ISSN 0859-600X
Volume IX No. 4 October-December 2004

AQUACULTURE ASIA

After the wave

Aquaculture Asia and NACA extend our condolences to the millions of people affected by the earthquake and tsunamis of 26 December 2004. We are deeply saddened by the event and will work to assist people to rebuild their lives and livelihoods, in collaboration with our partners throughout the region. A consortium of like-minded organizations has been formed to collaborate in the medium and long-term recovery of farmers, fishers and coastal communities. More inside.

Catfish and conservation

Walking catfish genetics in Thailand

Sarawak's indigenous Tor species

Captive breeding of vulnerable Indian Carp

Now available on CD-ROM!

Napoleon wrasse breakthrough!

Live reef fish market trends

STOP PRESS: REBUILD !

Ban Nam Kem, Takua Pa district, Phangnga province Thailand. Photo by Simon Funge-Smith.

After the wave

The tsunamis of 26 December 2004 have devastated many coastal communities throughout the Indian Ocean. Hundreds of thousands of people have lost members of their families, their homes and their livelihoods. In the short term, the critical need has been for emergency supplies of food and water, shelter and medical assistance. These emergency relief efforts are being undertaken by humanitarian agencies.

In the medium to long term, survivors will begin to rebuild their lives. It is at this stage that NACA can contribute. As an intergovernmental organization working in development contexts, with its wide network of professionals, NACA has access to the experience and expertise to assist in rebuilding the shattered livelihoods of stricken communities, specifically those dependent on aquaculture and coastal fisheries.

Immediate and current response: CONSRN

Since December 2004, NACA has been collecting and assessing information from affected coasts in order to inform relief and reconstruction efforts. NACA has also begun to work with other organizations to co-ordinate efforts and to collaborate on certain specific activities. To this end, the FAO Regional Office for Asia and the Pacific, the Southeast Asian Fisheries Development Center, the Bay of Bengal Program, the WorldFish Centre, NACA and its STREAM Initiative have formed a *Consortium to Restore Shattered Livelihoods in Tsunami-Devastated Nations*, referred to as CONSRN.

Currently, CONSRN provides a tsunami news monitoring service, collecting and presenting media clips relevant to coastal livelihoods, fisheries and aquatic resources and reporting these daily on consortium partner websites. CONSRN has published tsunami impact assessment reports, updated frequently, which provide a more in-depth assessment of the situation on a national basis. There is also a discussion forum to publicly debate emerging issues available on the NACA website, http://www.enaca.org. Other services will be introduced as necessary, including the web-based reporting of plans, activities and their outcomes, in order to maximize co-ordination and minimize duplication.

Towards NACA's role in building a strategic response

In 2001, at the request of its' 16-nation Governing Council, the remit of the Network of Aquaculture Centres in Asia Pacific was expanded from aquaculture development alone, to aquatic resources management. Member governments also mandated the NACA STREAM Initiative to help support poverty alleviation, to improve communications, and to help shape institutions and policies to provide better services to poorer stakeholders, who forage from paddies and small water bodies, glean from shores and

Continued on inside back cover...

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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.

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Printed by Scand-Media Co., Ltd.

AQUACULTURE ASIA

Volume IX No. 4 **ISSN 0859-600X**
October-December 2004

Trade, food safety and traceability

2004 has been a year dominated by trade disputes and market access problems. This time the hammer has fallen hardest on shrimp, with the industry dogged by antibiotic residues, allegations of dumping, tariffs and falling international prices. Unfortunately there are no signs that things are likely to be any different in 2005, in fact, it seems likely that issues of market access are steadily becoming more difficult and complex.

Global concerns about food safety have clearly been on the rise for some time. When it comes to food consumers the world over have repeatedly demonstrated near-zero tolerance for risk: If a product isn't perceived as *safe*, they just won't buy it. A food safety issue can also lead to sudden market closure by governments. These outcomes are perhaps most famously demonstrated by bovine spongiform encephalopathy or "mad cow disease". BSE also demonstrated that nobody benefits from a food safety scare: When the issue broke, beef exporters from non-affected countries speculated - with some enthusiasm - that they would be able to capture a greater share of the international market. They were utterly wrong: Consumers virtually stopped eating beef; there was no international market left to capture; and it was years before public confidence recovered. Many farmers were forced out of business.

With this kind of background it is understandable that governments are introducing more stringent food safety requirements to reduce risk such as lower chemical residue limits and testing for microbial contamination. Increasingly, governments and the private sector are also taking an interest in traceability: Where did this product come from ? How was it processed ? Who handled it ? They want to know, or at least, to be able to find out. Much cost and disruption can be avoided if the source of a problem can be idenfied and the affected product removed. Without traceability a whole industry can fall under suspicion due to a problem caused by a single supplier. Unfortunately, traceability is not without cost, and implementing it in the Asian context - an industry dominated by large numbers of small-scale producers - is complex and difficult.

Nevertheless, the U.S. Food and Drug Administration (FDA), has just issued its final regulations on the establishment and maintenance of records to protect the U.S. human food and animal feed supply, in accordance with section 306 of the *Bioterrorism Act*. The new regulations require persons who manufacture, process, pack, transport, distribute, receive, hold, or import food to destined for the US to establish and maintain records. These records must identify the immediate previous source of all food received, as well as, the immediate subsequent recipient of all food released. The record retention period for human foods ranges from six months to two years depending on the shelf life of the food. Records for animal food, including pet food, must be retained for one year. If you are engaged in food-related trade to the US I encourage you to look into the requirements as they could affect your business. Further details (including a fact sheet) are available from the FDA website at:

http://www.fda.gov/oc/bioterrorism/bioact.html

Wishing you a peaceful and prosperous 2005.

Simon Wilkinson

AQUACULTURE ASIA

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Small ponds in peaty soils and carambas on a river

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

We saw two examples of how aquaculture is improving incomes and enhancing livelihoods of rural communities in two Indonesian villages – one inland, one along a river - in the province of Jambi in Sumatra during the Program Implementing Unit annual workshop, this time held in Jambi.

The first was a pond culture system of *Pangasius hypopthalmus* in a village called Tangkit some 20 kilometers from the capital town. The ponds are small, 200 square meters, dug on peaty soils that used to be planted with pineapples; they cannot be drained as the water table is very high. The system includes the profuse growth of swamp cabbage as well as duckweed and, in a few ponds, *Azolla* to extract the excess phosphorus and nitrogen from the pond water. Moist pelletized feed made by the farmers themselves and based on Jambi's Freshwater Aquaculture Development Centre formulation, is used. The fish meal component comes from trash fish landed in a coastal town called Kuala Tungkal in neighboring Riau, two hours away by truck.

The yield comes up to 1 to 1.2 tons over a 4-month growing period, according to Pak Hernowo, senior staff of the Jambi Balai Budidaya Air Tawar (BBAT) or Freshwater Aquaculture Development Centre, and Mr Agus Apun Budhiman, head of Policy and Planning of the Directorate General of Aquaculture in Jakarta. At 8,000 rupiahs/kg (almost 1 US dollar in today's rates), the farmers gross income from a pond per crop would be almost 1,000 US$. Buyers go to the village to purchase the harvest.

The system was started by the BBAT through a small demonstration pond in the village in the late 90s. Agus Budhiman said he and the former BBAT head Pak Maskur (former head of the Jambi BBAT and currently head of the Sukabumi Freshwater Aquaculture Development Centre in West Java) scouted the area some time in 1996 and saw possibilities for *Pangasius* culture. They set up a demonstration pond. At that time the BBAT was newly established in Jambi with two research personnel (headed by Mr. Maskur, who had trained in aquaculture research for a year in Thailand's Inland Fisheries Institute under NACA's junior scientist program). It has since expanded rapidly in research and development coverage personnel and capability (thanks to national and provincial government support and Japanese government assistance through JICA, which has provided good research equipment, including a pilot feed mill, and expertise). The centre now regularly trains farmers, produces fish seed it sells to farmers for nursing and provides technical services to the fishfarmers in water quality monitoring, disease control, feeds and feeding, and overall cultural management. It also produces fingerlings for release

From a single government demonstration pond set up in 1998, Jambi's Provincial Fisheries Officer Pak Herman said there are now some 350 households in the area farming fish this way, each household normally operating 3 to 4 ponds. Adoption of the system by the villagers only started in 2001, he said. He estimates that the number of ponds now in operation total more than 20 hectares of water surface area. I saw some new ponds being dug. We did not go into the economic benefits from the system but Agus and Hernowo pointed out to me the new, concrete and wooden farmers' houses with tiled roofs that have since replaced bamboo and thatched roof dwellings of five years' back. The farmers group (kolompok tani), which includes the women, work on value addition of their farm products (which still includes pineapple). We bought jellied pineapple wrapped in nicely woven grass bags. The list of processed products announced in a well-maintained community billboard beside the mosque includes a number

The Governor of Jambi, Honorable Zulkifli Nurin and Director General for Aquaculture Dr Fatuchri Sukadi release fingerlings of patin and kissing gouramy during the launching in Jambi Province of the intensified fisheries development program of Indonesia.

of ways the fish is farm- processed making them convenient for preparing native dishes.

The other system is of floating wooden cages stocked with red tilapia or the other species of *Pangasius*, which is a very popular fish in Sumatra. The system is well demonstrated in Batanghari river. There are only around 300 cage units in operation in that stretch of the river encompassed by the community (Pematang Jering). The potential is said to be more than 2000.

Jambi's Provincial Governor Mr. Zulkifli Nurdin and Director General for Aquaculture Dr Fatuchri, Sukadi, invited us to a fish-releasing ceremony. 5,000 *Pangasius jambal* seed were released along with, 15,000 kissing gouramy (*Helostoma teminchi*) produced by the Jambi Freshwater aquaculture development centre. The governor also gave several outstanding fish cage culturists citations. A seed transport vehicle (a motorbike equipped with styrofoam-lined tanks that costs around 1,000 US$ was donated by the government. The occasion also led to a grassroots dialogue between the community and the government with some very articulate spokesmen from the community on one side and the governor, the district head and the fisheries officers on the other side. The people knew exactly what they wanted: Improved roads for better marketing of produce, technical assistance to the fish cage culturists, more fish seed transport units (three more were promised) and an easy credit scheme.

My visit to Jambi was to take part in the second yearly UPT (Technical Implementing Unit for aquaculture development) national seminar workshop routinely conducted since 1995 and this time attended by some 150 UPT researchers and staff. The meeting featured presentations of new research findings, exchange of experiences in implementing aquaculture development activities, examining new concepts and systems for promoting technology adoption and rural development projects. Indonesia, which has recently launched its intensified fisheries development program aims to raise per capita fish consumption from the present 22 to 30 kg per year, generate more rural jobs and increase exports. Aquaculture is expected to contribute to more than 30 percent of the targets. The following technical information were kindly provided by Pak Maskur:

Above: The Jambi Province Governor and other provincial and district officials and Dr Fatuchri giving awards to five outstanding farmers in the village. Below: Agus Budhiman, Head of Planning and Policy at the Directorate of Aquaculture, Jakarta and Hernowo of the Centre talk with one of the hatchery technicians.

Tilapia Culture:

- Stocking density of tilapia fingerling per caramba: 1,000 fish
- Size of caramba, average: 4 x 2 x 1.5m^3
- The culture cycle: 4-5 months/crop
- Capital and operational cost per crop: 2,600,000 rupiah (Construction of caramba: 1,000,000 and opertional cost: 1,600,000 rupiah)
- The production per caramba per crop: 350-400 kg
- The price of tilapia per kg: 8,000–9,000 rupiah.

Patin (*P. jambal*) Culture:

- Stocking density of patin in caramba Batanghari river is 1000 fingerling per caramba
- Sizes of caramba vary, but average size is 2 x 3 x 1.5 m3 or 2 x 4 x 1.5 m^3
- Culture period is 5-6 months
- Capital and operation cost per cycle: 3,000,000 rupiah. (Construction of caramba: 1,000,000 and operational cost: 2,000,000 rupiah. (1 US $: 8,500 rupiah)
- The production per caramba per crop: 500 kg
- The price of patin per kg: 6,000-7,000 rupiah on-farm.

Captive breeding of vulnerable Indian carp *Cirrhinus reba* with Ovaprim for conservation of wild populations

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Captive breeding programs have become one of the principal tools used in attempts to compensate for declining fish populations and simultaneously to supplement and enhance yields for fisheries[1]. Among minor carps, *Cirrhinus reba* is one of the more popular food fish and is widely distributed in India, Bangladesh, Pakistan, Nepal, Burma and Thailand[2,3,4]. In India, it is common in the Gangetic belt of the northern region of the country and also in the Cauvery River of the south. With its initial quick growth and local market acceptance it can be used in pond culture along with Indian major carps. The fish has an attractive appearance due to hexagonal scales over its body surface. Its maximum size is reported to be around 30 cm in length and 500 g. The flesh does not contain many bones and has a good flavor.

C. reba is a bottom feeding omnivore although the young feed voraciously on zooplankton and grow very quickly, even faster than the young of catla and mrigal. *C. reba* does not spawn in ponds even though they attain full maturity there. Currently, *C. reba* is considered as 'vulnerable in natural waters' due to a decline in its abundance, extent of occurrence, area of occupancy and habitat[5].

Though culture, breeding and larval rearing technology of the major carps has been available for decades other minor carps of commercial importance have been largely ignored. In the long term it will be necessary to utilize India's vast water resources in a more productive way through the development of alternative culture systems with non-conventional fish species. Recently, *C. reba* has drawn attention as one of the potential new candidate species for aquaculture and captive breeding[6,7]. There are many watersheds where major carp culture is not congenial or technically viable but these can be effectively utilized for culture of minor carp. Moreover, consumer choice and acceptance relative to the major carps has to be taken into account for needs-based culture of this species. A review of the literature shows that very few attempts have been made so far on captive breeding and stocking of this fish in freshwater aquaculture systems. However, we have successfully carried out induced breeding trials and are maintaining a good captive-bred population.

Segregation of broodfish.

Literature review

C. reba is an annual breeder with a single spawning period restricted to south-west monsoons extending from May to July in Assam and Bangladesh, and June to August with a peak in June in West Bengal. The spawning season of *C. reba* and some common carps of south India commences by the end of

October, with maximum spawning taking place in the first half of the season[8]. *C. reba* breeds in the river Cauvery near Bhavani under summer conditions also in the absence of the flood[9] from June to September irrespective of the nature of water, weather it maybe turbid flood water or clean non-flooded water, in the afternoon and during the night[10]. The spawning grounds may be any shallow section of the river bed or shallow inundated stretches adjoining the river, and breeding may occur in the wet-bundh under the influence of the run-off water rushed into the tank from adjoining areas. As in the case of major carps certain hydrological conditions resulting from the riverine flood are the main factors responsible for spawning of *C. reba* in the river. The shallow waters affording the optimum range of temperature (approx. 28-30 C) may be a factor that induces the fish to spawn[10].

The potential value of its culture in ponds by co-stocking with Indian major carps was first pointed by Job[11]. As a capture fishery, *C. reba* contributes a sizeable production from the river Ganga and previously also from the river Narmada[12].

Study area and techniques used

Brood fish of *C. reba* (n = 77) were collected from river Punarbhava and river Bhagirathi during November-December and were reared in the farm of a progressive fish farmer at village Beldanga in the Dist Maldha, West Bengal. The length of the fish ranged from 205-255.0 mm and weight of the fish ranged from 205-275 g. The brood fish were stocked in a pond and fed with rice bran and mustard oil cake (1:1) at the rate of 3% of total body weight of fish per day. The fish attained sexual maturity in the month of April-May. In nature *C. reba* mature at the end of their first year, when they attain 22.5-25.0 cm in length. Males mature earlier and at a smaller size than females. Mature males and females are easily distinguished with males identified by their reddish genital opening and oozing of milt when a slight pressure is applied on the abdomen. Females are identified through a bulging abdomen, soft distended belly and swollen pinkish vent. For the breeding experiment male and female fish were taken in the ratio of 2:l and were kept into separate nylon hapa for conditioning. Ovaprim was administered in the evening at the rate of 0.5 ml/kg body weight for females and 0.4 ml/kg body weight for males. After injection both males and females were kept in spawning hapa. Eggs were collected in the early morning and the spent fishes were dipped into potassium permanganate solution ($KMnO_4$) and then released back into stocking pond. The physicochemical parameters of water in the breeding pool were analyzed as per standard methods followed by as per APHA[13].

Outcome

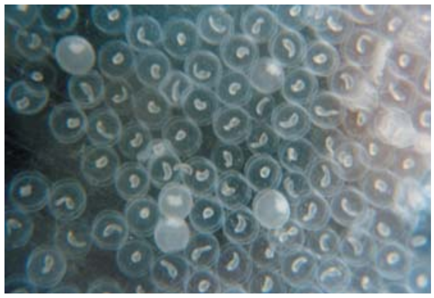
Spawning commenced 4 -5 hrs after injection and was completed within 6-7 hours. A total of 35 liters of eggs were collected from 50 individuals. The fertilization rate was on the high side and ranged from 90- 95%. The average fecundity was 420,000. The average diameter of eggs was 2.24 mm and average weight was 0.0042 mg. The eggs were shifted into hatching hapa and some fertilized eggs were kept in plastic tubs under laboratory conditions to measure the timing of hatching. Hatching started 10-12 hours after injection. Hatchlings measured about 3.2 mm in length and absorbed their yolk sac within 12 hours. At four days hatchlings were around 4.9 mm in length and 0.012 g. At this stage the spawn were ready to release into a well-prepared nursery pond (0.01 ha) for further rearing. The survival of the hatchlings up to the 4th day was more than 90 % in both hatching conditions. However after 15 days of larval rearing the survival rate was reduced to 55%.

Induced breeding trials of *C. reba* using carp pituitary extract have been

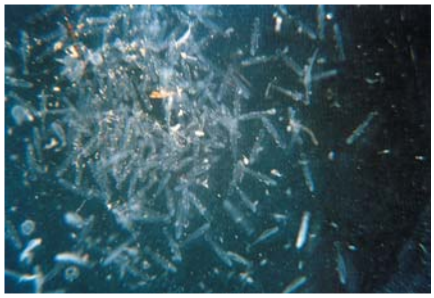
Above: Male C. reba. Below: Female.

Above: Administering Ovaprim hormone. Below: Collection of fertilized eggs from hapa.

Measuring eggs of C. reba.



Egg development 5-6 hours after fertilization.



Newly hatched larvae of C. reba.

attempted previously[14] in the wastewater aquaculture system of a hatchery. The best results obtained in that study were with primary and secondary injections of 2 and 5 mg/kg in the females and 2mg/kg in the males. However, no studies have been previously attempted using synthetic hormone.

The high rate of spawning, fertilization and hatching we achieved suggests that the dosage of ovaprim we used is suitable for use by fish farmers. As *C. reba* is one of the potential food fish among the other minor carps, it is essential to conserve natural stocks and improve the fishery. Based on our present success the species can be bred in captivity and a ranching program could be undertaken in selected natural waters for species restoration in collaboration with state departments. The introduction of this fish in freshwater aquaculture ponds with major carps could be a successful step towards its commercialization. Long-term conservation, however, will only be successful if the causes of its decline in wild populations are identified and remedied.

Acknowledgments

We express our sincere thanks to Dr. D. Kapoor, Director, NBFGR. We are also grateful to Project Implementation Unit, National Agricultural Technology Project, New Delhi for financial assistance.

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Conservation of the Asiatic catfish, *Clarias batrachus* through artificial propagation and larval rearing technique in India

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The Asian catfish, *Clarias batrachus* popularly known as *magur* is highly popular in India as an expensive table fish. It is distributed in Eastern and North Eastern India particularly in West Bengal, Orissa, Bihar, Assam and Meghalaya and other Asian countries such as Thailand, Philippines, Cambodia, Myanmar and China. The availability of wild-caught magur seed is insufficient to meet demand due to a combination of over-exploitation, aquatic pollution, spread of disease, uncontrolled introduction of exotic fishes and habitat modification. To conserve this species and to sustain large-scale culture as an economic proposition, it is becoming increasingly necessary to take up breeding and larval rearing of magur under controlled conditions.

We conducted a study of the breeding and larval rearing of *C. batrachus* in both on-station and on-farm situations, mainly at Canning, Nimpith and Kalyani of West Bengal. This article documents our successful experiences and I hope that it will assist farmers to take up culture of this species and to profit from it.

Identification of mature brood fish

Mature male and female fish can be identified by observing their genital papillae. A fully mature female looks a bit heavier as its abdomen is distended with eggs. A male on the other hand looks slender and more streamlined. In the females the genital papillae is short, oval and slit-like and protrudes or draws with even the slightest pressure on the abdomen. In males, the papilla is conical and elongated with a pointed reddish tip and it never draws in.

Selection of Brooders

Farm raised brooders as well as monsoonal migrating stocks are used for breeding. In selecting brooders, care should be taken to assure that they are healthy and free from obvious signs of disease, with barbels intact and at least one year in age and more than 150g.

Triggering dose of inducing agent to brooders

Two types of inducing agent, carp pituitary gland extract (CPE) and Ovaprim were used. The ideal dose of CPE is 20mg / kg body weight for males and 35mg / kg body weight for females. The ideal dose of Ovaprim is 0.75ml and 2ml / kg body weight for males and females respectively. The fishes were injected near the base of the pectoral fin. After injection, they were kept in a cement cistern with aeration. The females were kept under observation to detect the most appropriate time for stripping. This can be determined by holding the female in vertical position and applying slight pressure to the belly. The free flowing condition of the female is reached when eggs come out spontaneously as soon as the fish is tilted backwards from its vertical position. Usually female fish attain the free flowing condition of eggs around 17 hours after injection.

Milt collection

When the optimum time for stripping was reached, both male and female fish were anesthetized by applying a mixture of 1:4 clove oil and absolute alcohol @ 5 ml / 50 l of water for easy handling of the brooders. Deep

Triggering dose.

Milt collection requires removal of testes.

Fertilised eggs.

anesthesia takes 25-30 minutes to achieve. The abdomen of the anesthetized male was cut open and the two testicular lobes taken out and quickly cleaned with cotton. Thereafter the testes were cut into small pieces with the help of a fine scissor and collected on a piece of fine meshed net dipped in a small glass bowl filled with 0.9% saline solution. The pieces of testis are then squashed within the piece of net and the sieved milt is collected in the bowl containing the saline solution.

Stripping and Fertilization

The anaesthetized female fish were held and pressure applied on their belly. The orange to greenish eggs come out from the vent as a spray and were collected in a clear sterilized enamel bowl. While stripping was being done, the milt suspension (in 0.9% saline solution) was collected with the help of a dropper and spread uniformly over the stripped eggs. At the same time, the egg and milt suspension is mixed with the help of a fine soft brush for fertilization. When stripping and subsequent addition of milt suspension was completed, the bowl was vigorously shaken for a few seconds to improve fertilization. Thereafter, freshwater was added in the bowl to wash away the residues and washings were poured out. Milt collection to fertilization should be completed within 2.5 minutes. Generally, fertilization rates of 80 % and 70% were obtained with CPE and Ovaprim respectively if all the conditions remain favourable. The fertilized eggs are transparent while the unfertilized ones become opaque within four to five hours.

