธิบายถึงแนวทางในการวางแผนแก้ไขปัญหาที่อาจจะเกิดมาจากคุณภาพน้ำที่เปลี่ยนแปลงอย่างรวดเร็วรวมทั้งปัญหาน้ำไม่พอใช้ในฟาร์มซึ่งเป็นอุปสรรคในการผลิตกุ้งเป็นอย่างมาก โดยเฉพาะในช่วงที่ไม่สามารถใช้น้ำจากแหล่งน้ำได้ ทั้งนี้อาจจะเป็นเพราะปัญหาคุณภาพน้ำหรือโรคระบาดต่างๆ

(The problem on deterioration of water quality in every crowded shrimp farming area has been continuosly discussed for its long-term solution by shrimp farming stakeholders including government and private sectors. This includes not only the development of measures for protection of water pollution in newly developed areas, but also the guideline for improvement of water quality in the polluted areas for re-use. Water sources in some crowded shrimp farming areas have not yet been absolutely polluted and water quality is still not too poor for shrimp production. This type of water may yield successful crop if the proper technologies for water improvement and control are closely followed. This article will explain the guideline in planning for solution of the major problems on sudden change of water quality and the shortage of water supply for exchange during deteriorated water quality or disease outbreak crisis.)

ถ้าท่านได้ติดตามสถานการณ์การเลี้ยงกุ้งมาโดยตลอด จะพบว่าปัญหากุ้งน็อค หรือการจับกุ้งขายก่อนกำหนดจะพบมากขึ้น โดยเฉพาะอย่างยิ่งในแหล่งที่มีฟาร์มเลี้ยงกุ้งอยู่หนาแน่น และในฟาร์มที่มีการเลี้ยงกุ้งในความหนาแน่นสูง (มากกว่า 30-35 ตัว/ตารางเมตร) และเหตุการณ์ดังกล่าวมักจะเกิดขึ้นในฤดูแล้งหรือในช่วงที่ไม่สามารถเปลี่ยนถ่ายน้ำได้ ซึ่งกุ้งจะมีปัญหาในเรื่องโรคเหงือกเป็นส่วนใหญ่ นอกจากนี้ในฟาร์มที่รับน้ำจากทะเลเปิดโดยตรงไม่มีบ่อเก็บน้ำก็อาจพบเหตุการณ์กุ้งตายโดยไม่ทราบสาเหตุได้เช่นกัน ปัญหาต่างๆเหล่านี้มักจะสรุปกันว่าเกิดมาจากน้ำไม่ดีทั้งสิ้น การแก้ไขก็จะทำได้ยาก เพราะน้ำไม่ดีอย่างไร และจะแก้ไขโดยวิธีไหนก็ไม่มีใครให้คำตอบได้อย่างแน่นอน ซึ่งถ้าธุรกิจการเลี้ยงกุ้งที่มีมูลค่าสูงหลายหมื่นล้านบาทต่อปี มาฝากความหวังกับการแปรปรวนของคุณภาพน้ำที่ใช้เลี้ยงกุ้งโดยไม่มีแนวทางแก้ไข หรือปรับปรุงในส่วนที่แต่ละฟาร์มสามารถทำได้ อนาคตของผู้เลี้ยงกุ้งคงจะสิ้นสุดลงในไม่ช้านี้ ดังนั้นในแต่ละฟาร์มที่ก่อสร้างขึ้นมาด้วยทุนมหาศาล แต่อาจจะไม่ได้วางแผนการแก้ไขปัญหาระยะยาวได้นั้น ก็น่าที่จะได้มีการนำปัญหาที่เกิดขึ้นในแหล่งนั้นๆ มาพิจารณาหาทางแก้ไขให้เข้ากับสถานการณ์ของฟาร์มในแต่ละแหล่ง ซึ่งโดยทั่วไปแล้วเรื่องที่สำคัญที่สุดจะต้องนำมาพิจารณาก็คือ การปรับปรุงปริมาณน้ำที่จะสามารถนำมาใช้ได้ ให้สัมพันธ์กับปริมาณน้ำที่ต้องการใช้ในช่วงเวลาหนึ่งๆ ซึ่งเราจะต้องวางแผนจัดการให้เหมาะสมกันมากที่สุด โดยมีแนวทางการจัดการดังนี้

(For intensive culture (over 30-35 pieces/m2) in crowded shrimp farming areas, it is observed that sudden shock of shrimp followed by emergency harvest always occur. This generally happens during the dry season or water critical period when gill problems are mainly found. If seawater is directly introduced to grow-out pond without pre-treatment in reservoir, shrimp mortality may also occur. It is always concluded without specific answer that poor water quality is the cause of the above problems. Therefore, it is difficult to solve the problems if real causes have not yet been identified. If our billion US$/year-shrimp farming business relies on these variable water quality without any definite solution or improvement, there will be no future for our farmers. Therefore, the farms with high construction cost which have had no measure or plan for long-term solution on the above problems, should compile all information regarding the problems occurred in that area and find out the solutions suitable for their own farms. In general, improvement of management plan for water supply to match with water requirement in each period, should

be considered. The guideline for suitable water management includes:)

1. การเพิ่มปริมาณน้ำที่สามารถนำมาใช้ได้ ในฟาร์มขนาดเล็กโดยทั่วไปแล้วมักจะไม่ได้สร้างบ่อเก็บน้ำไว้ เนื่องจากมีพื้นที่ค่อนข้างจะจำกัด จึงมีความเสี่ยงสูงมากในการเลี้ยงกุ้ง แนวทางในการแก้ไขก็คือการเพิ่มประสิทธิภาพในการสูบน้ำให้สูงที่สุด เนื่องจากจำเป็นจะต้องใช้เวลาในการสูบน้ำสั้นๆ ในช่วงที่แน่ใจว่าคุณภาพน้ำดีที่สุดในขณะนั้น ประกอบกับการเตรียมการที่ดีในช่วงก่อนน้ำตาย สำหรับเรื่องการวางแผนการถ่ายน้ำ และการปรับโปรแกรมการให้อาหารในช่วงน้ำตายจะอธิบายรายละเอียดภายหลัง ในฟาร์มขนาดใหญ่ที่มีบ่อเก็บน้ำอยู่แล้ว ก็ควรจะมีการปรับปรุงบ่อเก็บน้ำให้ได้ใช้ประโยชน์สูงสุด โดยการเพิ่มความสามารถในการเก็บกักน้ำในบ่อให้นานที่สุดก่อนที่จะสูบไปใช้ และสามารถจะใช้น้ำในบ่อเก็บน้ำให้ได้ปริมาณมากที่สุด เพราะบางฟาร์มที่สร้างมานาน และไม่มีการขุดลอกบ่อพักน้ำเลย จะพบว่าตะกอนจะมาตกอยู่ทางด้านหน้าเครื่องสูบน้ำ ทำให้ตื้นเขินปิดกั้นทางสูบน้ำไปใช้ หรือเกิดจากการติดตั้งเครื่องสูบน้ำสูงเกินไป จึงสูบน้ำได้ในปริมาณน้อยกว่าที่ควรจะได้ นอกจากนี้การเพิ่มระยะเวลาในการพักน้ำโดยจัดวางแนวทางการเคลื่อนตัวของน้ำในบ่อพัก เพื่อให้น้ำได้เคลื่อนตัวช้าๆ ในบ่อเก็บน้ำเป็นเวลานานที่สุดก็จะทำให้เกิดการตกตะกอนได้ดีมากขึ้น น้ำก็จะสะอาดขึ้น โดยอาจจะใช้ระบบการสร้างคันดินบังคับให้น้ำเคลื่อนตัวไปในทิศทางที่เราต้องการได้ นอกจากนี้การเพิ่มอากาศในบ่อพักน้ำก็จะช่วยให้ขบวนการย่อยสลายของเสียที่ปะปนเข้ามากับน้ำเกิดได้สมบูรณ์ขึ้น ทั้งยังเป็นการผสมผสานน้ำเก่าและใหม่เข้าด้วยกัน ทำให้คุณภาพน้ำลงที่อีกด้วย ส่วนในฟาร์มที่มีบ่อพักน้ำขนาดเล็กไม่เพียงพอ หรือมีแต่คลองส่งน้ำก็ควรจะมีการพิจารณาเพิ่มปริมาณการเก็บกักน้ำให้มากขึ้น โดยอาจลดจำนวนบ่อเลี้ยงลง ซึ่งในทางปฏิบัติแล้วฟาร์มทั่วไปจะไม่นิยมกระทำกัน เพราะทำให้เสียเนื้อที่ในการผลิตกุ้งไป แต่ในที่นี้อยากจะชี้แจงให้เห็นถึงปัญหาที่เกิดขึ้นเสมอๆ คือในฟาร์มที่มีบ่อเลี้ยงกุ้งอยู่มากและปล่อยกุ้งลงเลี้ยงในความหนาแน่น 30 - 35 ตัว/ตารางเมตร โดยมีปริมาณน้ำใช้จำกัด เมื่อเกิดปัญหาน้ำไม่พอใช้กุ้งทุกบ่อก็จะเริ่มมีปัญหา ต้องทะยอยจับขาย ซึ่งมักจะได้กุ้งขนาดเล็กไม่ได้ราคา และผลผลิตต่อไร่ต่ำ แต่ค่าใช้จ่ายจะสูงเต็มที่เนื่องจากใช้พื้นที่และอุปกรณ์ทั้งระบบ แต่ในทางกลับกันถ้าเราลดพื้นที่ในการเลี้ยงลง 30 เปอร์เซ็นต์ เพื่อนำมาเป็นบ่อเก็บน้ำ เราก็จะมีน้ำใช้เพิ่มขึ้นมาอีก 30 เปอร์เซ็นต์ ในขณะที่บ่อเลี้ยงกุ้งก็ลดลง 30 เปอร์เซ็นต์ ปริมาณน้ำก็จะเพียงพอต่อการแก้ไขปัญหา สามารถเลี้ยงกุ้งได้ขนาดใหญ่ขึ้น ใช้อุปกรณ์น้อยลง ค่าใช้จ่ายต่ำลงขณะที่ผลผลิตต่อไร่ก็จะเพิ่มมากขึ้น ฟาร์มก็จะอยู่รอดได้ อนึ่งในบางฟาร์มที่มีบ่ออยู่เป็นจำนวนมาก และมีบ่อเก็บน้ำเพียงพอ แต่บ่อบางบ่อมีปัญหาอยู่ตลอดการเลี้ยง ไม่ค่อยได้ผล หรือขาดทุนอยู่เสมอ บ่อจำพวกนี้ก็ควรจะปิด หรือนำไปใช้ในกิจการอื่น เช่น เลี้ยงปลา หรือเก็บน้ำไว้ใช้ในกรณีฉุกเฉินก็จะเป็นการดีกว่าที่จะเพิ่มการขาดทุนให้แก่ ฟาร์ม เป็นต้น

