ISSN 0859-600X

Volume XII No. 4 October-December 2007

AQUACULTURE ASIA

New freshwater aquaculture practices in Myanmar

Kolleru carp culture in India: A different kind of boom

Business approach to national broodstock centres

Crawford®

Providing Claims Services to the Aquaculture Industry

- Algae blooms
- Disease
- Large scale
- Weather losses
- Mass escape
- Non-compliance
- Pollution & Environmental contamination
- Predators
- Super chill
- Theft
- Damage to equipment, cages, moorings

A global network of offices in 63 countries, provides local expertise in a rapidly growing aquaculture industry.

Specialists available in Australia, Canada, Chile, China, Greece, Holland, Hong Kong, Italy, Norway, Spain, South Africa, UAE, United Kingdom and United States.

For more information contact Mark Vos, tel: + 31 6 21 544 344 or markvos@crawco.nl

2006 The CIPS Supply Management AWARDS FINALIST

INSURANCE DAY LONDON MARKET AWARDS 2006 WINNER

THE BRITISH INSURANCE AWARDS 2006 FINALIST

Insurancetimes awards 2006 finalist Loss Adjuster of the Year

EXCELLENCE IN EVERYTHING WE TOUCH℠

Crawford®
www.crawfordandcompany.com

Crawford & Company | Trinity Court | 42 Trinity Square | London | EC3N 4TH | Tel: 020 7265 4000

AQUACULTURE ASIA

Volume XII No. 4
October-December 2007

ISSN 0859-600X

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

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

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

Printed by

Scand-Media Co., Ltd.

Live with what you've got

The aquaculture industry seems to have a fascination with alien species. If we haven't got it, then we have to have it! There seems to be a feeling that if a species is highly successful in other countries then perhaps we are somehow missing out on a major commercial opportunity by not farming it here - and exporting it back!

Many countries in the region continually and actively seek to import 'new' species. The problem is that they just aren't being careful enough. The principles of import risk analysis are well understood and 'signed onto' by most countries in the region, but unfortunately when it comes time to implement them the principles are shown the door. It is an unfortunate truth that the majority of alien species introductions in Asia still take place in an ad-hoc 'try it and see' manner, with no regard for the potential consequences.

There have been a few big 'success' stories, sure. *Penaeus vannamei* is arguably a success in that in the space of a few years it has come to dominate production of farmed shrimp in Asia, having more-or-less displaced production of the indigenous *Penaeus monodon*. However, it hasn't all been good news. Introduced without adequate care or control, the alien white shrimp brought with them some unwelcome alien passengers – serious viral pathogens such as Taura syndrome virus to further trouble an already struggling industry. Losses due to disease in shrimp aquaculture are a multi-billion dollar problem and the impact of whitespot and yellowhead were well known. So why were people so complacent about introducing new species from elsewhere?

Disease issues aside, alien species have the potential to become serious pests. There are many examples of this. Rainbow trout – one of the all-time translocation favourites – has caused serious declines and even extinction of indigenous fish species in some areas where it has been introduced. Taking *P. vannamei* again, these are now commonly found in the wild in some countries – whether they are escapees from aquaculture or have established breeding populations is not known – and neither is whether they are competing or adversely affecting indigenous shrimp or other species.

Economic issues also need more attention. The effect of most of the region switching to vannamei at the same time prices has been a massive boom in production – and a massive slump in prices, causing serious financial hardship for many farmers. Are they really better off now, than they were five years ago? It is worth noting that those countries that 'dared to be different' and kept farming their indigenous monodon have escaped this effect, at least to some extent.

Asia has an astronomical number of indigenous aquatic species, and many that have some potential for aquaculture. Why do we continue to look abroad when we have so much in our own backyard? What more could we possibly need?

Simon Wilkinson

AQUACULTURE ASIA

In this issue

Sustainable aquaculture

Page 5.

Genetics and biodiversity

Page 12.

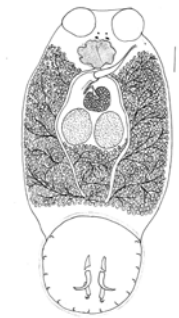
Research and farming techniques

Page 22.

Asia-Pacific Marine Finfish Aquaculture Network Magazine

Page 28.

NACA Newsletter



Page 40.

A different form of dumping: The need for a precautionary approach for yet another new species for shrimp farming in Asia

Sena S. De Silva, C.V. Mohan and Michael J. Phillips
Network of Aquaculture Centres in the Asia-Pacific, PO Box 1040, Kasetsart Post Office, Jatujak, Bangkok 10903, Thailand

The shrimp farming sector in the Asia-Pacific region is one of the most lucrative of all aquaculture sectors. The sector went through a difficult period when over intensification, environmental degradation and other factors led to the emergence and establishment of many viral diseases in *Penaeus monodon*, the backbone of production in the past. To keep the sector alive, some nations introduced the exotic *P. vannamei*, and the use of specific pathogen-free (SPF) broodstock was seen as a means of combating these disease problems. However, many of the viral diseases that had affected *P. monodon* were also found to affect *P. vannamei*, and to rub salt into the wounds, new viral diseases that were never present in the region have also begun to appear. Despite this experience, there is now advocacy towards introduction of yet another exotic species, *P. stylirostris*, for which SPF broodstock have been developed. Again introductions seem to be poised to occur with out any consideration of the long term effects on biodiversity, disease risk or other potential environmental impacts. This article calls for a precautionary approach and proper analysis of risks before, rather than after, the potentially damaging widespread new shrimp introductions.

Dumping, in aquaculture terms, occurs when exporters flood a market with a low priced cultured commodity, at a price which is either below the price in its home market or is below its cost of production. Cases in point are the well publicized (and sorely contested) 'anti-dumping' cases against exports of tra (*Pangasianodon hypophthalamus*) and basa (*Pangasius boccourti*) and the export of shrimp from Asian and Latin American countries into US markets. In general, with regard to this form of dumping, which is essentially a trade and fair pricing issue, producing countries have a forum to turn to settle disputes which is the WTO - at least when they are members of the WTO.

What is pointed out in this article is not in respect of commodities as mentioned earlier but a new form of "dumping" which could occur with widespread introduction of new species. The term "dumping" is justified because the commercial transactions associated with such introductions in the region often do not take account of the potential environmental and biodiversity costs, and therefore an environmental subsidy is being provided by the host nation for the environmental impacts that may result.

The senior author recently attended the Indonesian aquaculture meeting, Indo Aqua 2007, Bali, Indonesia, and was surprised and perturbed by the promotion of *Penaeus stylirostris* as a new species for aquaculture in the region, as means of counteracting the emerging problems with *Penaeus vannamei*. Mention of this new species is also appearing in some trade magazines. The controversies are well known with regard to the introduction into certain countries of *P. vannamei,* a species that is alien to Asia, as a means of reviving the shrimp aquaculture sector that was based on the indigenous *P. monodon* which unfortunately succumbed to various disease problems. Even to date, in spite of the very high production of *P. vannamei* and the economic returns thereof, certain countries in the region such as India and Vietnam (in the southern region) have endeavored to revive the culture of *P. monodon* through the adoption of improved farming practices, and resisted the introduction of *P. vannamei*. The positive impacts of the former and the benefits it has brought to small scale shrimp farmers in such countries (Briggs *et al*, 2004) are well documented, although farmers of both *P. vannamei* and *P. monodon* are facing considerable problems due to downward price pressures associated with large volume *P. vannamei* production. All this is essentially history and whether *P. vannamei* impacts on biodiversity in Asia is yet to be seen and or proven, although there is evidence that the species is present in the wild and the long-term impacts can not be predicted at this stage (Senan *et al*, 2007).

It is a trend in the shrimp sector to produce specific pathogen-free (SPF) broodstock and post larvae. Such developments have primarily taken place in the West through years of enduring and carefully managed scientific research, and such stocks, including exotic species such as *P. vannamei*, have been introduced to many Asian countries. In theory, post larvae produced under strict biosecure conditions using true SPF broodstock have a higher probability of leading to a successful crop. However, this has not happened in many countries. Use of local pond-raised brood stock as 'SPF' stocks and their subsequent proliferation has led to several problems, including poor growth and increased occurrence disease outbreaks.

For obvious reasons, introductions of the so-called true SPF broodstock has also not always happened and is evident by the fact that in many *P. vannamei* culturing countries of the region, Taura syndrome caused by Taura syndrome virus (TSV), has been officially documented. In recent years, another exotic viral disease caused by infectious myonecrosis virus (IMNV) has also been reported from the region (NACA/FAO 2006). These disease problems only confirm, yet again, that introductions, especially of exotic species for aquaculture, always carry a risk of also introducing exotic pathogens, in addition to possible impacts on biodiversity in the long term (Flegel, 2006). The region which had to cope with WSSV for a long time has now to deal with two more dangerous exotic viruses, which have the potential to inflict long term damage on the shrimp industry. The cryptic nature of

crustacean viruses and their ability to cause multiple infections raises important issues to be addressed when considering the trans-boundary movement of crustaceans, including SPF/ SPR stocks.

The Regional Aquatic Animal Health Advisory Group of NACA has repeatedly expressed concern about TSV in Asia, especially because the pathogen is spreading and changing genetically. This could conceivably lead to changes in virulence, not only in *P. vannamei* but also in the susceptibility of local crustacean species. The high number of variants of TSV represents a threat of unknown proportions to native species. IMNV, which was known to occur only in Brazil (first reported in Brazil in 2002), has now been reported from the region in June 2006 (NACA/FAO 2006).

If one examines the reasons for introductions, it becomes obvious that many national governments, producers and related aquaculture businesses, when faced with the prospect of continuously losing crops of *P. monodon* due to disease problems (e.g., white spot disease, monodon slow growth syndrome), naturally decided to try alternative species, but unfortunately without giving due considerations to the potential long term impacts of such introductions. In the race to produce large volumes of shrimp for a hungry market, the precautionary approach and risk management measures (e.g., import risk analysis, biosecurity measures) were not given a priority. Added to this, the availability of SPF broodstock provided a strong justification for many governments and shrimp producers to advocate introduction of non-native *P. vannamei*. On the production side, this species has done very well in the region. This cannot be denied - but the disease impacts are only beginning to emerge.

In response to the developing problems with *P. vannamei* culture, there is now emerging commercial advocacy for wider introductions of *P. stylirostris,* another exotic species to the region, apparently because of the existence of strains resistant to IHHNV and TSV. This species is already present in Asia, to a small extent and has been tried on an experimental scale in some countries, but again our understanding of pathogens and the potential impacts on biodiversity are still an insufficient basis for large scale introductions for farming.

Another issue that governments and business must consider in their decision-making is the risk of developing total dependency as SPF stock need to be introduced on a regular basis to meet the seed demands of the industry (SPF lines must be maintained in a biosecure environment to retain their status) and to avoid in-breeding and consequent loss of production performance. This may not be the best approach for the shrimp sector, if it has to survive in the competitive world. The same approach is even emerging for SPF *P. monodon* that are being introduced into Vietnam and elsewhere. Although the development of SPF *P. monodon* broodstock is to be applauded, the technology should be developed and widely adopted within the region to promote self reliance and the availability of local supplies. The solution perhaps lies in a consolidated approach in the region; the private sector and governments of the shrimp producing nations should invest more substantially in development of SPF broodstock of *P. monodon* and other local species, rather than developing a reliance on SPF stock from outside of the region. Such programs are currently under development in several countries.

So, just as *P. monodon* faced viral disease problems, the same is beginning to happen with *P. vannamei.* What is the solution? Should the solution be to (a) revive the culture of *P. monodon*, (b) try to live with *P. vannamei* and do the needful to avoid potential environment impacts and emerging disease problems and/or (c) introduce a new species alien to the region as advocated by the proponents of SPF broodstock of species such as *P. stylirostris*; in common parlance to keep on changing the pillow to get rid of the headache!!!

Obviously, the advocacy for large scale introduction of SPF *P. stylirostris* is almost totally commercially driven without obvious concern for the risks associated with long term environmental integrity and biodiversity (apart from its non-suitability for culture in Asia on the grounds of performance and the like). It is hoped that governments in the region pay careful attention to the need for proper risk analysis and biosecurity measures, and will not be content with a patchwork solution to a problem. Some questions which stakeholders must consider:

- Did the introduction of stocks of the alien species *P. vannamei* (both SPF and non-SPF) provide any long term solutions to the disease problems, or did it in fact make the situation worse by introducing additional pathogens to trouble farmers?
- Will the introduction of another exotic species to the region do any good?
- Has the long term impact of *P. vannamei* on local biodiversity been properly assessed and understood?
- What prevents us from reviving the native *P. monodon* industry?

We reiterate the position that patchwork and short term reactive solutions to problems are not the answer. We are dealing with intricate biological systems. We are duty-bound to future generations to preserve biodiversity in our ecosystems as it is the foundation of life on earth and at the heart of a healthy planet. Let us not heed to short term commercial gains (and consider who the real beneficiaries will be) and be misled by various new claims about *P. stylirostris*. It is regrettable that, although the commercial advantages of the introduction of SFP shrimp are well advertised (e.g., Wyban, 2007), the emergence of new diseases in the region associated with the introduction, and or long-term potential impacts on biodiversity are rarely or never addressed. Indeed, Briggs *et al.* (2004) pointed out the lack of caution by the private sector as opposed to the position of Asian governments.

This article has attempted to be forthright. We fear that some Asian nations will again be drawn into widespread introduction of yet another species of shrimp, with no concerns on long term impacts. NACA's interest as an intergovernmental organization is the long term sustainability of the aquaculture sector in the Asia-Pacific region, and the millions of small scale farmers who make a livelihood from aqua farming and who have been productive enough to provide over 40 percent of the food fish consumed globally at present. Let us ensure a careful and rigorous, science-based analysis and appropriate management measures put in place, before we see yet another new species, introduced and spread, leading to unforeseen future problems for the sector and the region's biodiversity.

References

NACA/FAO (Network of Aquaculture Centres in Asia-Pacific/Food and Agriculture Organization of the United Nations). 2006. Quarterly Aquatic Animal Disease Report (Asia and Pacific Region) 2006, 3 July-September 2006. NACA, Bangkok, Thailand. On-line version, http://www.enaca.org/modules/wfsection/article.php?articleid=7).

Flegel, T.W. (2006) The special danger of viral pathogens in shrimp translocated for aquaculture. Science Asia 32: 215-221. http://www.scienceasia.org/2006.32.n3/v32_215_221.pdf.

Briggs, M, Funge-Smith S., Subasinghe, R. and Phillips, M. (2004) Introductions and movement of *Penaeus vannamei* and *Penaeus stylirostris* in Asia and the Pacific. RAP publication 2004/10. Food and Agriculture Organization of the United Nations Regional Office for Asia and the Pacific, Bangkok, 2004, 70 pp.

Senan, W., Tangkrock-olan, N., Panutrakul, S., Barnette, P., Wongwiwatanawute, C., Niphonkit, N., Anderson, D.J. (2007, in press). The presence of the Pacific white leg shrimp (*Litopenaeus vannamei* Boone, 1931) in the wild in Thailand.

Wyban, J. 2007. Thailand's shrimp revolution. Aquaculture Asia-Pacific, Magazine, May- June 2007, 15-18.

Sustainable livelihoods of pangus farming in rural Bangladesh

Nesar Ahmed[1] and Mohammad R. Hasan[2]

1. Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh; E-mail: nesar_2000@yahoo.com; 2. Fishery Resources Officer (Aquaculture), Aquaculture Management & Conservation Service, Fisheries and Aquaculture Department, Food and Agriculture Organization, Rome, Italy; E-mail: Mohammad.Hasan@fao.org.

Development of aquaculture has generated considerable employment opportunities in Bangladesh through the production and marketing of fish and associated activities. Around 400,000 ha of freshwater ponds/ditches and more than 900,000 households are involved in aquaculture (ADB, 2005). Conditions are highly favorable for the rapid expansion of aquaculture as the quantity of seed produced has risen rapidly in recent years (Muir, 2003). Bangladesh is considered one of the most suitable countries in the world for small-scale freshwater rural aquaculture, because of its favorable resources and agro-climatic conditions. Over the last three decades, there has been a steady increase in inland freshwater aquaculture production. In Bangladesh, total fish production was estimated at 2.2 million tons in 2005 of which 882,091 tons (40%) were from inland freshwater aquaculture, 859,269 tons (39%) from inland capture fisheries, and 474,597 tons (21%) from marine fisheries (DOF, 2006).The main production systems for freshwater aquaculture in Bangladesh are extensive and semi-intensive pond polyculture of carps which accounts for 80% of the total freshwater aquaculture production (ADB, 2005; Ahmed, 2005). The remaining 20% are mainly from pangus, tilapia, small indigenous species (SIS) of fish and rice-fish farming (Muir, 2003). A current focus is on promoting pangus farming for food supply, increase income, and employment opportunity – all of these are important parameters of sustainable livelihoods.

Sutchi catfish, *Pangasianodon hypophthalmus* is an indigenous fish species of Thailand, living in the Mekong River (Roberts and Vidthayanon, 1991). The origin of pangus was from the Mekong River of Vietnam to the Chao Phraya

River of Thailand and then their distribution was spread to other countries such as Malaysia, Indonesia and China. It was introduced to Bangladesh from Thailand in 1989 (Banglapedia, 2006). Because of its introduction from Thailand the fish is popularly known as Thai pangus.

There is a great potential for Thai pangus culture in Bangladesh. The climate, water and soil conditions of Bangladesh have proved totally suitable for pangus production. Pangus is one of the most suitable catfishes for rearing in ponds. Pangus culture has proved itself as a profitable enterprise due to year round production, quick growth and high productivity. In addition, pangus can be stocked at a much higher density in ponds compared to other cultivable species (Ali et al., 2005). There is a huge demand for pangus in local markets, because of lower market price. Moreover, the vast majority of poor people consume pangus as this fish is delicious and tasty due to its high fat content. A large number of rural poor, most of them living below the poverty line, find employment in the pangus production and marketing systems. This study sought to broadly understand the livelihoods of pangus farmers and associated groups.