Hatching

Fertilized eggs were successfully hatched in two different ways according to the available resources. In one case, a carp hatchery was used. In this method fertilized eggs were spread first on a soft mosquito net frame, which was submerged under flowing water. In the second method, fertilized eggs were cleaned through repeated washing and water hardened fertilized eggs then put into a flow through system of glass jars or plastic tubs for further development, incubation and hatching. Generally the eggs hatch within 20-24 hours depending upon the water temperature. The optimum pH and water temperature for successful hatching was found to be between 7-8 and 27-31 C respectively. The optimum hatching percentage can be 75% if the above management is done meticulously.

Larval rearing

Larval rearing of *C. batrachus* can be divided into three phases.

Phase I: The plastic trays used for the rearing of hatchling were rectangular in shape (0.4m x 0.25m x 0.08m). The hatchlings were usually stocked in the rearing tanks @1000 individuals/liter maintaining a constant flow of water and depth of 6cm. Yolk sac absorption is usually completed within four days. No food was applied until the hatchling reaches the spawn stage (yolk sac absorption) as mouth and other internal organs are fully developed only when the spawn stage is achieved. Decomposed eggs, eggshells and other dirt were siphoned out thrice daily.

Phase II: Larger rectangular plastic trays were used (1m x 0.5m x 0.25m) with continuous water flow and slightly greater depth of 8cm maintained in the rearing tray. Stone chips (0.5cm) were provided in the corners and middle of the tray as hides to reduce cannibalism. The spawn were usually stocked @100 individuals per liter of water. Finely sieved (40-50 um filtered) live zooplankton @ 0.4ml /100 individuals was given daily at 0600, 1200 and 1800. At the time of feeding the water inlet and outlet were stopped for about two hours to facilitate feeding. Excreta and decaying particles were siphoned out three times daily. After eight days of rearing, the fish had reached fry stage (16mm in length and 30mg in weight).

Phase III: A cemented cistern (2m x 1.5m x 0.5m) was used for the rearing of fry. Continuous water flow with a water depth of 15cm was maintained. Stone chips (0.8cm) were provided in the corners and middle as hides to reduce cannibalism, along with some water hyacinth. The fry were usually stocked @25 individuals/liter of water. Finely minced tubificid worms were fed @ 2% of the total biomass at 0600 and 1800 hrs and home made prepared feed at 1200 and 2400 hrs. The artificial feed was prepared with a mixture of molluscan meat (70%), egg (20%), soybean cake (10%) and vitamin B premix (500mg / kg feed). These ingredients were boiled and prepared as a paste like mixture and then vitamin B was mixed in. This prepared feed was then applied in the form of dough balls.

Acknowledgement

The author is greatly indebted to the authorities of Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith; Director of Fisheries, Government of West Bengal and Director, ICAR Research Complex for NEH Region for providing necessary facilities.

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Topical issues in genetic diversity and breeding

Genes and Fish

A perspective on breeding and genetics of walking catfish in Thailand

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What is walking catfish?

Walking catfish, or "pla dook" in Thai is a common name for a group of *Clarias* species that are distributed throughout south, eastern and southeastern Asia and Africa. There are at least five *Clarias* species that inhabit rice paddies and marshes across Thailand[1], amongst which *C. macrocephalus* and *C. batrachus* are the most common. Walking catfish are the main ingredient for Thai dishes such as *pla dook foo* (crispy deep fried - grilled walking catfish meat), *phaadpet pla dook* (stir fried walking catfish in chilli sauce) or grilled walking catfish that is always accompanied by the famous papaya salad *somtam*.

History of catfish culture in Thailand

Aquaculture of *Clarias* in Thailand has been expanding and current annual production is approximately 82,000 mt worth US$52 million by value[2], comprised mainly of hybrid catfish (*Clarias macrocephalus* x the introduced African sharp-tooth walking catfish, *Clarias gariepinus*). In the past, the supply of walking catfish came solely from the wild catch. Since 1960 Thai farmers have developed breeding and culture technologies for *C. batrachus*[3] despite its relatively lower preference to Thai consumers compared to *C. macrocephalus*. Farmers produced *C. batrachus* because it was hardy and grew faster resulting in higher yield per unit area in a shorter culture period than *C. macrocephalus* (19-60 t/ha within 4 months for *C. batrachus* vs 6-19 t/ha in 6-8 months for *C. macrocephalus*)[4].

The breeding techniques for *C. batrachus* were developed using local knowledge of farmers. The breeding method described here was reported by Sitasit[5]. However, it has not been widely practiced since 1987 due to the replacement of *Clarias batrachus* in the culture system by the hybrid.

The breeding farms producing *C. batrachus* are confined mainly to the Samutprakarn area where rice paddies (1-2 ha) were modified by digging ditches 2-3 metres deep and 3 metres wide around the inner sides of the rice paddy. Small and shallow ditches were dug along the field to create rectangular platforms approximately 3 metres wide. Holes of 20-30 cm in diameter and 20 cm deep were dug at 1 m interval throughout the platforms. Then grass was allowed to grow naturally. Around mid February brooders of mixed sexes were stocked into the large ditch while the rest of the pond was exposed. After 2-3 weeks or whenever water was available, ponds were flooded. The flooding of the previously exposed soil coupled with holes and available grass roots stimulated spawning. Each pair of male and female fish occupied a hole and spawned shortly after flooding. The whole system was left untouched for a

Clarias macrocephalus and C. batrachus. The distinct difference is shape of skull (arrows): the occipital process of Clarias macrocephalus is round while that of C. batrachus is pointed.

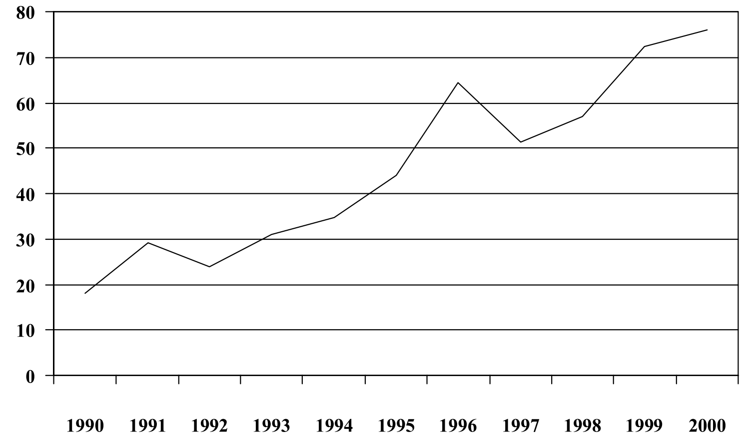
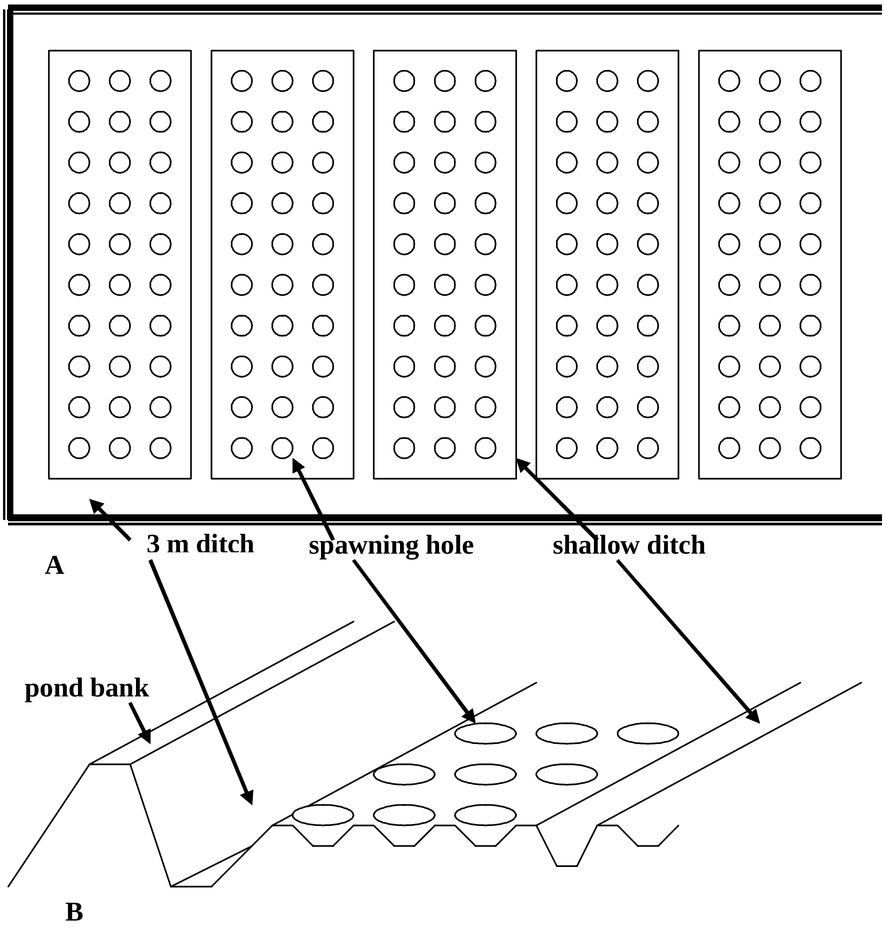


Fig.1 Annual production of catfish from aquaculture in Thailand from 1990-2000 (unit: 1,000 mt).



A diagram showing a typical Clarias batrachus breeding pond: a) top view, b) cross section

period of 9-12 days until fry were seen. If sufficient amount of fry was observed the water level was lowered until the breeding holes became partially exposed and fry were collected by scoop-net. Each breeding cycle produced approximately 125,000-2,200,000 fry/ha.

During that period aquaculture production of *Clarias* was primarily *C. batrachus*. The culture area was mainly in Suphanburi, a province west of Bangkok that has extensive irrigation systems. *C. batrachus* was stocked in earthen ponds of approximately 0.3-2 ha. The catfish were fed trash fish mixed with rice bran and water was changed occasionally. The culture system was not hygienic due to extremely poor water quality. However, the fish are able to tolerate extreme conditions of low oxygen due to accessory air breathing organs in the gill cavity. Although extremely high yield per unit area was achieved, culture of *C. batrachus* was rather risky due to frequent disease outbreaks and its low price during the outbreak.

Successful commercial artificial breeding of *C. macrocephalus* was achieved around 1985, some 25 years after the technology was developed in a laboratory[6]. Despite the successful production of fry and the high price of the species, culture of *C. macrocephalus* was limited by several factors including slow growth, disease outbreaks, and a remarkably low yield compared to *C. batrachus*[4].

Genetic approaches to improve quantity and quality of production

Attempts to improve performance of *C. macrocephalus* with the application of genetic principles had generally failed. Selection programs were established based on individual's phenotypes ("mass selection"). Although efficiency of this method is usually low, it requires less facilities and resources compared to other techniques such as "family selection" in which many families of fish have to be separately maintained. Mass selection to improve growth rate of *C. macrocephalus* gave positive results with improvements of 11.8% by weight and 2.3% by length achieved after three generations[7]. However the program was not pursued further. Mass selection for disease resistance (i.e. to *Aeromonas hydrophila*) was carried out at the Department of Aquaculture, Faculty of Fisheries, Kasetsart University and resulted in improved survival rate after disease challenges[8]. The program was terminated after only two generations due to mass mortality of the selected fish caused by other pathogens. It is likely that response from mass selection declined in successive generations due to a reduction of variance of traits, or overwhelmed by negative correlated response and/or inbreeding[9].

Chromosome manipulation techniques were also employed to improve growth rate by inducing triploid sterility. Surprisingly, the growth rate of triploid *C. macrocephalus* did not improve over that of the diploid counterpart despite its sterility[10]. Induction of gynogenesis produced all female C. macrocephalus[11, 12] which was preferable due to presence of eggs at harvest. However, the technique was not commercially feasible due to the low hatching rate of the gynogenetic fry.

A turning point in catfish farming in Thailand, from a production view point, was reached when the sharp-tooth African catfish *Clarias gariepinus* was introduced in 1987. It was not well accepted by consumers because of its unfamiliar features and poor flesh texture. Subsequently, it was hybridized with the native *C. macrocephalus* to improve growth and disease resistance of the latter. The hybrid with maternal genome from the native catfish showed improved growth rate over *C. macrocephalus* although no significant heterosis was observed[13]. Anecdotal information also supported improved disease resistance over *C. macrocephalus* while the overall appearances and flesh texture were improved through inheritance from the maternal species i.e. the *C. macrocephalus*.

Impacts of the hybrid on natural populations

As the culture of the *Clarias* hybrid expanded, the abundance of the native species declined. Although the destruction and rapid alteration of habitats could have been one of the major causes for such a decline, possible adverse impacts from the escaped hybrids cannot be ignored. Recently, *C. batrachus* was listed as a threatened species of Thailand[14]. The allozyme surveys of natural populations of *C. batrachus* across Thailand have revealed a high level of genetic differentiation between populations while the variation within populations was rather small[15]. The findings indicated contributions of a small number of parents occupying isolated habitats.

Besides the destruction and rapid alteration of habitats, impacts of the hybrid between *C. macrocephalus* and *C. gariepinus* that escaped from farms to natural waters in all probability accelerated and or contributed to a reduction of abundance of native catfishes. The hybrid may have out-competed the native species due to its aggressive feeding behavior. More seriously, introgression of *C. gariepinus* genes into genomes of *C. macrocephalus* has been detected in central Thailand[16] and in other areas[17]. Such introgression can eventually lead to extinction.

Attempts have been made to sterilize the hybrid by induction of triploidy[18]. Unfortunately the triploid hybrid was not completely sterile and growth performance did not improve. Until now no measures have been undertaken to avoid further adverse impact of the hybrids on biodiversity.

Further Studies

It would be extremely difficult to suddenly stop farmers from culturing the hybrid catfish in Thailand. Aquaculture of the hybrid can be discouraged only if high performance strains of pure *C. macrocephalus* were available. Thus a genetic improvement program is currently underway at the Department of Aquaculture, Faculty of Fisheries, Kasetsart University, aiming to improve the growth and disease resistance of *C. macrocephalus* through within- family-selection with the aid of microsatellite genetic markers developed by Na-Nakorn et al[19].

While culture of exotic species is rapidly expanding, culture of native species such as walking catfish would provide an alternative way to reduce adverse environmental impacts caused by alien species. Therefore, each country should extend more effort on developing culture systems for native species with sufficient concern on genetic management of cultured stocks. In addition to increasing the income from aquaculture, the use of native species could contribute to the conservation of native species.

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Peter Edwards writes on

Rural Aquaculture

Decline of wastewater-fed aquaculture in Hanoi

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Encroachment of Hanoi on wastewater-fed aquatic vegetable fields.

Encroachment of housing developments on wastewater-fed fish ponds.

Previous columns dealt with peri-urban aquaculture in Kolkata, South Asia (April – June 2003, Vol. VIII, No. 2) and in Southeast Asia (July – September 2003, Vol. VIII, No.3). Recently under the auspices of a DFID funded project on "Capacity-building for effective decentralized wastewater management" implemented by a UK consultancy company (GHK International) with partner organizations in Hanoi, Vietnam and Dhaka and Khulna, Bangladesh, I witnessed recent developments in wastewater-fed aquaculture. In this column, I'll present my impressions from Hanoi on fish culture and cultivation of aquatic plants; in the next issue of the magazine I'll discuss wastewater-fed duckweed in Khulna.

Wastewater in Hanoi is still discharged without treatment, although plans to install conventional wastewater treatment plants are to be implemented, into a network of rivers that flows to the south of the city through Thanh Tri district, and eventually into the Red river. Farmers through experience accumulated over the past four decades have developed wastewater-fed aquaculture involving either a polyculture of finfish (mainly the Indian major carp rohu, the Chinese silver carp and tilapia) with or without rotation with rice, or aquatic vegetables (mainly water mimosa and water spinach). A large number of individuals, especially people of lower socio-economic status, are involved in production and marketing of wastewater-fed produce, either part or full-time. Produce is also consumed by a large number of people, especially the poor.

In terms of gender, while men are especially involved in fish culture and in transportation and wholesale marketing of fish, women predominate in the farming and transportation of aquatic vegetables on bicycles and motorcycles. Women also dominate retail and purchase of produce in markets.

I first visited wastewater-fed aquaculture in Thanh Tri district in 1991 with Drs Le Thanh Luu and Do

Construction material yard built on a former fishpond.

Lady farmer explaining how to cultivate water mimosa on wastewater.

Van Hiep. Although I have visited on occasion since, I was shocked by the recent rate of change with the rural landscape of fields and ponds rapidly being converted into one of brick and concrete. Under the first phase of the Hanoi Master Plan for sewerage, drainage and environmental improvement, wide drainage canals, storage reservoirs and a pumping station have been installed in areas recently occupied by wastewater-fed fish ponds. Buildings are sprouting like mushrooms all over the district, right up to the water's edge of fish ponds. Large blocks of buildings co-exist with the remaining fields. Women aquatic vegetable farmers interviewed, without exception, fear that urbanization will soon encroach onto their fields with the loss of their livelihood.

The old Thanh Tri district has recently been divided into two. The northern half in which most wastewater reuse takes place was renamed as a new district, Hoang Mai and declared an urban area in November 2003. The Chairman of the People's Committee of Yen So Commune, one of the major wastewater-fed aquaculture areas, confirmed that the fish pond area had declined over the last 10 years due to use of land for construction. "The city is moving here" he exclaimed!

Lady farmer transporting water spinach from wastewater-fed fields.

Women selling water spinach and water mimosa raised on wastewater on a Hanoi market.

While the map for 2001 in the Hanoi city Master Plan indicates large areas of fish ponds, as observed during my recent visit, none were indicated for Hoang Mai district for 2020. Most of the government support for aquaculture is to be for high-value aquaculture species such as red tilapia, river catfish and giant freshwater prawn. The emphasis is to be on new technologies in aquaculture with incremental development in line with industrialization and modernization. The trend is to be conversion of wastewater-fed fish culture into organic fish culture with intensive culture. The fish species component is to change to high quality seed and some special aquaculture species.

The area devoted to growing wastewater-fed terrestrial vegetables has declined even more than that of ponds and aquatic plant fields in Hoang Mai. This is because the higher and drier land formerly used to cultivate terrestrial vegetables was more likely to be built on first than lower waterlogged land used for aquatic vegetables and fish culture. Furthermore, Hanoi has a program to promote "safe vegetables" in three other districts of the city. Although it is recognized that use of nightsoil, septic tank sludge and wastewater as fertilizers on vegetables is still widespread, it is not recommended. Guidelines for safe vegetables specify better management of pesticides and no nightsoil or wastewater, although use of composted livestock manure is allowed.

Although rapid change of land use to urban development with an associated marked increase in land value is the main factor in the on-going demise of wastewater-fed aquaculture and agriculture in Hoang Mai district, there are other factors involved. The increasing content of industrial effluents in the total wastewater stream has a significant adverse effect on both fish growth and survival. Farmers reported that fish ponds could only safely accommodate 10-30% wastewater by volume, much lower than previously, due to suspected toxic chemicals. The Chairman of the People's Committee of Yen So commune told me that farmers recently lost 2 tonnes of fish in the pond adjacent to his office because of mass mortality due to poisonous wastewater. Farmers now have to supplement low volumes of wastewater with other fertilizers such as livestock manure, although little is available, and readily available beer and wine residues as feed. As the price of pelleted feed is high, farmers lose money if they use them to raise relatively low-value wastewater-fed fish.

Furthermore, the quality of fish raised on wastewater is said to be poor, with a bad smell and taste because of industrial chemical effluents in the previously mainly domestic wastewater. As most fish raised in wastewater-fed ponds are also small, they are difficult to sell in the increasingly sophisticated Hanoi markets. Wastewater-fed fish supplied as much as 40% of Hanoi's daily requirement for freshwater fish in the past but now they are mainly marketed in remote rural areas, mainly for poor people, in central and north Vietnam. In contrast, most wastewater-fed aquatic vegetables are marketed in Hanoi. Although consumers are concerned about quality as well as price of aquatic vegetables, most are unaware of their origin.

Wastewater-fed aquaculture appears to be a transient phenomenon of pre-industrial and early industrial societies in which reuse of wastewater is socially acceptable because of high population pressure and scarce resources. Once the economy starts to expand rapidly, a series of factors constrains wastewater fed aquaculture: Increasing shortage and value of peri-urban land; declining quality of wastewater as a nutrient source due to increasing contamination with industrial effluents and associated declining quality of produce; increasing demands of more affluent consumers for large and often carnivorous species even though these are higher priced than wastewater-fed fish; and ability of farmers to meet the demand for alternative farmed species because of availability of seed through R & D and pelleted feed from agro-industry. However, Vietnam has many cities that are at an earlier phase of development and in some of which wastewater reuse occurs and still has relevance.

Artificial propagation of the indigenous Tor species, empurau (*T. tambroides*) and semah (*T. douronensis*), Sarawak, East Malaysia

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There is an increasing realisation, a need and a trend to explore possibilities of culturing indigenous species. This becomes a reality only if species with a culture potential can be artificially propagated. This article summarises the success story of artificial propagation of two very important mahseer species, of high value and with high culture potential, carried out in Sarawak, East Malaysia. Furthermore, this is a good example of an international collaboration of research & development, in which NACA also played a role.

Introduction

Tor species, commonly known as mahseers, are widely distributed in Asia, in the Himalayan and South-east Asian regions, in the trans-Himalayan region (of Pakistan, Nepal, India and Myanmar) and in South-east Asia (including Thailand, Lao PDR, Cambodia, Vietnam, southern China, Peninsular Malaysia, Borneo, Sumatra and Java). The habitats of *Tor* species range from mountainous streams and rivers to fast flowing rivers in the plains, often preferring clear, swift-flowing waters with stony, pebbly or rocky bottoms (Shreshtha 1997). Currently about 16 species of *Tor* have been described, but the taxonomy of some remains uncertain and controversial. Some of the *Tor* species are considered to be excellent sport fish and Ogale (2002) described *T. khudree*, "as a sport fish, that provides unparalleled recreation to anglers from all over the world, better than salmon". Mahseers are often mooted as potential candidates for aquaculture, especially in the wake of the recent push toward the culture of indigenous species; mahseers are highly prized in most of Asia, and are sought after as food fish.

One possible factor hindering the culture of *Tor* species is the dependence of wild caught mature fish for artificial propagation, which lays a further stress on ever dwindling natural populations due to habitat degradation arising from forestry and associated developments. Breeding techniques are being developed for several *Tor* species in a number of countries. Most hatchery production of *Tor* juveniles,

94 hours post fertilisation, 1 post-hatch (total length = 9.82 mm).

5 days post-hatch (total length = 12.24 mm).

Pond-reared empurau at 60 weeks old (total length=250 mm, weight = 180 g).

Above & below: Empurau brood fish can be up to 20 kg.