(1. In general, there are no reservoirs attached to most of small-scale farms for increase of water supply due to their limited areas. Therefore, the operations of these small farms are always risky. The only solution for this type of farm is to maximize the pumping capacity to match with the time limited for pumping in each day, particularly during the highest tide which is the best quality. Suitable water management before neap tide should be well prepared. Plans for water exchanges and adjustment of feeding scheme during neap tide will be described later. In case of large-scale or medium-scale farms installed with reservoirs, the existing reservoirs for most efficient storage (eg. increase volume and storaging time) should be improved by excavation of silt settling at the bottom for long period. Silt are generally found to accumulate in front the inlet of water pump which blocks water flow in supply canal. Pumping capacity is also reduced if it is installed too high. Efficiency of silt settling in reservoir will increase if water keep moving as slow as possible in reservoir. Installation of internal dikes in reservoir may be able to control water flow velocity and its direction for better siltation, thus improves water quality. Aeration in reservoir will increase the decomposition of organic matters in water supply and also help to mix new and old water to keep water parametres stable. If farm has too small or no reservoir, some existing grow-out ponds should be converted to serve as reservoir. Farmers may not practically prefer this measure due to the loss of their production ponds. When grow-out ponds with 30-35 pieces/m2 stocking density are in full operation without efficient water storage, farmer may have to harvest some ponds before schedule to avoid the damage caused by shortage of water supply. This early harvest of small size shrimp causes lower in price and production yield while costs of production (except feed), particularly for farm management as full operation are still high. If 30% of grow-out pond area has been converted to reservoir for water storage during critical period, shrimp yields/pond and sizes in these remaining 70 % ponds will increase to compensate for 30% non-productive ponds. Meanwhile, overall profit margin becomes higher because operation cost of these non-operated (30%) grow-out ponds have been dissolved. Though reservoir has been installed, some grow-out ponds may always face the problems and economic loss. These ponds should be closed or converted to culture other species such as finfish, crab, etc., or to reserve more water.)

2. การวางแผนการใช้น้ำในแต่ละช่วงเวลา เมื่อเราสามารถเพิ่มปริมาณน้ำที่สามารถนำมาใช้ได้แล้ว ปัญหาที่ต้องนำมาพิจารณาต่อไปก็คือ จะใช้น้ำอย่างไรเพื่อให้ได้ประโยชน์สูงสุด โดยใช้น้ำในแต่ละช่วงเวลาให้น้อยที่สุด โดยเราสามารถจะหาทางวางแผนป้องกันล่วงหน้าได้ 3 ขั้นตอน คือ

(2. If there has been sufficient water supply, next measure for consideration in water management plan is its most efficient use in each period. This planning will cover the following steps:)

2.1 การวางแผนการปล่อยกุ้งให้สลับเวลากัน เพื่อให้ปริมาณการใช้น้ำของกุ้งที่ปล่อยในแต่ละกลุ่มไม่ตรงกัน เช่น อาจแบ่งกลุ่มปล่อยกุ้งเป็น 2 - 3 กลุ่ม โดยแต่ละกลุ่มเว้นระยะห่างกัน 40 ถึง 50 วัน เป็นต้น ซึ่งเมื่อกุ้งกลุ่มแรกมีอายุ 60 - 80 วันเริ่มใช้น้ำมากขึ้น แต่อีกกลุ่มหนึ่งก็ยังคงใช้น้ำปริมาณน้อยอยู่ และในขณะที่กลุ่มแรกมีอายุ 120 - 150 วัน ซึ่งมีความต้องการใช้น้ำสูงสุด แต่อีก 2 กลุ่มก็ยังใช้น้ำน้อยอยู่ และเมื่อเริ่มจับกุ้งกลุ่มแรกได้ ความต้องการใช้น้ำในกุ้งกลุ่มที่ 1 และ 2 ก็จะทะยอยมากขึ้นสลับกันไป เป็นต้น นอกจากนี้แทนที่เราจะใช้วิธีปล่อยกุ้งสลับเวลากัน เราก็อาจใช้วิธีปล่อยกุ้งเวลาเดียวกันแต่ความหนาแน่นต่างกันก็ได้ หรือใช้วิธีผสมผสานกัน เช่น ปล่อยกุ้งกลุ่มแรกในความหนาแน่น 35 - 40 ตัว/ตารางเมตร เมื่อกุ้งอายุได้ 30 - 40 วัน ก็เริ่มปล่อยกุ้งในกลุ่มที่สอง ในความหนาแน่นประมาณ 30 - 35 ตัว/ตารางเมตร หลังจากนั้นอีก 10 - 20 วัน ก็ปล่อยกุ้งกลุ่มที่ 3 ในอัตรา 40 - 45 ตัว/ตารางเมตร ซึ่งเมื่อกุ้งในกลุ่มแรกมีอายุประมาณ 100 - 120 วัน เริ่มต้องการใช้น้ำมากขึ้น กุ้งจะมีขนาดประมาณ 20 - 25 กรัม สามารถเริ่มทะยอยจับขายออกบางส่วน ซึ่งจะทำให้ปริมาณการใช้น้ำลดลง พอเพียงสำหรับกุ้งอีก 2 กลุ่มที่เพิ่งเริ่มโตขึ้นมา และเมื่อกุ้งกลุ่มที่ 2 และ 3 เริ่มโต ต้องการใช้น้ำมากขึ้น เราก็สามารถจับกุ้งในกลุ่มที่ 1 ขายได้ และทะยอยจับกุ้งในกลุ่มที่ 2 และ 3 ขายได้ต่อไป การใช้น้ำปริมาณมากๆ พร้อมกันก็จะไม่เกิดขึ้น น้ำก็จะพอเพียงแก่ความต้องการ

(2.1 Gradual stocking : Shrimp should be gradually stocked so that water requirement in each group will be different. Stocking should be divided into 2-3 groups with an intervals of 40-50 days When first group reaches 60-80

days, water requirement will be more than the newly stocked-second group. While first group has reached 120-150 days which requires maximal water exchange, water supply from reservoir is still enough for 70-100 days old-group 2 and 20-60 days old-group 3. When shrimp in group 2 and 3 become larger and require more water exchange, group 1 has been harvested. If it is necessary to stock PL at the same time, different stocking densities should be considered. Manipulation of stocking densities and stocking intervals is an alternative. For example, the second group (30-35 pieces/m2) is stocked after the first group (35-40 pieces/m2) has reached 30-40 days. 10-20 days later, the third group (40-45 pieces/m2) is then started. When first group with medium stocking density has reached 100-120 days (20-25 gm body weight), partial harvest can be carried out in order to minimize water requirement. Water in reservoir will be then sufficient for the growing group 2 and 3. When group 2 and 3 grow older and require more water exchange, group 1 should have been totally harvested. Meanwhile group 2 with lowest stocking density can also be partially harvested. Therefore maximal water requirement in each group will not occur at the same time thus reserved water is sufficient.

2.2 การให้อาหารที่ถูกต้อง ปริมาณการใช้น้ำในฟาร์มกุ้งจะมีความสัมพันธ์โดยตรงกับปริมาณอาหารที่ใส่ลงไปในบ่อ ถ้าเกิดการผิดพลาดในการประมาณอาหารที่ให้กุ้งกิน ทำให้อาหารเหลือก็จะเป็นเหตุให้เกิดการเน่าเสียเกิดปุ๋ยธรรมชาติขึ้น เร่งให้แพลงค์ตอนเจริญอย่างรวดเร็ว คุณภาพน้ำจะเปลี่ยนแปลงเกิดตะกอนมากขึ้นโดยเฉพาะอย่างยิ่งเมื่อเกิดการตายของแพลงค์ตอนพร้อมๆกัน จึงจำเป็นจะต้องใช้น้ำในปริมาณมากจึงจะแก้ไขปัญหาได้ การให้อาหารสดในช่วงเวลาน้ำตายก็จะเป็นสาเหตุที่ทำให้น้ำเกิดการเน่าเสียได้ แต่เราก็สามารถหลีกเลี่ยงได้โดยอาจใช้หอยกะพงเป็นๆแทนปลา หรือ หอยแกะเนื้อได้ การลดอาหารในช่วงลอกคราบ หรือช่วงอากาศเย็น (<25o c) ก็จะเป็นการช่วยป้องกันเศษอาหารเหลือเน่าเสียที่พื้นบ่อได้อีกวิธีหนึ่ง นอกจากนี้การยืดระยะเวลาในการเช็คยอนานเพิ่มขึ้น ก็จะเป็นอีกสาเหตุหนึ่งที่ทำให้อาหารเหลือได้

(2.2 Proper feeding : Water requirement in each pond directly relates to amount of feed given. If there is mis-calculation/estimation in the amount of feed required, remnant feed will be decomposed and serve as organic fertilizer to accelerate the growth of phytoplankton. After overblooming of phytoplankton and followed by sudden collaps, pond water quality will deteriorate and organic load of dead plankton will accumlate at bottom. Water exchange from reservoir is then badly needed. Using freshfeed as complementary feed during neap tide also causes poor water quality. It is avoidable if fresh fish is replaced by alive horse mussel. Reduction of feed during moulting and cold weather (<250C) should improve pond bottom condition. If time for feed check in feeding tray is prolonged, uneaten feed will be dissolved and cause mis-calculation of feed requirement and poor water quality.)