Methodology

Study area

The primary area for the study was Bhaluka upazila (sub-district) under Mymensingh district, situated in the north-central part of Bangladesh. Mymensingh district is divided into 12 upazilas. Among them only Bhaluka upazila was selected for this study since it is an important area for pangus farming due to the availability of hatchery-produced fry, favorable resources and climatic conditions such as the availability of pond, warm climate, cheap and abundant labor, and favorable socio-economic conditions. In addition to these, farmers of this area got training on pangus farming with the help of the Mymensingh Aquaculture Extension Project (MAEP) which was financed by the Danish International Development Assistance (DANIDA). This upazila was therefore selected for this study.

Data collection methods

A combination of participatory, qualitative and quantitative methods was used for data collection. Data were collected for five months from October 2005 to February 2006. The Participatory Rural Appraisal (PRA) tool Focus Group Discussion (FGD) was conducted with pangus farmers and associated groups (fry traders, fish traders, transporters

A typical pangus farm.

A series of ponds – pangus farming is expanding rapidly due to high economic return.

Pelleted feed is wide used for commercial pangus farming.

Construction of ponds - employment opportunity for the rural poor.

and day laborers). FGD was used to get an overview of particular issues such as existing practices of pangus farming, socio-economic conditions and livelihood situation. A total of 10 FGD sessions were conducted where each group had 6 to 12 persons and duration was approximately two hours. For questionnaire interviews, a total of 60 farmers were conducted. Farmers were interviewed at their houses and/or farm sites. The interviews focused on farming systems, production technology, productivity, production constraints, and livelihood outcomes. The DFID (Department for International Development) sustainable livelihoods framework (DFID, 1999) was applied to structure the analysis of collected data (Figure 1).

Livelihood strategies

The livelihoods of a large number of small and marginal farmers are associated with pangus production in the study area. Pangus farming was first started in 1998 in Bhaluka upazila of Mymensingh district. Before pangus farming, most farmers were involved in fry rearing, tilapia farming, integrated rice-fish farming, etc and a few were involved in carp polyculture, although this area is not suitable for carp farming due to lower soil fertility. The vast majority of respondents (90%) produced pangus because of its profitability although few farmers cultured for their own consumption.

According to the survey, all interviewed farmers were observed to practice monoculture of pangus in the study area. The peak season of pangus farming is from March to December/January. The majority of farmers stocked their ponds from as early as March to May and harvested their fish at least three months after, and subsequently at intervals until the end of the year. In general farmers practiced three categories of farming systems namely: i) intensive, ii) semi-intensive, and iii) traditional. Pangus farms based on traditional feeding practice generally use supplementary diets consisting of mixture of locally available feed ingredients such as rice bran, wheat bran, oil cake, etc. Farmers with intensive feeding practice depend on commercially manufactured pelleted feeds while a semi-intensive category refers to a feeding system on farm-made aquafeed, i.e., mixture of feed preliminary comprised of rice bran, wheat bran, oil cake, fish meal, flour, dried fish, oyster shell, salt, and vitamins.

Regardless of farming systems, the average annual stocking density of fingerlings was estimated at 23,847 per ha. Most respondents reported multiple stocking while few farmers (mainly traditional) stocked once per year. Little pond preparation measures such as dike repairing, removal of aquatic weeds and predatory fish were undertaken by the pangus farmers before the stocking of fingerlings.

Most of the farmers used fertilizers for grow-out of pangus. The purpose of using fertilizers in the pond is to create conditions which would help to increase the growth of natural food (e.g., phytoplankton, zooplankton and benthos) thereby increasing fish production. In general, farmers used two types of fertilizer namely organic (cow dung) and inorganic - urea and triple super phosphate (TSP). According to the survey, 60% of farmers used cow dung, 57% urea and 43% TSP at varying frequencies. On average, annual fertilization rates were estimated at 903 kg/ha of cow dung, 259 kg/ha of urea and 192 kg/ha of TSP (Table 1).

The productivity of pangus is closely related to feed inputs. Supplementary feeds were used by all of the farmers for pangus farming. On average the annual quantity of feed supply was estimated at 13,723 kg/ha. These days industrially produced commercial fish feeds are

Feeding of pangus.

Live pangus in a market.

widely used to increase pangus production in the study area. All respondents under intensive farming system were found to use industrially manufactured pelleted feeds.

The average annual yield of pangus was estimated at 8,343 kg/ha. The productivity of pangus is significantly higher than carps. The annual yield of carps in the greater Mymensingh area averaged 3,300 kg/ha (Winrock International, 2004). Responses concerning the reasons for increased pangus productivity included an increased supply of feed and quality fry, maintenance of water quality, disease control, and overall better management of the pond.

A large number of rural poor are involved in the domestic pangus marketing chain as local agents, traders, intermediaries, day laborers and transporters. The domestic market chain from farmers to consumers encompasses mainly primary, secondary and retail markets, involving sales agents, suppliers, wholesalers and retailers. In general, trucks and pickups are used to transport live pangus to the markets. Plastic containers with water are commonly used for keeping the pangus during transport. Pangus are traded whole, un-gutted, and fresh without processing. The price of pangus depends on quality, size and weight, seasonality, market structure, supply and demand, and taste. The average farm-gate price of pangus was estimated at US$ 0.62 per kg.

Livelihood assets

Different combinations and components of capital assets are required for people to engage in pangus farming in rural Bangladesh. The sustainable livelihoods framework draws attention to five types of capital upon which pangus farmers' livelihoods depends: human, natural, financial, physical and social (Scoones, 1998; DFID, 1999).

i) Human capital

Human capital represents the skills, knowledge, ability to labor and good health that together enable people to pursue their livelihood strategies (Ashley and Carney, 1999). As well as being of intrinsic value, human capital is required in order to make use of any of the four other types of asset (Carney, 2002). It is therefore necessary, though not on its own sufficient, for the achievement of positive livelihood outcomes. In the pangus farming sector, people are moderately healthy and they have built up skills through their own knowledge and in some cases through the technical assistance from DANIDA-funded MAEP. Respondents from questionnaire interviews had an average of 5.6 years of experience in pangus farming. Most farmers were quite young, with an average age estimated at 39 ranging from 29 to 50. Amongst the surveyed group of pangus farmers, the reported illiteracy rate was found to be 58%.

Pangus farming has generated employment opportunity for day laborers.

A fish trader with pangus.

ii) Natural capital

Natural capital of pangus farming represents the natural resources - land, water and wider environmental goods that are stable for farmers to support production. However, rapid population growth in fish farming communities have led to accelerated natural capital depletion that has affected pangus production as well as income. According to the survey, most of the households (87%) had a single pond, and the remainders (13%) had two ponds. The average area of pond was found to be 0.23 ha. Farmers relied on rainfall and ground water for pangus farming.

iii) Financial capital

Financial capital denotes the financial resources that people use to achieve their livelihood objectives. Financial capital of pangus farming represents the incomes, savings, credits, etc. The pangus culture industry has the potential to generate considerable amounts of financial capital. Across the study, the average annual net return from pangus farming was estimated at US$ 2,170 per ha (Table 1). Almost all respondents reported pangus farming to be their primary occupation and their major incomes to come from pangus farming, on average 71% of their total income. In the study area, 70% of respondents used their own money for pangus farming, while the rest received small loans from various sources such as moneylenders, fish traders, NGOs, and banks. The average amount of credit received by a farmer was estimated at US$ 220 per year.

Transporting feeds by a van.

Local branches of national banks provide credit to the pangus farmers. The Grameen Bank, Bangladesh Krishi Bank and other national banks have been providing loans for developing pangus farming. The Grameen Bank, a specialized bank for micro credits that awarded the Nobel Peace Prize for 2006, is active in several villages of pangus farming areas.

iv) Physical capital

Road, transport, shelter, market etc are the physical capital of pangus farming that enables people to pursue their livelihood strategies. However, pangus farming communities are often disadvantaged due to the poor road and transport facilities, higher transport costs, poor infrastructure of markets, and lack of electricity facilities. Most of the farmers lived in very poor housing conditions, their houses typically made of mud, bamboo and paddy straw. These factors in turn affect the livelihoods of the pangus farmers.

Trucks are commonly used for transporting live pangus to the markets.

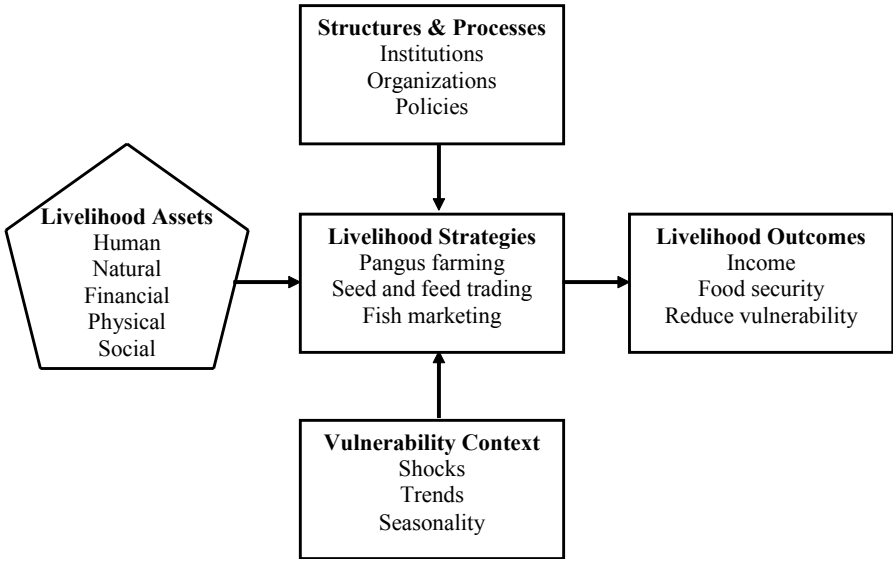
v) Social capital

Almost all community people are disadvantaged in social capital such as the networks, groups, trust, access to institutions, etc. The lack of social capital has affected livelihoods of poor people in fish farming communities. Low levels of social capital are both cause and consequence of the vulnerability of the poor. In the study area, rich farmers and wealthy people forced poor farmers to sell their pond and land. Friction between the two sides sometimes led to scuffles involving villagers. Unfavorable social environment can also pose risk of losses through poaching of fish and poisoning ponds. These incidents were reported to be significant in the study area.

Vulnerability context

The livelihoods of farmers and associated groups as previously defined in terms of capital assets are further affected by the vulnerability context. The vulnerability context refers to the shocks, trends and seasonality that have affected livelihoods of people in pangus farming communities. The external environment of pangus farming in which people exist:

Figure 1: A simplified form of the sustainable livelihoods framework (adapted from Rabbani et al., 2006).



- Shocks – illness, natural disasters (flood, drought and heavy rain), conflicts among community people, diseases of fish etc are the shocks of pangus farming.
- Trends – population trends, political trends, economic trends etc may aggravate the problem of meager incomes of pangus farming communities.
- Seasonality – of production, of prices, and of employment opportunities have affected livelihoods of poor people.

Transforming structures and processes

Transforming structures and processes are the institutions, organizations, policies and legislation that shape livelihoods. An absence of appropriate structures and processes is a major constraint to the sustainable development of pangus farming in rural Bangladesh. Many organizations - both private and public sector do not reach pangus farming areas. NGOs have not played much of a role in the development of the industry in general. Thus, lack of institutional and administrative help, inadequate extension services – all have affected livelihoods of poor farmers and associated groups.

Livelihood outcomes

In spite of poor resources, livelihood outcomes of pangus farming are positive and most farmers (90%) have increased their income, food security, and basic needs. Basic needs include drinking water, housing, health facilities and economic security. Most of the farmers have improved their social and economic conditions through pangus farming. Almost all farmers who reported improved conditions noted that before pangus farming they took food only once or twice in a day. Now farmers' households are able to eat rice three times a day and also eat better quality food. Clearly there have been visible qualitative and quantitative changes in standard of living, food consumption, and level of economic activity in the pangus farming areas. Before pangus farming, a large number of farmers lived below the poverty line. The pangus farming has increased their economic solvency and improved social status which substantially improved their livelihoods.

A range of associated groups have also benefited from pangus farming. Pangus production has generated employment opportunities for the rural poor. Improvements in the standard of living which have occurred for fry traders, fish traders, intermediaries, transporters and even day laborers including women and children. The opportunities for day laborers to find work have increased significantly due to pangus farming. Additional employment opportunities are also generated in the commercial fish feed industries, fish hatcheries, fish markets especially transport sector from rickshaw pullers to large trucks which carry pangus to local markets.

Conclusions

The pangus farming sector plays an important role in the economy of particular areas of rural Bangladesh, contributing to increased food production, diversifying the economy, and increased employment opportunities. There has been a steady increase in the production of pangus by small and marginal farmers. However, concerns arise about the long-term sustainability of pangus farming due to high production costs mainly for feed, lack of credit facilities, limited resources, poor institutional support, and inadequate extension services. It is therefore necessary to provide technical assistance and low-interest credit with institutional and policy support for sustainable pangus farming as well as for sustainable livelihoods to the farmers and associated groups.

Table 1. Inputs and returns of pangus farming in the study area.

Items		Mean	SD
Pond size (ha)		0.23	0.09
Inputs	Stocking (no./ha/year)	23,847	6,578
	Feeding (kg/ha/year)	13,723	4,892
	Fertilization (kg/ha/year)		
	Cow dung	903	241
	Urea	259	89
	TSP	192	56
Outputs	Productivity (kg/ha/year)	8,343	3,231
Feed conversion ratio (FCR = quantity of feed/ productivity)		1.64	0.41
Cost-return analysis (US$/ha/year)	Production cost (PC)	2,964	853
	Gross revenue (GR)	5,134	1,761
	Net return (NR=GR-PC)	2,170	696
Benefit-cost ratio (BCR = GR/ PC)		1.73	0.43

SD: Standard deviation

Acknowledgement

The information presented in this article is extracted from the result of a case study "the economics of aquaculture feeding systems in Bangladesh" carried out as a part of FAO Inland Fisheries and Aquaculture Service (FIRI)'s regular work program on "Study and analysis of feed and nutrients (including fertilizers) for sustainable aquaculture development". The first author is grateful for the funding support received from the FAO. The views expressed in this article are those of the authors and do not necessarily reflect the views of the FAO.

References

ADB. 2005. An Evaluation of Small-scale Freshwater Rural Aquaculture Development for Poverty Reduction. Operation Evaluation Department, Asian Development Bank (ADB), Manila, Philippines.

Ahmed, G.U. 2005. National Aquaculture Sector Overview – Bangladesh. Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy.

Ali, M.Z., Hossain, M.A. & Mazid, M.A. 2005. Effect of mixed feeding schedules with varying dietary protein levels on the growth of sutchi catfish, *Pangasius hypophthalmus* (Sauvage) with silver carp, *Hypophthalmichthys molitrix* (Valenciennes) in ponds. Aquaculture Research 36:627-634.

Ashley, C. & Carney, D. 1999 Sustainable Livelihoods: Lessons from Early Experience. Department for International Development (DFID), London, UK.

Banglapedia. 2006. Exotic Fish. Banglapedia, National Encyclopedia of Bangladesh.

Carney, D. 2002. Sustainable Livelihoods Approaches: Progress and Possibilities for Changes. Department for International Development (DFID), London, UK.

DFID. 1999. Sustainable Livelihoods Guidance Sheets. Department for International Development (DFID), London, UK.

DOF. 2006. Fishery Statistical Yearbook of Bangladesh 2004-2005. Fisheries Resources Survey System, Department of Fisheries (DOF), Dhaka, Bangladesh.

Muir, J.F. 2003. The Future for Fisheries: Economic Performance. Fisheries Sector Review and Future Development Study, Commissioned with the association of the World Bank, DANIDA, USAID, FAO, DFID with the cooperation of the Bangladesh Ministry of Fisheries and Livestock and the Department of Fisheries, Dhaka.

Rabbani, M., Prakash, V.A. & Sulaiman, M. 2006. Impact assessment of CFPR/TUP: a descriptive analysis based on 2002-2005 panel data. CFPR Working Paper Series No. 12:1-31, BRAC and Aga Khan Foundation Canada.