Stripping and dry fertilizing.

including *T. khudree*, *T. mussullah*, *T. putitora* and *T. tor* for stocking programs, are derived from hand-stripping mature spawners caught from reservoirs, lakes and rivers during spawning seasons with or without use of hypophysation (Kulkarni 1971; Tripathi 1977; Sehgal 1999; Ogale 2002). More recently, research with these species has focused on inducing spawning in captive, pond-held broodstock. Joshi et al. (2002) and Gurung et al. (2002), successfully hand-stripped domesticated *T. putitora* broodfish without use of hormones while Nandeesha et al. (1993) induced spawning in pond-reared *T. khudree*. Joshi et al. (2002) also reported natural spawning in a pond-held T putitora.

Empurau, *T. tambroides* also known as kelah or belian, and semah, *T. douronensis* are indigenous to Sarawak, East Malaysia, and are the most valued freshwater fish species of the State. These two species are distributed throughout southeast Asia from Indonesia to southern China (Kottelat et al. 1993; Zhou and Cui 1996; Roberts 1999). Empurau and semah have significant cultural and economic importance in Sarawak, being highly prized and valued by indigenous communities. However, both species are now threatened in the wild due to environmental degradation and over-fishing. Consequently the Government of Sarawak embarked on a research and development program on the artificial propagation of the two species, when it established a special facility in this regard, the Indigenous Fisheries Research & Production Centre (IFRPC), in Tarat, Serian. Many attempts were made to artificially propagate these two species at this facility, using pond-reared broodstock, but with little success. The pond reared broodstock was originally caught from the wild as fingerlings and some of the broodstock were over eight years old, and weighed more than 20 kg.

In the above context the Division of Inland Fisheries, Department of Agriculture, Sarawak, in conjunction with the School of Ecology & Environment, Deakin University, Victoria, Australia, commenced a R & D project on the artificial propagation / captive breeding of these two species, under the leadership of Professor Sena S. De Silva. The project commenced in July 2001 and this paper entails the approach undertaken and the successes of the project.

Empurau and semah were caught from both the Limbang (4°4.6'N; 115°17.7'E to 3°52.6'N; 115°21.7' E) and Adang (4°4.54'N; 115°18.92' E to 4°6.27' N; 115°21.5' E) rivers, and transferred to the IFRPC. The bulk of the fish were collected over the period 1990 to 1993 and ranging in weight from about 200 g to 2.5 kg. These stocks, considered to be the broodstock were grown and maintained in either concrete or plastic-lined ponds (0.014-0.145 ha, 1.6-1.86 m deep), or circular tanks (1.9-3.0 m diameter, 0.9-1.1 m deep) with a

Table 1: Dimensions of semah and empurau broodfish, eggs and larvae

Parameter	Semah		Empurau	
	Mean	Range	Mean	Range
Mature females (induced to ovulate)				
Total length (mm)	519	440-635	678	610-749
Fork Length (mm)	456	385-565	575	500-660
Weight (g)	1499	600-3,300	3817	2,500-4,900
Mature males (running ripe)				
Total length (mm)	402	265-520	599	545-660
Fork Length (mm)	345	210-457	515	465-580
Weight (g)	851	300-2,300	2414	850-3,900
Eggs				
Diameter of stripped eggs (mm)	2.48	2.00-2.90	2.69	2.20-3.08
Weight of stripped eggs (mg)	11.1	6.8-16.1	13.3	9.5-18.8
Diameter of water-hardened eggs (mm)	2.92	2.52-3.28	3.21	2.88-4.44
Larvae				
Total length (mm)	8.79	7.29-9.38	9.08	7.40-10.21
Notochord length (mm)	8.78	8.54-9.07	9.37	8.96-9.69
Yolk -sac length (mm)	5.06	4.56-5.33	5.79	5.42-6.15
Yolk-sac breath	2.90	2.46-3.23	2.95	2.40-3.23
Yolk-sac depth	1.76	1.38-2.03	1.92	1.67-2.19
Yolk-sac depth	0.84	0.75-0.90	1.09	0.94-1.25

constant flow water and supplementary aeration. Ponds and tanks were stocked with fish of both sexes. Stocking densities ranged from 0.25 to 0.5 fish m^{-2}, depending on size and condition of the facilities.

The approach

The first step under the collaborative project was to get an insight into all forms of information that were available with the IFRPC. As always, there was a large amount of data that had been collected over the years, most from landings. The archival data was sieved through and analysed, particularly in relation to gonadal maturity. The gonadal maturation data, and estimations of gonadosomatic index (GSI), indicated, as expected of most riverine species, that the main spawning season of the two species was related to the rainy season, perhaps with two peaks in the year. The data also enabled a deduction of the mean maturation size of the two species, and it was also evident that mature, running ripe males were present in the riverine populations to some extent almost throughout the year. Egg diameter distributions of preserved ovaries indicated that semah and empurau, in all probability, are serial spawners capable of spawning several times in a season, provided that key environmental stimuli (i.e. monsoonal rains, etc.) are present. However, it is uncertain which is/are the real cues, except to suggest that rains/flow rate in the river had a major influence.

Previous artificial induction attempts using hypophysation techniques, which are routinely effective for most cultured finfish species, have not been successful. The primary reason for this appears to be that the ova did not mature beyond stage IV and hence the ineffectiveness of hypophysing. It was considered that the inability to reach maturation could be related to nutritional factors and so the diets on which the potential broodstock were maintained were analysed. This revealed that the fish were maintained on sub-optimal diets and that none of the diets given to the broodstock had sufficient amounts of highly unsaturated fatty acids, in particular, eicosapentaenoic acid (EPA: 20:5n-3), docosahexaenoic acid (DHA: 22:6n-3) and arachidonic acid (AA: 20:4n-6). Consequently, from January 2002, the fish were placed on a diet formulated for Murray cod, *Maccullochella peelii peelii* from Australia (De Silva et al. 2004), which was thought to fulfil the nutrient requirements of the two *Tor* species, of which little is known, and to have had a fatty acid profile suitable for maturation of most fish species. The broodstock condition improved and in April 2002 a few individuals when cannulated were found to have ova in Stage IV and V maturity stages.

The next step was to determine which was the most effective hormone to be used. In this regard different dosages of the hormones, and different methods of introduction were assessed through a series of controlled trials on both empurau and semah. In the trials mature females (induced to spawn) from 600 g and from 2,500 g and running ripe males, from 300 g and 850 g for semah and empurau respectively were used. All broodfish were individually pit-tagged (passive implant transponder), so as to enable reliable and accurate inventory control.

The various hormone treatments and dosages used were: Carp Pituitary Gland (CPG) (4 mg/kg followed by 8 mg/kg 17-27 hours later) human chorionic gonadotropin (HCG) (Pregnyl , Organon Laboratories Ltd) (300 iu/kg); and Ovaprim (Syndel Laboratories Ltd) (0.5 ml/kg) and Ovaplant (Syndel Laboratories Ltd) (75 and 150 mg pellets, 21-71 mg/kg). Combinations of hormones were administered in separate intra-musculature injections below the second dorsal fin. Males were given a single injection of either HCG (250 iu/kg) or Ovaprim (0.2-0.25 ml/kg), or not injected. After injection, females and males were placed together in 2000 litre

Above & left: Make-shift hatchery jars used in the trials

covered concrete tanks that were supplied with a constant flow of water and aerated. In all instances broodfish were handled with anaesthetic (MS 222; 1: 10,000) and in saline baths for prophylactic purposes, to reduce stress and reduce risk of infection.

The latent period was defined as the time between injection and stripping of gametes. To determine if ovulation had occurred, female semah and empurau were anaesthetised and pressure was applied to the abdomen to determine whether eggs could be stripped from the fish. These examinations commenced as early as 17.75 hours, though the bulk were 22-28 hours after the first injection, while latest examination occurred as late as 67 hours. During this period fish were examined up to four times.

Spawning induction

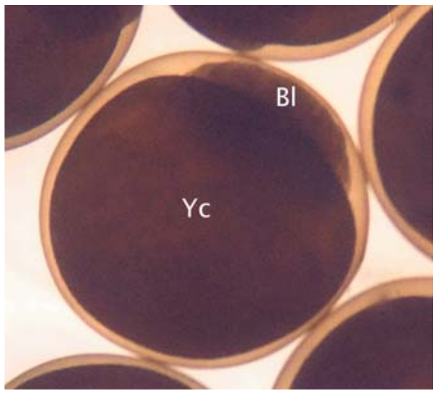
A total of 66 female empurau and 139 female semah were treated with hormones. Both pond-held and tank-held empurau and semah were induced to ovulate. Ovaprim was the most successful treatment for inducing ovulation in both species. Of the 130 females that were injected with Ovaprim, 55% of empurau and 24% of semah ovulated, while 42% and 10% of empurau and semah that were injected with Ovaprim, respectively, produced eggs that hatched (Fig. 1). In contrast, eleven females were injected with CPG, but one semah only ovulated, and ten females were injected with HCG but none ovulated. Of the 54 females that were implanted with Ovaplant, three semah ovulated and were stripped, but no eggs hatched.

Ovaplant pre-treatment

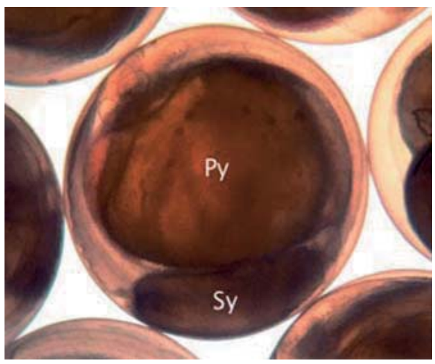
Thirty-six female empurau and 98 female semah were pre-treated with Ovaplant, 14-50 days (mean 31 days) prior to commencing spawning trials. Use of Ovaplant greatly improved the success rate of spawning induction using Ovaprim (Fig. 1). A total of 60% of female empurau received both Ovaplant and Ovaprim treatments ovulated, and 50% of injected fish produced eggs that hatched. In contrast, 38% of female empurau that were treated with Ovaprim only ovulated, while 13% of injected fish produced eggs that hatched. This trend was less clear for semah, 24% of fish ovulated for each treatment, while 9% and 12% produced eggs that hatched.

Ovaplant dose rates ranged from 21 to 71 mg/kg, though fish that received dose rates of 31-60 mg/kg (empurau) and 28-68 mg/kg (semah) ovulated following Ovaprim injection. A higher percentage (31%) of semah that received a high dose of Ovaplant (>45 mg/kg) ovulated following Ovaprim injection, but for empurau there was no clear relationship between dose rate of Ovaplant and spawning induction following Ovaprim injection.

Empurau that were implanted with Ovaplant 25-50 days were more likely to be induced to ovulate following Ovaprim injection (67-69% of fish), and produce eggs that hatched (56%-67% of fish) than did fish implanted 14-24 days prior to Ovaprim injection (ovulation = 38% of fish, produce eggs that hatch = 25% of fish) (Fig. 2). Although 40% of semah that were implanted with Ovaplant 14-24 days prior to Ovaprim injection ovulated following Ovaprim injection, no eggs hatched. A lower proportion of semah that were implanted with Ovaplant 25-50 days were induced to ovulate following Ovaprim injection (20-22% of



3.7 hours post fertilisation (3.13 mm diameter). Bl= Blastodisc; Yc = Yolk cell.



72 hours post fertilisation (3.29 mm diameter). Py = Primary yolk sac; Sy = Secondary yolk sac.

fish), but some fish produced eggs that hatched (9-15% of fish) (Fig. 2).

Eggs were hand-stripped from fish 23-53 hours post-injection (at 26-30 C), but hatch rates were greatest in eggs stripped 23-26 hours post-injection. The number of eggs stripped ranged from 30 to 2,150/kg (mean 875 eggs/kg) and 45-4,460 eggs/kg (mean 960 eggs/kg) for empurau and semah, respectively.

The number of eggs that could be stripped from the one female following initial stripping declined significantly with time. The number of eggs in subsequent strippings was <1% to 56% (mean 24%) of initial stripping.

Eggs and embryonic development

Embryonic development of other *Tor* species have been described previously (Kulkarni 1971; Desai 1972; Kulkarni 1980). Stripped eggs, prior to fertilisation were firm, and pale yellow to dark golden orange in colour. Semah eggs were "pale" in colour whereas "pale", "medium" and "dark" coloured eggs were stripped from empurau. There was no obvious relationship between broodstock diet and egg colour in the present study. Further, there was no apparent relationship between hatch rate of empurau eggs and egg colour.

Semah eggs were slightly smaller than empurau eggs. Prior to fertilisation eggs were 2.0-2.90 mm (mean 2.48 mm) and 2.20-3.08 mm (mean 2.69 mm) for semah and empurau, respectively. Within 15 minutes of fertilisation, eggs swelled in diameter by up to 20%. After this, egg diameter did not change over the remaining incubation period. Water-hardened eggs were spherical, demersal, non-sticky and translucent. The surface of the eggs was crenulated. Development rates were similar for semah and empurau.

Eggs were incubated in tilted plastic jars with flow-through water directed to the bottom of the jar to ensure continuous rolling motion of the eggs; thereby avoiding fungal infection. Hatching occurred 69-90 hours post-fertilisation. At hatch larvae were 7.3-10.2 mm TL and commenced feeding 4-5 days post-hatch. Juveniles were reared in static greenwater ponds. For fish up to 18 weeks of age, SGR's were 1.5-3.4%/day and for older fish (18-52 weeks of age) were 0.1-1.2 %/day (Fig. 3). At 60 weeks of age, empurau reared in one pond (AP11) were 100-270 g in weight (mean 179 g) (Fig 3). These results represent the first successful captive spawning and rearing of both species.

Conclusions

Historical date (from Sungai Adang Station, Sarawak), anecdotal reports and results from the current study support the view that both empurau and semah are asynchronous or intermittent spawners capable of spawning at several times per year, providing that key environmental stimuli are present. In the present study, one female semah was induced to ovulate four months after being stripped. Studies of pond-reared fish have shown that *T. putitora* can breed most months of the year (Gurung et al. 2002), but the frequency at which single females could spawn in a single year is unknown. Subhan and Hafeez (1998) suggested *T. putitora* undertook at least two spawning episodes each season. Shreshtha (1986) found that *T. putitora* ovaries possessed three size classes of eggs, the proportions of which varied throughout the year. Asynchronous spawners possess both primary oocytes and heterogenous populations of vitellogenic oocytes that may undergo final oocyte maturation on several occasions during the annual spawning season (Tyler and Sumpter 1996). Results from the present study support the view that mahseer are asynchronous spawners and that single females could spawn at least twice in a season.

Further research is required to improve and refine spawning and rearing techniques and associated facilities to mass-produce juveniles for stock enhancement purposes. In the present study inducement of spawning in semah was considerably more difficult than for empurau, and the quantity of deformed larvae (>14%) in each spawn was more than desirable. In particular research should focus on broodstock nutrition and refinement of hormone treatments. Joshi et al. (2002) fed an artificial diet to domesticated *T. putitora* that contained 35% protein at 2%/day, and subsequently reported natural spawning in a pond-held fish. It is likely that the ability to induce spawning in captive, domesticated stocks of empurau and semah will improve over time as the nutritional requirements of broodstock are met and spawning and associated husbandry techniques are improved. Also, there is a need to determine optimal rearing protocols for juveniles and yearlings. While the present study showed that empurau and semah can be grown in earthen ponds, there is a need to evaluate stocking densities, dietary requirements and feeding strategies to enhance growth and survival. Only after these aspects have been determined should commercialisation of the culture of these two species be promoted.

The captive breeding study is supplemented with a study on the genetics of the broodstock, using molecular genetic techniques, together with the genetic diversity of other *Tor* species. It is believed that this study will enable to provide useful insights into management practices for sustaining the genetic diversity of broodstock, ensure that genetic diversity of wild stocks are not overly influenced by stock enhancement using captive bred young for future conservation purposes, and that it will also shed light on the taxonomy and phylogeny of *Tor* species. In this regard this will be the first time in the region when the aquaculture development of an indigenous species has taken in to consideration genetic aspects, and therefore biodiversity issues, from inception.

This article is based on extracts from a manuscript submitted to the journal Aquaculture Research by these authors.

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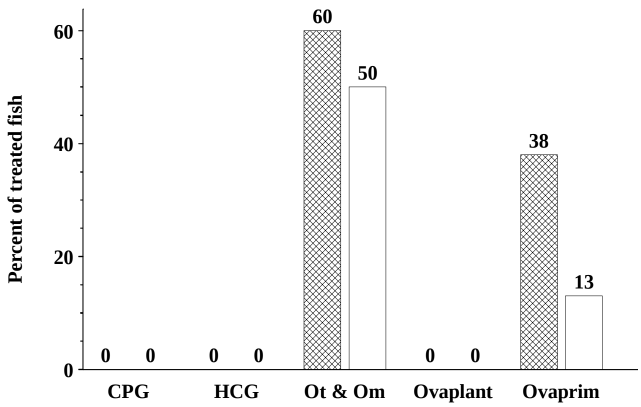
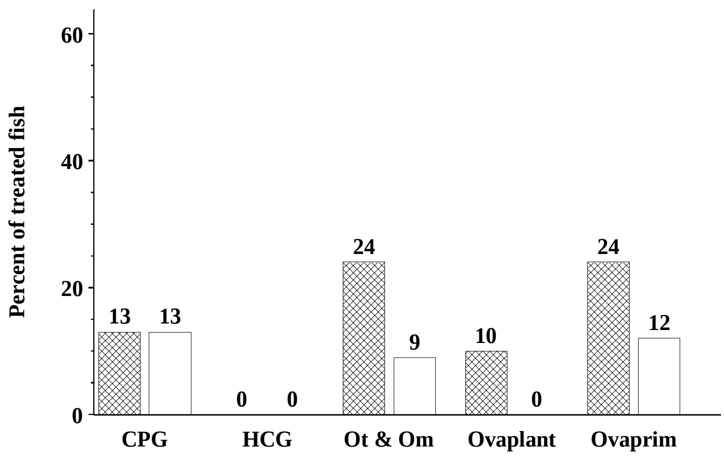
Figure 1a:



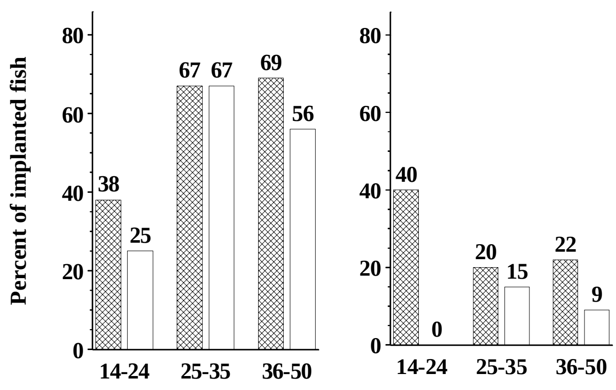
Effects of different hormone treatments on induction of spawning (shaded) and hatching success (clear). (a) Empurau. (b) Semah. (Ot & Om = Pre-treatment with Ovaplant followed by spawning induction with Ovaprim).

Figure 1b:



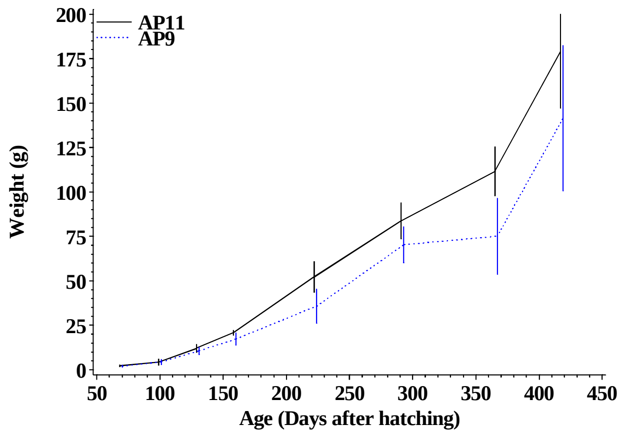
Percent of fish induced to spawn (shaded) and percent of fish induced to spawn and successfully hatch (clear) for fish that received Ovaplant at different time (14-24, 25-35 & 36-50 days) prior to induction of spawning with Ovaprim. (a) Empurau (b) semah

Figure 2:



Growth (mean weight SE) of empurau in two ponds, AP9-with bamboo poles and AP11 without bamboo poles

Figure 3:



Growth (mean weight SE) of empurau in two ponds, AP9-with bamboo poles and AP11 without bamboo poles

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B. areolata with average body weight of 9.0 g obtained from a flow-through seawater system.

Feeding of juvenile spotted Babylon in rearing tanks.

Research and development on commercial land–based aquaculture of spotted babylon, *Babylonia areolata* Link 1807, in Thailand: Pilot grow-out operation

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From an aquaculture point of view, the spotted babylon, *Babylonia areolata* has many desirable biological attributes for profitable aquaculture production including fast growth, high survival, low FCR, and relatively simple culture techniques. Considerable interest has recently developed regarding the commercial aquaculture of spotted babylon in Thailand. Various aspects for land-based grow-out of juvenile spotted babylon to marketable sizes were investigated in large-scale culture. This research is necessary to develop an economically viable aquaculture operation with regards to decreasing the maintenance time and production costs of spotted babylon during grow-out phase. A pilot land-based grow-out operation based on a flow-through seawater system was developed to pilot large-scale production using the optimal culture protocols from previous studies. Thereafter, the economic analysis of the pilot growing-out operation will be conducted and the culture techniques transferred for the commercial application of this species in Thailand.

Culture system design

The culture system used was based on a flow-through seawater system. Hatchery-reared juvenile *B. areolata* were grown indoors in rectangular canvas rearing tanks measuring 3.5 x 4.5 x 0.8 m^3 with 15.7 m^2 total bottom area. The water depth in the rearing tank was 50 cm. Each tank was supplied with flow-through of unfiltered, ambient natural seawater at a rate of 150 litres $hour^{-1}$. Salinity and temperatures ranged from 29-30 ppt and 29-32^{o}C, respectively. Natural light was used to provide a 12:12 h light : dark cycle. The culture tank bottom was covered with a 5 cm layer of coarse sand (0.5-1.0 mm mean grain size) as substrate. The substrate was cleaned with a water jet and sun dried for 6 hours at 30-day intervals.

Juvenile spotted babylon were cultured for 240 days between January to August. The juveniles used in the growth and survival trials were produced in the university hatchery according to as the methods described by Chaitanawisuti and Kritsanapuntu (1997). Individuals from the same cohort were initially graded by size in order to minimize differences in shell length and to prevent possible growth retardation of small babylon when cultured with larger individuals. The snails used for the present experiment were graded to the same size with an average shell length and body weight of 9.6 mm and 0.2 g, respectively, and divided into duplicate batches of two culture treatments. They were reared in 3.5 x 4.5 x 0.8 m rearing tanks as described above. Initial stocking density was 350 individuals m^{-2}, with 5,500 individuals per tank. Size grading was not conducted for all treatments throughout the grow-out period. Snails were fed ad libitum with fresh meat of carangid fish, *Selaroides leptolepis*, once daily at 09:00 hrs. The amount of food consumed was recorded daily. Uneaten food was removed and weighed after the animals stopped feeding.