2.3 การจัดระบบการถ่ายน้ำ การประหยัดน้ำไม่ใช่การงดถ่ายน้ำ แต่การประหยัดในที่นี้หมายถึงถ่ายตามความจำเป็น ตามลำดับก่อนหลัง และที่สำคัญจะต้องจัดการก่อนที่จะเกิดปัญหา แต่โดยทั่วไปเมื่อพบว่าแพลงค์ตอนในบ่อเกิดขึ้นอย่างหนาแน่นมาก จึงจะเริ่มทำการถ่ายน้ำ ซึ่งในกรณีเช่นนี้จำเป็นจะต้องใช้น้ำปริมาณมากๆ จึงจะเจือจางแพลงค์ตอนที่หนาแน่น หรือลดการเจริญของแพลงค์ตอนเหล่านั้นได้ ซึ่งนอกจากเป็นการสิ้นเปลืองน้ำแล้ว การเปลี่ยนน้ำคราวละมากๆจะมีผลกระทบโดยตรงต่อสุขภาพของกุ้งด้วย เพราะอาจทำให้กุ้งปรับตัวไม่ทันเนื่องจากคุณภาพของน้ำเปลี่ยนแปลงอย่างรวดเร็ว แนวทางแก้ไขก็คือ การทะยอยถ่ายน้ำตั้งแต่เริ่มพบว่า แพลงค์ตอนเริ่มมีการเจริญมากขึ้น ซึ่งจะใช้น้ำปริมาณน้อยในแต่ละวัน ในทางปฏิบัติแล้วปัจจัยที่จะบอกเราได้ทางอ้อมก็คือ การตรวจวัดค่าความแตกต่างของความเป็นกรดเป็นด่างของน้ำในตอนเช้าและตอนบ่าย โดยจะต้องเปลี่ยนถ่ายน้ำอย่างสม่ำเสมอ เพื่อที่จะควบคุมค่า pH ของน้ำในช่วงดังกล่าวไม่ให้มีความแตกต่างกันเกิน 0.5 หน่วย เป็นต้น

(2.3 Good water management : Saving water does mean no-water exchange. In fact, it means utilization of water in an efficient way. Water will be exchanged as necessary and priority. It should be done as prevention measure before problems occur. In general, pond water is exchanged after overblooming of phytoplankton. This heavy water exchange to dilute those plankton requires excess water from reservoir. It also affects shrimp health due to the sudden change in water quality and parameters. This can be solved by gradual exchange which requires minimal water since the first observation of irregular planton growth in pond. In practical, the differences of water pH between morning and afternoon will indirectly determine the overblooming of phytoplankton. If the difference in pH is over 0.5, water exchange should be carried out regularly.)

นอกจากนี้ยังมีปัจจัยอื่นๆ ที่เกี่ยวข้องอีก เช่น การจัดวางแนวเครื่องตีน้ำ ก็จะต้องจัดให้เกิดแรงน้ำพัดพาเอาตะกอนที่เกิดขึ้นในบ่อเข้าสู่ศูนย์กลางให้ได้ พื้นขอบบ่อจะสะอาดขึ้นกุ้งก็จะกินอาหารได้ดี ไม่เหลือเน่าเสียที่พื้นบ่อ เป็นต้น จะเห็นว่าแนวทางในการจัดการคุณภาพน้ำให้ดีและพอเพียงแก่ความต้องการนั้น จะต้องอาศัยข้อมูลต่างๆ และประสบการณ์ของนักวิชาการในแต่ละพื้นที่แต่ละฟาร์ม มาประยุกต์และวางแผนการจัดการให้ละเอียดรอบคอบ การแก้ปัญหาจึงจะได้ผล ทั้งนี้เนื่องจากสถานที่ และสภาพแวดล้อมในแต่ละพื้นที่จะไม่เหมือนกัน

(Direction of paddle wheel installation which should circulate pond water and accumulate pond waste to the centre, is also important. It will make the remaining bottom area clean thus increase feeding ability. Due to the differences in conditions and environment, the good water management in order to have sufficient supply as needed, requires the compilation of informations and expertises from various farms in those area for modification and preparation of the efficient management plan suitable for their own farms.)

ในระบบการเลี้ยงกุ้ง ปัจจุบันซึ่งมีการลดการใช้น้ำลงมาก แต่ปัญหาที่ตามมาก็คือ ถ้าบังเอิญมีของเสียสะสมอยู่ในบ่อมากเกินไป จะทำให้เกิดแพลงค์ตอนในกลุ่มไดโนแฟลกเจลเลต เจริญขึ้นมามากและแพลงค์ตอนกลุ่มนี้บางชนิด สร้างสารพิษ บางชนิดมีแอมโมเนียอยู่ในเซลล์มาก ซึ่งถ้าแพลงค์ตอนกลุ่มนี้ตายลงพร้อมๆ กัน ก็อาจเป็นสาเหตุหนึ่งที่ทำให้กุ้งอ่อนแอ เกิดการติดเชื้อได้ง่ายขึ้น เพื่อป้องกันหรือลดปัญหาดังกล่าว จะต้องเตรียมบ่อให้ดี กำจัดของเสียที่ก้นบ่อออกให้เหลือน้อยที่สุด นอกจากนั้นถ้าสามารถหาแหล่งน้ำที่เหมาะสมมาใช้ในการเปลี่ยนถ่ายได้บ้าง เพื่อเจือจางของเสียหรือปริมาณแพลงค์ตอนในบ่อเป็นครั้งคราวก็จะเป็นปัจจัยช่วยในการแก้ปัญหาได้ดีอีกปัจจัยหนึ่ง

(Though minimal water exchange is now generally practised, due to viral disease outbreak, it may lead to the overblooming of dinoflagellate plankton of which some species produce toxic gases or NH3 that cause shrimp weak and easily susceptible to diseases. Measure to prevent this problem in advance is to have good pond preparation before stocking. Accumulated pond waste at the bottom should be efficiently removed. Additional water supply from reservoir is required for necessary water exchange to dilute the excess plankton.)

What's New in Aquaculture

News

Farms may be allowed to raise *Vannamei* shrimps

The Business Standard reports that the Indian Aquaculture industry might move towards producing *L. vannamei* for export markets, in a move similar to that seen in China recently. The species is currently being reviewed by the exotic species committee of the Ministry of Agriculture to determine its suitability. Some concerns have been raised over the possibility of introducing new viral diseases with imported broodstock. The full story is available from: http://www.business-standard.com/today/story.asp?Menu=22&story=20168

Norway Donates $2.18 Million for Vietnam's University of Fisheries

The Norwegian Government will provide non-refundable aid of 17 million kroner ($2.18 million) to Vietnam for a project to improve the capacity of the Vietnam University of Fisheries between now and 2006. The project will help the university to improve its aquaculture research and training quality. It also aims to meet the country's urgent demand for human resources in the fisheries sector, and help the environment and aquaculture cultivation. *Source: Vietnam News Briefs, 26 June.*

Malaysia Expands Aquaculture Zones

Two thousand hectare in the Malaysian Merotai constituency will be gazetted as an aquaculture industrial zone to help further develop the sector and improve the livelihoods of rural communities in the area, according to Agriculture and Food Industry Assistant Minister Datuk Dr Patawari Patawe. *Source: New Straits Times-Management Times, June 12, 2003.*

Vietnam to Invest US$ 11.7 million in Aquaculture Breeding Centres

The Vietnamese Ministry of Fisheries (MOFI) is investing US$ 11.7 million to build five new aquaculture breeding centres and upgrade existing ones between 2002-05. The five new centres will be built in the provinces of Hai Duong, Dak Lak, Tien Giang, Hai Phong and Vung Tau. The expansion is a result of the increasing domestic demand for aquaculture products, especially in the north. The 107 breeding farms presently in the north only meet 30% of local demand, leaving local raisers to import from the central region.

In other Vietnamese aquaculture news, the southern central region, comprising Da Nang City and the five provinces of Quang Nam, Quang Ngai, Binh Dinh, Phu Yen and Khanh Hoa, plan to continue expanding their aquacultural activities until 2010, seeing aquaculture along with cash crop agriculture as a means of increasing economic development in the region. The region plans to expand its area to 33,000 hectare from its present 19,000. *Source: Vietnam News Briefs, May 30, June 3, 8, 2003*.

Vietnam's Ha Tinh Region Undergoes Shrimp Boom

American Technologies Inc (ATI), a US-based aquaculture and technology company, recently released 300 million baby shrimp into its central province breeding grounds to boost production. The company has so far invested US$ 50 million in 2,000 hectare of unused land, which it has turned into lakes for breeding shrimp. The 300 million baby prawns (*tom he*) and black-tiger prawns (*tom su*) were released last week into more than 300 artificial ponds covering an area of 500 ha; this will be expanded to 700 ha by the end of 2003 and 2,000 ha by the end of 2004.

It is hoped that 1,000 tonnes of shrimp will be produced worth US$ 6.7 million. The project has created a huge labour market for people in the harsh-weather region. Thousands of local workers are now involved in the project with an additional 4-5,000 jobs to be created in the next few years. Many more jobs are also expected to be created in related sectors. Vietnam is now the sixth largest shrimp producer in the world (5%), with the US and Japan being its main markets. *Source: The Vietnam Investment Review, May 26, 2003; Vietnam News Briefs, May 29, 2003.*

Public Library of Science launches open access biology journal

With help from a $9 million grant from the Gordon and Betty Moore Foundation and in-kind support from the Howard Hughes Medical Institute, has launched a nonprofit scientific publishing venture that will provide scientists with high-quality, high-profile journals in which to publish their most important work, while making the full contents freely available for anyone to read, distribute, or use for their own research.

PLoS Biology will compete head-to head with the leading existing publications in biology, publishing the best peer-reviewed original research articles, timely essays, and other features. We will begin accepting papers on May 1st.

Visit http://www.plos.org/cgi-bin/advocates.pl?email=a.maru@cgiar.org to sign up. For more information visit www.plos.org or contact Harold Varmus at plos@plos.org. [*This is a great initiative please support it if you have an interest - Ed.*].

New Limits of Metal Consumption from Fish Set

The United Nations Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO) have announced limits for the amount of metals and chemicals that can be consumed in food, including cadmium and methyl mercury. The Joint Expert Food Committee for Food Additives and Contaminants (JECFA) reevaluated

previous studies and the risk assessments for the two metals. For Cadmium, the Committee decided that there was no case to change the advice of a maximum of seven micrograms per kilogram of body weight as a provisional tolerable weekly intake (PTWI). However, in the case of methyl mercury, the advice has adjusted the PTWI to 1.6 micrograms per kg of bodyweight from a previous figure of 3.3 micrograms/kg. This is to prevent adverse effects on developing fetuses in pregnant women. Some fish species, most notably swordfish and sharks, are known to be the most significant source of this chemical in food. However, in many countries fish plays an extremely large role in meeting nutritional requirements. The committee therefore stressed that public health authorities should take this into account when setting limits. *Source: Food and Agriculture Organisation of the United Nations [www.fao.org], July 2003).*

Aquaculture Groups Counter Claims of Adverse Effects of Shrimp Farming

Aquaculture groups have responded and countered the claims of environmental degradation and adverse social impacts made in a recent Environmental Justice Foundation (EJF) report on the issue of shrimp farming entitled "Smash and Grab" [http://www.ejfoundation.org/reports.html#smashandgrab] Whilst the Global Aquaculture Alliance (GAA) [http://www.gaalliance.org] recognises that in the past abuses have occurred, solutions in fact lie in working with groups such as the EJF to further improve farming practices and GAA has been doing so for some time. The GAA goes on to state that some of the figures in "Smash and Grab" were misleading or out of context. One key issue regarding the use of fishmeal in shrimp feeds is that, rather than exploiting a protein source that would usually be used in direct human nutrition, fishmeal is composed of small bony fish which are seldom utilised. Further to this, except for El Niño periods, the production of fishmeal has been stable for the last two decades. Shrimp farming also diverts fewer than 8% of what would normally be used for pig and poultry feeds rather than human needs. Regarding the social injustices attributed to shrimp farming, GAA state that a critical goal of Bangladesh's new Seal of Quality Program is the regulation of child labour, in a country where 600,000 depend on aquaculture as a source of livelihood. Finally, regarding the issue of the waste and by-catch associated with the collection of wild caught young shrimp, this is being eradicated by the use of hatchery-reared stock. (Source: GAA Website, July 2003 [http://www.gaalliance.org]; AquaFeed.com, July 2003, Shrimp-Farming Report Strong on Attack, Weak on Facts). The GAA response to the report is available online from http://www.gaalliance.org/issu4.html].