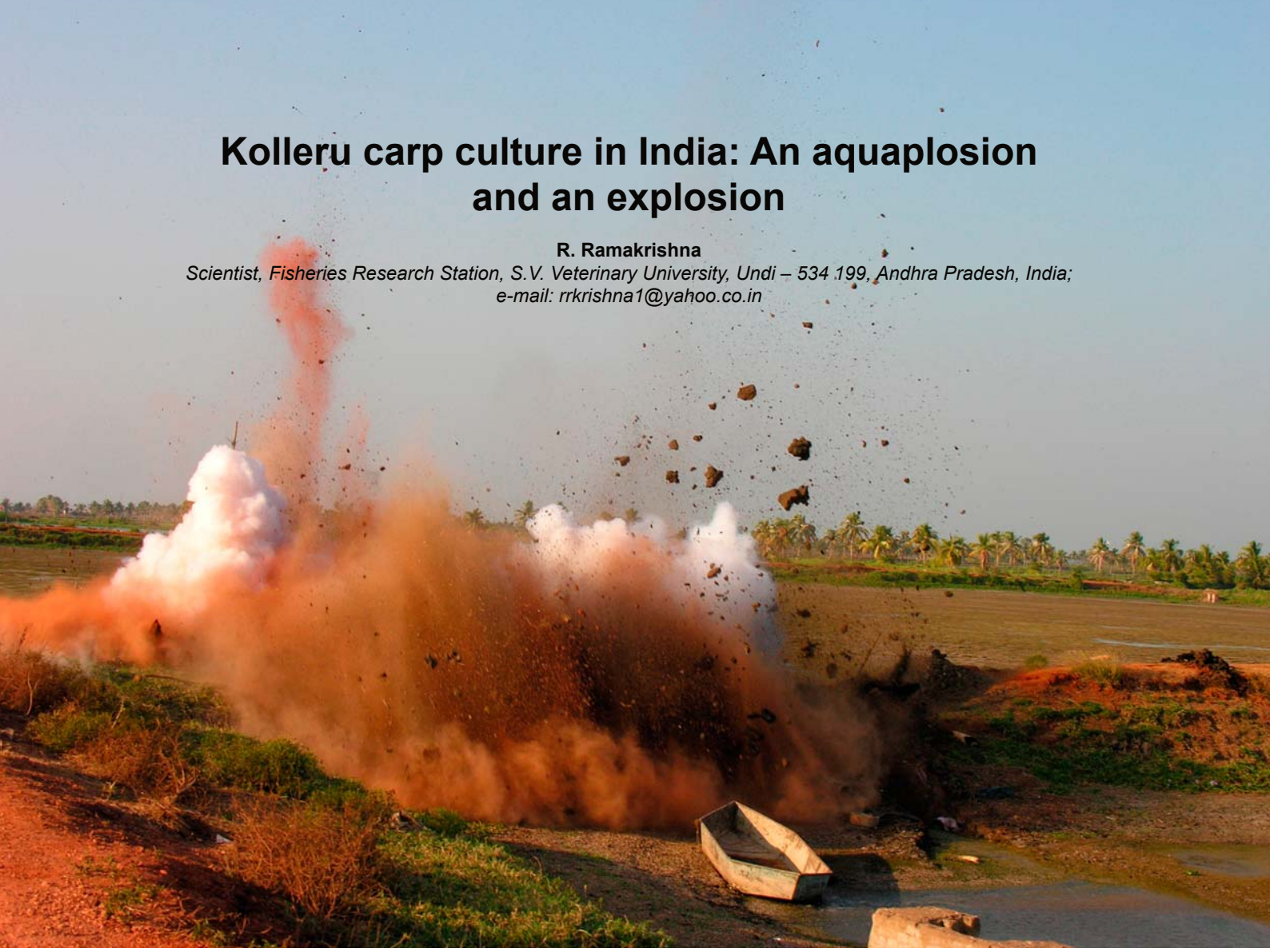
Robart, T.R. & Vidthayanon, C. 1991. Systemic revision of the Asian catfish family Pangusiidae, with biological observations and descriptions of three new species. Proceedings of the Academy of National Sciences of Philadelphia, 143: 97-144.

Scoones, I. 1998. Sustainable rural livelihoods: a framework for analysis. IDS Working Paper 72, Institute of Development Studies (IDS), Brighton, UK.

Winrock International. 2004. Mymensingh Aquaculture Extension Component Impact Evaluation Study. Winrock International, Dhaka.

Kolleru carp culture in India: An aquaplosion and an explosion

R. Ramakrishna
Scientist, Fisheries Research Station, S.V. Veterinary University, Undi – 534 199, Andhra Pradesh, India;
e-mail: rrkrishna1@yahoo.co.in



A trial blast to demolish unauthorized fish ponds encroaching a designated wildlife sanctuary.

Andhra Pradesh, an east-coastal state in southern India leads the country in carp culture, shrimp culture and also scampi culture. Indian major carp culture in earthen dug-out ponds represents the first phase of aquaculture in the state which has sustained for more than quarter of a century. Because of rapid expansion and intensification, by 2002, the carp culture area increased to about 80,000 ha[1]. Almost 98% of the carp culture in the state developed in- and around the largest fresh water lake in India, the Kolleru, which extends between the West Godavari and Krishna districts and is now recognized as the fish bowl of India. This semi-intensive carp culture system, popularly called as Kolleru carp culture, has a production range of 7.5 – 12.5 metric tones/ha/year and an annual state production of 600,000 metric tonnes, achieved by growing basically two species *Labeo rohita* (rohu), the dominant species[2], and *Catla catla* (catla), at the ratio of 80 - 90 : 10 – 20, with a rare addition of *C. mrigala* (mrigal), in heavily fed and fertilized still water ponds, supporting thousands of farmers and hundreds of thousands of people in allied industries and services. The system has become a unique model of carp culture, not only for the rest of the India, but also for other Asian countries, for example, Bangladesh and Myanmar. More specifically, for the past 15 years, the Kolleru carp culture has become a Mecca, attracting carp farmers, scientists, fishery-policy makers and administrators from other Indian states and also from several foreign countries who are interested in understanding the unique features of the system.

However, with the unprecedented development of the carp culture system, the inherent 'socio-economic-environmental' problems and user conflicts have become increasingly more severe and complex. Because of the devastating losses to agricultural crops and human habitat due to occurrence of heavy floods in September 2005, in both the districts, severe criticism arose from the general public that the fish ponds acted as obstructions and were responsible for the inundations and the consequent losses.

This grave situation prompted the public in the flood affected areas, environmentalists and other persons and parties claiming to have a serious interest in the restoration of the Kolleru lake to insist upon the Andhra Pradesh state government to implement Government Order number 120 (G.O. 120), which had been passed by the state government in 1999, declaring the area between the '0 to +5' contour of the lake as a wild life sanctuary (WLS) covering approximately 30855 ha. The order had also mandated the removal of all obstructions including fish ponds located with in this sanctuary. With the concurrence of the state government, Mr. Lav Agarwal the District Collector of West Godavari in which major portion of the Kolleru lake located, and Mr. Naveen Mittal, Krishna, started and successfully completed the Kolleru Restoration Operation (Kolleru operation) with a minimum of conflict and with

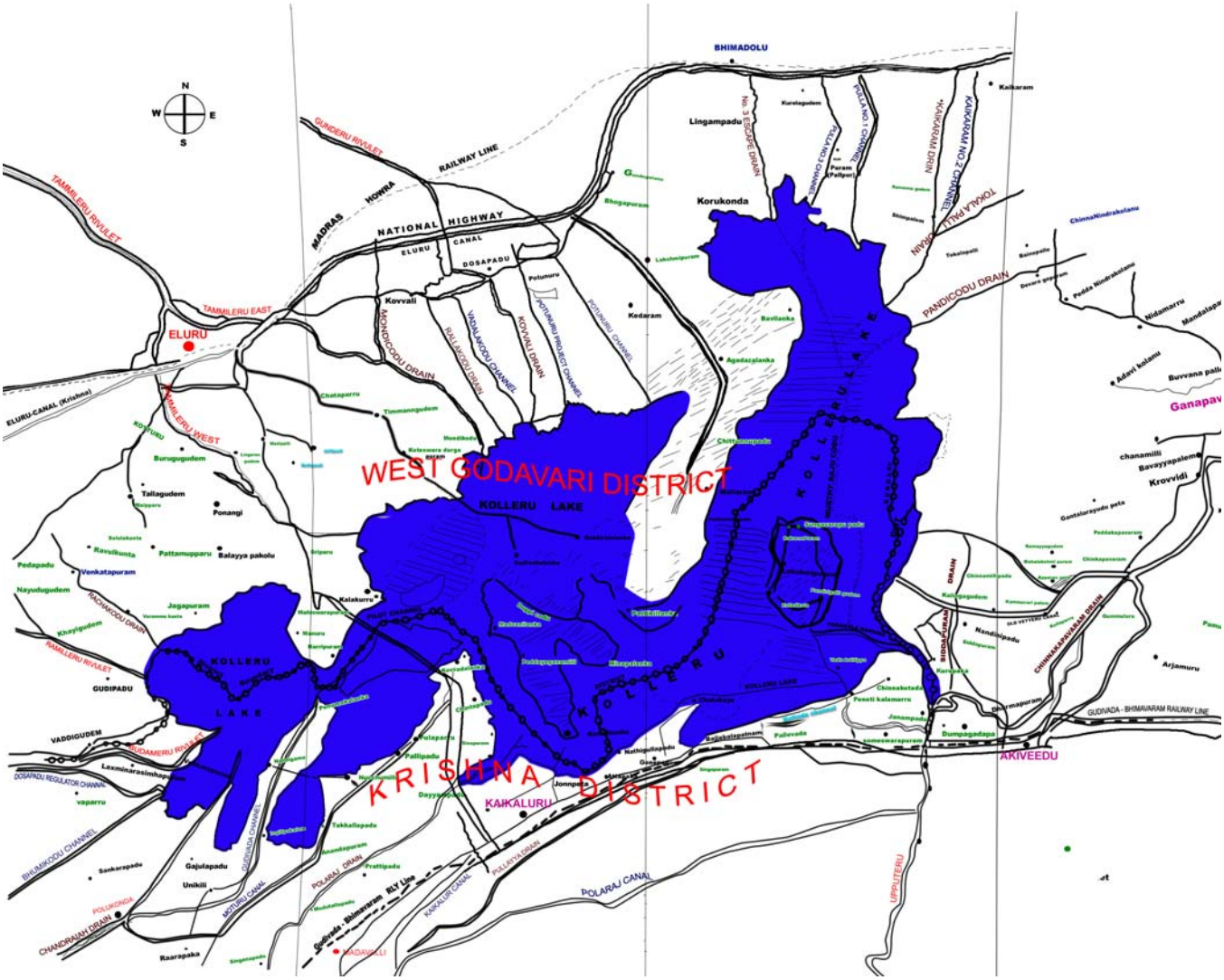
the strong support of the state government and under the active supervision of the central empowerment committee (CEC), appointed by the Supreme court of India.

In this article I present an account of the Kolleru operation, which is hailed by the Andhra Pradesh state government as a national victory, for the benefit of fish farmers and stake holders of similar fresh water aquaculture systems either in India or rest of the world, especially Asia. The presentation includes the following: a brief historical background of the Kolleru carp culture; the evolution, environmental, social and legal issues entwined with the development of this unique model of freshwater fish culture system; the Kolleru operation itself; and the rehabilitation measures being implemented.

Kolleru restoration operation

The first phase of Kolleru operation was started in the second week of November 2005 in both West Godavari and Krishna districts by the respective District Collectors, by ordering the breach of the embankments of the fish-ponds to be demolished either manually or mechanically. Beside each of the breached ponds was erected a warning banner that read “This breach is made by the government; those who repair it shall be prosecuted”. The second phase of operation, in the first week of Jan 2006, was marked by demolition of the identified fishponds by making breaches of more than 10 m length and deep enough for draining off pond water by gravitation. The third phase of operation, an unprecedented one in the history of world aquaculture, was started in the third week of February 2006, by blasting the embankments of the unauthorized fish ponds, especially the bigger ones using explosives. For each pond (40 ha and more) a 150 m long embankment was blasted and the remaining part was removed. In West Godavari district a trial blast was conducted in an empty-dried pond. The third phase was also marked by setting up of integrated check posts comprising the staff revenue, police and forest departments (13 in West Godavari and 4 in Krishna district), to prevent transport of seed, feed and other inputs to the ponds in the WLS. The fishponds constructed in the WLS, in the personal lands (with legal rights of ownership) were also demolished in the last phase, which was started in May, 2006.

Then there was a brief pause, as the Central Empowerment Committee (CEC) suspended the operation on 26 February 2006, until 11 March the day on which CEC was meeting at Hyderabad (the state capital), to listen to the submissions of different objectors who were opposing the implementation of the Kolleru operation. The CEC,



which had previously toured the areas concerned in the Kolleru, held an open hearing session before declaring its decision on 20 March, to demolish all the remaining fishponds located in the wildlife sanctuary. On 10 April 2006, the Supreme court of India instructed the state government to implement the directions of CEC. The total operation was completed within 15 June 2006, the dead line fixed by the CEC.

The Kolleru operation was the culmination of a complex mixture of economic, social, environmental, legal and political issues and user conflicts, all of which are focal points of national and international importance in the field of aquaculture.

Demolition of fish ponds

In the Kolleru operation a total of 1,776 fish ponds covering an area of 17,890 ha were demolished. In the West Godavari district 1,140 fish ponds covering 11,580 ha, and in the Krishna district 636 fishponds with an area of 6,310 ha were demolished. In total 2,916 fishponds built in occupied lands covering an area of 29,470 ha, were destroyed.

Why was the Kolleru operation executed?

Dr. T. Pantanjali Sastry, an environmentalist, filed a writ petition[3] in 1998, in the Andhra Pradesh High Court, pleading for appropriate measures to restore the Kolleru lake to its original state and pristine glory, by stopping the discharge of industrial effluents in to the lake, construction of houses and roads in the catchment area and conversion of hundreds of hectares of land into fish ponds. Through another petition[4] in 2001 in the same court, Mr. Y. Nagendranath, a former drainage board member sought for the removal of all kinds of obstructions in the Kolleru lake to facilitate free flow of water and also to prevent discharge of all types of effluents. On the other hand, several individual farmers and cooperative fish culture societies also fielded petitions in the state high court requesting the court not to disturb fishponds located within the wildlife sanctuary.

The High Court delivered judgment on 13 July 2001, and declared valid the notification issued by the Andhra Pradesh state government in G.O.120, notifying a 30,855 ha area in '0 to +5' contour as a wildlife sanctuary and prohibiting all kinds of aquaculture and agriculture except for traditional fishing and traditional agriculture practices. In the judgment, the court also directed the state government to take immediate steps for stopping and regulating the effluents being discharged in to the lake, and also to endeavor to remove all encroachments to bring back Kolleru its pristine glory.

Mr. Pranay Waghray, Executive Director of Nallamala Foundation, an environmental working group, filed an application (No. 381) before CEC, raising the issue of destruction and degradation of Kolleru lake in general and Kolleru Wildlife Sanctuary in particular. The CEC heard the parties concerned on 8 July 2004 and 31 January 2006.

In a parallel development, heavy floods occurred on 19 and 20 September 2005 due to cyclonic rains, causing devastating losses to rice agriculture in thousands of hectares in upstream areas of West Godavari and Krishna districts. The inundations continued for a prolonged period of over 40 days. This alarming situation drew the serious attention and concern of general public, district administrators, the state government, and print and electronic media as well, and lead to the allegation that the fish ponds in the lake and surrounding areas the Kolleru were responsible for obstructing the flood water, with the resultant inundation and losses. The cabinet sub-committee, headed by the minister for agriculture, Andhra Pradesh state, toured the villages covered in the wildlife sanctuary in April and again in October 2005. The cabinet sub-committee directed the collectors of the two districts to take immediate measures to remove obstructions in the lake to ensure free flow of flood water so that farmers would be able raise the rice crop in the immediately following season. In the first week of November 2005, the District Collector, West Godavari constituted 14 action teams, with officials from revenue, police, irrigation and forest departments for the execution of Kolleru operation phase 1. Almost simultaneously Kolleru operation phase 1 was started in Krishna district also.

To assist the administration of the two districts in the execution of Kolleru operation, special officers, one each from Indian administrative service, police service, and forest service were also appointed by the state government on a temporary basis till the operation was completed.

Kolleru operation: Support and opposition

The Kolleru operation naturally attracted both considerable support and opposition. While many of the reasons for conducting the operation are outlined above, many people also opposed it on the basis of their economic interests in the area or activities. Opposition groups in general also argued that the livelihoods of Kolleru people should be given priority over protecting birds or wildlife.

A prominent person from Andhra Pradesh opposed Kolleru operation, not as a whole, but the manner in which it was implemented. He was Dr. Jayaprakash Narayan a voluntarily retired officer from Indian Administrative Service, to lead two important social movements "Lok Satta" and 'Vote India' in both Andhra Pradesh and rest of the India. He toured the Kolleru during the last phase of the operation, addressed the Kolleru people and advocated that: 1. The ponds built obstructing the drains and channels only must be demolished; 2. the large farmers should be sent out of the Kolleru; 3. fish culture should be placed in the hands of poor people in Kolleru; and 4. that the Wild life sanctuary should be restricted to "0 to +3" contour (rather than the 0+5 contour).

The significance of Kolleru Lake

Geographical details

The Kolleru Lake is a natural geological depression formed as a balancing reservoir between the West Godavari and Krishna districts. The lake is demarked into '0' to '+10' contours with the mean sea level as the reference point. Kolleru is a pulsating lake; when in full flood the water level expands to over 901 km^2 at +10 contour and recedes to 125 km^2 at +3 contour during the lean season[5].

Four rivulets, eighteen drains and 22 irrigation channels empty in to the lake and along with them the effluents from industries, agriculture, urban sewage and fish ponds also. A 63 km long brackish water creek 'Upputeru' drains Kolleru water into the Bay of Bengal. The lake has a catchment area of 3,403 km^2 in the uplands and 1,360 km^2 in the delta areas[5].

Ramsar lake

The Ramsar convention held in Iran in 1971 which has a status of an international treaty identified the lake as one of the wetland ecosystems of International importance[6]. The environmentalists contend that as a signatory of the Ramsar convention, the Indian Union Government, and by that obligation the state government also, have the responsibility to protect the lake and make it free from pollution and all kinds of unauthorized occupation and obstructions.

Villages and population

The bed area of the lake (which corresponds to the area declared for the wildlife sanctuary) has 50 villages (island or bed villages), while the marginal area has 98 (belt) villages spread over in 73 revenue villages, including hamlets. These villages together comprise about 300,000 people, most of whom belong to scheduled castes and tribes[5]. Fishing is the dominant occupation for the lake population.

Wild fishery

Traditionally, the Kolleru is a rich source of wild fishery with significant biodiversity, and a primary source of livelihood for thousands of families dependent on traditional fishing. 128 species of fish and 12 species of prawns were recorded from the fishery catches of the lake and 35 species were recorded in the tidal zone of Upputeru[5]. During 1988 to 1991 fishery production ranged between 2,950 and 3,417 metric tones with an average yield ranging from 218-253 kg/ha[8]. Duck rearing, by maintaining flocks on the natural food available in the open lake, was also an important occupation. In fact, some fish farmers were duck farmers before the advent of carp culture.

Manual breaching of fishpond embankment, (a warning banner can also seen).

Fishing craft and gear in Kolleru

The individual fishermen in Kolleru conduct fishing by using locally developed craft and gear, perfected over ages by tradition and experience. Generally each fishermen is equipped with the following craft and gear: *Doni* – a 10-12 feet long, single person driven canoe, made by scooping out the plinth area of a palm tree of a selected (bent) shape; rowing boats – both small and large. The smaller boats are 5-6 metres long with a 90cm beam width and used for transport of harvested fish and also passengers from village to village within the lake. Bigger boats are about 10 metres long and are used exclusively for transporting cargo. The fishermen use different types, and sizes of traps, locally called *mavus,* to catch different species and sizes of fish.