Growth data

Over 240 culture days, average growth rates in shell length and body weight were 3.86 mm month^{-1} and 1.47 g month^{-1}. At the end of the experiment, average shell length increment and body weight gain were 30.9 mm and 11.8 g. Average survival rate exceeded 95.7% and the feed conversion ratio was 1.6. The snails can reach the marketable size of average body weight of 9-10 g within a 6-7 months culture period. Based on continuous and year-round production, all 10-growout ponds are stocked out in the first month with the first harvest at six months. Five days were allowed for pond cleanup and restocking. Each pond is harvested twice during a 1-year cycle. Based on growth data from the pilot study, 95% of the snails were of marketable size on day 180 at an average weight of 9.0 g. The average weight of yield was 49.5 12.3 kg per pond (495 kg per cycle), and total annual yield was 990 kg. Spotted babylon have some attributes desirable for commercial culture. These include fast growth, high survival, low FCR, and relatively simple hatchery and culture techniques. However, a culture period more than 240 days from seedling to market is relatively long.

Economic analysis for pilot grow-out operation

Fifty five thousand hatchery-reared juvenile spotted babylon (average body weight of 0.30 g) were stocked at a density of 350 snails m^{-2} (5,500 per pond) as per the culture system and rearing conditions described above. Thirty percent of individual snail weights were sampled for growth measurements at 30-day intervals and a grow-out duration was 180-day cycle. On the last day individual the final weight and feed conversion ratio of spotted babylon averaged 9.0 0.8 g and 1.8 0.4, respectively. Table 1 summarizes production and harvest data used for the economic analysis. Duration of grow-out and average weight at harvest is based on the results of the pilot study.

The initial investment required for construction of the grow-out facility was US$ 4,528.8 (table 2). Construction of the building and grow-out ponds were the largest cost components, representing 51% and 20% of the total investment cost, respectively. These two components of the hatchery represent 71% of total investment requirements The laboratory equipment and water supply are the second most expensive items in equipping the hatchery, representing 15% and 10% of the total investment, respectively. Annual ownership costs were estimated to be US$ 676 with annual operating costs estimated at US$ 3,947. Total annual cost for the marketable size production of spotted babylon culture was US$ 4,624 (Table 3). Annual ownership and operating costs accounted for 15% and 85% of the total annual cost, respectively. The two major ownership cost items were depreciation and interest on investment accounting 13% and 2% of total annual cost, respectively. The hired labour and spotted babylon juveniles are the highest variable costs, accounting for 30% and 27%, respectively, of the total annual costs. Electricity and feed were the second most expensive operating cost items representing 12% and 10% of total annual cost. The cost associated with producing spotted babylon marketable sizes is expressed as US$ per kg, with costs per kg at selected final weight presented in Table 4. The cost of producing 990 kg of marketable size snails in this hatchery design was estimated at 4.66 US$ per kg. Under conditions of 95% survival, final weight of 9.0 g and selling price of 5.8 US$/kg showed the best results in

Table 1: Parameters used for economic analysis of grow-out operation of spotted babylon using flow-through culture system.

Parameter	Value
Farm size:	
• Total farm area (m^2)	300
• Pond size (m)	3.5 x 4.5 x 0.8
• Total pond area (m^2)	157
Stocking data:	
• Average initial weight of juvenile (g)	0.30
• Stocking density (no. m^{-2})	350
• Stocking density (no. per pond)	5,500
Harvest data:	
• Duration of growout (days)	180
• Pond preparation (days)	5
• Average number of crops per year per pond	2
• Average final weight (g)	9.0
• Survival (%)	95
• Feed conversion ratio	1.8
• Average yield per pond (kg)	49.5
• Average yield per crop (kg)	495
• Total annual farm yield (kg)	980.4
Sale price:	
• Sale price (US$/kg)	4.5-5.8

Table 2. Initial investment requirements of ten grow-out ponds for spotted babylon marketable sizes in flow-through culture system.

Item	Cost (US$)	% total cost
Buildings (roof and concrete floor of 300 m^2)	2,298.90	50.78
Pond construction (ten 3.0 x 4.5 x 0.5 m canvas ponds)	919.50	20.30
Laboratory equipment (freezer, water quality devices, and lab equipment)	689.70	15.24
Water supply and drainage (seawater pump (2.7 kW) and pipe, valves, couplings)	459.80	10.14
Aeration (air blower of 2 kW and airline)	160.90	3.54
Total cost	4,525.80	100

Table 3. Annual enterprise budgets for a ten-pond aquaculture facility for spotted babylon. A stocking density of 400 per m^2 and a wholesale price of 5.8 US$ per kg are assumed.

Item	Value	% variable (US$)	Percent of total cost
Variable costs (US$)			
Repair and maintenance	135.8	3.42	2.92
Hired labours	1,379.3	34.96	29.85
Feed	482.8	12.21	10.44
Juvenile purchase	1,264.4	32.06	27.37
Electricity	551.7	13.97	11.93
Interest on operating capital	133.5	3.38	2.88
Total variable costs (US$)	3,947.5	100	85.39
Fixed costs (US$)			
• Depreciation	583.8	86.37	12.62
• Interest of investment capital	92.8	13.63	1.99
Total fixed costs (US$)	676.6	100	14.61
Total annual costs (US$)	4,624.1		100

this study. Gross return at these levels is 5,747.2 US$ (Table 5) and net return for production is US$ 1,128 (Table 6). Return on capital and management is US$ 1,803.2 (Table 7). Cash-flow budgets were developed to examine profitability in relation to the timing of expenditures and earning. Under these conditions, a constant selling price of US$ 5.8 / kg results in a positive cash flow by year four. The proposed enterprise is marginally feasible if costs can be lowered considerably by targeting production and vertically integrating hatchery and grow-out operations.

The feasibility of producing spotted babylon marketable sizes in pilot commercial grow-out operation continues to be examined. Although

Rearing tanks of 3.0 x 3.0 m with flow-through seawater system for grow-out of juvenile spotted Babylon to marketable sizes.

returns are small, production with 95% survival and selling price of US$ 5.8 per kg is economically feasible under the assumptions employed. This study presented a positive net return and return and a payback period of less than ten years, which are often used as business investment criteria. The relative attractiveness of an investment should also include an evaluation of markets and realistic sale, site selection, technology and management requirements. In Thailand, live spotted babylon fetches prices ranging from US$ 9.2 - 13.8 / kg at seafood restaurants and US$ 5.5 - 6.5 / kg at farm outlets. Under the conditions used in this study (juvenile price of US$ 0.02 / juvenile, production feed price of US$ 0.3 /kg, stocking density of 400 /m^2, and sale price of US$ 5.8 / kg) farming of babylon snail resulted in a net return and return on investment of US$ 1,128.2 and 0.39, respectively. The proposed 10-growout ponds operation is economically feasible under these conditions. Reducing the culture period to five months and reducing the juvenile cost to 0.01 US$ per individual would improve the economically feasibility of the operation. Aeration and/or water exchange are necessary for flow-through culture system and have been accounted for in the present economic analysis. Targeting production, high-value markets and areas could also improve profitability.

With regard to production, profitability indices were most sensitive to changes in average final weights and survival. In general, snails are rendered unmarketable by stunting and deformities, characteristics which are presumably genetically-based, and which are related to low growth rates (i.e. final average weights) and survival. Based on pilot production data, results of an economic analysis of a proposed 10-pond production system for spotted babylon suggested that the enterprise would be commercially feasible at current market prices for 9.0 g snails, marginally feasible at 8.0 g, and uneconomical at 6-7 g. Costs can be lowered considerably by reducing the culture period, improving growth and survival, using locally hatchery and grow-out operations. Vertical integration of a hatchery operation with the grow-out phase would substantially improve economic feasibility. This economic analysis is intended as a guide and must be modified to reflect individual situations.

Table 4. Estimated total annual cost for production of spotted babylon marketable size at selected final weights and 95% of survival rate.

Final weight (g)	Number of snail per kg	Production (kg)	Total annual cost (US$)	Cost per kg (US$)
7.0	142	774.6	4,619	5.96
7.5	133	827.0	4,619	5.59
8.0	125	880.0	4,619	5.25
8.5	117	940.2	4,619	4.91
9.0	111	990.9	4,619	4.66
9.5	105	1,047.6	4,619	4.41
10.0	100	1,100.0	4,619	4.19
10.5	95	1,157.9	4,619	3.99

Table 5. Gross return* for production of spotted babylon to marketable sizes at selected final weights and prices, assuming 95% survival.

		Sale price (US$ per kg)			
Final weight (g)	Production (kg per year)	4.5	5.1	5.5	5.8
7.0	774.6	3,485.70	3,950.50	4,260.30	4,492.70
7.5	827.0	3,721.20	4,217.70	4,548.50	4,796.60
8.0	880.0	3,960.00	4,488.00	4,840.00	5,104.00
8.5	940.2	4,230.90	4,795.00	5,171.10	5,453.20
9.0	990.9	4,459.10	5,053.60	5,449.90	5,747.20
9.5	1,047.6	4,714.20	5,342.80	5,761.80	6,076.10
10.0	1,100.0	4950.00	5,610.00	6,050.00	6,380.00
10.5	1,157.9	5210.60	5905.30	6,368.50	6,715.80

* Computed for each level of final weight ranging 7.0 to 10.5 g and sale price (US$ 4.50 to 5.80).

Table 6. Net return* for production of spotted babylon marketable sizes at selected final weights and prices, assuming 95% survival.

		Sale price (US$ per kg)			
Final weight (g)	**Production (kg per year)**	**4.5**	**5.1**	**5.5**	**5.8**
7.0	774.6	-1,133.30	-668.50	-358.70	-126.30
7.5	827.0	-897.80	-401.30	-70.50	117.60
8.0	880.0	-65.90	-13.10	22.10	48.50
8.5	940.2	-388.10	176.00	552.10	834.20
9.0	990.9	-159.90	434.60	830.90	1,128.20
9.5	1,047.6	95.20	723.80	1,142.80	1,457.10
10.0	1,100.0	331.00	991.00	1,431.00	1,761.00
10.5	1,157.9	591.60	1,286.30	1,749.50	2,096.80
Net return* was calculated from the gross return minus to the total amount cost (US$4,624.10).					

Table 7. Return on capital and management* for production of spotted babylon to marketable sizes at selected final weights and prices, assuming 95% survival.

		Sale price (US$ per kg)			
Final weight (g)	**Production (kg per year)**	**4.5**	**5.1**	**5.5**	**5.8**
7.0	774.6	-458.30	6.60	316.30	548.70
7.5	827.0	-222.80	273.70	604.50	852.60
8.0	880.0	16.00	544.00	896.00	1,160.00
8.5	940.2	286.90	851.00	1,227.10	1,509.20
9.0	990.9	515.10	1,109.60	1,502.90	1,803.20
9.5	1,047.6	770.20	1,398.80	1,817.80	2,132.10
10.0	1,100.0	1,006.00	1,666.00	2,106.00	2,436.00
10.5	1,157.9	1,266.60	1,961.30	2,424.50	2,771.80
* Computed for each level of final weight ranging 7.0 to 10.5 g and each selling price by subtracting annual operating cost (3,947.50 US$) from gross returns.					

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

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

I am farming *P. monodon* and for the first 80 days, the shrimp have grown well but when I changed the pellet to a larger size (No. 5), the shrimp started to grow slowly. What is the cause of this problem ? (This question was asked in Ampher ranod, Singkla province during September – October).

Slow growth of shrimp can be caused by many factors, some of which may interact to affect growth. Farmers should consider recent events, the season, and conditions in the culture area. Some of the main factors are:

1. The condition of culture area, sediment deposits in the pond, water exchange frequency and water quality affect the shrimp and, if conditions are not good, cause them to reduce feeding or to stop eating altogether. The last factor is often important, as the pond bottom will start to become dirty after several months of culture, which can lead water quality to deteriorate.
2. High stocking density of PL can place pressure on the natural food supplies and environment in the pond. If the wastes have not been removed the pond may become polluted. If there is an excessive plankton bloom it may crash leading to a lack of oxygen and high ammonia in the pond as the bloom decomposes.
3. Changes in weather. Heavy rain or lack of sun for a long period, strong wind or monsoon can all cause the shrimp to stop eating. If there is a storm or monsoon in an area for 4-5 days, it will affect the growth of the shrimp and it may take them at least 7-10 days to recover.
4. Salinity. In the dry season water salinity sometime rises above 35 ppt. and the water cannot be exchanged. This can caused a fluctuation in water colour due to plankton crashes that can affect the shrimp. In the rainy season, the opposite may occur – low salinities may be a problem on farms using low salinity culture and this may also cause fluctuations in plankton populations.
5. Sampling weight of shrimp. At present there is usually 2-5 % of slow-growing shrimp (2-3 g) in ponds when culture period is 70-80 days, with a normal shrimp weighing about 10-15 g. In this case, we should not include the weight of these shrimp for calculation of the amount of food.
6. Low quality feed. Mostly the problem is the stability of feed pellets in water. This has not been commonly reported for some time, and it is not a serious problem for growth of shrimp.

I have a shrimp farm in Rachaburi province and the water becomes turbid from soil, particularly after in newly-filled ponds after it rains. It prevents the shrimp from eating, what can I do?

The colloid sediments are mostly a problem in newly excavated ponds and are made worse by rain after the sediment is washed in. They prevent sunlight from penetrating the water causing the plankton to die and leading to low oxygen levels and high ammonia concentrations. Farmers can avoid this problem by checking the water quality in the area before culture starts. It is possible to use a chemical to precipitate the fine sediments from the water column.

I stocked my shrimp in August – September in Trad province and cultured for 70 days. During this time there was a lot of rain and the shrimp reduced their rate of food consumption by more than 50 %. Afterwards the shrimp were weak and thin, and even though the climate returned to normal the shrimp did not increase eating again. At harvest time my production was 20-30 % lower than estimated in every pond. I do not know where I lost the shrimp and I didn't see any shrimp die during culture period. What happened?

This problem is common in every area and usually happens in the cold season when there isn't any sunshine for several days or after several days of rain. These events cause the shrimp to eat less or stop altogether, which adversely affects their health, leading to disease and cannibalism. To prevent this problem the farmer should plan to culture shrimp in a more suitable season and also to harvest before the onset of the cold season. If this is not possible then during the culture period the farmer can use fresh food in place of pellets at night. The use of highly concentrated fish sauce to improve the smell of pellets and make them more attractive to the shrimp is one method that can be applied.

5. ในช่วงที่มีฝนตกติดต่อกัน จำเป็นหรือไม่ต้องลงปูนขาวตามบริเวณขอบบ่อ

ตอบ จำเป็นอย่างยิ่งในกรณีที่เป็นบ่อขุดใหม่ในบริเวณดินกรด ซึ่งมักจะสังเกตได้จากคราบ สนิมเหล็กสีส้มเคลือบตามผิวดิน หรือสังเกตจากค่าความเป็นด่างซึ่งมักมีค่าต่ำกว่า 50 ส่วนในล้านส่วน และมีค่าความเป็นกรดเป็นด่าง (พีเอช) ต่ำกว่า 7.5 โดยอาจทำให้กุ้งลอกคราบไม่ได้หรือเปลือกไม่แข็ง ดังนั้นจึงควรมีการลงปูนตามคันบ่อเพื่อลดความเป็นกรด หากพบว่าน้ำในบ่อมีค่าพีเอชลดลง หรือมีค่าความเป็นด่างต่ำกว่า 50 ส่วนในล้านส่วน ควรลงปูนขาวในน้ำเพื่อเพิ่มค่าพีเอช และเติมปูนคาร์บอเนตเพื่อเพิ่มค่าอัลคาไลน์ต่อไป

6. ในระหว่างช่วงฝนตกอยู่ ควรจะเลื่อนเวลาการให้อาหารกุ้งหรือไม่

ตอบ การจะเลื่อนเวลาหรือไม่ขึ้นอยู่กับปัจจัยหลายประการ เช่น ความรุนแรงหรือต่อเนื่องของฝน เวลาของอาหาร หรือสภาพทั่วไปของบ่อและคุณภาพน้ำ โดยเฉพาะอุณหภูมิและปริมาณออกซิเจนในน้ำ การตัดสินใจเลื่อนอาหารหรือไม่ ต้องขึ้นกับปัจจัยหลาย ๆ ปัจจัยรวมกัน เช่น หากฝนตกต่อเนื่องกันหลาย ๆ วัน คงไม่จำเป็นต้องเลื่อนเวลา แต่ควรจะลดปริมาณอาหารลงอย่างน้อย 20-30% หรือมากกว่าหากอุณหภูมิของน้ำต่ำกว่า 23°C หากฝนตกหนักในช่วงบ่ายซึ่งตรงกับอาหารมื้อ 3-4 โมงเย็น อาจเลื่อนเวลามาเป็นหลังฝนตกได้ อย่างไรก็ตามหากเลื่อนเวลาอาหารมื้อใดมื้อหนึ่งแล้ว ควรจะต้องเลื่อนมื้อต่อไปภายในวันนั้นด้วย รวมทั้งเปลี่ยนเวลาเช็คยออาหาร หลังจากนั้นในวันต่อไปควรจะให้อาหารตามเวลาปกติ

7. เลี้ยงกุ้งกุลาดำไปได้ประมาณ 80 วัน กุ้งโตปกติ แต่พอเริ่มเปลี่ยนเป็นอาหารเบอร์ 5 กุ้งไม่โต หรือโตช้ากว่าปกติมาก ไม่ทราบเกิดจากสาเหตุใด เป็นเพราะอาหารไม่มีคุณภาพหรือเปล่า (ในช่วงเดือนกันยายน - ตุลาคม เลี้ยงกุ้งอยู่ที่ อ.ระโนด จ. สงขลา)

ตอบ ปัญหาเรื่องกุ้งโตช้า เกิดจากปัจจัยที่สำคัญ ๆ หลายอย่าง โดยเฉพาะอย่างยิ่งอาจเป็นผลมาจากปัจจัยหลายๆ ปัจจัยรวมกันแล้วส่งผลกระทบต่อกุ้งในรูปแบบหรือความรุนแรงแตกต่างกันไป ดังนั้นเกษตรกรควรทำความเข้าใจและแยกแยะหาสาเหตุของปัญหาของฟาร์มของตนเองตามเหตุการณ์และฤดูกาล ตลอดจนพื้นที่เลี้ยงกุ้งด้วย ซึ่งสาเหตุสำคัญ ๆ พอจะสรุปได้ดังนี้

7.1. สภาพการเลี้ยงกุ้ง หรือวิธีการเลี้ยงกุ้งที่เปลี่ยนแปลงไป โดยปัจจุบันมีการเปลี่ยนถ่ายน้ำลดลงอย่างมาก ทำให้สภาพภายในบ่อเกิดการหมักหมม และคุณภาพน้ำเปลี่ยนแปลงสูงมาก ส่งผลให้กุ้งกินอาหารลดลง หรือหยุดกินบางช่วง กุ้งจึงโตช้าโดยเฉพาะอย่างยิ่งหลัง 70-80 วัน เพราะสภาพบ่อเริ่มเสื่อมมากขึ้น

7.2. ความหนาแน่นของกุ้งที่ปล่อยสูงมาก ทำให้ต้องเพิ่มอาหารลงไปในบ่อ ประกอบกับขาดการเปลี่ยนถ่ายน้ำระบายของเสียออกจากบ่อ เป็นสาเหตุให้เกิดการเน่าเสีย หรือเกิดแพลงค์ตอนพืชเจริญมากเกินไป เมื่อแพลงค์ตอนเหล่านี้ตายพร้อม ๆ กัน จะทำให้เกิดภาวะออกซิเจนต่ำ และมีปริมาณแอมโมเนียสูง ในรายที่บ่อมีสภาพหมักหมมอยู่แล้วอาจทำให้กุ้งตายได้ทันที ส่วนบางรายอาจทำให้กุ้งกินอาหารน้อยลงหรือไม่กิน ซึ่งกว่าเกษตรกรจะแก้ไขปัญหาได้ก็จะใช้เวลาไม่น้อยกว่า 4-5 วัน จึงทำให้กุ้งโตช้าลง การเปลี่ยนถ่ายน้ำเพื่อระบายซากแพลงค์ตอนออกจากบ่อจะช่วยแก้ไขปัญหาได้มาก

7.3. สภาพอากาศที่เปลี่ยนแปลงสูง เช่น ฝนตกหนัก อากาศปิดเป็นเวลานานติดต่อกัน เช่น มีพายุ หรือมรสุมพัดผ่าน ทำให้กุ้งกินอาหารลดลงหรือไม่กิน ดังจะเห็นได้ว่า ถ้ามีพายุฝนพัดผ่านจังหวัดใดเป็นเวลานานติดต่อกัน 4-5 วัน จะมีกุ้งถูกจับขายก่อนกำหนดเป็นจำนวนมาก และในรายที่กุ้งไม่ตายแต่ก็จะ ทำให้กุ้งไม่โต เนื่องจากไม่ได้กินอาหารเลย และต้องใช้เวลาไม่น้อยกว่า 7 - 10 วัน จึงเริ่มฟื้นตัว ซึ่งถ้าในช่วงดังกล่าวนั้นมีฝนหรืออากาศหนาวเข้ามาก็จะทำให้กุ้งเครียดเพิ่มขึ้นจนอาจตายได้ในที่สุด เพื่อหลีกเลี่ยงปัญหาดังกล่าว เกษตรกรควรจะต้องวางแผนการปล่อยกุ้งให้ดี เพื่อไม่ให้กุ้งขนาดเล็กผ่านช่วงอากาศเปลี่ยนแปลง รวมถึงต้องเตรียมการให้พร้อม โดยก่อนถึงช่วงดังกล่าวต้องทำการปรับปรุงสภาพแวดล้อมในบ่อให้ดี เช่น แพลงค์ตอนไม่หนาแน่นเกินไป พื้นบ่อสะอาด เป็นต้น การใช้อาหารสดเสริมในช่วงกลางคืนก็จะช่วยได้ โดยเฉพาะอย่างยิ่ง ในช่วงอุณหภูมิต่ำ

7.4. ความเค็มของน้ำ ในช่วงหน้าแล้งถ้าน้ำมีความเค็มสูงกว่า 35 ppt. และไม่มีการเปลี่ยนถ่ายให้เหมาะสม จะทำให้สีน้ำเปลี่ยนแปลงบ่อย เกิดการตายของแพลงค์ตอนพร้อมกัน ทำให้กุ้งกินอาหารน้อยลง ส่วนในช่วงฤดูฝน ฟาร์มที่ใช้น้ำความเค็มต่ำมากก็จะพบปัญหาเดียวกันคือ เกิดแพลงค์ตอนน้ำจืดเจริญมากเกินไป และเกิดตายพร้อม ๆ กัน นอกจากนั้นมักจะพบว่า เมื่อความเค็มต่ำมากกุ้งที่มีขนาดใหญ่มักจะตายหลังจากลอกคราบ จึงทำให้น้ำหนักเฉลี่ยของกุ้งไม่เพิ่มขึ้นได้เช่นเดียวกัน