90 Fish Extinctions in Bangladesh

According to an article in the Bangladeshi press, the nation's fisheries resources have been dramatically reduced, with as many as 90 of the original 254 freshwater species once found here extinct and others such as the national fish (Hilsa) severely depleted. This is thought to be due to a combination of factors, prime amongst them indiscriminate fishing activities, the siltration of rivers and pollution. There is now is a negative gap between demand for fish and its production. The article states that more research, research facilities and personnel are required, and emphasis should be placed not only on increasing fish production but also increasing its quality. 12. *Source: The Independent, July 11, 2003; World Sources Inc, July 18, 2003.*

Bangladesh Shrimp Quality Certificate Planned

Asia's first shrimp certification training course is planned for August in Cox's Bazar, Bangladesh. The four-day event is organised by the Aquaculture Certificate Council (ACC) in cooperation with the Shrimp Seal of Quality (SSOQ) programme. The objective of the course is to produce qualified certifiers who will be able to assess and certify hatcheries, producers, processors and suppliers, ensuring that they are in compliance with environmental, social and food safety criteria. 14 With the current media attention and increasing global concern over shrimp farming activities, it is thought that those who adhere to the criteria and international codes of conduct will have much more of an advantage on the international market. The Bangladesh Shrimp Seal of Quality Newsletter is available from the NACA website at http://www.enaca.org/SOQ-Newsletter-Aug-Oct.pdf A Seal of Quality is an internationally accepted quality assurance certification program for shrimp. It guarantees buyers that Bangladesh shrimp meet the hygiene, human rights, labour and environmental codes. The Seal is awarded to firms that meet the codes. Usually, the SOQ is owned by an industry association that polices its members. *Source: United News of Bangladesh, July 14, 2003.*

Vietnam Condemns US Catfish Dispute Decision; ITC Rules in Favour of US

Vietnamese businesses and producers have been quick to denounce the actions of the US Department of Commerce (DOC) following its recent decision that Vietnam does in fact dump catfish on US markets in an effort to undermine US catfish producers. The Ministry of Trade, Ministry of Fisheries and VASEP called it an "act of protectionism". It is feared that trade agreements and relationships between the two countries will be adversely affected as Vietnam sees the DOC decision as unreasonable and their calculations flawed, based as they are not on Indian production as was reported in past press releases, but Bangladeshi. It is also feared that this will lead to thousands of Vietnamese farmers facing bankruptcy. However Vietnamese organisations will endeavour to locate new markets to alleviate any adverse economic effects resulting from the ruling. The Ministry of Fisheries has also intervened and told Cuu Long (Mekong) Delta exporters not to try and reduce the purchase price of catfish, asking for businesses to be calm and to seek solutions together. The final decision in this saga was made by the US International Trade Commission, which agreed in a 4-0 vote that imports of

Vietnamese frozen fillets are injuring the domestic catfish industry. This vote clears the way for the imposition of stiff duties by the Commerce Department. It is estimated that 500,000 Vietnamese are involved in the catfish trade and the dispute has dominated the national press. Some US Senators who view the US action as trade protectionism are also now supporting their case. Meanwhile in the US, catfish producers have welcomed the news and the reassurance it gives their industry. The US farm-raised catfish industry employs more than 13,000 workers in Mississippi, Arkansas, Louisiana, Alabama and nine other states, and is the largest aquaculture industry in the United States. Often these workers are poor and marginalized. The Vietnamese Fisheries Minister has since stated that to combat the adverse effects of this situation, fish breeders of the Mekong Delta must begin to look towards other species to counteract the negative impact tariffs may have on aquatic exports, in addition to maintaining a high quality of product free of antibiotic residues.. *Source: Asia Pulse, June 25, 2003; BBC Monitoring International Reports, June 28, 2003; Delta Farm Press, June 23, 2003; Herald Tribune, July 23, 2003; The Vietnam Investment Review, June 23, June 30, 2003; The Seattle Times, July 24, 2003; Vietnam News Briefs, June 24, 2003; The Washington Post, July 13, July 24, 2003.*

US Lawsuit over Claims of Shrimp Dumping by Asian Producers

Under Bill No. HR2406 submitted to the United States Lower House Committee for Ocean Seafood and Wildlife Preservati, Vietnam and other Asian shrimp producers could face dumping charges. Vietnam is one of seven countries, including Thailand, India, China, Ecuador, Indonesia and Brazil, accused of this practice. Additionally, the US Southern Shrimp Association (SSA) has met with legal representatives, the Duwey Ballantine Law Firm, to investigate and prepare for a lawsuit. *Source: Vietnam News Briefs, July 11, 2003.*

Search on for fish disease detection test

Australia's government-funded research body, CSIRO, is developing a test designed to detect a disease which could seriously affect Australia's burgeoning marine aquaculture industry. A team of CSIRO Livestock Industries' researchers at the Australian Animal Health Laboratory (AAHL) will establish techniques to detect the disease-causing agent - red sea bream iridovirus - which can wreak havoc on more than 30 species of fish.

Project leader, Dr Mark Crane, explains that while the virus has not been detected in Australia, it has caused serious fish-stock losses in Japan's marine aquaculture industry. "Snapper, tuna, red sea bream, sea bass, mackerel and yellowtail kingfish could all become infected," Dr Crane says. "This virus is therefore a significant threat to Australia's marine aquaculture industry." The tests we currently have available cannot reliably identify this virus."

"With so many fish species potentially adversely affected, and with the disease being listed internationally by the World Organisation for Animal Health (OIE), the Fisheries Research and Development Corporation (FRDC) has determined that developing tests for the virus is a priority."

Dr Crane and the team will develop tests to detect and identify red sea bream iridovirus in Australia. The tests should be ready for use in State Fisheries laboratories by the end of 2006.

Dr Eva-Maria Bernoth, Manager Aquatic Animal Health for the Department of Agriculture, Fisheries and Forestry - Australia (AFFA), says preparedness for an outbreak of an exotic aquatic animal disease is a crucial part of AQUAPLAN - Australia's National Strategic Plan for Aquatic Animal Health.

"Australia is fortunate to have an aquatic animal sector free from many diseases that occur elsewhere in the world," Dr Bernoth says. "To ensure it stays that way we need to continually enhance our diagnostic capability by adding new tests to our repertoire."

The project is supported with funds made available under the Federal Government's Budget Initiative, 'Building a National Approach to Animal and Plant Health'. It is managed through the FRDC's Aquatic Animal Health Sub-program.

Bangladesh Shrimp Foundation Formed

A newly formed shrimp foundation in Bangladesh intends to form a comprehensive database of information about the shrimp industry over the past 15 years, including training materials. This material will be available on an as-needed basis to any stakeholder in the industry, including service-providers, rights activists non-government organisations, or any other grassroots operators.

This autumn the foundation also intends to co-host a conference on "Application of Standards and International Codes of Conduct in Aquacultural Extension of Developing Countries" with the Network of Aquaculture Centres in Asia-Pacific (NACA). It is hoped that this will lead towards the building, operating and transmitting of a certificate system of quality control in the prevailing conditions of limited infrastructure and thousands of small-scale farmers. UN organizations like the FAO and international certifying bodies will take part in the conference.

In Bangladesh, shrimp is a major export item. However, despite the speed of growth of shrimp culture, it has remained controversial due to socio-economic and environmental problems and is under mounting international scrutiny and criticism, particularly in the UK press. To compound this issue, the lack of knowledge on technical issues such as fry catching or breeding also presents problems.

The foundation will therefore focus on socio-economic problems and quality control issues, which can cause concern to importing countries and international buyers and, as a consequence, the conference intends to involve such bodies or their representatives in the proceedings. *Source: The Independent, May 27, 2003.*

Cambodia's Fisheries Value Recognised

Fisheries in Cambodia are now more valuable than the country's rice crop, according to recent data compiled and released from the Ministry of Agriculture's Department of Fisheries. Fisheries accounted for 12% of gross domestic product (GDP) in 2001, represented by some 400,000 tonnes, whilst rice accounted for only 10%. This compares with fishery production estimates of 60,000 tonnes in 1984.

The increase is thought to be due in part to improved methods of accounting for fisheries catch and consumption, as prior to the survey the catch estimates were a result of guesswork. The new approach is based on consumption; an average Cambodian consumes 30-40 kg per year. The findings are discussed in a report presented to the Mekong River Commission (MRC). It is hoped that these new figures will go some way to improving fisheries resources within Cambodia as they clearly demonstrate its importance. The previous low estimates have led to pollution and the destruction of fish populations as their importance was often overlooked. It is also thought that the importance of fisheries is underreported in Thailand and Vietnam. *Source: STREAM Cambodia Communications Hub, June 2003; The Cambodian Daily, June 2003*.

New products

New Smart Material Beats Aquaculture Fouling

A new smart material promises considerable aid in the search for the consistent meaty, well-formed oyster. It comes in the form of a traditional shaped oyster tray which is manufactured with new smart materials - specially designed polymers (plastics), that contain slow release, harmless biodegradable antifouling chemicals.

This new material can be used in the fabrication of grow-out trays used in the oyster industry. The technology can be readily applied to the highly productive method of off-the-bottom culture of single oysters, using trays suspended from rafts and long lines.

The smart oyster tray has anti-fouling properties

It is well known that adequate water flow through the tray is critical to obtain maximum growth rates for the oysters. Poor flow means less nutrients and lower grade, less meaty oysters. The build up of algal blooms on culture substrates can restrict good water flow and the supply of nutrients to the growing oysters.

With algal bloom comes colonisation by other "fouling organisms" eg: mussels, barnacles, tunicates, tube worms (polychaete annelids), bryozoa (either branching or flat and encrusting), hydroids (a small branching organism related to jellyfish and sea anemonies) and encrusting sponge. An abundant growth of these organisms soon means stiff competition for available food supplies and the solution, until now, has been much labour intensive activity to keep fouling at bay.