Wild fishing in Kolleru

Four main types of fishing are practiced in the lake: 1. Individual fishing – by operating *doni* by a single fishermen; 2. *dadikattu* - a wall like structure made with split bamboo strips, enclosing a specified area, traps are fitted to the vents; 3. *doddi fishing* – *doddis* are relatively deeper areas in the lake, where more fish tend to congregate and in this method of fishing the *doddis* are dewatered and harvested; 4. *kampagari fishing* – in certain pockets in the lake the water flow is obstructed by placing weeds and branches of trees, thus encircling and blocking the area from which fish is to be harvested.

Agriculture

Though the Kolleru lands are fertile, agriculture has long been beset with serious problems[7] specific to this low lying area (last to irrigate and first to inundate; frequent loss of crops properties and lives due to frequent occurrence of devastating floods; exclusive dependence on boat transport; necessity of pumping out water to make the field ready; storing water in temporary reservoirs and providing it back for feeding the rice crop; persistent skin diseases due to constant contact with water, severe leech infestations etc). Naturally, for decades, the Kolleru inhabitants suffered from malnutrition, ill-health, and abject poverty.

Natural bird habitat

The imperial Gazatte described Kolleru as "a peerless fishermen's paradise" and "bird heaven[5]". Ornithologists compared the natural food available for birds with a 'bird-buffet'. The lake was providing shelter, breeding and propagation grounds for about 188 species of migratory and local birds, belonging to 46 families. Out of these, 20 species have been classified as endangered[5]. The Andhra Pradesh government, in 1963, declared a 20 km area in the lake as closed area for the protection of pelicans.

Ironically, many inhabitants in the lake derive part their income through illegal hunting and sale of Kolleru birds. As back as in about 1937, the famous poet from Andhra Pradesh 'Chalam', in his popular book 'Musings', besides depicting the scintillating experience of

boat travel in the pristine Kolleru waters, the joy and pleasure of watching the beauty of Kolleru lake scenarios, and also the gracious moments of innumerable mating, nesting, and brooding birds and their offspring, also mournfully narrated the human cruelty displayed in hunting those birds and birdlings, through various hunting methods including shooting.

Brief history and status of the carp culture

History

A joint team, appointed by the state government, comprising officers from agriculture, fisheries and cooperative departments submitted its report in 1974. In this report were mentioned the first ever suggestions for the development of the fisheries in the lake. In 1976 another special team was appointed entrusting the task of identifying the lands between the +3 and +5 contours, to be used for constructing fishponds. To provide Kolleru people an alternate source of livelihood, Mr. J. Vengala Rao, the then Chief Minister of the state encouraged them to take up pond fish culture. In 1977 and 1978, a total of 133 fishponds, with an area of 2,914 ha were constructed in West Godavari and Krishna districts to benefit 9,493 members of the 132 newly formed Co-operative Societies[5]. This was the start of commercial fish culture in the lake. But, soon, the unsuccessful cooperative societies were forced to hand over fish ponds to financially resourceful private farmers for a specified but extendable lease period, in order to pay off their loans. The private farmers achieved successful crops with sound profits that attracted other private persons, thus, heralding an era of rapid expansion and intensification of fish culture in both Kolleru lake area and also in the neighbouring non-Kolleru areas in both the districts, witnessed in the subsequent 20-25 years. This culture became popular in the name of 'Kolleru carp culture' and evolved in to a model of carp culture for the rest of the Indian states and also some other countries mentioned already.

But it is true that in many instances, the expansion propelled by small number of commercially-oriented farmers for possessing increasingly larger area for culture, was indiscriminate and not in accordance with the principles of sound and sustainable aquaculture. In the process of expansion thousands of acres of government land, and land allotted by the government for purposes other than fish culture, was occupied without authorization and converted into fishponds of up to 200 ha and farms up to 1000 ha. Despite the picture painted of these larger farmers by the media, in fact, the bulk of the farming community were small and marginal farmers. These were the people that were really concerned with the sustainability of carp culture as it was the only source of their livelihood and also of developmental activities of their families (children's education, marriages etc.) and also health care expenditure.

In general, Kolleru carp culture mostly comprises farmers from the two districts belonging to a cross section of society with diversified professions, although certain classes of society have been the dominant fraction. In the later phases of expansion, private entrepreneurs from other districts of Andhra Pradesh, and even from other states of India also took up fish culture on a significant scale.

The other factor contributed for the expansion of the carp culture was the conversion of lands possessed by the local population, either legally or illegally, as a common property of a particular village. In most instances these lands were leased out by the villagers, in an open auction to the outside entrepreneurs, before, or, after the construction of fish ponds. The income was shared by the villagers. But in many villages the residents formed into cooperative groups (locally called 'bantas') and undertook culture on their own, by raising finances from money lenders from outside, or, alternatively, these ponds were leased out to selected persons, usually to the leaders at the village level. Misappropriation of the funds and resources of the banta owned ponds is not infrequent.

Present status of the Kolleru carp culture

After the Kolleru operation, the estimated area of carp culture in the Kolleru and surrounding areas in the districts now stands at around 60,000 ha, producing about 450,000 metric tonnes, valued at Rs. 1,035 crores (US$25.28 million). Almost all this produce is exported to nineteen Indian states with West Bengal followed by Assam at the top. There are 63 carp hatcheries and nursery units in the state producing an estimated 700 crores of spawn (7 billion three-day old seed) and 210 crores of fry (2.1 billion of around 2.5 cm size). Andhra Pradesh is self-sufficient in seed production and also exporting the Indian major carp seed to the neighbouring states Karnataka and Tamilnadu, Orissa and Maharashtra.

Carp culture is a direct source of livelihood for about 8,000 farmer families. Also, it provides an indirect employment to about a million people, especially in the rural areas, including women, engaged in supporting industries or activities. These are production and supply of seed, supplementary feed, organic and inorganic fertilizers, water and soil quality amendments, fish health management chemicals, and also pond (farm) management, harvesting, ice manufacture, packing, processing and transport. The Indian major carp culture system as with any other successful aquaculture system may be compared to a big Banyan tree providing support, shelter for thousands of birds belonging to many different species and families.

Despite laden with serious problems such as recurring diseases, water quality problems etc. the Kolleru carp culture has proved itself to have the inherent strength to thrust forward even in the troubled waters. One of the contributing factors for the sustainability of the Kolleru carp culture is that, unlike in shrimp and scampi culture in the state, disease issues are minimal thus far[9].

After Kolleru restoration operation

By the end of September 2006 four months had passed since the completion of the Kolleru operation. Presently there are signs of an emerging and sprouting lake in the 'demolished area', and the local fishermen have resumed traditional fishing. During the Kolleru operation and before also, the district administrators promised the implementation of various rehabilitation programmes to the people who would lose their livelihood and they paid special attention to implement the schemes even as the Kolleru operation was in progress.

Programmes of livelihood and restoration

The various kinds of livelihood programmes were: Support for self employment by granting loans on subsidy (through different state government departments) to buy net materials; to start dairy; buy autos or tractors; sewing machines etc.; educational tours for the villages covered in the operation to Chilka lake (the biggest brackish water lake in India, also another Ramsar lake, situated in the neighbouring Orissa state). The idea of the administrators was that the Kolleru people can witness first hand the cooperative efforts of the local fishermen for earning their livelihoods after implementation of a similar but earlier operation in the Chilka lake. Study tours were conducted to Kerala, a southern state on West coast of India, to learn from the local cooperative societies in the production of value added fishery products. Demonstration on the preparation of ready to cook value added products from the Indian major carps rohu and catla by staff of the Central Institute of Freshwater Aquaculture (CIFA), functioning in the Krishna district so that interested Kolleru people may start mobile fishery canteens.

On 6 October 2006, a central government official declared that US$1.28 million would be made available to provide livelihoods for Kolleru people, adopting measures to attract migratory birds, and developing Kolleru as a tourist centre.

The expert committee, formed by the special officer on Kolleru operation recommended various fishery related and other rehabilitation measures which were: establishment of post harvest, fish processing centers to be run the self help fishery groups to produce and market value added products from fishery catches from Kolleru such as pickles, fillets etc., establishment of craft and gear manufacturing centres for commercial production of nets, net materials and rafts; marketing Kolleru fish, shellfish and fishery products through a brand signified by Kolleru; developing schemes for the promotion of eco-tourism and health tourism.

Ranching of fish and prawn

Also several measures were recommended for enhancing fishery production and restore ecology of the lake. These were: ranching the seed of Indian major carps *L. rohita, C. catla, C. mrigala* and grass carp *C. idella,* and also self-reproducing, high value prawn species i.e. *M. rosenbergii, M. malcolmsonii* to enhance the economic value of fishery catches from wild Kolleru; declaration of fishing holiday during specific seasons; declaration of fish sanctuaries in the deeper, specified areas of Kolleru lake to protect breeding grounds of the species important from commercial and biodiversity points of view; re-establishment of 'Kolleru Lake Development Board', consisting of experts from different fields concerned, including fisheries, to monitor and ensure the implementation of several related issues mentioned already. According to the state fisheries commissioner 5.6 million fingerlings of Indian major carps have already been released into the lake.

It remains to be seen how far a Kolleru inhabitant, who, so far, enjoyed a regular income from carp culture at about US$400 per year, will be satisfied with the livelihood programmes being implemented, for, most of the beneficiaries have to acquire new skills and adapt to a changed life style demanded by the new professions.

In July 2006 the CEC members visited, for the first time after the Kolleru operation, to evaluate how efficiently the operation had been executed, and also how the rehabilitation schemes were being implemented. The members participated also in carp seed ranching programme in Kolleru.

The Kolleru carp culture had all the ingredients required for the initiation, expansion and intensification of which the crucial ones were: suitable soil and water resources, highly entrepreneurial and resourceful farmers, peaceful social and political situation conducive for the growth of an aquaculture system, strong support by research and extension agencies, accommodating market for constantly increasing production, well developed supporting industries and transport net work. However, the Kolleru operation reveals that all these are essential, but not sufficient in themselves, for the permanent success of an aquaculture system. Some other essential characters required are: clear ownership rights of land concerned; active support of the government; winning good will and encouragement of not only neighbors but also the general public and other user groups; strict adherence to the best management practices so as to protect the quality of pond water, the fish produced, and also the environment; ensuring judicious and proportionate sharing of the fruits of aquaculture by all the social classes involved.

The difficulties of the genuine carp farmer

If one considers the support of society in general for carp culture in the state, there is little sympathy in any section of the society for the farmers who lost ponds that were in the wildlife sanctuary. But the real agony is of the genuine carp culturists in the rest of the culture area, in both the districts, who have dedicated all the prime of their lives, and invested their hard earned financial resources, most of them for two generations, for the development of carp culture in the state, but who are now left with a diminished self respect. Along with the fish farmers who built ponds in unauthorized lands, these genuine farmers are also looked down upon, as if their growing fish is an illegal or a prohibited activity. It will require a concerted effort to erase the tarnished image of a general carp culturist depicted by the ill-informed general public, print and electronic media, fumigated with many misconceived opinions about aquaculture in the state, disregarding the invaluable contribution of aquaculture and farmers to the economy and nutritional needs of a society.

Still, two thirds of intact carp culture area (about 60,000 ha), is in the hands of legal right holders in West Godavari and Krishna districts. Though located in the non Kolleru area and above +5 contour of the lake, the effluents from most of these ponds are destined ultimately to be discharged into the Kolleru Lake itself. For the restoration of Kolleru Lake, prevention of the discharge of fish pond effluents, besides industrial and urban effluents, is an inevitable measure. The prevention of effluent discharge into the lake was supported in the judgments of the Supreme court of India and the High court, Andhra Pradesh. It is known that the character of fish pond effluents is also determined

and impacted by the important management practices implemented during the on-going culture. In future also there is every possibility that the state and central governments and the courts will take a serious view of aquaculture, if it violates sound management principles, induces user conflicts and affects other user groups, the rights of consumers and other sections of the society. On the other hand, unsound management practices drastically decrease the economic efficiency of the carp culture in several ways and ultimately may result in serious losses, which, in turn, may force the farmers to abandon the culture. To ensure further sustainability of this un-paralleled carp culture system in Asia, for decades to come, it is time that a through and urgent review of the entire carp culture system in the state is undertaken, problems identified, and remedial measures implemented.

Acknowledgements

The author thanks Dr. Manmohan Singh, IAS, Vice-chancellor, Dr. A. Seshagiri Rao, Director of Research (Animal Sciences), Dr. P. Mastan Reddy, Dean (Fisheries) of Sri Venkateswara Veterinary University, Andhra Pradesh for their encouragement; Mr. D. Munichandra Reddy and Mr. K. Varaprasada Rao, Scientists, Fisheries Research Station, Undi and also Mr. P. Haribabu, Assistant Professor, College of Fisheries Science, Nellore for their cooperation. Mrs. N. Sridevi is acknowledged for her help the preparation of the manuscript and arrangement of photos. The district public relations officer (DPRO), West Godavari and also innumerable resource persons who provided valuable information on Kolleru operation are also thanked.

References

1. Ramakrishna, R. and Nandeesha, M.C. (2006). Innovations in Indian major carp culture technology by the farmers of Andhra Pradesh, India. Aquaculture compendium – CAB international. 14 p. (In print).

2. Veerina, S.S., Nandeesha, M.C. and Gopal Rao, K. (1993). Status and technology of Indian major carp farming in Andhra Pradesh, India Special publication No. 9; Asian Fisheries Society, Indian Branch. 52 p.

3. Writ petition No: 33587 of 1998, filed in the High court, Andhra Pradesh.

4. Writ petition No: 12497 of 2001 in High Court, Andhra Pradesh.

5. Mittal, R. (1993). Management plan for Kolleru bird sanctuary. Forest Department, Government of Andhra Pradesh. 318 p.

6. Shivaji Rao, T. (2003). Conflict between development and environment of Kolleru lake area. In: Y. Anajaneyulu and K. Durga Prasad (Eds.), Lake Kolleru-Environmental status (past and present); 168-184.

7. Murthy Raju, Ch. (1964): Kolleru (In 'Telugu', the mother tongue of the people of Andhra Pradesh). Amaravathi press and publications Limited, Hyderabad, 131p.

8. Venkateswara Rao, K., Ramakrishnaiah, M. and Rama Raju, T.S. (2003). The fish and fisheries of lake Kolleru. In: V. Anjaneyulu and K. Durgaprasad (Eds.), Lake Kolleru – Environmental status (Past and present): 124-133.

9. Ramakrishna, R. (2005). Studies on certain diseases of fresh water fishes. Ph.D. thesis. Berhampur University, Orissa, India. 155 p.

The business approach to operating national broodstock centres: An innovative strategy for developing the freshwater aquaculture seed industry in Viet Nam

Roehlano M. Briones, Tran Thi Huyen Trang, Nguyen Cong Dan, Nguyen Huu Ninh, Pham Van Khanh, Nguyen Hien Thi, Don Griffiths and Trinh Quoc Trong.

The freshwater fish seed industry in Viet Nam supports a dynamic freshwater aquaculture sector, which has made significant contributions to incomes and food security. Freshwater aquaculture production has been growing rapidly since the late 1980s, with output value reaching US$ 585 million in 2001 (FAO, 2004). The Ministry of Fisheries (MOFI) of Viet Nam projects production to grow by 11.4% annually from 1999 to 2010 (MOFI, 1999). Likewise, seed demand is projected to grow annually by 4.9% from 2005 to 2010 (MOFI, 2003).

Recently however, deterioration in seed quality has been cited as a major constraint to the growth of downstream freshwater aquaculture. This has been attributed to poor broodstock quality and poor management practices. In response, the Government of Viet Nam has recently approved the establishment of three National Broodstock Centres (NBCs) under MOFI, to maintain and upgrade seed quality nationwide.

Establishment of the NBCs occurs within the context of doi moi (reform or renewal) policy, which mandates market-oriented reforms. Hence, while the government subsidized the construction of broodstock centre facilities, it delegated responsibility to finance operating or running costs to the NBCs themselves, essentially as self-sustaining businesses. The adoption of a business strategy for broodstock centres is an important institutional innovation that could possibly be a model for seed industry development in other countries.

Implementation of the new strategy soon made clear the need for sound business planning to support operations and financing. Hence the MOFI, with support of the Danish Agency for International Development, undertook a capacity-building initiative for the NBCs based on a systematic assessment of business conditions and participatory business planning. This paper presents the framework, method, and outcomes of this initiative.

Background and rationale

In Viet Nam, the majority of seed supply is obtained from hatcheries, which are either government-owned or private companies. The industry has witnessed the deterioration of genetic quality in several cultured fish species, a trend that has become evident since the late 1970s (Thien, Dan, and Tuan, 2001). This has been attributed to a decentralized system in which genetic quality of broodstock was the responsibility of individual hatcheries.

The creation of the NBCs represents a shift to a centralized "pyramid system" for genetic improvement (Figure 1), which is widely practiced in animal breeding (Notter, 2004). At the apex are the national centres, who are the main custodians of the breeding nuclei. In the middle are the multiplier hatcheries, which in turn disseminate the improved breeds to commercial farmers.

The NBCs are under the auspices of the Research Institutes for Aquaculture (RIA 1, RIA 2 and RIA 3 covering the Northern, Southern, and Central regions respectively). At the time of writing, NBC 1 has a mandate for operations in the Northern region, while NBC 2 which is under construction has a mandate for the Southern region (funds have been approved for NBC 3 for the Central region, but construction has yet to commence). NBC 1 is located in Hai Duong, Phu Tao province, while NBC 2 is in Cai Be, Tien Giang province. NBC 1 was originally a provincial hatchery, while NBC 2 was the Research Centre for Aquaculture of RIA 2. At both Centres, the MOFI made sizable investments (up to US$2,000,000) to construct modern facilities for research and broodstock development.