7.5. วิธีการสุ่มชั่งน้ำหนัก เนื่องจากในปัจจุบันจะมีกุ้งแคระแกรนปะปนอยู่ประมาณ 2-5 เปอร์เซ็นต์ ดังนั้นช่วงที่กุ้งมีอายุ 70-80 วัน กุ้งที่โตปกติจะมีน้ำหนักประมาณ 10-15 กรัม ในขณะที่กุ้งแคระแกรนจะมีน้ำหนักประมาณ 2-3 กรัม ซึ่งเป็นขนาดที่เริ่มติดแห ดังนั้นเมื่อนับจำนวนกุ้งเล็กที่เพิ่งติดแหเพื่อหาน้ำหนักเฉลี่ยก็จะทำให้ได้ค่าที่ต่ำกว่าปกติ จะเห็นได้ว่าถ้ากุ้งบ่อใดมีกุ้งแคระแกรนมาก เวลาหาค่าเฉลี่ยควรแยกกุ้งดังกล่าวทิ้งไปก่อน จะทำให้ได้ค่าที่ถูกต้องมากขึ้น

7.6. อาหารคุณภาพต่ำ ส่วนใหญ่มักจะเกิดมาจากสาเหตุของอาหารยุ่ย แตกเร็ว แต่มักจะเป็นเพียงบางชุดเท่านั้น และไม่ได้เกิดบ่อยมากนัก และสังเกตได้ง่าย ซึ่งโดยทั่วไปแล้วก็ไม่ได้มีผลกระทบกับอัตราการเจริญเติบโตมากนัก เพราะเป็นช่วงสั้น ๆ เท่านั้น

จะเห็นว่าปัญหาที่รุนแรงที่สุดที่ทำให้กุ้งโตช้าในช่วงปลายของการเลี้ยงก็คือ ปัญหากุ้งไม่กินอาหารที่ให้ วิธีการป้องกันหรือแก้ไขก็คือ การควบคุมคุณภาพน้ำและบ่อให้ดี หรือหลีกเลี่ยงการเลี้ยงกุ้งในช่วงที่อากาศแปรปรวนมาก ๆ ประกอบกับการให้อาหารสดเสริมในบางครั้งเพื่อช่วยให้กุ้งกินอาหารดีขึ้น

8. เลี้ยงกุ้งที่จังหวัดราชบุรี น้ำเป็นตะกอนดินขุ่นมาก โดยเฉพาะหลังจากฝนตกหรือมีการเติมน้ำใหม่เข้าบ่อ ทำให้กุ้งไม่กินอาหาร ควรจะแก้ไขอย่างไร

ตอบ การเกิดตะกอนดินแขวนลอย ส่วนใหญ่มักจะเกิดกับบ่อใหม่ที่ขุดในบริเวณดินร่วน ซึ่งเมื่อมีฝนตกหนักจะชะเอาดินตามคันบ่อลงมา หรือเมื่อเปลี่ยนน้ำจะทำให้ตะกอนดินฟุ้งขึ้นมาได้ เมื่อน้ำขุ่นมากจะทำให้แพลงค์ตอนพืชตายเนื่องจากแสงไม่พอ เป็นผลให้เกิดออกซิเจนต่ำลง และเกิดแอมโมเนีย หรือไนไตรท์มากขึ้น นอกจากนั้นตะกอนดินยังเข้าไปจับเหงือกอีกด้วย ซึ่งถ้าแก้ไขช้าจะทำให้กุ้งเครียด กินอาหารน้อยลง อ่อนแอ และติดเชื้อแบคทีเรียตายในที่สุด อาการที่จะสังเกตได้ชัดเจนคือ ตอนกลางคืนหรือเช้ามืด จะมีกุ้งสีแดงเข้ม หรือแดงอมม่วง ปะปนอยู่มาก ซึ่งจะต้องรีบแก้ไขโดยปิดเครื่องตีน้ำในเวลากลางวัน ขณะที่ออกซิเจนในน้ำสูง เพื่อให้ตะกอนดินตกลงมาบางส่วน น้ำจะโปร่งใสขึ้น ทำให้แพลงค์ตอนพืชเจริญได้ ดังนั้นวิธีนี้จะได้ผลขณะที่ปัญหาเพิ่งเกิดขึ้น และยังมีแพลงค์ตอนอยู่ เมื่อแพลงค์ตอนเจริญขึ้นมากตะกอนจะไม่เกิดขึ้นอีก แต่อย่างไรก็ตามถ้าปิดเครื่องตีน้ำแล้วตะกอนยังคงมาก จำเป็นจะต้องใช้สารตกตะกอนช่วยบ้าง หรือมีการถ่ายน้ำออกบางส่วนแล้วเติมน้ำที่มีแพลงค์ตอนเข้ามาแทน การแก้ปัญหาดังกล่าวอาจจะต้องใช้เวลา 3-4 วันจึงจะดีขึ้น วิธีป้องกันปัญหาระยะยาวคือ ไม่ควรตากพื้นบ่อนานเกินไป หรือนำรถไปไถหน้าดิน เพราะจะทำให้ดินร่วนฟูมากขึ้น การใช้วิธีฉีดล้างตะกอนดินออกไปให้มากที่สุดก็จะช่วยลดปัญหาได้ดี แต่จะต้องเตรียมพื้นที่สำหรับเก็บน้ำที่ล้างบ่อให้ดี นอกจากนั้นควรมีบ่อสำหรับตกตะกอนเพื่อเตรียมสำหรับใช้ในการเปลี่ยนถ่ายน้ำ อนึ่งการใช้สารตกตะกอนที่มีขายอยู่ในปัจจุบันจำเป็นจะต้องนำมาทดสอบก่อนการใช้เพื่อหาอัตราส่วนที่เหมาะสม เพราะถ้าใช้มากเกินไปจะทำให้ตะกอนที่จับตัวกันอยู่มาอุดตามซี่เหงือกกุ้งได้ ดังนั้นจึงควรใช้สารตกตะกอนขณะที่ตะกอนในบ่อยังไม่มากนัก และยังมีแพลงค์ตอนพืชเจริญอยู่จึงจะได้ผล

9. ปล่อยกุ้งเดือน สิงหาคม-กันยายน ที่ผ่านมาที่จังหวัดตราด เมื่อเลี้ยงกุ้งมาได้ประมาณ 70 วัน เป็นช่วงที่มีฝนตกมาก พบว่ากุ้งเริ่มกินอาหารลดลงมากกว่า 50 เปอร์เซ็นต์ หลังจากนั้นเริ่มพบกุ้งตัวผอม สกปรก เกาะตามขอบบ่อตลอดเวลาจนถึงจับขาย และหลังจากที่อากาศเริ่มดีขึ้น ปรากฏว่าการกินอาหารของกุ้งก็ไม่เพิ่มขึ้นเลยหรือเพิ่มน้อยมากในขณะที่กุ้งก็มีขนาดเพิ่มขึ้นตามปกติ ซึ่งเมื่อจับขายพบว่าผลผลิตต่ำกว่าที่ควรเป็นประมาณ 20-30 เปอร์เซ็นต์ เกือบทุกบ่อ ไม่ทราบว่ากุ้งหายไปไหน ทั้งๆที่ไม่พบกุ้งตายในระหว่างเลี้ยงเลย และจะมีวิธีป้องกันอย่างไร

ตอบ ปัญหาดังกล่าวนี้เป็นปัญหาที่พบบ่อยมากในทุกพื้นที่ และจะรุนแรงมากในขณะที่มีอากาศหนาวติดต่อกันนานหรือมีอากาศปิดและฝนตกติดต่อกันร่วมด้วย ซึ่งเหตุการณ์ดังกล่าวนี้จะทำให้กุ้งไม่กินอาหารหรือกินลดลงมาก ทำให้กุ้งอ่อนแอ ฝังตัวอยู่กับดินเลนก้นบ่อ เกิดการติดเชื้อแบคทีเรีย และทะยอยตายหรือถูกกินไปเรื่อย ๆ ดังจะเห็นได้จากกุ้งไม่กินอาหารเม็ด แต่มีน้ำหนักเพิ่มขึ้น เนื่องจากได้กินกุ้งป่วยหรือกุ้งตายในบ่อ เป็นเหตุให้จำนวนกุ้งน้อยลงเรื่อย ๆ ซึ่งถ้าเหตุการณ์ดังกล่าวเกิดขึ้นนาน กุ้งอาจหายไปถึง 50 เปอร์เซ็นต์ หรือเป็นกุ้งผอมไม่มีคุณภาพ เนื่องจากป่วยติดเชื้อแบบเรื้อรัง การป้องกันโดยการวางแผนปล่อยกุ้งเพื่อจับก่อนช่วงอากาศแปรปรวนจะเป็นวิธีที่ดีที่สุด แต่อย่างไรก็ตาม เกษตรกรส่วนใหญ่จะหลีกเลี่ยงการเลี้ยงในช่วงดังกล่าวไม่ได้ ดังนั้นการใช้อาหารสดเสริมหรือทดแทนในช่วงกลางคืนจะช่วยลดปัญหาได้บางส่วน การใช้หัวน้ำปลามาเคลือบอาหารก็เป็นอีกวิธีการหนึ่งซึ่งจะช่วยให้กุ้งกินอาหารดีขึ้น

Research points to co-management options for poor fisherfolk in Vietnam

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The Ministry of Fisheries and Danish International Development Assistance (DANIDA) are promoting sustainable brackish water and marine aquaculture for farmers and fishing communities in five coastal Provinces in Vietnam through a project called SUMA or Support to Brackish water and Marine Aquaculture. SUMA operates under the Fishery Sector Programme Support (FSPS) that began in 2000. It promotes an enabling environment for pro-poor aquaculture to become an economically viable livelihood option for poor coastal communities. It has seven "outputs" including research, which is meant to diversify aquaculture. Research has produced promising results with benthic marine animals suitable for the co-management of seabed resources by artisanal fishing communities. Some of these species include sea cucumber (*Holothuria scabra*), seaweed (*Kappaphycus alvarezii*), abalone (*Haliotis asinine*), otter clam (*Lutralia philippinarum*), hard Clam (*Meretrix meretrix*), sea urchin (*Tripneustes gratilla*), green mussel (*Perna viridis*) and trochus (*Trochus niloticus*). They would be good for aquaculture-based fishery stock enhancement. Other species as alternatives to unsustainable aquaculture include sandbass (*Psammoperca waigiensis*), cobia (*Rachycentron canadum*) and swimming crab (*Portunus pelagicus*).

Most of the work has been carried out in Khanh Hoa province (Figure 1) and the alternative aquaculture species work at the Research Institute for Aquaculture Number 3 (RIA 3), the Institute of Oceanography, University of Fisheries and Sub-Institute for Organic Material Science whilst the work with otter clam involves the Research Institute for Marine Fisheries in Hai Phong.

Based on the findings from a study commissioned by SUMA to the Institute of Oceanography entitled 'Distribution and Status of marine Living Resources Around Diep Son Islands (Khanh Hoa Province) – Management Solutions' and a series of participatory meetings with the local communities, an area has been selected for the co-management of the benthic organisms listed above (See Figure 2 map of Van Phong Bay, Khanh Hoa Province). The focal point for this initiative will be a marine sanctuary or 'no take area' around which there will be an area for stock enhanced benthic resource management, in turn surrounded by an area where more intensive aquaculture practices can be carried out. For seabed resource management to succeed the initiative must have a good legal premise: The community needs to be assigned exclusive user rights for the resource for a significant period. This work follows the successful results obtained elsewhere in Khanh Hoa by the International Marinelife Alliance (IMA) at Trao Reef and the Marine Protected Area project at Hon Mun supported by MOFI, DANIDA and IUCN.

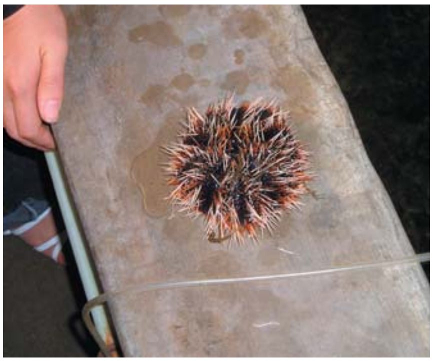
Two poor fishing communities, from Van Than and Van Thang Communes in Van Ninh district, Khanh Hoa province, took part in the initial benthic resource assessment as a precursor for the co-management experiment. For decades fisherfolk from these communities have collected benthic organisms as a part of their livelihoods. But increasing pressure on natural resources has left large areas of seabed denuded of the natural flora and fauna, leaving fishing communities looking for alternative sources of income, which, unfortunately, often involves destructive practices such as the collection of wild lobster seed for

Fig. 1: Map of Vietnam including the 5 Provinces where SUMA is operating.

Fig. 2 : Van Phong Bay in Khanh Hoa Province. The red circle shows Diep Son Islands as a co-management site.

grow-out systems in pens or cages based on 'trash fish' feeding. This has depleted the natural lobster stocks (*Panulirus ornatus*), degraded the environment, and led to over-fishing of

Sea-cucumber (Holothuria scabra) broodstock at the Research Institute for Aquaculture No.3.



*Sea-urchin (*Tripneustes gratilla*) produced at the Research Institute for Aquaculture No.3.*

several species of fish and crustaceans caught for lobster feed. The overall effect is species biodiversity reduction.

To date the research results have developed cost effective methods for quality seed production from hatcheries for sea cucumber, and sand bass with the likelihood of producing seed on a commercial scale for sea urchin and abalone in early 2005. Work involving the substitution of fish meal with green mussel silage will assist poor farmers to produce black tiger shrimp (*Penaeus monodon*) broodstock in cages previously used for the unsustainable lobster grow-out systems (Consultancy on Feed Development for Shrimp Broodstock, Vietnam July 2004).

At a recent Fishery Research Conference sponsored by SUMA to discuss the main research topics: Seed production, culture models, disease, artificial food and resource protection, the notion of developing a Vietnamese Fishery Research Forum linked with a regional initiative for 'Commodity Groups' was proposed, based on the main mariculture species groups: Finfish, crustaceans and molluscs. The Forum would facilitate exchange of information and coordination of the efforts to promote needs based research as a basis for pro-poor aquaculture diversification. The commodity groups would be stakeholders dealing with the same commodity. It would be part of a wider regional initiative of the Network of Aquaculture Centres in Asia-Pacific (NACA). The formation and subsequent networking of these commodity groups would stimulate the communication between research institutions, producers and processors /exporters in order to harmonize efforts towards stimulating sustainable aquaculture production. The creation and networking of commodity groups would also lead to better information exchange with similar groups in the region.

The MOFI/DANIDA Fishery Sector Programme Support will enter a second phase from January 2006 and it is envisaged that co-management plans will feature high on the list of activities designed to promote sustainable livelihoods in the Vietnamese coastal Provinces.

More information about SUMA is available from http://www.mofi.gov.vn/suma, and on FSPS from http://www.mofi.gov.vn/fsps.

Farmers as Scientists

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

Aquaculture development through NGOs

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Aquaculture development efforts until recently have been largely undertaken by the government agencies. However, with good results demonstrated in the culture of some of the aquatic species and the proven benefits of aquaculture to provide families with income and/or food, the NGO sector has begun to identify aquaculture as a potential area that can be used to benefit poor people. Successful examples emerging from countries such as Bangladesh, India, Cambodia and Vietnam have amply demonstrated that aquaculture can provide viable livelihood options to many people when the science based aquaculture activity is undertaken. Even the landless people can be gainfully employed by creating access to water bodies for such groups of people and employing techniques like cage and pen culture.

On the global scale , the enormous potentials of NGOs for aquaculture development was highlighted in the key note address of Mr. Michael New to the World Aquaculture conference held in Brazil in 2003. This was the first attempt to project the potential opportunities available in helping the poor through some of the proven technologies to the world's largest society of aquaculture professionals. Aquaculture's developmental stages can be traced to the patterns of agriculture development wherein initial hunting for food from nature turned into the identification of food crops and development of suitable agronomic practices. With capture fisheries showing marked decline or stagnation in many places around the world, aquaculture is gradually being recognized as an alternative to cater the food necessities of the growing population. Further, with the increasing population pressure and declining land resources, the potential of the vast, unexploited sea as an area to provide food for the growing population in the coming years is being recognized. Although mariculture technology is still in its early stages of experimentation and development, good rewards have been obtained from initiatives made to produce healthy seafood. In the freshwater and brackish water sectors, proven technologies for various species groups have now become available and they are being used to help people in improving their economy and food security, through a number of government programs. However, with the resource constraints and operational difficulties, as the governments are unable to reach large section of the population , other agencies must play an essential role to exploit the potential of aquaculture to the optimal level and on sustainable basis.

Recognition of NGOs role in rural development

NGO developmental history can be traced to the role of missionaries since the 16th century. Secular NGOs started emerging to counter the difficult circumstances arising from war , famine, floods , etc., which caused enormous pain to the people and that that could not be easily handled by governments in position. The formation of the Red Cross in the 18th century and emergence of few NGOs such as Save the Children, OXFAM, CARE , World Vision and others to address the emergent necessities of the suffering humanity demonstrated the potential of these movements of people with collective effort and common vision. Hence, in general , NGOs are known for working under difficult circumstances and generally are practical in their vision and approach. Today , several agencies recognize the positive contribution of NGOs in societal development and the World Bank has defined the NGOs as "independent of government , characterised primarily by being humanitarian or cooperative in nature rather than with commercial objectives . These organizations engage in activities to relieve sufferings , promote the interests of the poor , protect the environment , provide basic social services , or undertake community development".

A dedicated session on Aquaculture development: The role of NGOs

Recognising the increasing number of NGOs in aquaculture development and their positive contribution to the sector, during the World Aquaculture triennial conference held in Hawaii in March, 2004 , a separate half a day session on Aquaculture work of NGOs in developing countries was organized by Mr. Michael New and myself as session chairs. A good number of papers presented in the session detailed the contributions made by NGOs in aquaculture development in various countries of Asia and Africa. The outcome of the session highlighted the role played by NGOs in demonstrating the benefits of aquaculture in different countries and the potential opportunities available for the development of aquaculture through NGOs by circumventing the general problems encountered in the existing approaches. The session also had the opportunity to listen about the formation of a new NGO dedicated for aquaculture development and named "Aquaculture without Frontiers". A brief summary of the papers presented in the session is presented below.

Emergence of NGOs in Aquaculture sector

A lead paper presented by myself along with Mr. Michael New summarized the historical account of the development of NGOs and the role of some in demonstrating aquacultures potential in poverty alleviation. In Cambodia , the OXFAM group of NGOs along with FOS , Belgium, assisted to set up a fish seed production and research center in the 1980s. The long term commitment of these organizations in developing aquaculture technology with the participation of farmers demonstrated the viability of farmer participatory research in developing a good number of practical fish culture technologies. Small scale aquaculture techniques developed to help poor farmers resulted in several NGOs using the concept to increase fish availability in different parts of the country. Similarly in Bangladesh, the work carried out by CARE has demonstrated the viability of rice fish culture as a component of the integrated pest management system and has proved its utility in very many ways ranging from nursing of fish seed in the field to produce table size fish. Thousands of farmers have experimented with the technology and are deriving benefits from such a system. The organization has also successfully tried the concept of farming systems approach in extension wherein all components of the system are given the required importance and the wastes emerging from one system are effectively used as an input for another system. Pond fish productivity has been increased substantially by focusing on building the knowledge of farmers on the science behind the advocated technology . The most visible impact of aquaculture in terms of poverty alleviation is seen with the

Group photo of participants in the special session on Aquaculture development: The role of NGOs.

farming of freshwater prawn on the Southwestern part of the country. More than one hundred thousand families are involved with activity and risk of farmers has been reduced by educating them about sustainable farming techniques. Some families have been able to come out of the poverty by earning additional income from aquaculture.

Ms. Chusak Wuthiwaropas from Thailand making a presentation on helping farmers with improved feed technology.

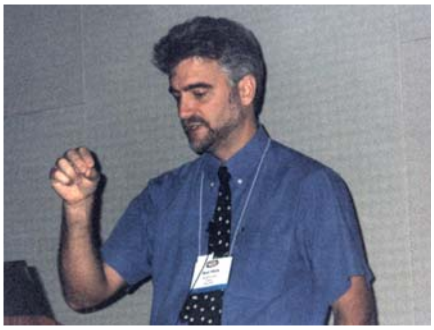
World fish center experience with NGOs

World Fish Center (WFC) has been specifically promoting partnerships as one of the areas of its working philosophy. NGOs are recognized as able partners that can reach large sections of the population cost effectively with the new information that can help in improving their economy. The rich experience of working with more than 50 NGOs in Bangladesh has helped the organization to evolve procedures on partnerships that can be used by other organizations with similar interests. Partnerships with NGOs have helped in reaching large numbers of farmers through their existing excellent delivery mechanisms. The aquaculture productivity of several thousand farmers has been increased significantly. During 2003 alone, more than 30,000 demonstrations were conducted using 35 NGOs. These demonstrations have been found to be useful in empowering farmers with knowledge and practical skills. With focus on women, the efforts made in partnering with such a large number of NGOs has helped in building the capacity of these NGOs in addressing the issues related to gender in aquaculture. In Africa too, partnerships are paving the way to explore aquaculture development through NGOs. The work carried out in Malawi with some NGOs has set a very good example of creating sustainable aquaculture systems in Africa. Based on the experience gained , partnership with NGOs in various other countries where the are active is being promoted. WFC has released publications that help in understanding the potential of NGOs and pathways to ensure success. Shared vision and commitment to help the poor in alleviating poverty are few of the most important criteria to have productive partnerships.

Mr. Pedro Bueno of NACA emphasized the benefits of farmer-based organizations in aquaculture development.

Best Management practices / Basic Management practices of aquaculture through farmer groups: NACA experience

The initiative of NACA (Network of Aquaculture Centres (NACA) , an intergovernmental organization set up an Asia in promoting the formation of farmer based organizations at the community level has given another new dimension to the development of aquaculture. These community based organizations are essential to build the group cohesiveness and find solutions to the common problems through collective efforts. These are another form of NGO which can either function independently or link with larger NGOs. The efforts made by NACA to prepare a list of farmer based organizations in various NACA member countries in Asia is a first attempt to document such organizations involved in aquaculture activities. The recent initiative of NACA on aquatic resources management strategies has given further boost to promote these grass roots level organizations. The experience gained by NACA through the STREAM Initiative among the tribal populations in the Jharkand State on the eastern part of India is an illuminating example on how the food security of the people can be strengthened through a collective approach. Another most successful intervention has been made in Andhra



Dr. Mark Prein narrated the opportunities to reach large population by empowering NGOs and partnering with them with well defined programs.

Dr. Anwara Begum Shelly from CARITAS , Bangladesh highlighted the benefits of shrimp culture, particularly to women.