Fouling can be removed at harvest either by hand or by low or high-pressure hose washing, however it is highly labour intensive work.

The CSIRO/CRC Aquaculture Smart Oyster Tray

The CSIRO/CRC Aquaculture Smart Oyster Tray offers a solution to these problems and promises higher-grade oyster and shellfish production. The Smart Oyster Tray is a high-density polyethylene, which contains an environmentally benign antifouling chemical agent within the polymeric matrix which is slowly released over time.

The development of this material required the identification and selection of a new antifouling polymer suitable for injection moulding and compatible with the antifouling agent. This was then manufactured for extensive field-testing. It was designed by a team of research scientists from both CSIRO and Australia's Co-Operative Research Centre for Aquaculture. The scientists involved in the development work of this new smart material have several years experience in the development and design of materials with increased functionality and have a high degree of success in the food and beverage packaging material market.

The antifouling chemical agent is an environmentally safe organic compound, which degrades in seawater in a matter of hours and does not bio-accumulate in marine species. This simple system prevents the attachment of algal blooms and other fouling organisms to the surface of the polymer. This product has applicability to the culture of edible oysters, pearl oysters, abalone and prawns.

Successful Testing & Trials

Toxicity testing with shellfish was conducted at the Tasmanian Aquaculture and Fisheries Institute

Field trials of the smart oyster tray

(TAFI) in Taroona, Tasmania. No adverse effects were found in shellfish exposed to the antifoulant, even at levels greater than the expected environmental concentrations.

The photographs show CSIRO's/CRCAquaculture antifouling polymers free of fouling after immersion for 125-days. In all trials the polymers are immersed as cylindrical structures because these foul faster and more uniformly than flat test panels.

This material has been successfully fabricated into oyster trays on a commercial scale. The antifouling agent and high density polyethylene was pre-compounded and processed into trays using standard industrial injection moulders.

CSIRO is currently interested in discussing the development of its technology for commercial use with parties with an interest in the manufacture and marketing of aquacultural products.

Applications for the CSIRO Smart Oyster Tray are likely to extend to other shellfish farming, nets used in aquaculture and underwater farming infrastructure.

For more information contact Dr Veronica Cross, CSIRO Novel Materials & Processes, Tel: 61 3 9545 2978, Email veronica.cross@csiro.au.

New publications

CD-ROM: Investigating Improved Policy on Aquaculture Service Provision to Poor People

The STREAM Initiative (Support to Regional Aquatic Resources Management) has released a multimedia CD containing the outputs of a DFID funded project on improving aquaculture service provision to the poor.

Four video documentary case studies are included (in Hindi with English subtitles) with interviews and perspectives from both aquaculture service providers and recipients in rural communities. These include a case study on support for poor and scheduled caste groups in Jharkand; a successful tribal village conducting aquaculture; recipients experiences of services provided by NGOs in support of poor and tribal groups; and service providers perspectives on the implementation of government schemes in support of aquaculture. The documentaries are accompanied by reports and powerpoint presentations.

A full video (50 minutes) of a street play "Majajal – the Big Fishing Net" is included, which was performed at the policy review workshop in Noida, Delhi. The play is in Hindi. Both English and Hindi scripts are provided.

A full set of the project publications are included in PDF format including outcomes of the stakeholders workshops, lessons learnt and review of progress towards policy change.

System requirements: Windows media player and Acrobat Reader.

Available from the NACA Secretariat, email publications@enaca.org or see our contact details on page 1.

CD-ROM: STREAM Publications November 2001-June 2003

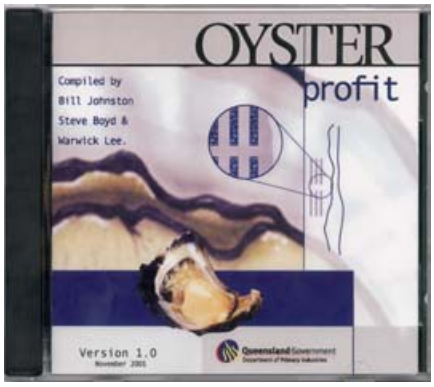
This CD contains a complete set of publications produced by the STREAM Initiative (Support to Regional Aquatic Resource Management). There are more than 100 documents including workshop reports, case studies and a monthly Media Monitoring service in PDF format. Most of the publications are in English but some (such as the media monitoring reports) are also translated in local languages including Vietnamese and Khmer. System requirements: Acrobat Reader.

Available from the NACA Secretariat, email publications@enaca.org.

CD-ROM: Oyster Profit

Oyster Profit is an economic and information package for oyster farmers. The main feature is a piece of software - 'Oyster Profit' – designed to help farmers accurately forecast production costs, cash flow and (hopefully) profits. You enter very detailed information about your costs (including spat, nursery, labour, shellfish safety, freight) production and markets (prices, sales) into a series of detailed spreadsheets and the program calculates a detailed break down (tables and graphs) of your

Continued on page 52



Shrimp Farming Practices and its Socio-Economic Consequences in East Godavari District, Andhra Pradesh, India - A Case Study

M.Kumaran, P.Ravichandran, B.P.Gupta and A.Nagavel

Central Institute of Brackishwater Aquaculture
75, Santhome High Road, R. A. Puram, Chennai-600 028, India.

Development of shrimp farming in the state of Andhra Pradesh, India grew at a phenomenal rate during the years 1990-1995. In 1990, a total of 6,000 ha was under shrimp farming and this rose to 88,300 ha during 1997-98. Presently about 78,700 ha is under culture which accounts for more than 50% of the brackishwater area potentially available in the state. The average yield was around 1,000 kg/ha during 1990-1994. This dropped to about 550 kg/ha in 1995-96 and reached around 630 kg/ha in 1998-99. The present study was carried out in East Godavari district of Andhra Pradesh to understand the nature of shrimp farming practices followed, its impact on the socio-economic status of local population, the influence of extension support and the constraints if any faced by the farming community.

Study area

East Godavari district has an area of 10,807 sq. km, with a population of 45,41,000 (1991 census). It is a major rice producing state with 52% of the total area of the district under rice cultivation. This district ranks fourth in shrimp farming with 6,221 ha of water spread area in 4,810 farms. Generally, farmers culture tiger shrimp (*Penaeus monodon*) because of its high market value.

Out of the 13 coastal mandals of the district 8 (Talarevu, Kakinada rural, U. Kothapalli, I. Polavaram, Katrenikona, Uppalakuptam, Mamidikuduru and Razole) were chosen and detailed study was carried out in 30 shrimp farms with respect to the culture practices, water, feed and health management. For the socio-economic component of the study, data was collected from 120 randomly chosen shrimp farmers using pre-tested questionnaire. Meetings of various stockholders were held in 6 villages to assess the impacts of shrimp farming.

Pond preparation

The farmers deep plough their ponds with tractors. Agricultural lime is applied @500-1000 kg/ha as a basal dose with 150 kg of dolomite and 25 kg of zeolite to adjust the pH, improve the plankton availability and to get a proper algal bloom. Some farmers apply dolomite as substitute to lime @ 750 kg/ha as basal dose and if necessary top-dress with 50kg/ha once in 10-15 days to neutralize pH fluctuations. In addition to the above, 10-12 kg of urea and 3-5 kg of super phosphate are also commonly applied when algal blooms are poor. Pond water parameters including dissolved oxygen (DO), salinity, temperature and transparency are monitored regularly by the farmers.

Stocking

Shrimp (*P. monodon*) seed (PL-20) are purchased at the rate of Rs.400-500 per thousand pieces from commercial hatcheries operating in Kakinada, Visahapattinam and Tuni. The are stocked at a density of 4-7/m^2 in ponds. Nursery rearing of post larvae to

Table 1: Andhra Pradesh – Extent of shrimp farming (District wise)

District	No. of farms	Land area (ha)	Water area (ha)
Srikakulam	211	647	542
Vizianagaram	8	101	48
Visakhapatnam	230	2830	2540
East Godavari	4814	7821	6221
West Godavari	16159	14374	11064
Krishna	37495	32856	26111
Guntur	10669	8821	7473
Prakasam	1707	5105	4084
Nellore	2050	7105	5684
Total	**73343**	**79660**	**63767**

juveniles is generally done in smaller ponds by the farmers. Before stocking, farmers have the seed tested for its quality including the PCR analysis for the white spot virus in private laboratories. This costs Rs.1,200-1,500 per sample for the tests.

Table 3: Farm size distribution in East Godavari District

< 2 ha		2 – 5 ha		> 5 ha	
No.	WSA (ha)	No.	WSA (ha)	No.	WSA (ha)
3959	3530	737	1339	118	1351

Feeding

Different brands of commercial pelleted feeds are used. Two types of feeding strategies are used by the farmers - 'extensive' (35% c.p) for the first 60 days and 'intensive' (32% c.p) for the remaining period. The cost is Rs. 1,250/ 25kgs and Rs.1,050/25 kg respectively. Frequency of feeding varied from 2-5 times during the culture period (twice per day up to one month, 3-4 times/day up to second month and 4-5 times/day after 90 days). About 1-1.5t of feed/ha/ crop is used. The average feed conversion ratio (FCR) for intensive feeding was 1.3-1.5 and for the extensive feeding 1.5–2.0.

Farmers generally used commercial feed attractants and vitamin-C @2-5g/ kg of feed mixed with egg or fish oil as a binder. Commercially available probiotics mixed with zeolite @15 kg per ha was also applied once in 15-30 days depending on the pond bottom condition. Feeds and other inputs were procured on credit basis and the trader was paid a commission of Rs.10-15/kg for harvested shrimp in addition to 24 - 36% interest for the loan. Most of the time the input traders monopolized marketing of the harvested shrimp crop as well. The farmers were forced to sell their produce to traders at a lesser price than the local market value. This system is called "buy back arrangement". The feed traders when supplying feeds under this system actively participated in the culture operations and rendered technical assistance to farmers.

Pond Management

During the first 30 days of culture period no water exchange is done. Thereafter 15-25% exchange is conducted once in 7-10 days. The farmers did not feel the need for frequent water exchange since the water quality in the ponds did not deteriorate due to low stocking density and possibly also due to use of probiotics. Aeration of the ponds using paddle wheel aerators (2/ha) for 4-6 hours/day is conducted by most of the farmers who also regularly monitor soil and water quality conditions of ponds, feed intake and health of the animals. On an average, two laborers per hectare are employed permanently for the routine culture operation. Additional casual laborers are employed during pond construction/preparation, harvest and post harvest operations. The daily wages range between Rs. 50 and 60 for men and Rs. 30 and 40 for women.