In creating the NBCs, several institutional options were open to the government. The first option is state-planning, in which supply decisions are centralized at the level of a planning authority, which also provides the resources (funds, facilities, and personnel) for the delivery of goods and services. The second option is profit-oriented supply, which became prominent in the hatchery industry after the doi moi (reform or renewal) policy. The third option is mission-oriented supply. This denotes production by a non-profit business entity that is organized for a social purpose. Resources are mobilized through cost-recovery (i.e. sale of products and services), donor contributions, partnerships with the private sector, and other such financial measures.

Problems with state-planning supply throughout the economy led to the dismantling of many types of state subsidies under the doi moi (reform or renewal) program. The NBCs were classified under the umbrella of enterprises to be run without a budget allocation from the government. However, it may not be feasible to operate the broodstock centres entirely as for-profit enterprises and expect them to deliver on their seed quality mission; after all, the hatchery sector (which runs on a for-profit basis) has also failed to improve genetic quality and promote seed production technologies. This leaves the third option, that of operating the NBCs as mission-oriented businesses (though under government ownership). In this way, the NBCs can focus on providing quality R & D products, while compelled to mobilize their resources and recover its running costs.

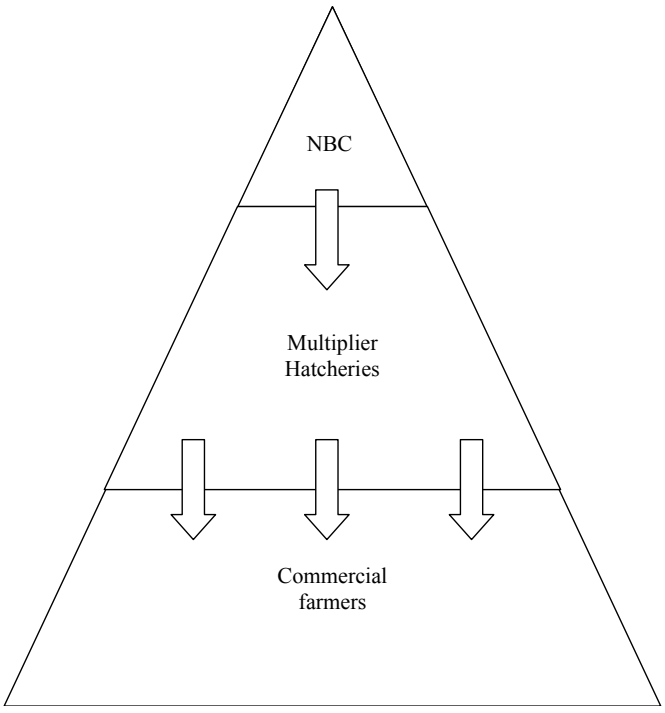
The "best practice" for a new enterprise is to begin with a useful business plan or feasibility study (Hishamunda and Manning, 2002). The business plan expresses the strategy for achieving the mission while maintaining financial sustainability. The business plan is therefore useful for internal purposes; it is also essential material for potential contributors and supporters of the NBC mission.

In preparation for business planning, information on the demand side and the supply side of the business was systematically gathered. This was followed by training for business plan formulation. Information on demand for NBC products and services was collected by a rapid rural appraisal of hatcheries in the North and South regions. Information on the supply side was undertaken through a multi-dimensional business assessment (covering human and physical resources as well as business systems). After assessment and training, a participatory planning exercise was conducted by the NBCs to draft the business plans.

Results from demand assessment

The rapid appraisal was conducted by a small-scale purposive survey of hatcheries in North and South regions (nine each, totaling 18 respondents). Findings of the survey include the following: First, seed production is a profitable business. On a per unit (broodstock or area) basis, private hatcheries tend to be more profitable than state-run hatcheries. In the short to medium term, most of the hatcheries project a favorable market outlook for

Figure 1. Pyramid system for breeding improvement.



their business. Hence, at the enterprise level, owners and managers share the same favourable market outlook of the government and other industry observers.

Second, all hatcheries replace broodstock largely by reproducing their own stocks. To a lesser extent, hatcheries obtain broodstock from grow-out farmers. Least important is obtaining broodstock from other hatcheries. Private hatcheries are more dependent on self-replacement. This suggests a potential for genetic deterioration, particularly for private hatcheries. Broodstock is replaced gradually, due to the long reproductive life of most of the species cultured, especially the Chinese and Indian carps and *Pangasius* catfish species.

Third, hatchery demand for mature broodstock is large. However, translated into equivalent seed to be on-grown as broodstock, the market demand is small relative to the production capacity of a typical hatchery, let alone a broodstock centre. This results from a combination of reproductive age, length of reproductive life, and fecundity of broodstock fish. Hence revenues from sale of seed may be small relative to the costs of maintaining genetically-managed and genetically-improved broodstock.

Fourth, quality broodstock is the most preferred product from the NBCs. Hatcheries also welcome training and technology transfer on techniques for disease control, as well as spawning and rearing of non-traditional species. On-farm trials, seed certification, and other types of training, while helpful, are not as desirable to hatchery owners/operators.

Evaluation of business capacity

Several problems were highlighted on the NBC supply side:

- Both NBC 1 and NBC 2 suffer from a shortage of human resources for research and extension.
- Because of their unfamiliarity with the business model for delivering research products and services, both NBCs suffer from inadequate business systems (related to organization, planning, and financial accounting).
- Both NBCs also need to build their network with other hatcheries to set up a formal multiplier system for improved seed.
- The status of the NBC as a research centre as well as a business enterprise creates confusion about the NBC purpose and action program.

On the positive side, the NBCs enjoy the advantage of long experience and informal relationships with hatcheries and other stakeholders in their respective regions, as well as strong support from their respective RIAs. They already share in the prestige earned by the RIAs from the successful dissemination of improved strains of common carp and tilapia. Both also benefit from an energetic management and cooperative staff, who are highly motivated by their elevated organizational functions and mandate. While some confusion remains on implementation details, management and staff in the NBCs fully embrace the business model for their organization.

Formulation of business plans

The business plan training guided the NBC management teams in understanding basic business plan concepts. The business plans consist of ten key elements:

1. Mission statement.
2. Market analysis.
3. Internal analysis of strengths and weaknesses.
4. Problem and goal identification.
5. Priority setting.
6. Objective setting.
7. Program formulation.
8. Organizational structure.
9. Organizational development plan.
10. Financial plan.

Rather than have professional consultants write the business plans, the NBCs wrote their own plans in a participatory approach facilitated by a regional and a national consultant. The two NBCs completed their business plans in early 2005. The following contain some salient points from the business plans:

The mission statements of the NBCs are:

- **North:** “Ensure timely production and provision of freshwater aquatic seed of high quality and culture techniques to the hatcheries in the North region”.
- **South:** “(1) to conduct research on genetic conservation, seed production, and grow-out of various freshwater species (2) to produce high quality freshwater fish seed for hatcheries in the South region.”

Both NBCs assess their market environment as highly favourable, consistent with the findings of the demand assessment. Meanwhile, the internal assessment of both NBCs reflects the problems raised in the business assessment. NBC programs and organizational structure are geared towards addressing these concerns. Both NBCs break down their overall mission into goals, tailored to address specific problem areas in the freshwater seed industry, namely:

1. Produce and disseminate genetically improved broodstock;
2. Maintain and disseminate broodstock of high genetic quality;
3. Preserve genetic diversity of indigenous fish species; and
4. Develop and transfer technologies to local hatcheries and fish farmers, with respect to fish reproduction, fish culture, and disease control.

The financial plans presented detailed projections and spending and revenue generation, covering the period 2005-2009. The summary financial projections for the first year of operation of NBC 1 and NBC 2 are respectively presented in Tables 1 and 2. The effort to maintain and disseminate broodstock of high genetic quality requires large annual outlays (ranging from about 70 to almost 90 thousand dollars). However projected cost recovery through sale of seed and other by-products is only around 40 to 50 thousand dollars. This is consistent with earlier findings based on the demand assessment. The resulting deficit is the external funding requirement.

In addition, other efforts to improve seed quality for the industry (including technology transfer and technology development activities) are also costly, further increasing the deficit. The external funding requirement for the first year ranges from 110 to 170 thousand dollars. To the extent that other institutions are willing to support the seed quality mission of the NBCs, the shortfall can be funded by donor contributions. Funds may be sourced from ODA, private foundations, aquaculture industry associations, local governments, and competitive research grants from the national government. The NBCs may also be supported by the RIAs and MOFI to gain access to development funds. As with other nonprofits, the business plans become an indispensable tool for resource mobilization of the NBCs.

Concluding remarks

This paper describes a business model for upgrading quality in the freshwater fish seed industry. The model was recently adopted by the NBCs of Viet Nam. In this model, the broodstock centre functions as a centre for research, development, and genetic preservation of the seed industry. It is nonetheless a publicly-owned, non-profit enterprise responsible for its own financial viability.

We demonstrate that the preparation of business strategies can be the product of participatory planning undertaken by the management and staff teams of the broodstock centres. Such planning is conditional on an objective assessment of internal problems, market environment in the seed industry, and prior capacity-building. The resulting plans point to a diversified set of resource mobilization efforts, including cost recovery by sale of seed, donor contributions, and grants from various public funding sources (both national and local).

The business model demonstrates a workable strategy to both address seed industry development, while reducing recurring cost burdens on the public sector. Based on the experience of the NBCs, we propose this model as a framework for the development of the freshwater fish seed industry in other developing countries.

About the Authors

Dr. Roehlano M. Briones is a senior fellow of Brain Trust Inc. Knowledge and Options for Sustainable Development, a private think-tank based in Manila. Ms. Tran Thi Huyen Trang is a consultant of Organizational Capacity Development, a private firm based in Hanoi. Dr. Nguyen Con Dan is the National Component Director of Support for Freshwater Aquaculture (SUFA), a MOFI-DANIDA project under the Fisheries Sector Support Program. Mr. Nguyen Huu Ninh is Vice-Director of the National Broodstock Centre for Northern Viet Nam. Dr. Pham Van Khanh is Director of the National Broodstock Centre for Southern Viet Nam. Ms. Nguyen Hien Thi is a socio-economic specialist with SUFA. Mr. Don Griffiths is the Senior Advisor to SUFA. Mr. Trinh Quoc Trong is a researcher at the National Broodstock Centre for Southern Vietnam. This paper represents the personal views of the authors, and not of any official institution in Viet Nam or Denmark. The usual disclaimer applies.

References

Hishamunda, N., and P. Manning. 2002. Promotion of sustainable aquaculture in Sub-Saharan Africa. Vol. 2. Investment and economic feasibility. Fisheries Technical Paper No. 408/2. Food and Agriculture Organization of the United Nations.

Ministry of Fisheries. 1999. National Program for Aquaculture Development Period 1999 – 2010. Hanoi. Mimeo.

Ministry of Fisheries. 2003. Brief Report: Seed Planning of Aquaculture to 2010. Mimeo.

Notter, D. 2004. Conservation strategies for animal genetic resources. Background Paper No. 22. Commission on Genetic Resources for Food and Agriculture, Food and Agriculture Organization of the United Nations.

Table 1: Summary financial projections for NBC 1, first year of operations.

Items	Amount (millions VND)
Expenses	
Genetic programs and broodstock dissemination	1,070
Development of new hatchery and culture technologies	1,390
Training and technology transfer activities	100
Others	80
Total expenses	2,640
Revenues	
Sale of seed for broodstock	400
Sale of seed for commercial grow-out	250
Earnings from developing new technologies	200
Total revenues	850
Total deficit (-savings)	1,790
Note: US$1.00 VND 16,000. Source: National Broodstock Centre of Northern Viet Nam.	

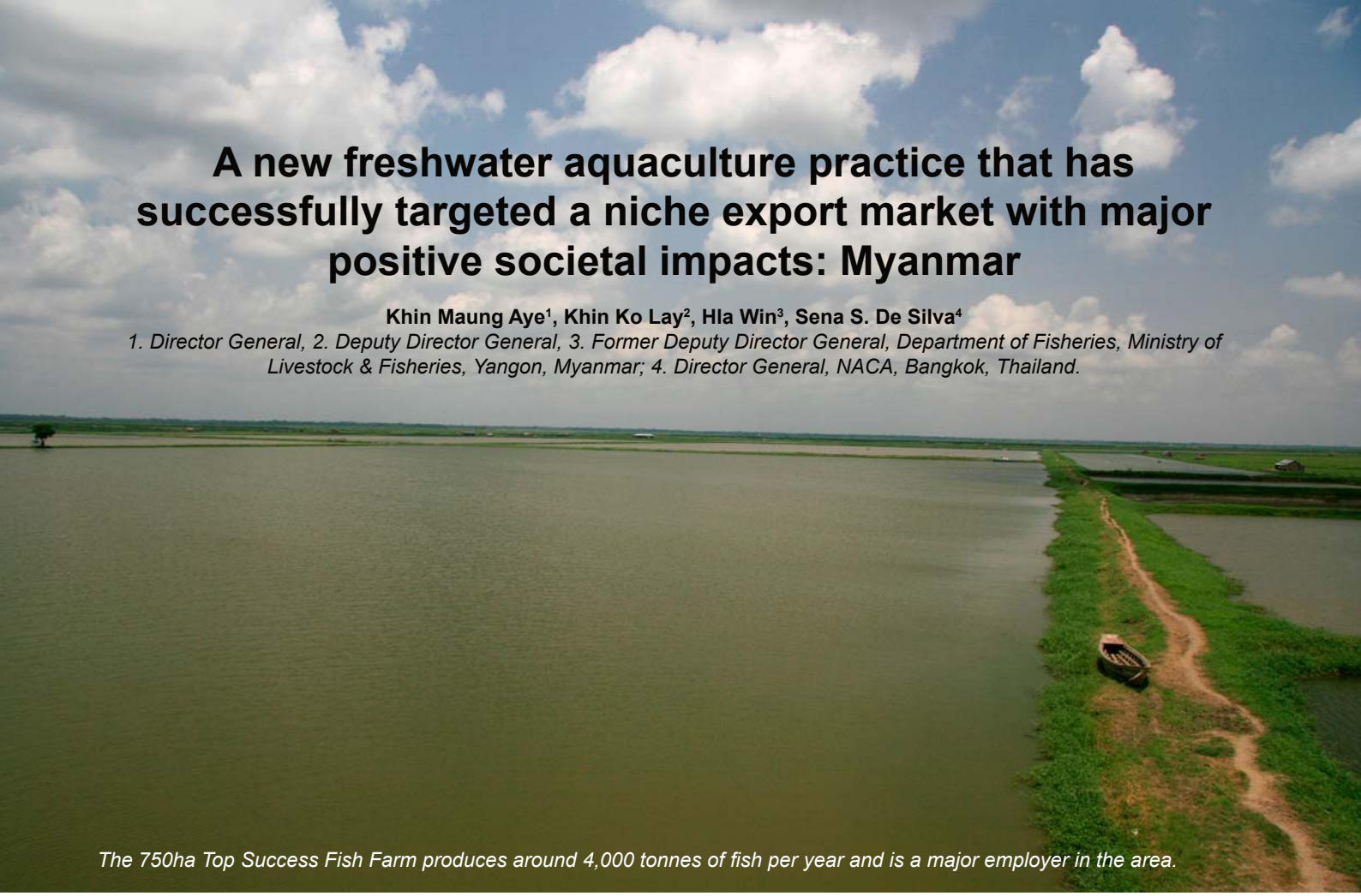
Table 2: Summary financial projections for NBC 2, first year of operations.

Items	Amount (million VND)
Expenses	
Genetic programs	1,424
Development of new hatchery and culture technologies	1,020
Training and technology transfer activities	636
Others	134
Total expenses	3,279
Revenues	
Sale of seed (total)	601
Total revenues	601
Total deficit (-savings)	2,678
Note: US$1.00 VND 16,000. Source: National Broodstock Centre of Southern Viet Nam.	

A new freshwater aquaculture practice that has successfully targeted a niche export market with major positive societal impacts: Myanmar

Khin Maung Aye[1], Khin Ko Lay[2], Hla Win[3], Sena S. De Silva[4]

1. Director General, 2. Deputy Director General, 3. Former Deputy Director General, Department of Fisheries, Ministry of Livestock & Fisheries, Yangon, Myanmar; 4. Director General, NACA, Bangkok, Thailand.



The 750ha Top Success Fish Farm produces around 4,000 tonnes of fish per year and is a major employer in the area.

Myanmar can be considered as a newly emerging aquaculture nation in Asia. In 2005-2006 the share of aquaculture accounted for approximately 22% to the fisheries sector. The production volume of the sector increased significantly in volume, 7.3 times in the last decade, or from 0.082 million tonnes in 1996/97 to 0.6 million tonnes in 2006/07. The great bulk of this aquaculture production is in freshwaters and consists of Indian major carps and to a lesser extent catfish and tilapia. The growth trends in the sector have been dealt in some detail previously (Win, 2004; Edwards, 2005).

Myanmar, particularly the southern states are blessed with vast quantities of freshwater, dominated by the Ayeyarwaddy and Salween River systems. Equally, it is blessed with a very rich freshwater fish fauna (Win, 2004). Some of the major culture species that are shared with neighboring countries such as India, Bangladesh and Thailand (De Silva et al., 2006).

In general, most aquaculture in Asia is composed of small holdings. In Myanmar too, this is so to a very large extent. However, a little known facet is that some aquaculture practices have developed and or transformed to cater to a fast developing intraregional export market, essentially consisting of indigenous freshwater species such as *Labeo rohita* (rohu) *Catla catla* (catla), *Cirrhinus mrigal* (mrigal) and *Pangasianodon hypophthalmus* (pangas catfish) and the exotic tilapia, *Oreochromis niloticus*. Overall in Myanmar two aquaculture farming systems are recognizable, a differentiation that has come into being in the last ten years; small farms, often family managed and owned catering to the local demands and large farms, often vertically integrated catering to the export markets.