Pradesh in the Southern part of India where farmers have been suffering heavy economic losses from disease problems encountered in shrimp farming. Building farmer based organizations at the village level through the formation of Aqua clubs and helping them to implement better management practices for shrimp culture has resulted in farmers being considerably more successful in shrimp culture. Such successful examples of farmers organizations are also evident in various other Asian countries such as Vietnam, Sri Lanka and the Philippines. The experience of Bangladesh in building such community based organizations and providing support to them through larger NGOs is another model worthy of experimentation in other regions. New approaches need to be evolved and tested to reach these grass root level organizations in terms of their need for information at the right time , capital for investment and access to market information and markets, etc.

The 2002 Governing Council meeting of NACA held in Lankawi has made explicit recommendations to provide organizational and technical support and advice wherever necessary for the formation of farmer-based organizations. The lessons learnt from European based farmer organizations in influencing policies and programs are used to strengthen the intervention strategies of NACA.

CARITAS experience in Bangladesh

More than two decades of experience of CARITAS in Bangladesh have shown the potential of aquaculture in poverty alleviation. Shrimp farming, which is generally perceived as a rich farmer activity requiring large investment, has been demonstrated as an activity that can also be undertaken by poor farmers, through a collective effort and making available required credit and other inputs. The income of families involved in aquaculture activities was doubled by using an integrated approach with an emphasis on wise use of resources available on the farm . The organisation of credit through the formation of self-help groups and assisting them with the necessary technical and social information has helped these poor farmers to derive benefits from aquaculture. CARITAS has also intervened to target women specifically and as result more than 40% of their project participants and beneficiaries are women.

ACIAR support to aquaculture activities through World Vision in Thailand

The Australian Centre for International Agricultural Research provided support to World Vision International to help farmers farmers in Northeast Thailand to develop low cost feeds using locally available materials in place of commonly used trash fish in hybrid catfish culture. The results of the study carried out by the NGO in partnership with the Department of Fisheries and farmers demonstrated the benefits of using various locally available ingredients like snail meat , rice bran and corn meal along with other ingredients like soybean meal, fish meal and vitamin and mineral mix. The study results demonstrated the benefits of using these feed ingredients to increase the productivity of hybrid catfish culture. Community based centers were established to train farmers on feed production using the new technology. The work carried out by World Vision is a good example to demonstrate the benefits of intervention strategies that are based on good research.

Opportunities for aquaculture development in Africa through NGOs

Dr. Joseph Molnar from Auburn University, USA reviewed the role of NGOs in African aquaculture development and highlighted the need to develop technologies in partnership with farmers using farming systems concepts and approaches. Such approaches are known to help in strengthening capacity of farmers to find solutions to problems by themselves. He also further emphasized the need for developing programs and practices that are gender sensitive and to empower women to truly derive the benefits from the new activity. A number of projects initiated in Africa for the development of aquaculture had failed as they attempted a top down approach with no consideration to the issues of operational viability and long term sustainability. However, recent successful efforts through NGOs have given hopes to introduce this new activity in the continent and integrate it with the existing farming systems. World Fish Centre has experience in some of the African countries , particularly in Malawi, in promoting family-scale aquaculture, now recognized as a good example for further development of aquaculture in Africa.

Government perceptions of NGOs

Cambodian Government Fisheries Director , Mr. Nao Thouk narrated on how NGOs have helped in developing the Fisheries Sector even when Cambodia was isolated from the international support. Fish is an important component of the Cambodian people’s diet and livelihoods. With the improvements in the data on the contribution of the fisheries sector to the national economy, it is now deriving good support from the Government. Many major programs of aquaculture development in the country are carried out by NGOs. Annual meetings of NGOs with the Department and planning of activities has resulted in avoiding wastage of resources. The role of NGOs in increasing the fish seed availability by setting up local seed production units at the community level with emphasis laid on empowerment of women with knowledge and skills of fish culture, such as those provided to men in the community and promotion of integrated systems of aquaculture as a component of the ongoing farming system were recognized as the significant contributions of NGOs.

Aquaculture without Frontiers

The concept of forming an independent organization to help in the development of responsible aquaculture has now become a reality with the initiative taken by Mr. Michael New to establish an international NGO called “Aquaculture without Frontiers”. The

Mission statement of the organization is “Aquaculture without Frontiers is an independent non-profit organization that promotes and supports responsible sustainable aquaculture in the alleviation of poverty by improving livelihoods in developing countries”. The organization, which has the foundation group members drawn from various countries and organizations, but in their individual capacity has developed the concept , organizational structure and operational strategy to make this as an unique organization with global approach.

The organization will work on the following principles

1. Provide assistance from individuals in the existing aquaculture community utilizing all age strata, from students to retirees , as appropriate.
2. Support responsible and sustainable aquaculture practices.
3. Concentrate on forms of aquaculture (and associated activities) that have potential to alleviate poverty through the enhancement of livelihoods.
4. Recognise and support the role that women play in aquaculture and linked activities.
5. Target grass root farmers.
6. Be culturally sensitive , non-discriminatory and non-aligned in religion and politics.
7. Carry out projects that are carefully monitored and assessed for efficiency.
8. Be transparent and accountable.

The organization also has developed an operational strategy that includes:

1. Promote and introduce practical techniques.
2. Demonstrate appropriate technology , including responsible resource use and integration with other income and food generating activities.
3. Assist in product development for consumption and sale / marketing.
4. Provide technical and management training for small scale farmers, farm workers , extension workers, agencies (including NGOs) working to develop aquaculture.
5. Increase awareness of the importance of the aquatic environment , animal welfare , and the potential of aquaculture.
6. Help to build capacity for seed supply.
7. Promote the development of microcredit schemes.
8. Maximise the potential of natural productivity.
9. Avoid ecosystem degradation by turning eutrophication into productivity.
10. Work for long term stability , not just short term relief.

The proposed activities of the organization , with limited resources, can only be carried out only when there is active support from aquaculture professionals. With the continuing demonstration of aquaculture’s potential and increasing investment in aquaculture education, research and development, formation of such an independent organization at this stage is recognized as an important step in the right direction. In another special meeting held with all those interested in the formation of this organization during the conference, the group endorsed Mr. Michael New to continue the effort in the formation of the organization. More details on the organization can be found at www.aquaculturewithoutfrontiers.org and Mr. Michael New can be contacted at Michael_New@compuserve.com.

Conclusion

Public opinion on the ability of NGOs to reach the poor under challenging circumstances is increasing. NGOs with clear vision , mission and goals coupled with democratic and transparent operating principles and practices have been largely successful in many parts of the world. In all cases, examination of history clearly demonstrates that the initiatives taken by some of the committed group of individuals have been largely responsible for the healthy growth of such institutions. Today, Red Cross, Save the Children, OXFAM, CARE, World Vision and others that were initiated to address problems in some parts of the world have grown to become global institutions. Some of these NGOs today operate with large budgets, most of which is contributed by the people. This clearly demonstrates that people support organizations once they are convinced with their commitment to transform the lives of the disadvantaged.

The growth of aquaculture science and the increasing number of aquaculture professionals throughout the world has created new opportunities for professionals to provide benefits to the poor. Hence, formation of AwF was viewed by everyone as a timely initiative. The session while recognizing the positive contributions already made by some of the NGOs through aquaculture, also took note of a few of the failures. In many instances, such failures have been largely due to inexperience of the NGOs and initiation of aquaculture activity for the short term economic gains instead of having long-term commitment to the discipline. A number of precautionary approaches were suggested to ensure the greater success of NGO work at the field level. They included the proper understanding and assessment of peoples necessity, identification of proper intervention strategies based on the capacity and needs of people, provision of adequate knowledge to people on the system to enable farmers themselves to decide on the appropriate actions and trials, to avoid aquaculture systems that are risky , and provision of credit through self help groups to ensure availability of inputs at the right time.

The participants recognized that the special session, organized for the first time to document the positive experiences of NGOs in aquaculture development, has helped in identifying the potential opportunities available in this field. It was felt that such platforms should be created more often to create awareness and promote the speedy growth of aquaculture with the participation of NGOs. Based on the suggestion, in the upcoming World Aquaculture Meet in Bali during May 2005 ,another special session on Aquaculture Development – the role of NGOs II is planned. It is expected that the session will provide further opportunities to learn from each others experience of NGOs in aquaculture development from different parts of the world. Those interested to participate in this session may please contact me at mcnraju@yahoo.com.

Asia-Pacific Marine Finfish Aquaculture Network

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Sustainable, profitable and socially responsible - building a 'triple bottom line' grouper and snapper culture industry in Komodo

Trevor Meyer, Sudaryanto, Peter Mous and Jos Pet

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With over 17,500 islands, and an estimated 80,000 km of coastline, Indonesia has long been recognized as having enormous potential for marine fish cage culture. However, a shortage of marine hatchery capacity as well as a lack in capacity to address technical challenges and to develop sustainable fish culture businesses have meant that existing cage culture of marine fish has fallen far short of its potential.

The Nature Conservancy, a US-based conservation organisation, has developed a model for regional marine fish cage culture industries in Indonesia. A pilot hatchery and grow-out project, based just north of Komodo Island, eastern Indonesia, has

Aerial view of Loh Bongi.

Network supported by:

Australian Government Australian Centre for International Agricultural Research

APEC

Above: The hatchery. Below: Shots of the grow out facility.

now been operational since January 2003, and has demonstrated the technical feasibility of the model with the first harvest of 500kg of estuary grouper *Epinephelus coioides* in June 2004. The pilot project is scaled to produce 25 tonnes of live grouper and snapper annually, but the successful development of the project into a viable operation will require its up-scaling to a production capacity of around 200 tonnes. Consequently, The Nature Conservancy is now looking for partners to assist in the transformation of this pilot project into a triple bottom line business – namely profitable, sustainable and socially responsible.

The cage culture operations will supply live grouper and snapper to the Hong Kong-based live reef fish trade. Market prices for live fish are high – typically between US$5 to US$30 per kg depending on the species – and an existing network of mobile fish buyers ensures that the live product can be sold at the farm gate, with no need for investment in processing, packing or export. In fact, the fish farm model described here was developed as part of a wider goal to contribute to the transformation the entire live reef fish trade to a sustainable practice.

The hatchery

The pilot project described here aims to demonstrate the viability of a fish culture industry of this type in remote parts of Indonesia and other parts of Southeast Asia.

The species of fish selected for culture were chosen taking into account the market price, ease of culture and local availability of broodstock. At Komodo, five species of fish are currently maintained as broodstock – estuary grouper Epinephelus coioides, tiger grouper *E. fuscoguttatus*, humpback or mouse grouper *Cromileptes altivelis*, mangrove jack *Lutjanus*

Marine Finfish Aquaculture Magazine
An electronic magazine of the Asia-Pacific Marine Finfish Aquaculture Network

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argentimaculatus and seabass *Lates calcarifer*. All were caught as juveniles or adults over the last five years in local waters, and thus are not threat to the genetic integrity of the local stocks, and avoiding the need of importing broodstock and eggs, with its attendant risk of disease introduction. In addition, a stock of leopard coral grouper *Plectropomus leopardus* have recently been included in the broodstock facility.

The broodstock are maintained in cages throughout the whole egg-production cycle. Techniques have been developed to allow egg collection, and excellent broodstock condition and minimal stress result in all fish species maintained (with the exception of seabass) spawning naturally, without the need for hormonal manipulation. This helps ensure good egg quality and high hatching rates.

The hatchery itself consists of a shore-based flow-through system. Water is drawn from the sea through sand filters, then directly to the hatchery and live feed production facilities. Water quality is excellent, with a temperature range of 26-31C, and salinity of 34 ppt. After passing through the hatchery, the water passes through a system of simple settlement ponds that act as a trap for particulate material and as a natural biological filter, before being returned to the sea.

Phytoplankton and rotifers (both small and super-small strains) are produced by way of batch cultures, using open mass-production techniques. Such systems result in modest productivity levels, but, most importantly, are simple and workable – necessary requirements if such hatcheries are easily replicated in other remote parts of Southeast Asia. Pure master cultures of algae and rotifers are available from research institutes in Indonesia, and imported products such as enrichment diets, Artemia cysts and high quality larval feeds are readily available from local agents.

Live feed production facilities, and the fish larval rearing and nursery units, are constructed from locally available materials, using local contractors, wherever possible. Small culture volumes are maintained in fiberglass tanks, whilst larger mass production volumes use concrete tanks.

Fish larvae are reared in 10 cubic metre tanks, and maintained on a diet of enriched rotifers, Artemia and high quality larval diets until weaning at 40 – 50 days of age, after which fish are graded and transferred to the nursery section of the hatchery, where fish are grown-on to a size suitable for transfer to cages. Larval rearing protocols are based on those developed at Gondol Research Institute for Mariculture, Bali and are thus proven, workable techniques, with typical larval survival rates of successful batches varying between 1 and 10%. The hatchery itself has been built in a modular form, allowing the replication and scale up of the existing facility with a minimum of disruption and at a minimum cost.

Grow-out farms and community involvement

A key part of this fish culture model is to use local communities in the cage grow-out of the grouper and snapper produced by the hatchery. Such communities are often well placed to do this, typically being located in suitable coastal locations for cage culture as well as having prior experience of holding live fish in cages, or at least in fishing. Consequently, this model has a further function in providing alternative livelihoods to communities previously reliant upon destructive reef fishing practices, and thus reducing the fishing pressure on vulnerable stocks of reef fish and the associated damage to coral reef communities.

Two community grow-out units had been established by July 2004, with the first harvest of grouper carried out during June 2004. Cages and related infrastructure are made from low cost, locally available materials such as wood and plastic drums, and are, therefore, restricted to sheltered locations, in close proximity to the local community involved in their operation. Each grow-out unit is scaled to rear up to six tonnes of grouper and snapper per annum.

Future development

The Komodo Fish Culture pilot project has successfully overcome a number of major technical challenges, and has shown that an operation of this type is technically feasible. The project is now ready, therefore, to enter its most critical and exciting phase: Transformation into a triple bottom line business that is not only profitable but that also benefits local people and is environmentally sound. As a global non-governmental, non-profit organization, The Nature Conservancy fully realizes that this transformation must be driven by the private sector, with the Conservancy only in a supporting and catalytic role. The approach to this process is that the Conservancy will carry out a final feasibility study, which will support the formation of a business group that will take over and up-scale the fish culture facilities and that will operate as an independent business. Fish culture companies who are interested in becoming involved in business development are invited to contact Trevor Meyer (tmeyer@tnc,org) or Peter Mous (pmous@tnc.org).

Mouse grouper Cromileptes altivelis.

Juvenile tiger grouper, Epinephelus fuscoguttatus.

Changing the nets.

First successful hatchery production of Napoleon wrasse at Gondol Research Institute for Mariculture, Bali

Bejo Slamet and Jhon H. Hutapea

Napoleon wrasse (*Cheilinus undulatus*) is one of the most expensive live fish for consumption in Asian markets, especially Hong Kong, Singapore and China. Nowadays, its capture and export is protected in many Asian countries, including Indonesia. The Research Institute for Mariculture at Gondol, Bali, Indonesia, initiated research on hatchery production technology for Napoleon wrasse in 1997. Captive broodstock began spawning in 1998, and numerous attempts were made to rear the larvae. After many years of research on gonadal development, spawning and larval rearing, RIM researchers finally produced 120 juvenile Napoleon wrasse in 2003, the first reported hatchery production of this species.

Rearing Napoleon larvae is more difficult compared to other marine finfish such as snapper and grouper. The difficulty reflects the small size of the newly hatched larvae and their small mouth gape. Egg diameter is only 620–670 m, total length of newly hatched larvae is 1.5–1.7 mm, and mouth gape at initial feeding is only 133 m.

RIM researchers attribute the successful larval rearing to the provision of high quality feed to broodstock, resulting in good quality eggs. In addition, researchers were able to provide good quality and appropriately sized live food (40-80 m) to the larvae during the initial feeding period before the yolk and oil globule were exhausted.

RIM researchers note that growth of Napoleon wrasse is extremely slow; at around 6 months of age the juveniles were only 5–6 cm total length. This feature may limit their attractiveness for aquaculture, despite the high price of this species in the live reef food fish trade.

Figure 1: Growth pattern of Napoleon wrasse larvae.

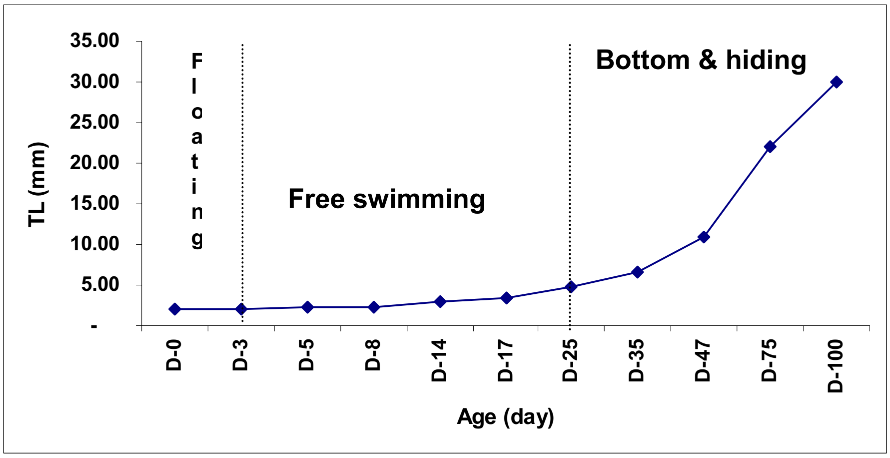
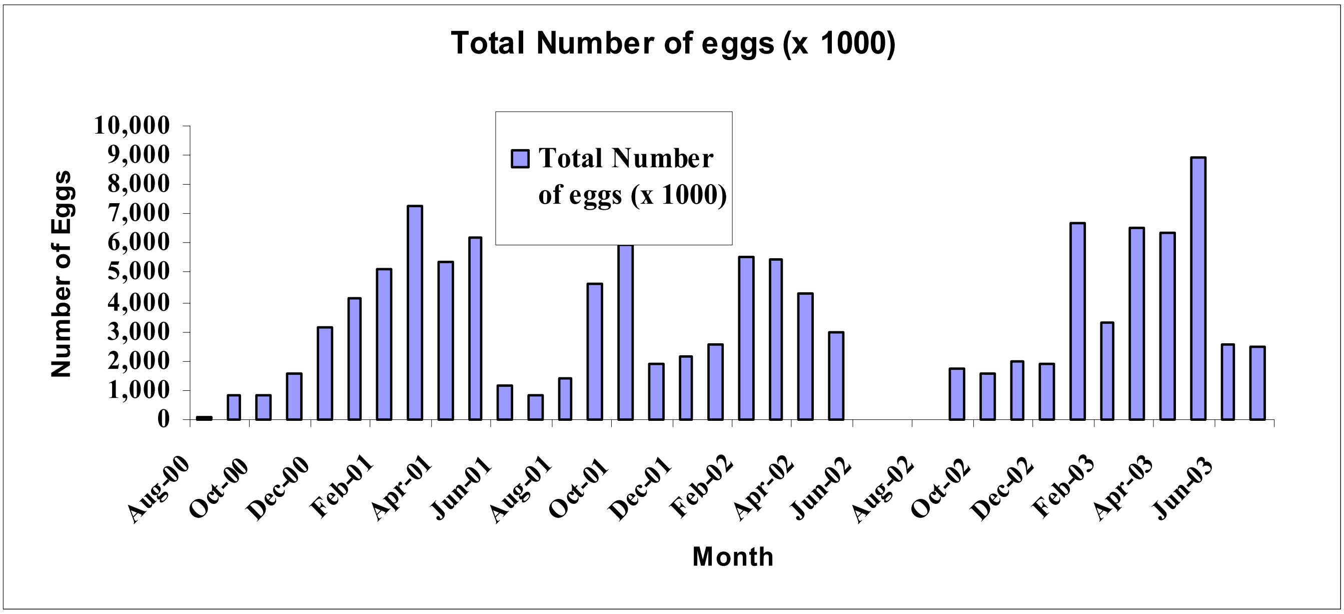


Figure 2: Egg production by Napoleon wrasse broodstock at Research Institute for Mariculture from 2000 to 2003.



Assessment of the use of coded wire tags (CWT) to trace coral trout (*Plectropomus leopardus*) in the live reef food fish trade

Mike Rimmer[1], Sarah Kistle[1] and Geoffrey Muldoon[2]

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This activity forms part of the Asia-Pacific Economic Cooperation (APEC) endorsed project to develop Industry Standards for the Live Reef Food Fish Trade – a collaborative project of the Marine Aquarium Council (MAC) and The Nature Conservancy (TNC).

As part of food quality and safety requirements of developing the standard, traceability of the fish from point of capture through to the restaurant has been identified by consumers of the live reef food fish trade (importers, wholesalers) as an issue of importance. This controlled tagging experiment was undertaken to assess the potential to implement traceability in the live reef food fish trade (LRFFT) in terms of 'tracking' the fish from point of capture to markets in Hong Kong.

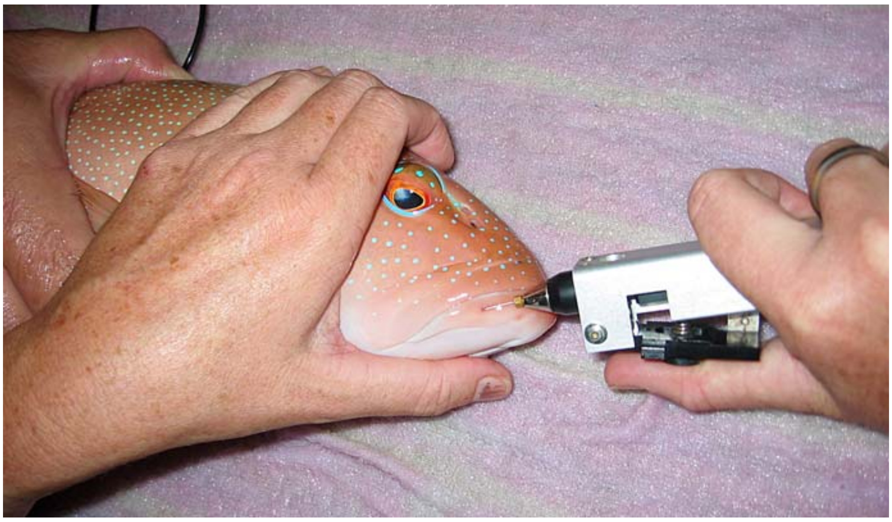
Coral trout (mainly *Plectropomus leopardus*) are captured using hook and line and transported live to collection facilities in the major ports along the coast of Queensland. From here they are loaded into live shipment bins and transported live to Hong Kong by air, in oxygenated bins. From Hong Kong they are either sold to local restaurants, or transhipped to mainland China.