Table 2. East godavari district- extent of shrimp farming

Mondal	No. of farmers	Area (ha)	Water(ha)
Kakinda Division			
Talarevu	961	2,336	1,905
Kajuluru	14	85	57
Karapa	46	139	102
Kakinada rural	10	27	18
U. Kothapalli	122	156	125
Rajahmundry Division			
Sakhinetipalli	516	656	524
Malikipuram	247	254	190
Razole	38	51	38
Mamidikuduru	306	376	314
Allavaram	738	1,094	782
Uppalakuptam	1,079	1482	1,244
Katrenikona	513	616	493
I. Polavaram	220	528	414
Total for the district	**4,810**	**7,801**	**6,207**

Production and Marketing

Shrimp growth of the shrimp is better during the summer crop with a yield of 0.8 to 2.0 t/ha/crop in 120-150 days. The yield during the winter crop is around 0.5-1.0 t/ha but it also more uncertain. After harvesting the crop, the animals were segregated/graded into different size groups, counted, weighed, and iced. In some farms shrimp were deheaded before icing. Women conducted the post harvest operations. The harvested crops are sold to the local merchants/ middlemen at the farm itself. As mentioned earlier many farmers had entered in to a "buy back arrangement" with feed dealers who had supplied the feed and other inputs on credit basis. Price of harvested shrimp varied from Rs. 275-400/kg depending on the season, stage and time of harvest.

Socio-economic status of shrimp farmers

A brief profile of shrimp farmers of the district is presented in Table 4. It is evident that more than half of the shrimp farmers (53.3%) had degree or higher level of education. About three-fourths of the farmers (73.3%) had other occupations (agriculture, business) in addition to shrimp

farming. Most were small farmers having a farm size of less than 5 ha of farm and about one third (33.3%) of them were large farmers with more than 5 ha.

Most of the farmers surveyed had more than five years of farming experience and did not appear to be not taking active interest in the affairs of local institutions. Their mass media exposure pertaining to shrimp farming was of fairly high (70%). More than half of the farmers had regular contact with extension personnel of the State Department of Fisheries (SDF) and other institutional agencies. The topics of discussion included issues such as seed quality, disease management, feed management. Their major sources of information were feed technicians, SDF personnel and fellow farmers. Barely one-fifth (16.7%) of the farmers had received training in shrimp farming related areas conducted by State Institute of Fisheries Technology (SIFT), Kakinada and (Marine Products Export Development Authority (MPEDA). Most of them wished to have training in disease prevention, seed quality detection, water quality management, application of probiotics and other advances in shrimp farming. Most of the farmers were high-risk takers. Most of them obtained inputs on a credit basis from local traders through buy back arrangements.

Participation of women in shrimp aquaculture

Women farmers are uncommon in shrimp aquaculture. But in East Godavari district the women of coastal villages took an active part in shrimp farming. Aquaculture is the main occupation of the women with agriculture as an additional source of employment for most of them. Their major participation was in pond construction, seed segregation and counting, collection of seed, de-weeding of the pond, harvesting of shrimp by handpicking, grading (according to size), counting, weighing, icing and deheading of shrimp. Women had regular employment for 4-5 months in a year in addition to their agricultural employment. They were paid Rs. 35-40/ day and a woman labor can earn Rs. 1,200/month from shrimp culture.

Integrated farming of Shrimp/Paddy/Coconut

Most of the farmers had paddy and coconut plantations in addition to shrimp ponds. The availability of water through Godavari irrigation canal helped them in raising two paddy crops. Irrigation water for paddy farming is mixed with creek water and used in shrimp farms as well. The use of irrigation water in shrimp farms had not resulted in any conflicts among the farmers. Most of the agricultural farmers have converted some of their agricultural lands into shrimp farms and both agriculture and aquaculture exist side by side. The paddy yield was about 2,000-2,500kg/ac/ crop which fetched an income of about Rs.10,000 to 12,000 per crop. The straw produced is used for as fodder for the cattle. Coconuts were planted on the farm bunds at a density of 40-50 plants/ha and an income of about Rs.4,000-5,000/ ha is realized from the fourth year onwards. Shrimp farming fetched an average income of about Rs.100,000-120,000ha/year.

Conversion of agricultural land

In East Godavari District, conversion of agricultural fields into shrimp farms is the only negative consequence reported by the farmers and local villagers. It was observed that due to the highly profitable nature of shrimp farming farmers have converted some portion of their paddy fields in to shrimp farms.

Employment and Wage improvement

The major positive consequence of the shrimp aquaculture reported is that it provides regular and additional employment to local villagers, both for men and women, directly or indirectly. This is particularly important in lean agricultural seasons. Agriculture provided on an average of two months employment broken throughout the year whereas in aquaculture it was continuous in a period of 4-5 months. Development of shrimp farming has almost doubled the wages of laborers. The daily wage for men had increased

Table 4: Profile of Shrimp farmers of East Godavari District

Profile Characteristics	Frequency & Percentage N=120
Educational status	
1.Primary school level	16 (13.33)
2.Middle school level	12 (10.00)
3.Upto SSLC	28 (23.33)
4.Above graduation	64 (53.33)
Occupation	
1.Aquaculture alone	32 (26.67)
2.Aquaculture+others	88 (73.33)
Farm size	
up to 2 ha	52 (43.33%)
upto 5 ha	28 (23.33)
above 5 ha	40 (33.33)
Farming Experience	
Up to 5 years	88 (73.33%)
above 5 years	33 (26.625)
Social participation	Minimum 81 (67.5%)
Mass Media Exposure	
Low	26 (21.66)
Medium	81 (67.5)
High	13 (10.8)
Extension Agency contact	
Low	20 (16.67%)
Medium	68 (56.67%)
High	32 (26.67%)
Training undergone	20 (16.67%)
Risk Taking Ability	High 86 (70%)
Credit (Buyback system)	81 (67.5)

from Rs. 30 - 40 to Rs. 80-100. In case of women, it had increased from Rs.15-20 to 35-40. The villagers reported that the standard of living in coastal villages have improved after the development of shrimp farming. Development of local infrastructure like link roads, transport, communication facilities etc had been possible because of shrimp farming in coastal areas.

Ancillary industries

Our study revealed that the growth of ancillary industries (such as hatcheries and feed manufacturing) along with other services (such as nursery or seed trade, feed retailing, transport, earth movers and other construction equipments, shops dealing with aquaculture products, petty shops and money lending) had helped in providing large scale employment to the local people and preventing emigration of rural poor to urban areas. Development of shrimp farming has contributed enormously to the local economy as well as that of the state.

Extension support

Due to the nature of shrimp farming the diffusion of appropriate information at appropriate time is vital. The main sources of information for farmers are given in Table 5. Three quarters of shrimp farmers (76.67%) indicated that local feed technicians and feed traders were their main source of information. Local feed traders, due to their sharing arrangement with shrimp farmers, regularly visited farmers and provided all necessary information. About fifty percent of respondents reported that personnel from state fisheries department and fellow farmers provided them necessary information. One fourth (25%) of farmers indicated that institutional information sources like MPEDA and Research institutions were their information sources. Printed literature from feed companies, institutions and meetings, seminars, farmer discussions were the other sources of information.

Constraints

The main constraints expressed by farmers are ranked according to their severity in Table 6. Viral disease outbreaks were considered as the major constraint by 82% of the farmers. The quality of shrimp seed from hatcheries is of great concern to 68% of the farmers. Weed infestation which is site specific, is one of the major constraints in certain areas of the district (52%). Other constraints reported include poor cooperation among farmers, poor water quality, price fluctuations during the time of harvest, middlemen in the market chain, lack of electricity to shrimp farms, inadequate technical guidance, lack of credit and insurance.

Table 5: Information sources of shrimp farmers in East Godavari district

Information Source	Frequency (N=120)	Rank
Feed technicians/traders	92	I
State Department of Fisheries	62	II
Fellow Farmers	56	III
MPEDA & Research institutions	30	IV
Printed literature from feed companies,SDF & Research Institutions etc	18	V
Seminars/workshops by feed companies	8	VI

Table 6: Constraints of shrimp farmers in East Godavari district

Constraints	Percentage N=120	Rank
Disease menace	98 (81.67)	I
Poor seed quality	81 (67.50)	II
Price fluctuation-low price at the time of harvest and middlemen	74 (61.67)	III
Weed infestation	62 (51.67)	IV
Poor cooperation among fellow farmers	58 (48.33)	V
Poor water quality	49 (40.83)	VI
Lack of Credit and Insurance	28 (23.33)	VII
Lack of electricity	21 (17.50)	VIII
Lack of technical guidance	16 (13.33)	IX
Lack of Govt. support	14 (11.67)	X
Cyclones	10 (8.33)	XI
Theft	6 (5.00)	XII

Table 7: Suggestions for improvement of shrimp farming practices in East Godavari district as suggested by the shrimp farmers

Suggestion	Frequency N=120	Rank
Ensure good quality control in seed - may be through certified by SDF Personnel.	72 (60%)	I
Price information through mass media	64 (53.33%)	II
Educate the farmers to chlorinate the diseased/contaminated water before release into creek or educate farmers to have separate drainage channel.	49 (40.83%)	III
Disease diagnostic centers at coastal towns	46 (38.33%)	IV
Credit and insurance	36 (30%)	V
Speedy settlement of legal hurdles	32 (26.67%)	VI
Government. support	28 (23.33%)	VII
Technical guidance	26 (21.67%	VIII
Electricity on nominal charge	24 (20%)	IX

Suggestions

Table 7 contains some of the suggestions identified by the farmers for sustainable shrimp production. Sixty percent of the farmers suggested that quality seed from hatcheries should be ensured through seed certification by SDF. About half of the respondents (53.3%) suggested that dissemination of price information through mass media channel during harvesting would help the farmers to secure good price for their produce. Most suggested that shrimp farmers

should be educated on the importance of chlorination of contaminated water before it is released into the creek and on developing favorable attitudes towards fellow farmers. Establishment of disease diagnostic centers at coastal villages, technical assistance by the scientists, SDF personnel, speedy settlement of legal hurdles, institutional credit and insurance and provision of electricity on nominal charges were the other suggestions.

Conclusions

Shrimp farming is successfully practiced in East Godavari District although with some constraints. The farming system in the district has unique features such as buy-back arrangements between the farmers and feed traders, mixing of borewell and creek waters with fresh irrigation water for culture, use of extensive and intensive feeds and integrated shrimp cum coconut - paddy farming. Private input dealers continued to be the prime information sources and disease outbreaks appeared to be the major threat to shrimp farming. In this connection It was suggested that a mechanism for seed certification by the State fisheries department has to be developed to ensure healthy shrimp seed. Shrimp aquaculture has contributed significantly in employment generation and infrastructure development of the coastal community and over all development of coastal areas. Since all strata of the coastal community are involved in one or other aspects of shrimp farming directly or indirectly there is no conflict or complaint against shrimp farming. But the conversion of agricultural fields to shrimp ponds has to be checked and shrimp farming should be regulated.