This larger farm enterprising venture towards the export market promotion is considered to have originated on a very small scale initially through a few business personnel who found a small export market for rohu in Bangladesh. Beginning about 12 years ago, this focus on the Bangladesh market has grown particularly in the last seven or eight years to other regions where there are considerable expatriate communities of Indian and Bangladeshi origin. Currently, the export earnings from freshwater fish are nearly US$72 million, and in 2006 for example the exports to Bangladesh alone accounted for US$26 million and the total exports of rohu is expected to reach US$120 million in 2007. Interestingly some of this fish earlier was being re-exported to the Middle East, but now direct marketing is opening up. All exports of freshwater fish are predominated by rohu, which accounts for nearly 83% in volume and 79% in value. By comparison elsewhere in the region, the export of cultured catfish from Vietnam and tilapia from China are ranked first and second with this new market in Myanmar the third highest. This market diversification is expected to continue with continued exports to Bangladesh, but the bulk increasingly headed to Middle East, with a small market share in the UK and other European countries.

As the market expanded the production practices had to keep pace, not only in production volume but also regularity in supplies particularly delivering a product of uniform size and so forth. To meet these criteria the farms expanded into larger scale more integrated operations with a variety of changes such as a move to larger sized production ponds. Furthermore, to bring about overall efficacy in the production systems, hatcheries, nursery rearing and grow-out became separate entities as part of a total market-oriented production system. Often, all three systems are owned and operated by one enterprise.

The average grow-out farm size could be as large as 400 ha, with a pond size ranging from 2-5 ha. In the grow-out stage for rohu for example, the target stocking size is typically around 20cm or 150-170 g. Fish are fed locally made feeds using local ingredients and harvest size could vary from 1.5 to 2.5 kg or over 3kg depending on the export market demands. The grow-out will take ten to fifteen months to meet the respective marketable sizes. Feeding is often conducted by placing the feeds in strategic points in the ponds in perforated polythene bags dipped in water and the contents replenished on a regular basis (Ng et al., 2007). Whilst the carps are almost exclusively pond cultured there is a growing trend for catfish farming to be conducted in cages in the lower reaches of the Ayeyarwaddy system. In this case too, there is an integration between different stages of culture and the grow-out in cages is conducted on an extremely intensive basis such as for example a cage of 23 x 10 x 6 m being stocked with 80,000 x 60g fish at any one time, and grown to market sizes of 1.5 to 2.5 kg on a needs basis. *P. hypophthalamus* (in Myanmar referred to as pangus) culture has still not reached the levels of rohu. It is expanding, however. In all instances as the farms grow in size there is a division of labour in the production system- multi-stage systems- where hatchlings, nursery rearing and grow-out are carried out as separate entities in space.

In all of the above activities there was an element of vertical integration and significant capital investment all supported by the Government of Myanmar through the provision of land leases, introducing relevant export regulations to meet or fulfill export quality criteria and putting in place efficient monitoring systems. To facilitate and enhance the sustainable development of the sub-sector, the Ministry of Live Stock and Fisheries provides loans to fish farmers through the Livestock and Fisheries Development Bank at the rate of 300,000 Kyats (approx US$2,300) per acre (or US$5,800/ha) with minimum interest. It is likely to increase up to 500,000 Kyats in the very near future. At present about 70% of the total bank loans are for fisheries and aquaculture development and related ventures.

The harvested products are processed in different forms depending on the market. For instance, whole ungutted fish of 1.5-2.5 kg are exported to Bangladesh on ice by boat taking approximately three to four days to reach the designated port in Bangladesh. Fish processed for export are generally gutted, cleaned, glazed and then frozen whole for export to Middle East countries, the UK and elsewhere. The processing activities are carried out according to strict hygienic and HACCP system. In the processing factories, the offal and the air bladder is separated from the gonads and sold locally for extracting oil and some of it for local consumption. In some plants where there is vertical integration. For example, one catfish plant which produces fillets of 200-400 g from 1.5-2.5 kg catfish the frames; the head and skin from the processing and strips of recovered flesh resulting from the processing are utilized to manufacture their own fishmeal (one tonne per day) which in turn is mixed with locally available other ingredients (soybean meal, palm oil cake, groundnut cake, rice bran, also see Ng et al., 2007) and pelleted into a feed of 20-27% protein content by dry weight (70 tonnes per day) exclusively for feeding catfish in grow-out cages in the Ngawun River and in nursery ponds.

The social impact of these aquaculture activities cannot be solely measured in terms of monetary value. It is clear that a large number of people have

Processing operations at Grand Wynn Manufacturing Co.

Rohu are blast frozen for export.

This article emanates from a NACA mission comprising of Sena S. De Silva, Hassanai Kongkeo, Thuy T.T. Nguyen and Simon Wilkinson in May 2007 to various aquaculture sites in Yangon and Ayeyarwaddy Division and extensive discussions with personnel from the Department of Fisheries, the Myanmar Fisheries Federation, farmers and processors. During the farm visits the mission was accompanied by U Myint Soe, Assistant Director, Department of Fisheries, Myanmar.

The article emphasizes the relatively recent developments in aquaculture in Myanmar which have revolved around the production of quality fish, species which elsewhere would be categorized as relatively less high-valued, consisting mostly of Indian major carps, and in particular rohu, *Labeo rohita*. It is targeted that the rohu exports for 2007 to reach US$120 million. These developments have brought about major changes in the culture practices and marketing, as well in the development of ancillary services such as feed developments using local ingredients, transport services and most of all in the processing industry, which currently has provided employment for approximately 2500 persons, mostly women. These developments have been made possible through governmental support in the provision of land leases, licenses, loans and others. Further more these developments are suggested to have had no significant negative impact on the availability of fish for local consumption.

found employment in the processing plants, the increased labour required to run larger farms have been part of the overall business development leading to a significant contribution to the Myanmar GDP. Myanmar now has 143 processing plants of varying capacity 81 of which specifically cater to processing rohu, pangas, and other cultured freshwater fish for export. Overall, it is estimated that the processing industry for freshwater fish provides employment to 2,400-2,800 persons approximately. In addition, new employment opportunities have been created as a result of the large farm sizes and the expanding transportation and distribution networks.

While aquaculture across Asia is generally facing problems of inbreeding and associated genetic deterioration of stocks due to lack of strategic planning in broodstock management, the situation in Myanmar appears to be well under control in this regard. This is probably the result of planned use of naturally available seedstocks for continued replenishment of the broodstock for hatchery rearing, thereby minimizing potential inbreeding. Myanmar is able to adopt this strategy because it is blessed with abundant water and natural fish seed resources, where hatcheries for aquaculture can recruit new broodstock at regular intervals from the wild (wild fry and fingerling catching is controlled strictly by the Government), currently at five year intervals for rohu.

In Myanmar aquaculture also goes hand in hand with conservation by releasing seedstock from hatcheries into adjacent natural waters from where broodstock originated. As well, the genetic aspects of the present broodstock management and stock enhancement strategies are being studied in detail to bring about

The Htoo Thit Pellet factory - ramping up capacity to 1,000,000 tonnes/year to meet the growing demand for pellet feed.

Above: The Yuzanna Group's Pangasianodon hypopthalamus culture in large floating cages in the Ayeyarwaddy Delta - each cage can hold 80,000 fish, harvest size is 1kg+ achieved in 6 months. Below: Feeding time inside the cage.

Than Zay retail market, Yangon.

further improvement so the current broodstock management program(s) and restocking program(s) could be made even more effective and of greater conservation value.

The question arises whether these developments in the culture practices have impacted on the local population in terms of affordability of fish. Fish is the main source of animal protein in Myanmar currently estimated at 41 kg per caput per year, one of the highest in the world. There is no ready answer to this question. At a regional level, past and present data suggests that there is a significant amount of relatively small scale aquaculture practices operating for supplying local consumer needs.

The limited information suggests that the preferred size for consumption locally is less than 1.5 kg sized fish, the desired size being indirectly linked to the income level. There is no evidence to believe that local fish prices in Myanmar have increased to any greater extent than other consumer/common food items, indirectly indicating that the aquaculture developments may not have had a direct impact on the local consumption patterns. As described above, these aquaculture developments have created significant employment opportunities with significant income generation to the community, which would positively impact on standards of living and food security. We felt that this series of developments in Myanmar are rather unusual when compared to that of the rest of Asia. The developments have been possible due to availability of large areas of land and reliable sources of good quality water, and government rendering the required backing to aspiring businesses. It is also important to note that the aquaculture developments in Myanmar are not overly stressing these systems, at least currently, by adopting very high stocking densities and feeding rates, apart from cage culture of pangasid catfish in rather fast flowing rivers, as has happened elsewhere. Consequently, these production strategies appear to be sustainable in the longer term.

References

De Silva, S.S., Nguyen, T.T.T., Abery, N.W., Amarasinghe, U.S., 2006. An evaluation of the role and impacts of alien finfish in Asian inland aquaculture. Aquaculture Research, 37: 1-17.

Edwards, P., 2005. Rural aquaculture in Myanmar. Aquaculture Asia. X (2): 5-8.

Ng, Wing Keong; Soe, Myint and Phone, Hla (2007). Aquafeeds in Myanmar: A change from farm-made to factory-made feeds. Aquaculture Asia XII (3): 7-12.

Win Hla, 2004. Opportunities and challenges in Myanmar aquaculture. Aquaculture Asia IX (2): 12-15.

Chaungthar Hatchery, Department of Fisheries - rohu dominates seed production.

Sustainable and safe black tiger shrimp seed will increase profit of farmers

MOANA (Asia) Ltd.

Farmers can expect to increase their profit substantially due to the recent launch of domesticated & SPF black tiger shrimp (*Penaeus monodon*) seed by MOANA, the leading aquaculture company in the development and supply of genetically improved and disease free seed of black tiger shrimp. The product will be launched first in Vietnam (February 2008) and immediately thereafter in India and Thailand (July 2008).

Stagnation in black tiger shrimp production

Over the last few years black tiger shrimp production has stagnated and has been gradually substituted with the non-indigenous white shrimp (*P. vannamei*, imported from the Americas) to meet increasing demand. The major factor compromising the production and sustainability of the black tiger shrimp industry has been the lack of a reliable supply of black tiger breeders and high quality seed.

Creating a sustainable solution

A key solution in the sustainable production of farmed black tiger shrimp is the consistent availability of 100% SPF seed. The present problems in the production are related to the fact that, contrary to white shrimp, the black tiger shrimp had not been domesticated yet. Hence the supply of breeders for seed production was and is still obtained from wild fisheries. Consistency in availability and quality of wild-caught breeders has decreased significantly over the past years. The only solution to this problem was to start a breeding program that would result in a genetically improved black tiger shrimp. This has been done over the past six decades for chickens, pigs and horses and since the late 70's also for some fish species. MOANA has done the same now for the black tiger shrimp.

Domestication and Genetic Improvement Breeding Initiative of MOANA

In 1999, MOANA started a visionary and ambitious scientific project in support of the revitalization of the black tiger shrimp industry. With the highest financial investment ever made in shrimp breeding, MOANA successfully developed the largest and most diverse gene pool of specific pathogen free parent stock worldwide. Over a period of three years, technologies have been developed on an industrial scale for the domestication of the black tiger shrimp. A family based genetic improvement program was launched for developing ever better breeds. The successful results of these initiatives have enabled MOANA to become the leading aquaculture company in the development and supply of genetically improved and specific pathogen free seed of black tiger shrimp. MOANA's innovative approach through pedigree-based selective breeding (non-GMO) will fill today's need for sustainable production and fully traceable supply of high quality seed throughout the value chain.

Solution for the black tiger shrimp industry is available now

MOANA's extensive research & development efforts are an important success factor in the company's achievements. MOANA's team of renowned experts, in collaboration with leading universities in Europe, USA and Asia, is continuously focusing on further improving the genetics and culture technologies of the black tiger shrimp. MOANA's specific pathogen free and traceable seed, guaranteed with a MOANA Certificate, will add value throughout the global supply chain, benefiting farmers, processors, exporters, retailers and consumers. Combined with MOANA's know-how, services and technology, farmers will have the opportunity to improve quality, quantity and consistency in their production. Resulting benefits such as increased survival and improved growth rates will lead to more stable income and higher profits.

At the moment MOANA operates in six countries on three continents. The company, founded in Belgium by Mr. Flor Indigne, has its headquarters in Hong Kong. MOANA's bio-secure facility on the Big Island of Hawaii, the Nucleus Breeding Center, supplies the parent seed to its overseas Multiplication Centers. Currently, MOANA operates Multiplication Centers in Vietnam, Thailand and India through which high quality SPF seed is made available to shrimp farmers. Vietnam, currently the largest black tiger shrimp producer in the world, followed by India and Thailand will be the first countries where farmers will benefit form the SPF seed. This will boost the local shrimp industry tremendously in the coming years. Further expansion is planned in other countries in Asia, Middle East, Africa and Latin America over the next years. More information can be found at www.moanatech.com. See the testimonials pages for supporting statements about the MOANA initiative.

MOANA yield: MOANA demo farm, Vinh Chau, Soc Trang, Vietnam 2007.

	Moana[1]	Industry average[2,3]
Stocking density PL/m^2	30	30
Culture period (days)	120	120
Survival (%)	76	66
Size (g)	32	25.3
Feed conversion ratio	1.40	1.47
Feed price (USD)	1.25	1.25
PL price (USD/1000)	15	3.75
Shrimp price / kg at harvest (USD/kg)[4]	5.9	5.0
Yield (kg/ha)	7,296	5,009
Income (USD/ha)	43,046	25,045
Cost PL (USD/ha)	4,500	1,125
Cost Feed (USD/ha)	12,768	9,205
Gross result (USD/ha)	25,778	14,715
Other cost (USD/ha)	10,433	7,163
Net profit (USD/ha)	15,345	7,552

1: Vietnam 2007; 2: Vietnam 2006; 3: Source: Master thesis, Nguyen Thanh Phuoc, Cantho University 2006; 4: At 24 July 2007.

Peter Edwards writes on

Rural Aquaculture

Dr Edwards is a consultant and Emeritus Professor at the Asian Institute of Technology in Thailand where he founded the aquaculture program. He has over 30 years experience in aquaculture education, research and development in the Asian region. Email: pedwards@inet.co.th.

Pilgrimage to traditional carp pond culture in Central Europe

Drs. Berka (left) and Varadi (right) who assisted my pilgrimage to the Czech Republic and Hungary.

Much has been written about contrasting philosophies of East and West concerning human interactions with nature. In Asia humans have been considered to be an integrated and relatively benign part of nature while in the West we have been stated to be in conflict with nature as we attempt to dominate the natural environment through science and science-based technology, including aquaculture. This view is written most eloquently by Elisabeth Mann Borgese in her 1980 book, "Seafarm, the Story of Aquaculture": "aquaculture has a philosophical base in the East and a scientific base in the West…in the East it is culture, it is life…it is embedded in the social and economic infrastructure…in the West, aquaculture is science and technology, embodied in industry and providing profits…it has no social infrastructure".

While there is some truth in these differences between Asian and Western philosophies and aquaculture practices, they are fast disappearing in rapidly developing Asia. Furthermore, they overlook a major European aquaculture system: carp pond culture in Central and Eastern Europe (CEE). Carp pond farming has an almost 1,000 year old history and cultural tradition and is an integral part of the physical landscape and social fabric of some CEE countries. Carp are currently farmed in nearly 0.7 million ha of ponds with an average annual production of 190,000 tonnes between 1999-2003.

I have been based for my entire professional life in aquaculture in Asia, carrying out research, teaching and promoting traditional Asian aquaculture practice, so I made a pilgrimage to the historic pond areas of the Czech Republic and Hungary to gain first hand experience of this traditional Western aquacultural practice. Laszlo Varadi of the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI) in Szarvas, Hungary kindly guided me for one week in July across Hungary and through the southern part of the Czech Republic to visit the major historic fish farming areas. In the Czech Republic we were joined by Zdanek Adamek of the Research Institute of Fish Culture and Hydrobiology Vodnamy and the University of South Bohemia, Ceske Budejovice who has in-depth knowledge of traditional Czech aquaculture. We visited many farms and a fisheries museum in both countries. I also gained further insight into current issues facing carp pond culture in discussions following the lecture I gave at the above research institutions in the two countries on how application of some of the principles of traditional Asian aquaculture might lead to more environmentally friendly modern aquaculture. I was also very fortunate to meet R. Berka, a distinguished retired scientist from the Czech Republic who has a wealth of experience on both the historical and recent development of carp pond culture in Europe

Overview of carp pond farming

Carp culture comprises three sequential pond stages which have remained more or less unchanged since it was developed in the 14th century, nearly 700 years ago. Carp are raised sequentially in three groups of ponds which are drained annually: nursing ponds are up to 1 ha in area and 0.5 m deep (and are often used later in the season as wintering ponds with deeper water) and produce the first year's fish; summering ponds up to 10 ha in area are used to raise 2 year old fish; and

marketing ponds at least 50-100 ha in area are stocked with 2 year old fish which are raised until they are 3-4 years old and have attained a marketable size of 1.5-3 kg.

The typical polyculture is dominated by common carp (*Cyprinus carpio*) stocked at 50-90% of the total, followed by Chinese carps (bighead carp, grass carp and silver carp) at 10-30% with a few percent of predators (pike, *Esox lucius*; pikeperch, *Stizostedion lucioperca*; European catfish, *Siluris glanis*) and other species such as tench (*Tinca tinca*). About 70-75% of the nutrition for the fish is from protein-rich natural food (plankton and benthos) with 25-30% from supplementary feeding with energy-rich grain (barley, maize, wheat). Cattle manure is mainly used to fertilize ponds but pig and poultry manure is used in areas where these livestock are raised in feedlots. However, ponds in many areas are eutrophic from agricultural, industrial or urban effluents or run-off so fertilization may not be required.

Ducks were previously raised on some fishponds in Hungary but are now raised separately as duck farming is now highly intensive. However, in both the Czech Republic and Hungary semi-wild ducks are raised to stock on special fish ponds for hunters. In the past in Hungary, ponds were drained only every 3 years and were rotated with a plant crop such as lucerne, maize or soybean but this practice has been discontinued since state owned farms have been privatised. There was also a fish, lucerne, rice rotation in some areas in Hungary which has also been discontinued.