Tagging, holding and transport

Tagging

An essential approach to any tagging of high-value marine finfish is that it does not significantly devalue the fish. The high wholesale and retail prices obtained in the live reef food fish trade are based in part on the aesthetic appeal of the fish, which includes colour and general appearance. For this reason, the use of external tags was rejected for this experiment as external tags typically cause significant damage to the skin, and over time often cause unsightly ulcerations. The wounds may directly lead to fish health problems because they provide a site for pathogen access.

The tags used in this study were coded wire tags manufactured by Northwest Marine Technology Inc. (NMT). Advantages of these tags over traditional plastic skin-penetrating tags is that they are (1) small, (2) bio-compatible, and (3) nothing remains penetrating the skin, thus preventing aesthetic damage and improving fish health. With no protrusion, the tags used in this study allow the wound to heal, removing any infection path.



Binary coded wire tags allow decimal coding (etching) that allows for either batch or individual identification. Above: A tag is being inserted into the lower mandible of fish. Below: An electronic wand is used to read the tag on receipt in Hong Kong.

Coded wire tags were injected in the mandible of each fish using a Handheld Multi-shot Tag Injector. Fish were routinely checked immediately after tagging, using a Handheld Wand Detector to determine that the tag had been injected. A full transport bin load of fish (280 fish, ~350 kg total weight) was tagged for this study

Due to a technical difficulty with the tag injector, only about 150 fish were tagged on Day 1 with the remaining 130 fish being tagged on Day 2. A tagging rate on Day 2 of around 150 fish per hour was achieved although the hourly rate would likely improve with experience.

Pre-transport holding

After tagging, the tagged fish were kept in a 10 m^3 circular tank in a recirculating system, and held at about 20^{o}C (standard holding practice for Australian live reef food fish traders). The 150 fish tagged on Day 1 were checked for tag retention on Day 2 with the retention check taking approximately 15 minutes for the 150 fish. Of those fish checked, two had lost tags. Both these fish were retagged prior to shipment.

Transport

All 280 fish were loaded into a standard live fish transport ‘oxygen’ bin. These bins are around 0.8 m^3 capacity and can transport 300–350 kg of live coral trout for around 12 hours total transport duration. Oxygen is supplied to the fish during transport from a self-contained pressurised oxygen gas cylinder, and excess oxygen bleeds off from the bin to the outside atmosphere.

The fish were loaded onto a commercial flight from Cairns, Queensland, Australia to Hong Kong, China, at 0900 (GMT+10) and were offloaded in Hong Kong at 1900 (GMT+8) for a total transport duration of 12 hours. The fish, once unloaded in Hong Kong were given approximately 30 minutes to re-condition and acclimatise before being checked for tag retention. The rechecking the entire of batch of 280 in Hong Kong took 30 minutes.

Results and Discussion

Tag retention on receipt in Hong Kong was 278 fish out of 280 (96%). There was no mortality of transported coral trout.

It is likely that tag retention could be improved with additional experience. Some adaptation of the tag placement was required during the initial part of the tagging exercise so that the morphology of the fish assisted in the ease of needle/tag insertion. This decreased the fish handling time and reducing the likelihood of damage to the fish as well as tagging equipment. The initial tag site was to the centre of one side of the fish’s mandible, which was found to be difficult to penetrate, causing the tagging needle to bend. The crevice towards the tip of the fish’s mandible provided a natural guide for the tagging needle and a fleshier area for tag placement.

Continued on page 45

Below: Pack-out of live leopard coral trout from land based holding tanks into oxygenated bins and air transport containers for transhipment by air to Hong Kong.

Trade and market trends in the live reef food fish trade

Geoffrey Muldoon[1], Liz Peterson[2], Brian Johnston[3]

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Introduction

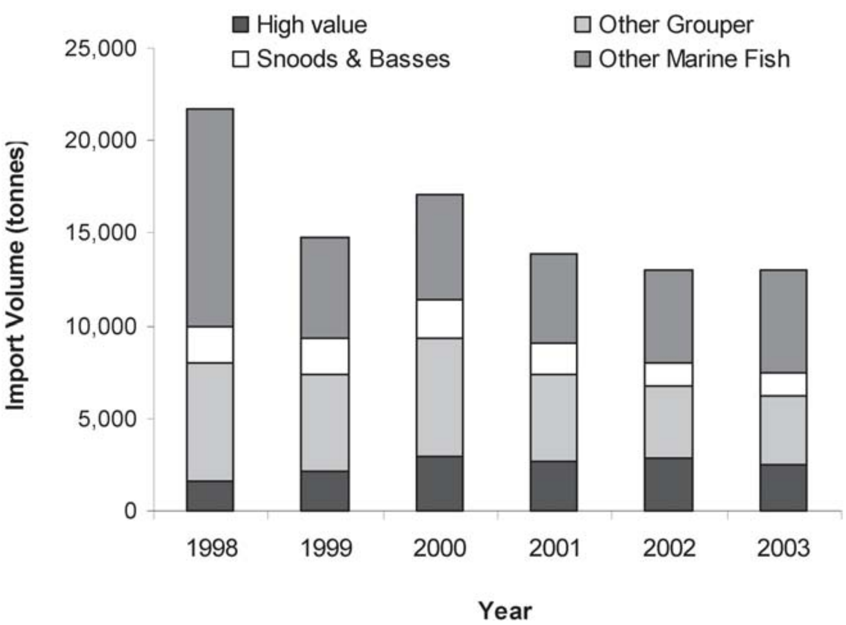
Live reef food fish are currently sourced from more than 20 countries in the Asia-Pacific region, some, located close to the principal demand centre of Hong Kong, having been in the trade for some time while other more distant countries are only recent, and infrequent, participants (HKCSD, unpublished data). Total recorded imports of LRFF into Hong Kong, China (Hong Kong) and the People's Republic of China (PRC), while declining from the peaks of the late 1990s, have remained stable since then (Figure 1).

Recent estimates, based on declared imports of LRFF into Hong Kong, put the annual volume of trade into Hong Kong at 13-14,000 tonnes, with a retail value of approximately US$400 million. As there is no requirement for the approximately 100 Hong Kong licensed live-fish transport vessels to declare imports entering Hong Kong by sea, these estimates are almost certainly lower than actual imports, which are more likely to be 15-20,000 t annually. The total regional trade has been estimated to be as high as 30,000 t per year (Sadovy et al. 2004).

A range of undesirable economic, environmental and social outcomes have often been identified as being associated with the trade, with the focus mainly on environmental issues. These include over-exploitation of coral reefs and coral reef fishes and the environmentally damaging aspects of some harvesting techniques, including cyanide fishing, targeting of spawning aggregations and the capture of immature fingerlings and juveniles for grow-out (Cesar et al. 2000; Sadovy and Vincent 2002). Other aspects of the trade are not well understood and would benefit from further research, particularly demand issues.

On the demand side, the future market potential for wild-caught and cultured live reef product is largely unknown. As incomes in Asia rise over the next decade and product sourced from aquaculture become more readily available, there is an expectation that consumer demand for LRFF will likewise increase. The trade, however, is susceptible to the economic environment, as evidenced in a downturn during the Asian economic crisis from which it has not yet fully recovered, and more recently, although to a limited extent, as a result of the Severe Acute Respiratory Syndrome (SARS) outbreak.

Figure 1: Annual volumes of reported imports of all live reef food fish into Hong Kong, China 1998-2003.



High value species include highfin grouper, humphead wrasse, giant grouper, leopard coralgrouper, and spotted coralgrouper. Other grouper include the green grouper, tiger grouper and flowery grouper. Other marine fish include wrasses, parrotfish and mangrove snapper. Source: Hong Kong Census and Statistics Department (HK CSD) and the Agriculture, Fisheries and Conservation Department (HK AFCD).

Trade data

Although the LRFF trade has been flourishing for several decades, economic and trade information is scant. Prior to 1997, data on the LRFF imports into Hong Kong were coarse with both marine and freshwater live fish categorized broadly as either food or ornamental fish. The Harmonized Code System (HCS) used in Hong Kong to monitor food imports was improved in 1997 to identify live reef food fish categories. Refinement of the HCS in 1999 enabled LRFF imports to be distinguished by key species and country of origin, further improving monitoring capacities. Trade agreements between Hong Kong and PRC provide for low tariffs on LRFF entering PRC through Hong Kong, with the result being that upward of 60% of all LRFF entering Hong Kong are re-exported to the PRC. With lower tariffs on foodstuffs likely when the PRC joins the WTO as expected, LRFF may soon enter the PRC directly. At present, there is limited capacity to record and monitor such imports.

Total recorded imports into Hong Kong have remained relatively stable since 1999, when import volumes declined considerably relative to previous years (Figure 1). The Hong Kong economy remained fairly robust for the duration of the Asian economic crisis that began in 1997, and only began to show signs of a downturn from the end of 1998. This downturn coincided with a fall in declared imports of approximately 30 per cent in 1999, mainly in the categories of the lower-value "other marine fish" and "other groupers". In 2003, while total imports into Hong Kong rose slightly (less than 0.5%), the SARS epidemic during that year may have influenced consumer demand for particular species. In 2003, the volume of high-value imports fell by 15 per cent. In contrast imports of the lower-value "other marine fish" category, which had declined three of four previous years, rose 10 per cent. The results are described in more detail in the next section.

Import volumes of major species by country of origin

The main exporting countries of wild-caught and farmed live reef fish remain mainland PRC; Thailand; Indonesia; Philippines; Australia; Malaysia; Viet Nam; and Taipei, China. Indonesia, Malaysia, Philippines, and Australia are the major exporters of high- and medium-priced wild-caught live reef fish, while smaller quantities are exported from Thailand, Cambodia, Viet Nam and the Maldives[4]. The largest quantities of farmed grouper are exported from Thailand and Taipei, China[5], mainly green grouper, while the PRC is the dominant supplier of other marine fish and snooks and basses. Infrequent and irregular exports of LRFF, mainly coral grouper and other groupers have also been reported from Fiji Islands, Marshall Islands, PNG, Seychelles, Singapore, and Solomon Islands[6].

The volumes of imports into Hong Kong of all major high- and medium-priced groupers and hump-head wrasse during 1999–2003 are shown in Figure 2. Indonesia and the Philippines are major suppliers of most species, although exports of coral groupers, green grouper, and flowery groupers from Indonesia have all declined during this period. Since 1999, total imports of coral groupers have increased by more than 60%, with new Australian exports making up more than 85% of this increase up to 2002. In 2003 Australian imports of coral grouper declined by almost 34% while coral grouper imports from the Philippines rose by almost 50% and total imports fell only slightly. In contrast, total imports of green grouper had declined by 35% from 1999 to 2002, primarily on the back of significantly lower exports from Thailand. In 2003, green grouper imports rose by more than 30%, with exports from Thailand in 2003 more than doubling. During the period 1999 to 2003, total imports of tiger grouper have more than tripled while total imports of flowery grouper have declined by almost two-thirds. These results are discussed in more detail in the context of the SARS epidemic in the next section.

Market trends and recent economic events

In general, the market has contracted somewhat over the past five years, becoming more focused on fewer species - primarily the high-value and mid-priced groupers. The main causes of these past and likely future market shifts are thought to be:

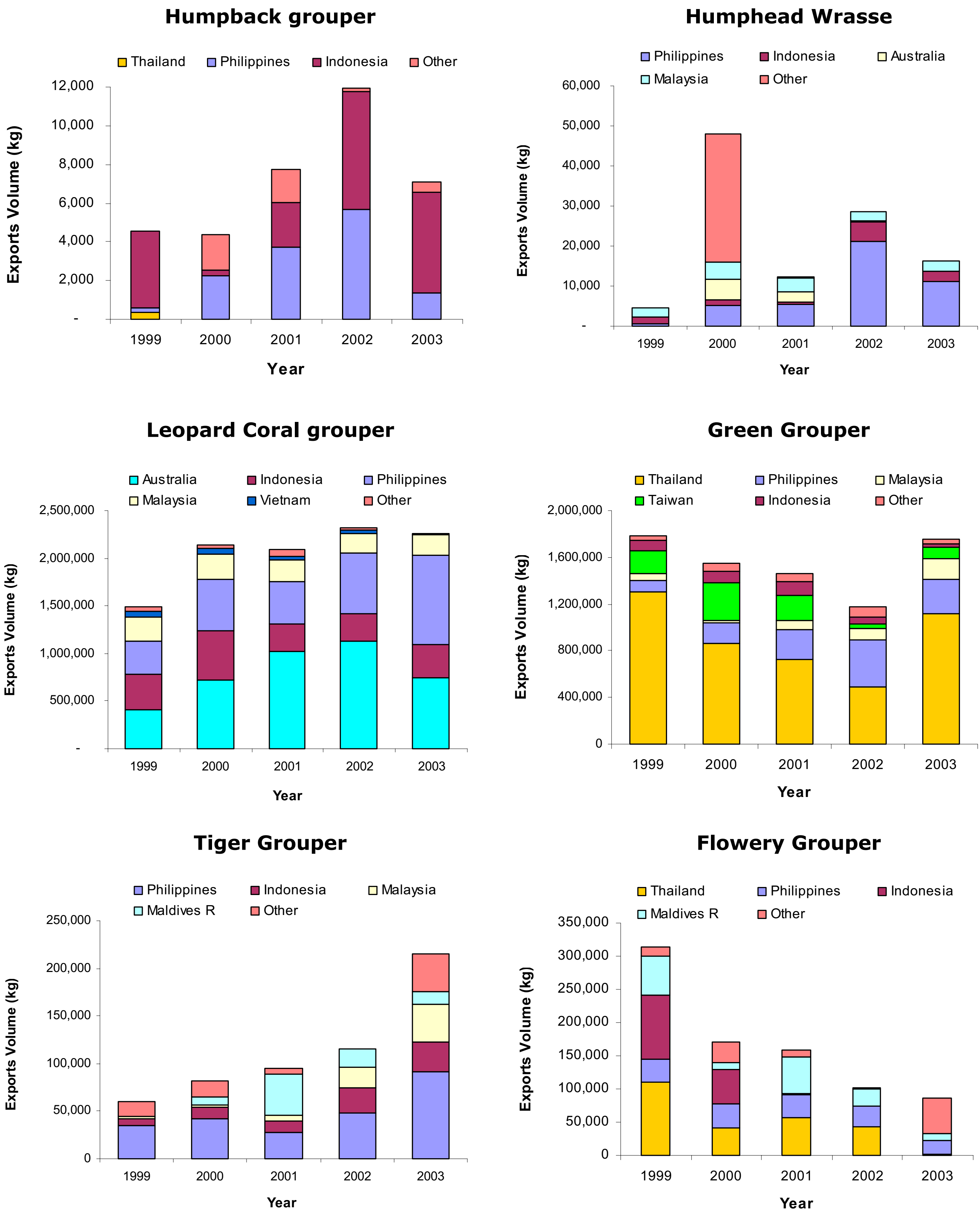
- Overall improvements in transport technology and access to air transport that have helped to increase imports of high-value species. This has been reinforced by relative increases in variable costs (fuel, fish feed, ship maintenance and insurance) of transporting fish to markets by sea[7].
- A decline of ~40% in the LRFF market since 1998. This falling demand has led to weaker retail prices, making the purchase and transport of lower-priced fish that make up the bulk of imports financially unviable, resulting in Hong Kong traders reducing volume of imports by sea.
- Increased aquaculture production of lower-priced "groupers". Grow-out of undersized wild-caught fish has expanded considerably in Southeast Asia. The increase in grow-out from hatchery production is seen as a positive industry development, but there is growing concern over the parallel increase in grow-out of wild-caught juveniles for market[8].
- Downturn in general business because of international health scares such as SARS and Ciguatera poisoning.

The remainder of this section will present empirical and anecdotal evidence on trade impacts of SARS to illustrate the vulnerability of supply countries to events and economic conditions in the major demand centre of Hong Kong.

Anecdotal evidence suggests a number of market responses to SARS influenced these changing consumption patterns. Following the first SARS reports in Hong Kong, restaurants began reporting cancellations of banquet bookings. Restaurants are traditionally the place where the higher-value and medium-value species are purchased and consumed, and so consequently much of their product is imported from overseas sources. With the number of patrons dining out at these restaurants falling markedly, many restaurants closed down for the duration of the SARS scare and, with the lower demand for high- and medium-value fish, many traders stopped buying fish from overseas suppliers. Conversely, with consumers preferring to eat fish at home as opposed to dining out, the demand for the lower-value and domestically caught fish is thought to have increased[9].

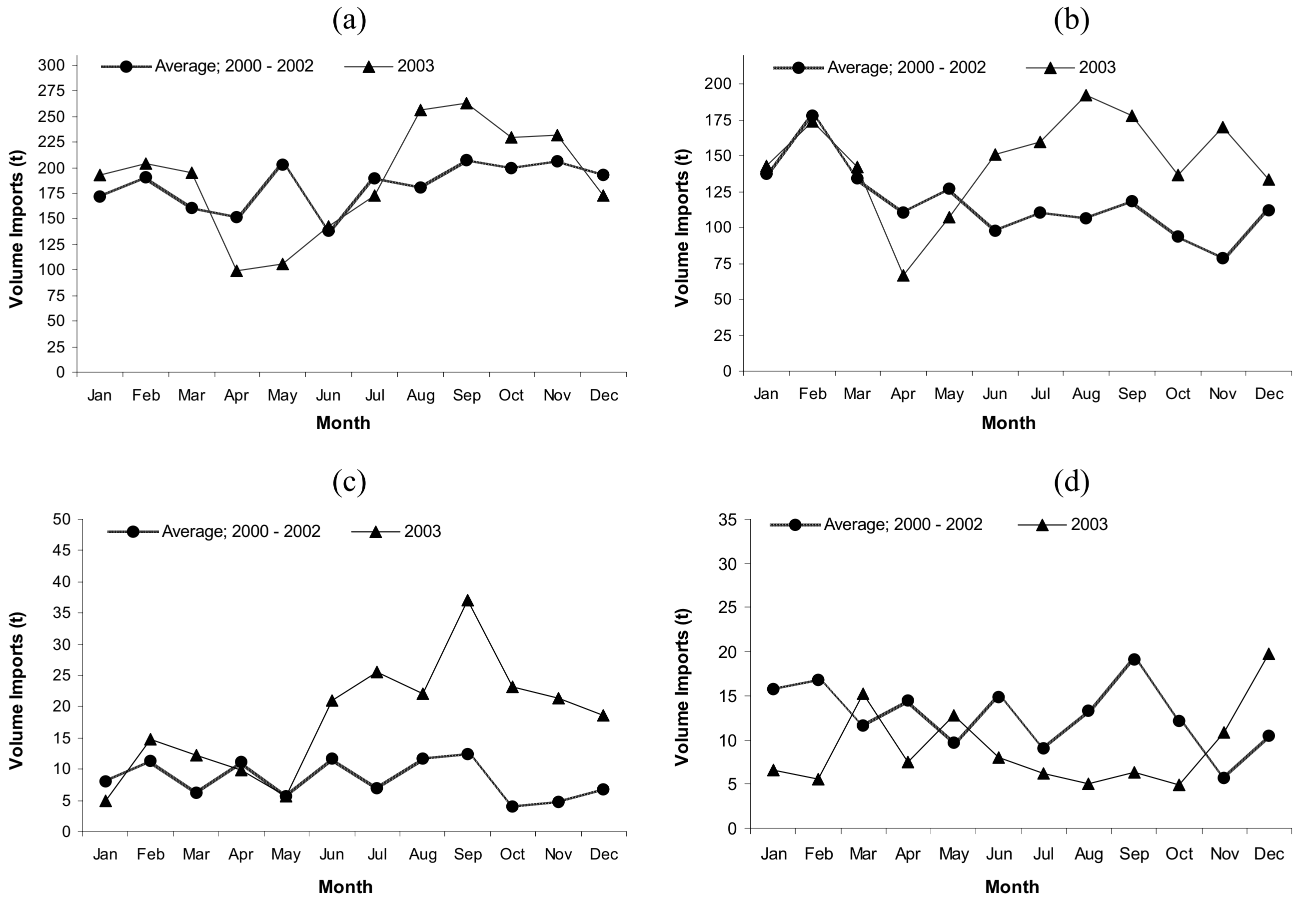
The impact of the SARS epidemic, during April and May of 2003, on individual species can be examined by looking at trends in both prices and import volumes across recent years. There were no real discernable impacts of SARS on the import prices of most high-value and mid-value species (see Figure 1 caption), including leopard and spotted coral grouper, highfin grouper, green grouper and tiger and flowery grouper (Pet-Soede et al. 2004). The SARS epidemic however, does appear to have had an impact on the demand for a subset of high-value species and other grouper species. Figure 3, which compares monthly imports in 2003 and monthly imports averaged across the years 2000-2002, illustrates declines in imports of four key species or species groups in the months affected by the SARS epidemic. In April and May of 2003 imports of

Figure 2: Import volumes for 6 species imported into Hong Kong, by country of origin for 1999–2003



Note: Those countries that make up the "other" category vary by species. In most cases, these countries do not export regularly. Countries that export several species include Cambodia, PRC, Singapore, Thailand, and Viet Nam. Source: Hong Kong Census and Statistics Department, Agriculture, Fisheries and Conservation Department, and International Marinelife Alliance (Hong Kong).

Figure 3. Total monthly volume of imports of four major species or species groups: a) leopard coral grouper, b) green grouper, c) tiger grouper, and d) flowery grouper imported into Hong Kong, China from 2000 through 2003. Monthly import volumes have been averaged across the years 2000–2002.