Acknowledgement

The authors are grateful to Dr.G.R.M.Rao, Director, of the institute for his encouragement and guidance. They are also thankful to Dr.N.Kalaimani, Head, Extension Division for his suggestions.

Continued from page 47

expected production output, cost structure, cash flow and economic indicators including the rate of return and your required break even point. You can also use the software to model the financial impact of a change in your business environment. If, say, the cost of labour goes up or the market price of oysters changes you can quickly see how it will affect profitability.

The CD includes a quite detailed reference section which contains licensing kits; contact information for farmers associations and government authorities; several species profiles and research notes including farming of triploid Sydney rock oyster and the native *Ostrea angasi* oyster; and several reports including a strategic plan produced to guide the development of the industry and the an operational review of the NSW Shellfish Quality Assurance Program.

The software was developed as a joint project by NSW Fisheries, the NSW Oyster Research and Advisory Committee, NSW Department of State and Rural Development and the Queensland Department of Primary Industries, Australia.

Available from the QDPI Online Shop, http://dpishop.dpi.qld.gov.au/bookweb/details.cgi?ITEMNO=9780734501639

Conclusion: We like it, a very useful decision making tool for oyster farmers. Cost AUD$ 220, Recommended.

CD: FAO Field Project Reports on Aquaculture: 1966-1995

We love this CD, it is a goldmine of information covering 1,712 reports produced by 257 FAO aquaculture field projects between 1966 and 1995. Many are included as full text documents including a complete set of 92 publications produced by NACA from inception to 1995 plus another 48 from the Asia Sea-Farming Development and Demonstration project. The CD has a lot of early information and training manuals on culture of shrimp, freshwater prawns and Asian seabass, and many publications on integrated aquaculture including a training manual from the Asian-Pacific Regional Research and Training Centre for Integrated Fish Farming, Wuxi, China.

Other Asian projects covered include the Bay of Bengal Programme, the South Pacific Aquaculture Development Project and many others. The CD also covers FAO projects in other regions of the world. Conclusion: Highly recommended - you can't get this information anywhere else.

Available from FAO, contact Sales and Marketing Group, Publishing and Management Service, FAO Information Division, Viale delle Terme di Caracalla, 00100 Rome, Italy. Fax +39, 06 5705 3360, email Publications-Sales@fao.org, or view their online catalogue at www.fao.org/icatalog/inter-e.htm.

CD: Simple Methods for Aquaculture

This CD contains five training manuals on Simple methods for aquaculture and the Handbook on small-scale freshwater fish farming. The manuals are written in an easy-to-read style focusing on the practical aspects of semi-intensive fish culture in freshwaters from site selection and fish farm construction to the raising, final harvesting and marketing of the fish. They present methods and equipment useful not only to those responsible for field projects and aquaculture extension but also for use in aquaculture training centers. The manuals included are: i) Water for freshwater fish culture; ii) Soil and freshwater fish culture; iii) Topography for freshwater fish culture iv) Pond construction for freshwater fish culture; v) Management for freshwater fish culture and vi) Handbook on small-scale freshwater fish farming. The manuals are in HTML format with many illustrations.

The CD slipcase includes a brief summary of how to set up the CD and how to browse the manuals and the entire contents is also available in both French and English. Conclusion: Recommended – a well presented training package. System requirements: Pentium I with 16MB RAM, 14" monitor, CD drive and Windows 95+.

Available from FAO, FAO Information Division, Viale delle Terme di Caracalla, 00100 Rome, Italy. Fax +39, 06 5705 3360, email Publications-Sales@fao.org.

Aquaculture Calendar

Spanning the Digital Divide: International Conference on the Development of Digital Libraries

The Agricultural Librarians Association of the Philippines (ALAP) is conducting a conference entitled "International Conference on Spanning the Digital Divide: Development of Digital Libraries". this will be held in Makati, Metro Manila from 6-7 November 2003. *Download the brochure from: http://www.enaca.org/PDF/Brochure_Digital_Library.pdf*

Global Shrimp Outlook: 2003, 3-6 November, Mexico

The potential impacts of an anticipated shrimp antidumping petition in the United States have elevated the topic of antidumping to the forefront of the program schedule for Global Shrimp Outlook: 2003, a Nov. 3-6 conference organized by the Global Aquaculture Alliance in Cabo San Lucas, Mexico.

The GSOL meeting will open with an antidumping panel discussion that will include legal counsel from Akin, Gump, Strauss, Hauer & Feld; strategic plans from the American Seafood Distributors Association; views of top industry leaders and an extended question-and-answer period. During this program, participants will propose consensus plans for dealing with the antidumping issue on both legal and business fronts.

In addition to antidumping discussions, Global Shrimp Outlook: 2003 will provide the best available information on current and future trends in the shrimp market.

Global Shrimp Outlook: 2003 is a by-invitation meeting for top shrimp buyers, sellers, processors and producers. To be considered for an invitation, contact the GAA office - e-mail gaa1@attglobal.net, telephone +1-314-293-5500, fax +1-314-293-5525 - to request a copy of the registration packet. Forms are also available online at http://www.gaalliance.org.

Environmental Management of Enclosed Coastal Seas, 18-21 November 2003, Thailand

The conference program will include three special session themes: i) Gulf of Thailand; ii) Asian forum for discussion of sustainable development in Asia and the preservation of coastal environments; and iii) NGO forum, to discuss the roles of NGOs in better understanding and promoting friendly coexistence between nature and people in coastal areas. The technical session themes will be related to the scientific, technical, management, educational and information aspects of coastal seas. Technical tours will be held after the conference to Kung Krabaen Bay, the King's project on Coastal Zone Management in Chantaburi Province and on Koh Chang Island in Trad Province. The deadline for submission of abstracts is 30 April 2003. *For more information visit www.emecs2003.com.*

2003 China International Recreational Fisheries and Aquaria Congress and Exhibition, 20-23 November 2003, Shenzen, China.

The first conference in China on recreational fisheries, aquaculture, ornamental fish culture and trade and game fishing. It is a good opportunity for scientists and industry related to aquaculture, fishery resource management, economy, ornamental fish, game fishing to share experience and get close to China and southeast Asia.
For more information email csfish@agri.gov.cn or visit http://www.cnfm.gov.cn/recreational/RecreationalFisheries.htm

Cancelled: Aquaculture Australia

Heighway Events, the organiser of the 'Aquaculture Australia' exhibition scheduled for Sydney's Darling Harbour Conference and Exhibition Centre from 3rd-5th December, has announced that the event will not now take place, following a low level of international stand bookings.

In a press release Heighway Events indicated that the continuing tough economic situation has meant that the key international participation which was important to the show's success - has not materialised, with overseas suppliers, under pressure to cut costs, unwilling to travel so far to what is seen as a relatively small market. Heighway Events is enormously grateful to all those who have supported 'Aquaculture Australia'.

Coastal and Freshwater Issues, 8-10 December 2003, India

The Institute for Ocean Management, Anna University, is organizing an International Conference to be held in Chennai. A pre-conference workshop on "Integrated Coastal Zone Management and Training will also be held from 3-7 December. The deadline for abstract submission is 15 October. *For further information visit http://www.annauniv.edu/iom/COFIS2003.htm*

The Eleventh International Symposium on Nutrition and Feeding in Fish

International Symposium on Nutrition and Feeding in Fish (XI ISNFF) will be held on Phuket Island in Thailand from 3 - 7 May 2004. This symposium will be the forum to continue scientific discussion on all aspects of fish nutrition including current knowledge and future perspectives in plenary sessions, workshops, oral presentations and pesters. In addition, emerging issues that relate to food quality and safety will be addressed. There will be an opportunity to organize meetings to discuss special topics that may lead to the formation of networking groups to promote the advancement of aquaculture nutrition science, technological development and discussions on potential regulatory issues where nutritionists could provide appropriate advice on

policy development.

WAS 2004 Special Session Announcements, 1-5 March 2004

A number of special sessions will be convened at the World Aquaculture Society Meeting in Hawaii, 1-5 March 2004. People wishing to participate in these sessions are encouraged to submit an abstract. The deadline for abstracts is 1 August 2003. The special sessions are as follows:

Economics & markets of marine finfish culture. The International Association of Aquaculture Economics and Management (IAAEM) and the Network for Aquaculture Centres in Asia-Pacific (NACA) will be co-sponsoring a special session entitled "Economics, Socio-Economics and Markets of Marine Finfish Culture" for the World Aquaculture Society (WAS) 2004 Conference in Honolulu, March 1-5, 2004. We are extending invitations to submit a paper for this session. This session will cover all aspects relating to the economics, socio-economics, policy, markets, and trade of marine finfish aquaculture around the world. Selected papers from this session will be published as a special issue of the journal Aquaculture Economics and Management. Please send confirmation with an abstract by August 1, 2003 to Professor Pingsun Leung psleung@hawaii.edu

Computers in Aquaculture. This special session is intended to be a forum for exchange of information on the latest innovations and developments for the practical application of computers and the Internet in aquaculture and fisheries. Another purpose for convening this special session is to bring together as many individuals as possible who are involved in the development and use of computer based information technologies so that we may meet one another and discuss how best to move towards integrating an international distribution network for the ever expanding array of Web sites, equipment, software, distance education opportunities and other products and services being developed for aquaculture. Abstracts are due by August 1 2003. For further information please contact either Dr John W. Ewart at the Delaware Aquaculture Resource Center, Sea Grant Marine Advisory Service, Graduate College of Marine Studies, University of Delaware, 700 Pilottown Road Lewes, DE 19958 Phone: 302-645-4060 Fax: 302-645-4213 E-mail: ewart@udel.edu. Online information and submittal forms are available at http://www.was.org/meetings/Hawaii/Pages/Hawaii2004.asp.

A*dvances in Aquafeed.* This special session, organized by Aquafeed.com is intended to be a forum for exchange of information on new feeds and the latest technology and nutritional innovations of practical application to the aquafeed manufacturing industries. Abstracts for the Aquaculture 2004 meeting are due by August 1, 2003. Please contact Suzi fraser Dominy, Publisher, Aquafeed.com at: editor@aquafeed.com, if you require further information. Aquafeed.com is a leading information resource for the commercial aquaculture feed manufacturing industries, visit their website at www.aquafeed.com.