Fish are harvested by sein nets in summer and autumn but at final harvest at the end of the year the water level is lowered and sein nets are used to force fish to swim into harvesting basins usually located outside the pond. Pond yields are relatively low, ranging from 600-1,500 kg/ha. A large majority of common carp production is sold live at Christmas for the traditional Christmas Eve dinner.

Until recently fish farms were state owned but they have now been privatized with some companies owned by worker stakeholders. Although aquaculture's contribution to employment is relatively small, in some areas it is one of the few livelihood options and helps to sustain rural populations. Today

A typically large fish pond with grain used as supplementary feed and feeding boat. Aranyponty Fish Farm, Hungary.

A feed storage silo on a eutrophic fish pond with green water, Czech Republic.

there are 50,000 ha of fish ponds in the Czech republic and 25,000 ha of ponds in Hungary, the two countries I visited.

Tour of historic fish farms

Following visits to the Research Institute, and fish farms dating to the 1940's, in Szarvas, southeast Hungary, we visited Aranyponty Fish Farm in the west of the country.

It was built by a nobleman more than 100 years ago in 1896 on poor quality agricultural land prone to water logging. It was originally a wetland but was drained in 1825 for agriculture. More recently it was a state farm and was purchased by its present owner, Ferenc Levai from the State in 1994 who began to diversify activities in 2000 so that the farm is now the core of the Rétimajor – Ponds Nature Reserve which was established in 1996 and covers about 1,500 ha. The fish pond system consists of 12 large ponds (10-70 ha), 16 small

ponds (1-5 ha) and 21 wintering ponds, with a total farm water surface area of 739 ha. More than 220 species of birds are registered on the farm, almost 60% of those found in Hungary, the majority of which have protection status. The reserve was designated as a Wetland of International Importance under the Ramsar Convention on Wetlands in 1997. The farm is one of only seven organic fish farms in Hungary currently certified by Bio-Kontrol Hungaria. There are various tourist and recreational facilities such as a hotel and a restaurant, angling, bird watching and nature trails. A former stable houses Hungary's only fishing museum. A field laboratory has been established in cooperation with HAKI to monitor the environment, develop innovative aquaculture technologies and study multifunctionality of fish farms. The farm revenues of the multifunctional pond farm are 20-50% higher than those of a conventional pond farm with only aquaculture, and in addition the former has a more diversified income which increases its economic sustainability and social acceptance.

We then drove north to Tata near Budapest, Hungary and visited the Tata Agricultural Shareholding Company. The largest fish pond belonging to the company is 219 ha in area with an average depth of 2 m. It was developed as a fish pond from a wetland in the 18th century and when the pond is drained, the old river with flowing water reappears. The pond is linked to the moat of a 15th century castle which was used as a royal hunting lodge and is believed to have been stocked with fish centuries ago. Today the moat is used as fish harvesting and storage basins.

Visits were made to fish farms in south Moravia and in the Trebon area, the largest of the three fish pond areas in south Bohemia, in the Czech Republic. There are hundreds of fish ponds of varying sizes dominating the landscape in the Trebon area. The largest fish pond in the Czech Republic was visited, Rozmberk, which is 489 ha at present although it was more than 700 ha in the past. It was built by damming a river running through water logged agricultural fields in the second half of the 16th century. A visit was also made to Bosilecky, 190 ha, which is the oldest fish pond in the Czech Republic with reliable evidence for its existence in 1355, 650 years ago. The pond is in the Trebonsko Protected Landscape Area and Biosphere Reservation which

A traditional wooden drainage monk on a fish pond, Czech Republic.

Fish harvest, Czech Republic. Photo courtesy of Zdenek Adamek.

comprises the village and surrounding countryside. The fish pond has reeds and sedges which shelter rare animals and plants and the pond attracts large numbers of migrating water fowl during the spring and autumn passage. Some water fowl also nest locally. There are also colonies of night herons and common terns on islets in the pond.

Environmental issues

Fish ponds are an integral part of the rural economy as well as the landscape because of their large number and often large size. Ponds were built in low-lying wetlands or areas with soil conditions too poor to support productive agriculture, sometimes from water logged fields which had earlier been converted from wetlands. In some areas, in particular in parts of southern Bohemia in the Czech Republic, centuries old fish ponds are the major feature of the landscape. Although they are all artificial, they look like lakes because they are so big. There has also been a continuous programme through the centuries of draining wetlands in Hungary to develop agricultural land as well as large fish ponds.

Bill board for Aranyponty Fish Farm advertising its multifunctional nature, Hungary.

Fisheries Museum at Aranyponty Fish Farm, Hungary.

Carp sign above the restaurant door, Aranyponty Fish Farm, Hungary.

Ferenc Levai, owner of Aranyponty Fish Farm with a ceramic exhibit in the museum, Hungary.

Water birds on a fish pond, Aranyponty Fish Farm, Hungary.

Fish harvesting and storage basins in the moat of the castle at Tata, Hungary.

Many ponds are multipurpose. Besides producing fish they may serve for recreation and tourism such as bird watching, angling and hunting specially bred, semi-wild ducks; water storage and flood protection of surrounding areas; irrigation; as nature reserves; and to preserve the local cultural heritage of aquaculture and carp consumption. The major flood experienced by the Czech Republic in 2002 would have been much worse according to Dr. Berka without fish ponds which held more water than storage reservoirs, even though their water holding capacity has declined by 25% due to silting in recent years.

The current low yield of carp ponds in the CEE is partly due to their multiple use, and especially from strong pressure from nature conservancy and environmental groups. Aquaculture may take second or even third place behind biological treatment of water, water retention and nature conservation. According to Dr. Berka, aquaculture in the Czech Republic is "fighting for existence" with environmental groups who would be "happy without fish in the ponds" even though all fish ponds in the country are artificial. Fish ponds have been taken over by environmentalists in Germany with a 50% decline in carp production Dr Berka revealed. He pointed out further that building fish ponds made the landscape more useful for humans as well as for nature: without aquaculture, there would be no water bodies; had wetlands not been converted into fish ponds, they would have been developed into agricultural land.

The Czech Government has set a limit of a ratio of 50:50 fertilizers to feed to produce carps in ponds according to Dr Berka. It is prohibited by law to add inputs to a fish pond but permission may be granted based on analysis of pond water quality and pond history. The main point of conflict is the desire of environment groups to consider a fish pond only as a natural wetland which is hardly feasible.

Environmental groups have also prevented the stocking of grass carp in ponds in the Czech Republic as it is not a native fish even though it would help to reduce excessive growth of aquatic macrophytes in the shallow ponds. In Hungary grass carp can still be stocked in fish ponds but not in reservoirs or natural waters.

The majority of ponds do function as wetlands because of their large size vegetated margins. Three fish farms in the Czech Republic and four in Hungary have protected fauna, flora and habitats under the Ramsar Convention on Wetlands. Under the all European project Natura 2000, it is predicted that

A monument to common carp in Trebon, Southern Bohemia in the heart of the largest area of fish ponds in the Czech Republic.

A smaller, village-level fish pond, Czech Republic.

further additional protected fish pond areas will be designated in the Czech Republic in which fish production will be decreased in many ponds to almost an extensive level.

Fish predators such as cormorants, herons and otters cause high economic losses to fish farmers although in the Czech Republic they are compensated under law for losses caused by protected animal species. The number of cormorants has increased dramatically in recent years in the Czech Republic as migrating flocks of tens of thousands of birds spend a few weeks on the ponds in spring and autumn as they pass through the region. Farmers are not concerned about a few hundred locally nesting cormorants but huge migrating populations from Northern Europe consume huge amounts of fish as a cormorant eats 0.5 kg fish/day according to Dr. Adamek who is involved in assessing fish loses due to animal predation.

At present the most important concern in Czech aquaculture is shallow ponds caused by siltation. This has always been a problem with ponds but in the past ponds have been desilted when the mud layer exceeded 40cm in depth. In recent years the silt load of water has increased as greater overall management of water has slowed down the flow rate and therefore the flushing rate and increased the siltation rate in rivers as well as in ponds. In the Czech Republic the average pond depth is now only 0.6-0.9m compared to 0.8-1.1m previously. Ponds are currently being desilted to increase their depth but it is expensive and requires government subsidy. It was easier to desilt ponds in the 1950s and 1960s before the era of pesticides, and even through the 1970's and 1980's, as there was a large demand for nutrient-rich sediments to put on agricultural land but there is no demand today. Fish pond sediments sometimes have to be treated like hazardous wastes because of a high pesticide content from improper agricultural practices during the previous socialist era.

Carp farming is increasingly being seen as part of the solution to nature conservation and not as a problem. As well as producing more fish, deeper fish ponds can store more water as well as provide a more suitable habitat for water birds. Shallow carp ponds were observed in Hungary during the tour which had been left idle for a few years. They had become infested with dense stands of emergent macrophytes and had therefore become unsuitable for water birds attracted to open water. In fact, fish farming may be the only economic way to manage fish ponds to prevent them from disappearing through vegetational succession so that they can also serve as a suitable habitat for water birds. A balance needs to be struck between the various multiple functions. It is a major developmental goal of carp farming in the CEE countries to maintain the condition of existing fish ponds so that they may continue to function as wetlands with potential to preserve habitats for diverse fauna and flora as well as rural landscapes. Multiple functioning of fish ponds is now considered to be a strength of pond aquaculture by the aquaculture fraternity.

Marketing

There are also marketing issues which threaten the sustainability of carp farming. Carp production is still profitable with farm gate prices of Euro 2.2-2.4/kg for carp of at least 1.5 kg but annual fish consumption is very low

Above left: Water gate at Rozmberk the largest fish pond in the Czech Republic. Above right: Fish harvesting basin at Bosilecky, the oldest fish pond in the Czech Republic.

An unused fish pond filled with reeds and sedges, Szarvas, Hungary.

in the CEE e.g., in 2006 in the Czech Republic it was only 5 kg/person/year (and only 1.1 kg/person/year of freshwater fish) and only 3.7 kg/person/year (only 0.7 kg/person/year of freshwater fish) in Hungary in 2006. Carp prices have been stagnant over the last 10 years.

Most carp are eaten at the traditional Christmas Eve dinner, over 90% of the carp consumed in the Czech Republic although only 30% of the total annual sale is at Christmas in Hungary. Carp are also used to stock ponds for anglers and are exported for human consumption as well as for stocking ponds for angling. Very little fish is processed as the price of processed fish is much higher than that of processed pork and imported marine fish such as salmon. *Pangasius* catfish is now imported from Vietnam and as it is a high quality product that is cheaper than locally farmed fish, it is considered to be a major threat to the sustainability of local aquaculture. Advertising campaigns are being carried out to try to increase consumption of carp, a high quality fish with low fat content as natural high-protein food contributes 70-75% of the total food for the fish, but there is concern that the traditional carp polyculture might not be able to survive the increasing trend for importation of fish.

Asia-Pacific Marine Finfish Aquaculture Network

Magazine

SKRETTING

Could domperidone via oral administration enhance final oocyte maturation and ovulation and in the long-term affect egg and larval quality in sand bass *Psammoperca waigiensis*?

Pham Quoc Hung[1], Nguyen Tuong Anh[2], Nguyen Dinh Mao[1]

1. Nha Trang University, Faculty of Aquaculture; 2. University of Natural Sciences, HCMC, Department of Zoology

Dopamine is a neurotransmitter that inhibits the release of hormones from the pituitary. In the teleost fish brain, hypothalamic factors are released and transported to the anterior pituitary via the hypothalamo-pituitary portal system (Finn-Arne Weltzien *at al*., 2005). Under natural conditions, there is a feedback mechanism in the fish that limits the release of gonadotropin (GtH). This mechanism uses dopamine, which inhibits the action of gonadotropin releasing hormones (GnRH). When dopamine is present in the fish, even GnRHa will have only limited success (Jeff Mittelmark et al., 2006). Domperidone (DOM) is a dopamine antagonist (DA) that blocks the action of dopamine. When GnRHa and a dopamine antagonist are used in combination, reproductive success dramatically increases (Jeff Mittelmark *et al*., 2006). The inhibitory effect of dopamine on GtH secretion and on GnGH-induced GtH release is well established in most freshwater fish species (Nguyen Tuong Anh., 1998). In Vietnam, beside the freshwater fish, several marine finfish species, spawning under captivity conditions can be induced by environmental stimulus or hormone injection in combination with a dopamine antagonist (Nguyen Tuong Anh., 1998). DOM is the dopamine antagonist that has commonly been used for cultivated fish and proven to be very effective and reliable in induced spawning cultivated freshwater fish (Naruepon Sukumasavin *et al.* 2000).

Sand bass (*Psammoperca waigiensis*) is a tropical marine finfish present in coastal waters in Asia Pacific such as Vietnam, Indonesia, Singapore, Thailand, Japan and Australia (Tamaki Shimose *et al*., 2006). In Vietnam, induced spawning with hormone

Figure 1. Selecting breeders.

injections and environmental stimulations has been achieved in captivity (Nguyen Trong Nho *et al.*, 2003). For the commercial purpose of sand bass fry production, injection of GnGH analog combined with DOM was recommended rather than inducing with environmental stimulus (Nguyen Trong Nho *et al.*, 2003). The injections might, however, cause stress to fish, affect health and in the long-term influence egg and larval quality (Kjørsvik *et al.*, 1990). Therefore, an alternative method of using the dopamine antagonist, DOM, via oral administration to minimize the injections has been tested. In the present study, we investigated whether DOM via oral administration could enhance final oocyte maturation and ovulation (FOMO), and long-term effect egg and larval quality in sand bass.

Materials and methods

The experiments were conducted in a backyard-shrimp hatchery at Nha Trang City, Vietnam from February to August 2007. Three year old brood fish, hatched in late 2004, were kept in the ponds in which the salinity ranged from 28-32 ppt and temperature from 28-32°C before the experiments. On February 19, 2007, four groups of 60 fish (sex ratio is 1:1) were distributed in concrete tanks. The holding density was 3 kg broodfish per cubic meter. Broodfish were daily fed of 3-5 % body weight with trash fish and once per week with squid. Vitamin E and C were also supplied once per week in order to help stimulation the gonadal development and maturation (Syamsul Akbar, *et al.*, 2005). Domperidone was ground and mixed with cassava powder and finally with trash feed to form a paste. Fish were fed DOM every 3 days. Water temperature during the experiments was maintained of 28-32°C and water exchange of 100 % was taken place twice per week.

The fish were anaesthetized in cold freshwater to measure weight, length and for stripping. Once each month fish were weighed to the nearest 0.1 g and measured to the nearest 0.1 cm in length. Females and males were anaesthetized to check for maturity every two weeks. No hormone manipulation was applied to induce spawning in this study. The fish were induced to spawn by adding water to simulate the rising of the tide. This water change also drastically brought down the temperature to 27 or 28°C. Absolute fecundity (FA) was calculated from counting of egg samples (0.5-1 g) at stage IV (complete yolk formation), and relative fecundity (FR) calculated from: FR=100 FA. W -1 where FA is absolute fecundity and W is total weight of the female. Egg diameter (right after stripping) was determined as the average from measurements of 50 eggs under microscope equipped with micrometer. Fertilization rate was estimated by examining at least 50 eggs at the 32-cell stage. Eggs were cleared in a solution of glacial acetic acid and saline (1: 20 v/v), examined under stereomicroscope and cleaved eggs were classified as fertilized (Tveiten *et al.*, 2001). Gonad samples from the posterior, middle and anterior part of

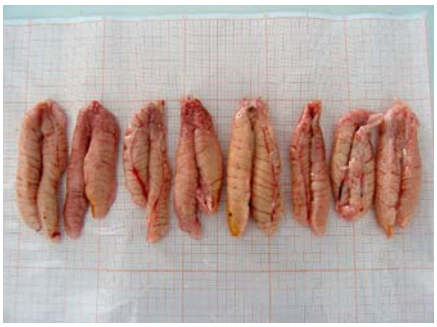


Figure 2. Ovaries from different groups have the same developed stages (complete yolk formation).

the right gonad were fixed in Bouin's fixative, dehydrated through an ethanol series and embedded in paraffin. The sections were cut at 4 - 6 um thickness and stained with Harris' Hematoxylin and Eosin for examination at light microscopy.

Eggs were considered normal when cleavage was symmetrical, cells had similar size and cell formation was complete, whereas abnormal eggs were associated with irregular cleavage, poor cell formation with vesicular inclusions, and deformation of blastomeres (Kjørsvik *et al.*, 1990). The proportion of eggs, which survived to the eyed stage, and until hatch, were assessed relative to the number of fertilized eggs. Hatching rate was possible to assess at the group level only. Hatching time was determined as the number of days from fertilization until 50% of the eggs were hatched. The effect of different DOM concentrations on the ovulating females, fecundity, egg diameter and embryonic development parameters

Table 1: Reproductive characteristics of female sand bass fed DOM during the breeding season.

Group	Weight (g)	Length (cm)	Absolute fecundity	Relative fecundity (egg kg^{-1})	Egg diameter (µm)	n
05 mg DOM /kg BW	313.5 ± 3.2	26.3 ± 2.5	112,250 ± 230	326 ± 3.4	756 ± 25	11
10 mg DOM /kg BW	325.2 ± 2.6	27.2 ± 3.7	106,421 ± 264	371 ± 4.5	740 ± 28	12
15 mg DOM /kg BW	291.7 ± 4.5	24.6 ± 4.3	98,160 ± 255	321 ± 6.5	755 ± 31	10
Control (no DOM)	296.7 ± 2.5	26.6 ± 3.3	100,160 ± 198	341 ± 6.8	735 ± 31	15

Table 2: Egg and larval quality of female sand bass fed DOM during the breeding season.