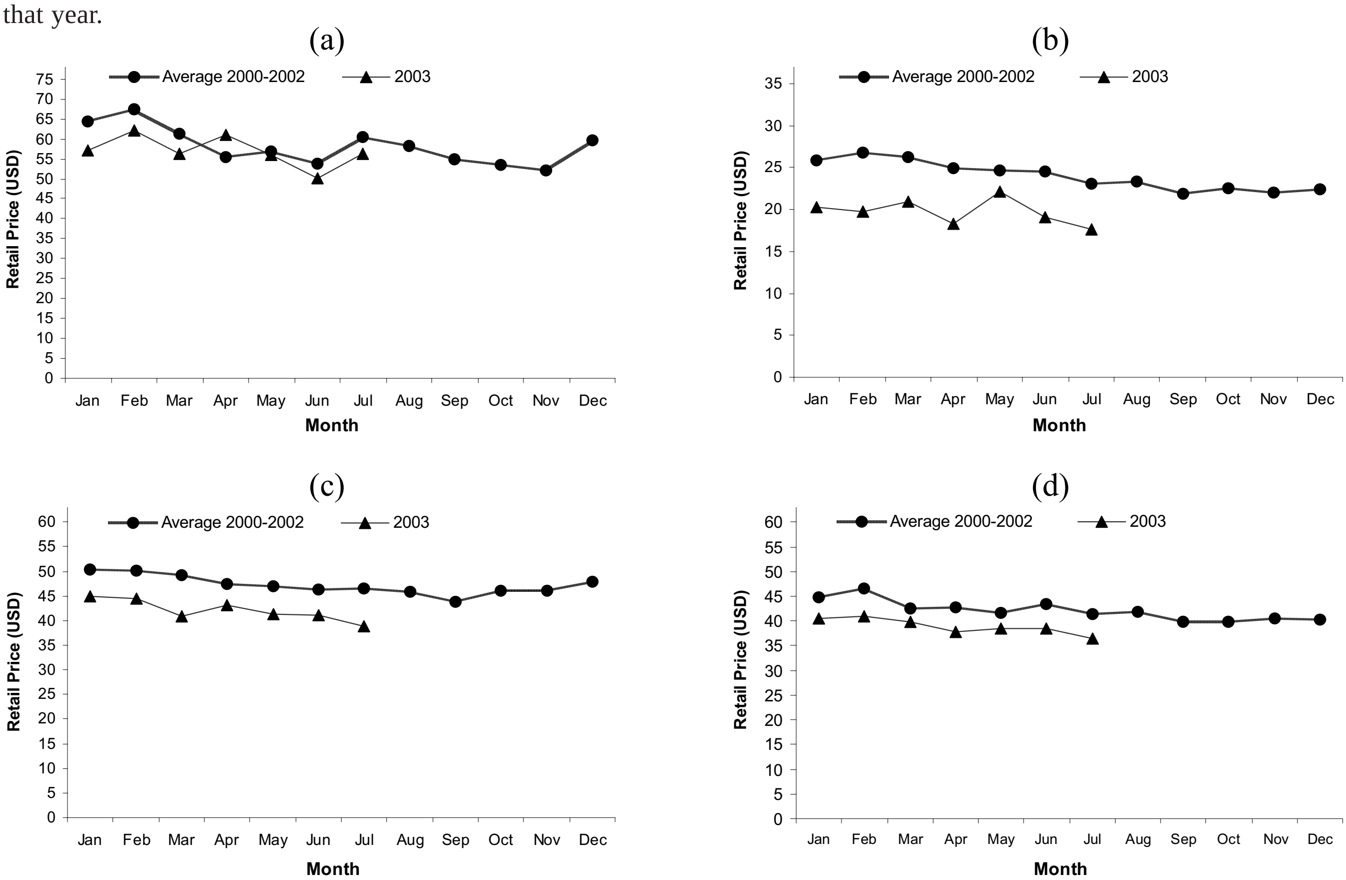
Source: Hong Kong Census and Statistics Department and Hong Kong Agriculture, Fisheries and Conservation Department, and International Marinelife Alliance (Hong Kong).

leopard coral grouper were 34 per cent and 48 per cent lower, respectively, than the average annual imports over the years 2000-2002. Imports were also lower for green grouper and "tiger grouper" species in April (39% and 11% lower, respectively) and May (16% and 1% lower, respectively). While imports of flowery grouper were 48 per cent lower in April than the 2000-2002 average, imports in May were 31 per cent higher than the 2000-2002 average. While recognising that the SARS event was likely a market demand phenomenon, it is possible that supply constraints influenced these observed declines in import volumes[10].

During the SARS outbreak, imports from countries in closer proximity to the Hong Kong market did not decline by as much as those from countries further away, compared with previous years. For example, imports of leopard coral grouper from the Philippines were not significantly lower than the 2000-2002 average, while imports of this species from Australia dropped by roughly 50 per cent in both April and May 2003. One reason might be that proximity implies lower transport costs, and hence lower total import costs, while another would be the availability of substitute markets. In Australia, local wholesalers reported beach prices being offered to fishers for live fish as low as 15 Australian dollars (AUD) per kilogram during the peak of the SARS outbreak, compared with an average price in April and May across all years from 1997 to 2002 of AUD 25.1 and AUD 25.9, respectively (G. Muldoon, unpublished data; T. Must, Fish Wholesaler, personal communication). According to several wholesale buyers spoken to during and after the SARS outbreak, many fishermen in Australia either sold their fish fresh or frozen[11] to domestic and overseas markets rather than live, or did not fish at all during this period.

Pet-Soede et al. (2004) noted in a previous issue of this Bulletin that prices of two high-value species, leopard coral grouper and highfin grouper, showed little, if any, change in price in response to SARS. They did, however, note substantial price reductions in beach prices received by fishers in Indonesia for live grouper. Similarly discounted prices were "offered" to fishers in Australia, with beach prices during the SARS outbreak 40 per cent lower than average prices for those months over the previous five years (G. Muldoon, unpublished data). Although only anecdotal accounts are available for the Philippines, live fish exporters noted that beach prices paid to fishers fell by 20 per cent during the SARS outbreak (B. Cheng, personal communication). These discrepancies in price variations in response to SARS that were experienced by participants in supply and demand countries may be cause to point to market distortions and profit taking by retailers in Hong Kong, at the expense of fishers and middlemen in supplying countries.

Figure 4. Monthly retail prices in Hong Kong of four major species or species categories: a) leopard coralgrouper, b) green grouper, c) tiger grouper, and d) flowery grouper, imported into Hong Kong, China from 2000 through 2003. Monthly retail prices have been averaged across the years 2000–2002, while monthly retail prices for 2003 are only available until July of that year.



Source: International Marinelife Alliance (Hong Kong).

Such inferences, however, based on these observations and with limited knowledge of the dynamics of supply and demand, would be difficult to substantiate.

A similar picture emerges for a broader range of species, including mid-value species, such that available data do not provide strong evidence of a SARS impact on price. Figure 4 compares monthly retail prices in 2003 with monthly retail prices averaged across the years 2000-2002 for four species of grouper. Ignoring SARS impacts, what is of interest is that for all species, with the exception of April for the leopard coral grouper, monthly retail prices in 2003 were lower than the corresponding monthly retail prices averaged across 2000-2002. This reinforces the anecdotal evidence provided by traders of a downward trend in prices for the whole trade. Again, discerning whether these price variations may be demand or supply responses is difficult based on available data. While prices in 2003 were lower for all species illustrated, patterns of import volumes were not consistent. For example, leopard coral grouper imports increased relative to the previous year in 2000 (44%) and 2002 (11%) but were stable in 2001, while tiger grouper imports increased in 2000 (36%), 2001 (16%) and 2002 (21%). In contrast, green grouper imports decreased in 2000 (13%), 2001 (5%) and 2002 (20%), as did flowery grouper imports in 2000 (45%), 2001 (7%) and 2002 (12%). A hypothesis that declines in import volumes should lead to price increases is not borne out here. A more likely premise is that the market overall is depressed, as is the Hong Kong economy generally. Further investigation would be required to establish whether the discrepancies in monthly import volumes between years and corresponding price movements are, in general, supply and/or demand responses.

Conclusions

Hong Kong remains the major destination for consumption of LRFF, despite declining import volumes, depressed prices and occasional health-related demand impacts. Of growing interest is the expanding market associated with increased incomes in mainland PRC. This growth is expected to continue into the future, placing increased pressure on supplies of LRFF. It has been observed however, that increases in present yields of high and medium-value LRFF species from the wild are limited by the biological constraints on total grouper production (Sadovy et al. 2004).

Aquaculture has been identified as both an alternative livelihood to engaging in often-destructive fishing practices and as a means of meeting future demand for the “high- and medium-value” grouper species when many fish stocks in Southeast Asia are showing signs of severe depletion. It is estimated that approximately 40 per cent of all LRFF in the trade are supplied from aquaculture, although the majority of these fish come from grow-out of wild-caught juveniles to market size. Any benefits from substituting wild-caught with cultured species depend on how successfully the mariculture industry relieves its dependence on wild stocks for juveniles and trash fish for feed through increased hatchery production and development of new diets (Sadovy et al. 2004). Moreover, the market impacts, and specifically price impacts, of this substitution may have significant effects on fisher income.

Footnotes

1. CRC Reef Research Centre Limited, PO Box 772, Townsville QLD 4810, Australia. Email: g.muldoon@impac.org.au
2. Advanced Choice Economics P/L, 30 Dean Road, Bateman WA 6150, Australia. Email: Liz.Petersen@tpg.com.au
3. Asia-Pacific School of Economics and Government, Australian National University. Email: njvj@austarmetro.com.au
4. Hong Kong Census and Statistics Department, Hong Kong Agriculture, Fisheries and Conservation Department
5. Both hatchery produced and wild caught grow-out fish.
6. Johannes and Riepen, 1995; Shakeel and Ahmed, 1997; Yeeting 1999a; 1999b; Johannes and Lam 1999; IMA Hong Kong, unpublished data.
7. Patrick Chan, personal communication.
8. In some regions, primarily juveniles are caught and grown-out locally, and sold when they attain market size.
9. Patrick Chan (Chairman, Hong Kong Chamber of Seafood Merchants), personal communication.
10. Supply constraints in source countries may be related to weather (monsoon, high winds) or seasonal variations in catch rates.
11. Beach prices for frozen and whole fresh fish during April and May of 2003 remained steady at between AUD 16.00 and 19.00 per kilogram, depending on the weight of the fish

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(Continued from page 39)

Conclusion

This feasibility study ably demonstrated the efficacy of tracing live reef fish from their port of origin using coded wire tags. Whilst this represented a positive step toward addressing food safety and health in the consumption of live reef food fish, the characteristics of the LRFFT imply that additional testing be undertaken to identify the most suitable tagging approach for widespread application throughout the LRFFT. Given that the trade is artisanal in nature, comprises a large number of fishers who are geographically dispersed over a wide area, and has numerous sites for landing and holding fish catches before shipment, the tagging method used will need to be relatively simple to use and inexpensive to operate.

Acknowledgments

We thank Adam, Chris and the rest of the staff at Kenneth Aquamarine, Cairns, for their assistance with tagging and checking the fish. We thank Kenneth Vy (Kenneth Aquamarine Products) for providing support and assistance in both Cairns and Hong Kong. We also thank the staff of Northwest Marine Technology Inc. particularly Lee Blankenship and Stan Moberley for their support.

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Aquaculture Calendar

For more events listings the NACA Events & Training page at

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

Pacific Fish Technologists, 31 January – 3 February 2005, Vancouver BC, Canada

The theme of the conference is Weaving the Net of Sustainability – How Do We Flourish & Nourish?

In order to achieve sustainability the ecology, economy and society must be viewed as individual pieces of twine that are woven together to make a tight and complex net. When looking at the net it is not possible to see the beginning or end of any particular twine as they are all integral parts of the final mesh. Likewise it is difficult to touch one twine within the net without vibrating others.

Whether you are attending this conference from an academia, processing, harvesting, environmental or governmental agenda all of the topics covered will be of relevance. Our goal is simple, to ensure the fishing industry continues to FLOURISH, so that all of us are NOURISHED!

We're planning a program to cover seafood quality, contaminant issues, nutrition & health benefits, regulations and marketing issues. Visit the conference website for the call for papers and further details, http://www.pft2005.org/. Contact is ralph.drew@pft2005.org.

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

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

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

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

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

The objectives of the conference are to i) provide an assessment of the dependence of farmers and fishermen on coastal zone resources, and the ecological implications of resource use based on case studies and participants' experience; ii) identify processes in, and tools for managing the land-water interface for solving agriculture-fishery-aquaculture-ecosystem conflicts in coastal areas; iii) exchange the findings on land-water interface management from case studies in various countries; iv) develop concept notes on comprehensive assessment frameworks for coastal zones and identify research collaboration opportunities. Expected outputs of the conference will include publication of papers in the conference proceedings, and key messages and supporting research will form input into the Comprehensive Assessment process, identification of actions that can be taken, future research needs, and collaborative efforts to solve problems.

The conference is organized by the World Fish Center, International Rice Research Institute, International Water Management Institute, People's Committee of Bac Lieu Province, Vietnam and Can Tho University, Vietnam For more information, contact Dr Chu Thai Hoanh, IWMI, email cthoanh@cgiar.org.

Sustain Fish 2005, 23-25 March 2005, Cochin, India

Sustain Fish 2005 will provide a forum for meaningful deliberations on various issues plaguing fisheries and to find solutions for improving the sustainability of fish production systems. It will also examine the technological appropriateness of fishing and rational utilization of fishery resources for providing quality protein to the ever-growing human population at lower costs. The main thrust areas for discussions will be: 1. Wild fish stock management; 2. sustainable aquaculture; 3. technology, quality and safety of seafood; 4. socio-economics and marketing; and 5.

policies and regulations. Call for abstracts: The deadline for submission of abstracts is 31 December 2004. For further information about the conference and abstract submission, visit http://www.sustainfish2005.com, or contact: The Convener – Sustain Fish 2005, School of Industrial Fisheries, Cochin University of Science and Technology, Fine Arts Avenue, Cochin 682 016, India, Tel +91 484 235 1029, Fax +91 484 235 1029, email info@sustainfish2005.com.

Marine and Freshwater Toxins Analysis, 11-14 April 2005, Baiona, Spain

The symposium will address new developments and validation efforts in the analysis of marine and freshwater toxins, and is held as a joint meeting with the AOAC Task Force on Marine and Freshwater Toxins.

Presentations will address special needs of the community from toxin monitoring to new concerns in the intentional contamination of food and water. The conference venue is the University of Vigo, in new on-site conference facilities. The University, home to the Department of Analytical and Food Chemistry, is located near Baiona and Vigo in the Galicia region of northwestern Spain. In addition to being the largest European producer of mussels, shellfish-rich Galicia is also a very beautiful and historic area. In addition to contributed posters and oral presentations, there will be several keynote presentations and opportunities to discuss state of the art detection methods. The symposium will also offer unique opportunities to presenters and attendees:

- To learn more about the Marine and Freshwater Toxins Task Force and how to contribute to this new and exciting effort to foster the development and validation of powerful and practical methods for toxin analysis, and greater availability of toxin standards.
- A forum to meet with international members of the seafood industry, their associations, and also regulatory agencies. These stakeholders, who are the ultimate users and/or benefactors of the analytical methodology, will also find that the symposium and Task Force can be used to express their needs.
- To observe or participate in the activities of focused subgroups in the areas of saxitoxins, diarrhetic toxins, yessotoxins, domoic acid, and others. Subgroups have proven to be the most effective means of developing methodology needs and validation strategies. Symposium presenters and attendees are welcome to attend.

For more information contact james.hungerford@fda.gov or visit: http://www.aoac.org/marine_toxins/task_force.htm

Asian Aquafeeds 2005, 12-13 April 2005, Kuala Lumpur, Malaysia

Asia aquafeed production is estimated at 5.4 million tonnes in 2002. In view of the scale of this industry and that formulated feeds can comprise up to 60% of the total production cost in intensive aquaculture operations, more efficient technologies must be developed to convert raw materials into aquaculture produce.

The 2-day seminar is planned with the aim of bringing together industry stakeholders within the field of aquaculture feed production to discuss the latest available technologies and resources so as to create a sustainable strategy for the growth and development of aquaculture in Asia. The seminar will be of interest to fish and shrimp feed producers, nutritionists, feed mill operators, feed milling and processing equipment suppliers, feed ingredient suppliers, as well as researchers, aquaculture producers and policy makers. Call for papers: Oral papers, posters and abstracts will be in English. Oral presentations are by invitation only. Abstracts are invited for poster presentations. Presenters are invited to submit abstracts, not exceeding 250 words. Dateline for the submission of abstracts is January 31st 2005. Format for the presentations can be obtained on request by email to wkng@usm.my or ngwingk@yahoo.com. Acceptance of papers will be at the sole discretion of the Technical Committee.

For further information, visit http://www.vet.upm.edu.my/~mfs, email myfisoc@time.net.my or contact: Asian Aquafeeds 2005, Malaysian Fisheries Society, Aquatic Animal Health Unit, Faculty of Veterinary Medicine, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, Telephone : + 603-8946 8288, + 604-6533 888 Ext:4005, Fax : + 603-8948 8246. A brochure/registration form is available for download from: http://www.enaca.org/PDF/Aquafeed2005brochure.pdf

World Aquaculture 2005, 9-13 May 2005, Bali, Indonesia

It's the biggest aquaculture conference on the planet and in 2005 it will be held in Bali, Indonesia. WAS 2005 will create a unique opportunity to meet farmers, scientists and government regulators from every corner of the globe. An international trade show will be held simulteously. For more information, including a downloadable conference brochure, abstract submission and registration details visit the WAS website, http://www.was.org.

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

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

What's New in Aquaculture

News

FDA Bioterrorism regulations: Record keeping requirement

The U.S. Food and Drug Administration (FDA) today issued final regulations on the establishment and maintenance of records to protect the U.S. human food and animal feed supply in the event of credible threats of serious adverse health consequences or death to humans or animals. FDA also issued draft guidance to FDA staff and industry, which details the internal procedures the agency will follow before requesting access to records.

This final regulation implements section 306 of the Bioterrorism Act, which directs the HHS Secretary to issue regulations requiring persons who manufacture, process, pack, transport, distribute, receive, hold, or import food to establish and maintain records. These records identify the immediate previous source of all food received, as well as, the immediate subsequent recipient of all food released.

"These records will be crucial for FDA to deal effectively with food-related emergencies, such as deliberate contamination of food by terrorists," said Dr. Lester M. Crawford, Acting FDA Commissioner. "The ability to trace back will enable us to get to the source of contamination. The records also enable FDA to trace forward to remove adulterated food that poses a significant health threat in the food supply."

The final regulation is the fourth regulation designed to increase the safety and security of the U.S. human and animal food supply under the authority of the "Public Health Security and Bioterrorism Preparedness and Response Act of 2002" (the Bioterrorism Act).

The record retention period for human foods ranges from six months to two years depending on the shelf life of the food. Records for animal food, including pet food, must be retained for one year. The maximum record retention requirement for transporters of all types of food is one year.

Records must be retained at the establishment where the activities covered in the records occurred or at a reasonable accessible location. To minimize the burden on food companies affected by the final rule, companies may keep the required information in any format, paper or electronic. All businesses covered by this rule must comply within 12 months from the date the rule is published in the Federal Register, except small and very small businesses. Small businesses (11-499 full-time equivalent employees (FTEs)) must comply within 18 months from this date, and very small businesses (10 or fewer FTEs) have to comply within 24 months from this date.

When FDA has a reasonable belief that an article of food is adulterated and presents a threat of serious adverse health consequences or death to humans or animals, any records or other information to which FDA has access must be available for inspection and copying as soon as possible, not to exceed 24 hours from time of receipt of the official request. The records access authority applies both to records required to be established and maintained by the final rule, or any other records a covered entity may keep to comply with federal, state, or local law or as a matter of business practice.

The Bioterrorism Act allows FDA to bring a civil action in federal court to enjoin the persons who fail to comply with this rule. FDA also can seek criminal actions in federal court to prosecute persons who fail to establish and maintain records, as required by the final rule.

FDA has already issued three other final regulations under the Bioterrorism Act, which are in effect. They cover:

- Registration foreign and domestic food facilities;
- Prior notice of food shipments imported or offered for import into the U.S.; and
- Administrative detention, so that food products that might pose a threat of serious adverse health consequences or death may be detained.

FDA will be holding seven public meetings in January and February 2005 to explain the requirements of the final rule to interested parties and answer questions.

Registration is on a first-come, first served basis. Additional information on how to register for one of the public meetings or information about all four rules designed to protect the U.S. food supply is available from the FDA website at http://www.fda.gov/oc/bioterrorism/bioact.html.

EU To Relax Restrictions On Indonesian Shrimp Imports

The European Union (EU) which has been strictly regulating the tolerable limits of antibiotic residue in shrimp from Indonesia, intends to relax its restrictions, said Mr. Sumpeno Putro, spokesman of Maritime Affairs and Fisheries Ministry. The antibiotics whose tolerable limit had been lowered by the EU were chloramphenicol and nitrofuran, he added.

"Previously, the EU had required that shrimp to be allowed to enter its markets must be free of those two antibiotics or zero tolerance," he said. However, he said, the EU had recently decided that the detection limit of detection instrument for cloramphenicol was as high as 0.3 part per billion (ppb) and nitrofuran 1.0 ppb. Therefore, Sumpeno said, as long as shrimp exports to the EU did not pass the tolerable limits they would be tolerated. He said with the new regulation, it would be easier for Indonesia to export shrimps to EU. Source: Antara - The Indonesian National News Agency, November 12, 2004.

Continued from inside front cover...

reefs, fish or manage small-scale aquaculture, as part of their livelihoods.

Since that time NACA has worked to support the livelihoods of many people across Asia Pacific who manage aquatic resources, especially those who are vulnerable, have few assets and limited influence. The network and the initiative in particular, now work with partners to facilitate the development of institutions and policies that support the livelihood objectives of farmers and fishers.

Many of the groups that rely upon coastal and inland aquatic resources are extremely disadvantaged; many more in coastal areas of Bangladesh, India (including the Andaman and Nicobar Islands), Indonesia, The Maldives, Myanmar, Malaysia, Sri Lanka, The Seychelles, Somalia, Tanzania and Thailand now collectively face challenges of apocalyptic proportions. Hundreds of thousands have suffered trauma and bereavement; around 1.8 million have no home; support networks, governance structures, towns, farms and boats are destroyed. Critical near shore reef, mangrove and sea grass habitats may be damaged and many coasts eroded; in places water and land have become salinized. Short and longer term income streams associated with activities in coastal towns, industries and tourism have been disrupted.

SPIRIT

From the earliest news, offers of assistance began pouring into NACA from our partner organizations and colleagues all over the world. The response has been truly overwhelming and it has rapidly become apparent that a tremendous will to act and pool of expertise exists in the international fisheries and aquaculture community.

To focus the collective effort, NACA, as part of a strategic response, has established a *Special Program in Response to Impacts of the Tsunami* (SPIRIT). Through SPIRIT, NACA will work with its partners and through CONSRN to support community development projects that will help people to rebuild their livelihoods and become self-sufficient. Such activities will target reconstruction and development of livelihoods that are based on aquaculture, coastal fisheries and other aquatic resources. Contributions to support NACA SPIRIT have been made by both organizations and individuals and include:

- Volunteering of professional and technical services: In-kind contributions from people who wish to donate their time,
- Donations of money to a Coastal Livelihoods Rehabilitation Fund, established to support SPIRIT activities,
- Programs and projects with other entities that will be implemented by or in collaboration with NACA and/ or CONSRN.

The 'Special Program in Response to Impacts of the Tsunami' intends to use this support, in the first instance, to contribute to the reconstruction of institutions affected by the recent tsunamis, with a particular emphasis on helping them to support the livelihoods of nearby coastal communities that depend upon aquaculture, and fisheries. This will be achieved by working with existing or natural partners of NACA, and supporting them to link with and underpin the actions and efforts of the communities that they serve. It is intended that this will help to fulfil some immediate needs of institutional and community reconstruction, build community support mechanisms that will sustain in the medium and long term and naturally foster stronger outreach tendencies in the culture of re-emerging institutions.

Aquaculture Asia

As efforts to rebuild the livelihoods of coastal communities get underway, Aquaculture Asia will document the stories of farmers and fishers with a view to sharing the successes and hard lessons learned during reconstruction. A myriad of difficult issues are certain to emerge, and we will work to stimulate debate and to share the solutions and experiences of coastal communities and the people working with them with you, our readers. Ed.

WORLD AQUACULTURE 2005

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