Economics of shellfish culture. A session will focus on the economics of shellfish (i.e., culture, management, etc). Those interested in participating in this session are encouraged to submit an abstract. The deadline for submitting the abstract is 1 August 03. Any questions about the session should be directed to Chuck Adams, University of Florida (cmadams@mail.ifas.ufl.edu). This session is being developed under the auspices of the National Shellfisheries Assocation.

The aquaculture work of NGOs in developing countries

An idea to form a new NGO, tentatively called 'Aquaculture without Frontiers' (see www.was.org for further details), aimed specifically at assisting in the alleviation of poverty in developing and transition countries through aquaculture, was put forward in a keynote paper presented at the 2003 conference of the World Aquaculture Society (WAS) in Brazil in May 2003.

Recognizing the role of and need for NGOs to use aquaculture to assist in mitigating the projected shortage of fish, a workshop on the aquaculture work of existing NGOs in developing countries is being organized in conjunction with next year's annual WAS meeting ('Aquaculture 2004', 1-5 March 2004, Honolulu, Hawaii) with the following objectives: i) to review the experiences of NGOs in aquaculture and to identify potential future opportunities; ii) to document the institutional experiences on aquaculture development through NGOs; and iii) to understand the perspectives of governments and donors assisting NGOs in this type of work. Attendees will include Caritas Bangladesh, NACA, the World Bank, and the WorldFish Center. It is hoped that this initiative will help to publicize the significantly positive contributions of existing NGOs and their donors to aquaculture in developing countries, as well as assist in promoting the formation of 'Aquaculture without Frontiers'. The abstract deadline for this session has been extended to 1 September 2003.

International Institute of Fisheries Economics and Trade Conference, 26-29 July 2004, Japan

The theme of the biennial conference is "What are responsible fisheries ?". Conference topics include a wide variety of seafood markets, fishery management, and aquaculture-related issues. Seafood processing, marketing, and consumption issues, medical and ornamental substances from the sea, and international seafood trade issues will be covered, as well as policy issues including capacity reduction, fishery management by cooperatives, ecosystems approaches to management, and bio-economic models. The conference will be held at the Tokyo University of Fisheries. A pre-conference professional tour will be available July 21-23 visiting fishery management/marketing cooperatives, and July 24 visiting Tsukiji market and other links in the Japanese seafood market chain in Tokyo, plus a post-conference symposium.
For more information visit http://oregonstate.edu/Dept/IIFET/Japan/Japancall.html or contact iifet@oregonstate.edu.

What's New on the Web

This column aims to help raise awareness of new and useful internet resources in the aquaculture community, particularly for those who don't have full-time access to a computer. Do you have a new website that might be useful for people ? Released a new publication for download ? Write to me at simon.wilkinson@enaca.org.

New publications

Marine Finfish Aquaculture Network

Report of the Grouper Hatchery Production Training Course, May 2003

This report summarises the outcomes and training provided at the Gondol Research Institute for Mariculture. Includes photographs of the facilities and practical sessions. It also describes progress made by participants in last years course – a number of participants have successfully bred grouper for the first time as a result of their attendance. 37 pages, PDF 830KB.
http://www.enaca.org/Grouper/Publications/Training-Report-2003.pdf

Consortium on Shrimp Farming & the Environment

Shrimp Aquaculture in Africa and the Middle East, the Current Reality and Trends for the Future

A new case study published by the consortium on Shrimp Farming & the Environment. This study is intended to review the actual situation of shrimp aquaculture development in the two regions as well as the problems and prospects for future development. It is clear that a certain amount of investment will occur in the future. Given that these are two of the last tropical regions of the world where shrimp aquaculture development has not occurred on any significant scale it should be possible to learn the lessons from other parts of the world and apply them in these contexts. The countries in this report are: Egypt, Iran, Mozampique, Madagascar and some information on other countries in both regions. PDF, 42 pages, 429KB.
http://www.enaca.org/Shrimp/Case/Africa/FinalAfrica.pdf.

Support to Regional Aquatic Resource Management (STREAM)

STREAM Journal Volume 2 Number 1 January-March

Contents this issue include: Learning insights from the Fisheries Resource Management Project; An orientation on the SIAD approach and participatory local development planning; Group-building, production success and the struggle to prevent capture of the resource; Urban agriculture, water reuse and local economies: Case study of coastal riverine settlements of Ondo State, Nigeria; Livelihoods analysis: Actual experience from using PRA, a sustainable livelihoods approach to fisheries development for poverty alleviation in southeastern Vietnam.
http://www.streaminitiative.org/Library/pdf/pdf-journal/2003/vol1/SJ2(1).pdf

SPARK-STREAM Workshop on Livelihoods and Languages

Contents include Drafts of language-specific "Guide to Learning and Communicating about Livelihoods"; Drafts of articles for STREAM Journal and SPARK Newsletter; Priorities and practical follow-up for capacity-building in carrying out participatory livelihoods analysis; Follow-up plans.
http://www.streaminitiative.org/Library/pdf/regional/ss2.pdf

Second STREAM Regional Conference Report

Following a regional overview of STREAM's themes, country partners, donors and funding, and activities, participants visited four "stations" on the themes of livelihoods, institutions, policy development, and communications, working in groups representing National Coordinators, Communications Hub Managers, and Partners. They engaged in discussions with a "station leader" and each other to learn about and comment on objectives, activities, outcomes and outputs, and to consider issues that need addressing in STREAM.
http://www.streaminitiative.org/Library/pdf/regional/sc2.pdf

Investigating opportunities to support indigenous aquaculture in Australia

Report of STREAM visit to Kimberly, Western Australia with objective to meet with community members around Kimberley, visit the KAAC (Kimberly Aquaculture Aboriginal Coorporation) Multi-species hatchery in Broome and some examples of on-going aquaculture activities within communities.
http://www.streaminitiative.org/Library/pdf/regional/kaac.pdf

Aquatic Resources and poverty in the Philippines

An overview of the state of aquatic resources in the Philippines, its performance and importance in the Philippine economy. The report describes the policy environment that guides the action of key actors in the sector and a general analysis of trends that keep the poor from participating and benefiting from aquatic resource management.
http://www.streaminitiative.org/Library/pdf/philippines/aquatic1.pdf

Trans-Himalayan Coldwater Fisheries

The Symposium on Coldwater Fisheries of the Trans-Himalayan Region

The symposium was held 10-13 July 2001 in Kathmandu, Nepal. The symposium addressed the fish species,

distribution, fishing intensity, socio-economic conditions and livelihoods of fisher communities in the region as well as the impact of environment degradation, conservation measures and aquaculture technologies for indigenous and exotic cold water fish. The full proceedings are now available as an FAO Fisheries Technical Paper (364 pages, PDF 2.2 MB). http://www.enaca.org/NACA-Publications/Transhimalayanfisheries.pdf

Other publications

SPC Traditional Marine Resource Management and Knowledge Information Bulletin

Issue No. 15 is now available for download. Contents include: Aquaculture traditionally used in Hawai'i as a dynamic food production system; the construction and use of traditional sailing canoes, together with their economic and social roles in the Louisiade Archipelago of Papua New Guinea; the difficulties in setting up whale watching activities in a traditional whaling region of Japan; the importance of including archaeological data in marine science; and many other interesting subjects. http://www.spc.int/coastfish/News/Trad/15/

SPC Fisheries Address Book 2003

The new address book is now available for free download from the Secretariat of the Pacific Community website. [*A comprehensive and very useful publication – Ed.*] http://www.spc.int/coastfish/News/Address_Book_2003/Address_book_2003.htm

Freshwater aquaculture in the Lower Mekong Basin

The farming of fish and other aquatic animals and plants or aquaculture, is an increasingly important rural activity and source of food and income for people living in the Lower Mekong Basin. This paper reviews the status of inland aquaculture in the Lower Mekong Basin countries of Cambodia, Lao PDR, Thailand and Viet Nam. It identifies key factors shaping aquaculture development and provides recommendations to increase its future importance in food production and rural development in the basin. The paper provides a timely and important review of aquaculture as a significant means of food production and a contributor to rural livelihoods in the Lower Mekong Basin. http://www.mrcmekong.org/pdf/TP-7.zip

Kimberley Aboriginal Aquaculture Corporation Newsletter No. 13, June 2000

Contents this issue: Centenary Medal, KSRP Project, Official Opening Manbana, Dr Chan Lee – Retirement, Workshops – Thailand Aquaculture Mission, Indigenous Aquaculture Unit, STREAM Initiative – NACA, KAAC Constitution Change, Artist in Residence, Board of Directors of MSH Pty Ltd, Trochus Project, Aquaculture Licences, ACIAR Trochus Project, Community Projects. 5 pages, PDF 167 KB.

Valuing Wetlands In Decision-Making

Via the "Integrating wetland economic values into river basin management" project, the IUCN has produced the issue paper "Valuing wetlands in decision-making: where are we now?" and seven case studies that examine if and how wetland valuation changes management and development decisions. The case studies are based in Sri Lanka, Zambia, Cambodia, Cameroon, Pakistan, Kenya, and Uganda. To access the issue paper and for information on the project and the case studies, access http://www.waterandnature.org/v1.html

New website resources

AquaMarkets: The NACA Trade Page and Seminar Reports

The AquaMarkets 2003 Reports can now be accessed at www.enaca.org/aquamarkets. The information includes the draft Summary Reports of the Seminar and the Consultation, Recommendations, papers, powerpoint presentations, and related materials.

Since this is a new section of the website we are looking for regular contributions and content to post of the site. If you have some relevant (and timely) market information please contact us. We will post announcements, news, events, related papers on trade and marketing issues. We will appreciate suggestions on the structure and content of the aquamarkets page. Send your comments to aquamarkets2003@enaca.org

New SPC Aquaculture Website

The Secretariat of the Pacific Community (SPC) has released a new aquaculture portal website with links to countries, activities and commodities in the Pacific. A CD-ROM version of the site is being considered for people without access to the internet. You can access the site through: http://www.spc.int/aquaculture/site/home/index.asp.

Bay of Bengal Programme publications available online

The Support Unit for International Fisheries and Aquatic Research (SIFAR/oneFish) in Rome has made available online almost all the BOBP Publications that were formerly available only in hard copy or on CD-ROM. The information is now accessible over the web and you can go directly to the BOBP section in oneFish to access the documents http://www.onefish.org/id/3232. For further information please contact Yugraj Yadava, Director, Bay of Bengal Programme Inter-Governmental Organisation, Tel: # 91 44 28216552, email bobpysy@md2.vsnl.net.in.

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®

Advanced Solutions
for animal rearing

www.inve.com

INVE is the proud gold sponsor of WORLD AQUACULTURE 2003