Parameters of egg quality	Group			
	05mg DOM/kg	10 mg DOM/kg	15mg DOM/kg	Control (no DOM)
Fertilization rate (%)	67 ± 3.2	65 ± 2.4	55 ± 2.2	70 ± 2.5
Survival to the eyed stage (%)	62 ± 2.7	58 ± 2.2	51 ± 2.5	70 ± 4.2
Hatching rate (%)	40 ± 3.6	45 ± 2.3	38 ± 2.6	49 ± 3.3
Survival to finished yolk sac stage (%)	26 ± 4.6	23 ± 3.3	22 ± 5.6	33 ± 4.3
Embryonic development duration (h)	16.5± 3.7	17± 1.7	17.5± 3.4	16± 1.4
Fertilized egg diameter (µm)	750 ± 34	750 ± 27	790 ± 32	770 ± 22
Oil drop diameter (µm)	230 ± 17	230 ± 14	240 ± 13	236 ± 16
Larvae length at 1-day old (mm)	1.79 ± 0.4	1.84 ± 0.3	1.76 ± 0.2	1.75 ± 0.2
Larvae length at 2-day old (mm)	2.43 ± 0.3	2.38 ± 0.6	2.36 ± 0.1	2.38 ± 0.2
Larvae length at 3-day old (mm)	2.46 ± 0.2	2.45 ± 0.5	2.44 ± 0.1	2.45 ± 0.4

Figure 3a, 3b, 3c and 3d: Histological stages of sand bass ovaries fully developed at the same stage of the groups.

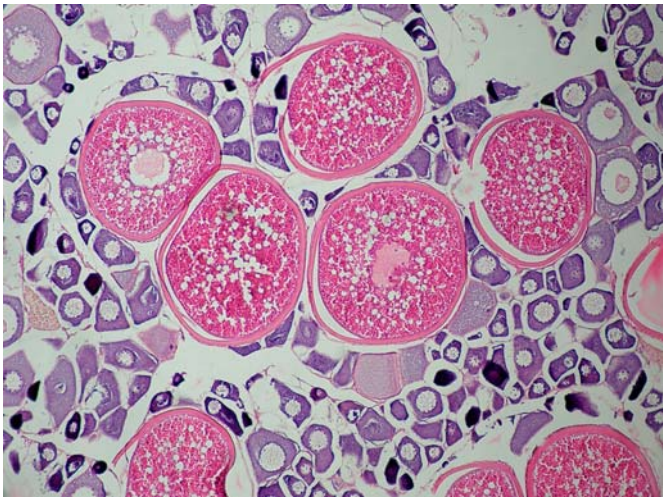


Figure 3a: The ovary section of 5 DOM group.

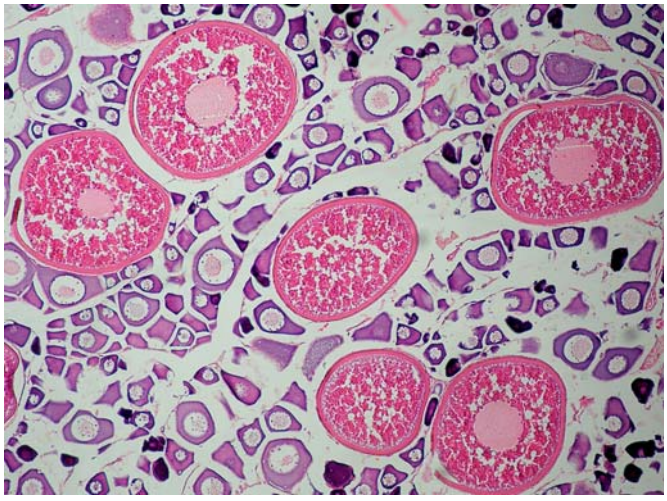


Figure 3b: The ovary section of 10 DOM group.

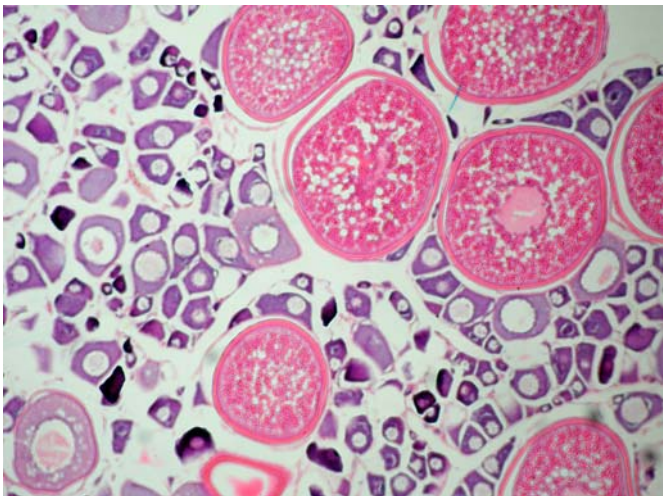


Figure 3c: The ovary section of 15 DOM group.

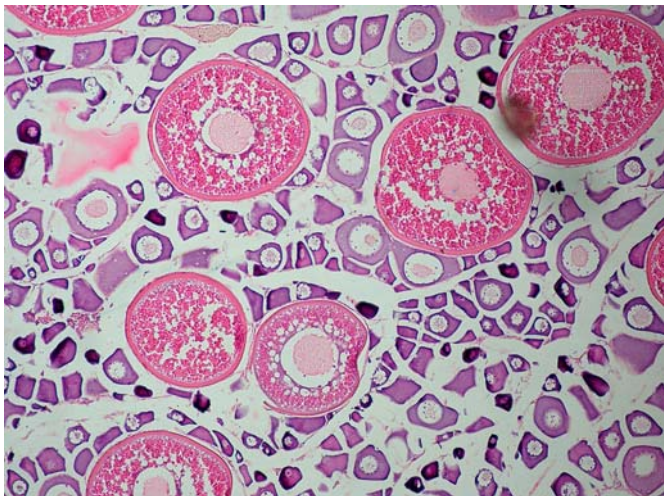


Figure 3d: The ovary section of the control group.

were assessed using one-way ANOVA. Treatment means were compared by least significant difference (LSD) at 95 % confident level. All computations were performed with SPSS 12.0 and excel software program. Values were expressed as mean ± standard deviation (SD).

Results

The present study indicated no significant differences of final oocyte maturation and spawning incidences between the groups treated with different DOM concentration during the breeding season from March to August. The first spawning was observed on April 8, 2007 for all groups after inducing with freshwater and water exchange. During the period from March to August, no significant differences about the number of ovulated females and males between the groups were observed. The inspection for ratio of ovulated females was taken every two weeks and the mean values were 42.34%, 66.28%, 39.45 % and 49.37% for 5 mg DOM, 10 mg DOM, 15 mg DOM and the control (fed no DOM) group, respectively (n = 36). The males were also checked for sperm at the same time as females and found that around 92% males (n= 28) in all groups reached final maturation and released sperm. Table 1 showed the average weight of the females used in this study was from 291.7 gram to 325.2 gram and the length ranged from 24.6 to 27.2 cm. No significant differences of batch fecundity, relative fecundity and egg diameter were found between the groups (Table 1). Table 2 showed egg and larval quality when eggs were incubated at temperature of 30°C. The mean values were derived from 15 spawns during the breeding season.

Discussion

The present study revealed that the sand bass spawned equally well whether they were fed DOM or not during the breeding season. No significant differences of FOMO, egg and larval quality among the groups were found. These might imply the evidence of lacking dopaminergic inhibition of GtH release in sand bass, a marine finfish species. In a study on Atlantic croaker (*Micropogonias undulatus*), Copeland & Thomas (1989) found evidence for lack of dopaminergic inhibition in this species. Maturation of the egg is a long process that involves complex physiological and biochemical changes. One important step, vitellogenesis, is a process in which yolk proteins are produced in the liver, transported to the ovary, and stored in the egg, resulting in tremendous egg enlargement (Barannikova *et al.*, 2002). The first spawning was observed at the same time in all groups after exchanging water implies

that the fish in all groups were at the same stage of gonadal development like at the end of vitellogenesis, for instances. Although these processes are completely regulated by hormones, but the results indicated the role of DA in blocking dopamine and stimulating GtH release in sand bass was not clear. The questions needed to discuss here is that whether the methods of mixing DOM with trash fish applied in this study were reliable and fish could take up the the DOM equally. On the other hand, we questioned whether DOM could be absorbed and transported to the blood stream, and then acted on the hypothalamo-pituitary portal system. Further study needed to be conducted to investigate this mechanism. For more understanding the role of the DOM in this work, measuring of follicle stimulating hormones (FSH) and luteinizing hormone (LH), or any steroid hormones involved in the reproductive process is recommended.

Hormones play a critical role in the reproductive process in teleost fish. They are chemical messengers released into the blood by specific tissues and travel through the bloodstream to other tissues, which respond in a variety of ways. One response is to release another hormone (Bernadette Vidal *et al.*, 2004). The primary tissues involved in this hormonal cascade are the hypothalamus, pituitary gland and gonads. GtH secretion is regulated by a dual hypothalamic control of GnRH and dopamine, which acts as a gonadotropin release inhibitory factor (GRIF) (Barannikova *et al.*, 2002). FOMO in fish is normally initiated by a surge of GtH II (Finn-Arne Weltzien *et al.*, 2005). In this study we investigated the potential of using DOM via oral administration and practically aimed to reduce the injections of hormone, which could stress the fish breeders. Among the most significant advancements in the field of aquaculture during recent decades is the development of techniques to induce reproduction in fish. Feeding DOM in sand bass is the first trial in Vietnam in an attempt to improving the seed production techniques. In an assumption, if DOM via oral administration could enhance spawning in sand bass, this technique might has allowed farmers to advance or extend the spawning season, use fewer breeders and obtain a desired fry production. Consequently, the farmers profitably breed, raise and manipulate the timing of reproduction to suit production cycles.

Hatching rates were not very high and ranged from 38 % to 49 %, lower than those compared with other studies (Nguyen Trong Nho *et al.*, 2003, Syamsul Akbar *et al.*, 2005). This might explain the observed differences were caused by poor male quality and /or water environmental parameters with parasites, which could negatively cause the embryonic development. In the present study, the male size was quite small at around 100 gram each, which gave a small volume of semen. Other reason could also affect the fertilization rate was the ratio between males and females. The learning lesson could be withdrawn from this study was the ratio should be 2 males to 1 female to ensure sufficient sperm for fertilisation if the body size of male was much smaller than female. The sand bass can be easily induced to spawn with water exchange or adding water to stimulate the tide rise. In a study in Thai Carp (*Puntius gonionotus* Bleeker), DOM is the DA has shown a better effect than other DA such as Sulpiride (SUL) and Metoclopramide (MET), which can also stimulate the secretion of GtH II and induce ovulation in fish (Naruepon Sukumasavin *et al.*, 2000). In fish, FOMO is controlled by the maturation inducing steroid (MIS) 17,20-dihydroxy-4-pregnen-3-one (17,20-P) (Nguyen Tuong Anh, 1998). This steroid may also be involved in FOMO in sand bass. Ovulation is often mediated by prostaglandins (PGs) (Barannikova *et al.*, 2001). Therefore, the point raised to discuss are whether MIS and PGs are regulated by the pituitary hormones in sand bass orally treated with DOM during the breeding season. The observation from this study, on the other hand, indicated quality of sand bass larvae was not differences between the groups. This would imply that DOM might not have long-term effect on egg and larval quality in sand bass. Further study might need to be conducted in older larvae and in juvenile stage of sand bass to conclude this assumption.

References

Barannikova, I. A., Dyubin, V. P., Bayunova, L. V. and Semenkova T. B. 2002. Steroids in the Control of Reproductive Function in Fish. Neuroscience and Behavioral Physiology, Vol. 32, No. 2, 2002.

Bernadette Vidal, Catherine Pasqualini, Nadine Le Belle, M. Claire H. Holland, Miskal Sbaihi, Philippe Vernier, Yonathan Zohar, and Sylvie Dufour, 2004. Dopamine Inhibits Luteinizing Hormone Synthesis and Release in the Juvenile European Eel: A Neuroendocrine Lock for the Onset of Puberty. Biology Of Reproduction 71, 1491–1500 (2004).

Copeland Paul and Thomas Peter, 1989. Control of Gonadotropin Release in the Atlantic Croaker (*Micropogonias undulatus*): Evidence for Lack of Dopaminergic Inhibition. General and Comparative Endocrinology 74, 474--483.

Finn-Arne Weltzien, Catherine Pasqualini, Marie-Emilie Sébert, Bernadette Vidal, Nadine Le Belle, Olivier Kah, Philippe Vernier and Sylvie Dufour, 2005. Androgen-Dependent Stimulation of Brain Dopaminergic Systems in the Female European Eel (*Anguilla anguilla*). Endocrinology Vol. 147, No. 6 2964-2973.

Jeff Mittelmark and Anne Kapuscinski, 2006. Induced Reproduction In Fish. Minnesota Sea Grant Project, University of Minnesota, USA.

Kjørsvik, E., Magnor-Jensen, A. & Holmefjord, I. (1990). Egg quality in fishes. Advances in Marine Biology 26, 71–113.

Nguyen Tuong Anh, 1998. Applied endocrinology in fish reproduction. Agriculture publishing house of Vietnam 1998 (in Vietnamese).

Nguyen Trong Nho, Luc Minh Diep and Nguyen Dich Thanh, 2003. Study on seed production of Sand bass *Psammoperca waigiensis* (Cuvier & Valenciennes, 1828), 2003. A research report under contract between the University of Fisheries and SUMA, Ministry of Fisheries, Vietnam 2003 (in Vietnamese).

Naruepon Sukumasavin, Suwannee Sakulthong and Ravee Sangthong, 2000. A Comparison of the Potency of Dopamine Antagonists on Spawning Induction in Thai Carp (*Puntius gonionotus* Bleeker). Kasetsart J. (Nat. Sci.) 34: 240 - 247 (2000)

Syamsul Akbar, Tinggal Hermawan dan Zakimin, 2005. Mass seed production of sand sea bass (*Psammoperca waiginensis*) at the Regional Center for Mariculture Development (RCMD) in Batam, Indonesia. Asia-Pacific Marine Finfish Aquaculture Network (NACA), Volume X No. 2 April-June 2005.

Tamaki Shimose and Katsunori Tachihara, 2006. Age, growth, and reproductive biology of the Waigieu seaperch *Psammoperca waigiensis* (Perciformes: Latidae) around Okinawa Island, Japan. The Ichthyological Society of Japan 2006. Ichthyol Res (2006) 53: 166–171. DOI 10.1007/s10228-005-0330-2.

Tveiten, H., Solevag, S.E., & Johnsen, H. K, 2001. Holding temperature during the breeding season influences final maturation and egg quality in common wolfish. Journal of Fish Biology (2001) 58, 374–385.

Effect of dietary protein and lipid level on growth performance of tiger grouper *Epinephelus fuscoguttatus* during late-stage grow-out

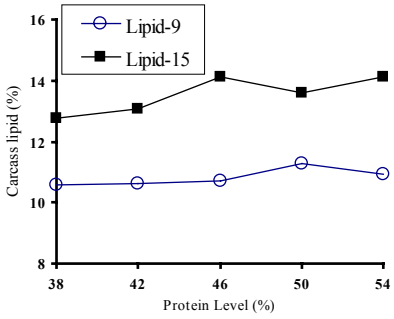
Nyoman Adiasmara Giri*, K. Suwirya, T. Sutarmat and M. Marzuqi
Gondol Research Institute for Mariculture, P.O. Box 140 Singaraja, Bali Indonesia 81101, e-mail: adiasmara_giri@yahoo.co.id.

Groupers are potentially important aquaculture species since they have a high economic value. Groupers, predominantly *Epinephelus* spp. have been cultured throughout Asia for many years based on captured wild seed and the fish reared on trash fish. Availability of compounded feed to replace trash fish is an important stage on grouper culture development. Protein and lipid are the major nutrients component of fish feed. Juvenile tiger grouper (11 to 100g) require diet containing 47 to 50% crude protein and 9% lipid for its good growth (Giri *et al*., 2004; Laining et al., 2004). However, there is no information on dietary nutrient requirement for larger size of grouper (>250g). This additional information is required to develop cost-effective feed through out the culture period. The objective of the present study is to find out the effect of dietary protein and lipid on growth performance of tiger grouper during late-stage grow-out.

Material and methods

Ten test diets were prepared to contain five levels of dietary protein, i.e. 38, 42, 46, 50, and 54% and two levels of dietary lipid, i.e. 9 and 15%. All diets have the same energy content of 3.4 kcal/g. Fish meal, casein, squid liver meal, shrimp head meal and soybean meal were used as protein sources. Diets were prepared as dry pellets, 12 mm in diameter. Feeding experiments were conducted in 30 floating net cages (1x1x1m^3) in Pegametan Bay, Buleleng-Bali. Forty fish at average weight of 274.4 g were stocked in each net cage. The experiment was a completely randomized design with two factors (protein and lipid level), and three replications for each treatment. Fish were fed test diet once daily in the afternoon to satiation level for 180 days.

Lipid content in carcass of tiger grouper fed test diets.



Results and discussion

The result of the experiment showed there was no interaction effect between the protein and lipid content of diet for weight gain, survival, and FCR. Increasing protein levels in the diet from 38% up to 54% did not significantly improve weight gain indicating dietary protein requirement of tiger grouper might be reduce in larger fish (Table 1). The present study indicated that a dietary protein 38% is sufficient to support good growth of larger (>250g) tiger grouper. This value is much lower compared to juvenile size of tiger grouper (11 g) that is reported to required 47% dietary protein (Giri et al., 2004) or 50% dietary protein for fish size of 50-100g Wt (Laining *et al*., 2004). Increasing levels of dietary protein showed better FCR (Table 1), indicated that tiger grouper consume more feed when protein content of diet is lower. Although the energy content of experimental diets is the same, fish prefer to utilize protein to meet their energy requirement over utilizing energy from lipid and carbohydrate sources. There was no significant effect of dietary lipid on weight gain, survival, and FCR of tiger grouper in the present study. Fish fed high lipid diet has higher carcass lipid content (Fig.2) indicating more energy of the diet was retained as body fat.

Conclusion

- Dietary protein 38% is sufficient to support good growth of larger (>250g) tiger grouper.
- Tiger grouper fed high lipid diets were fatter and more energy of the diet was retained as body fat.

References

Giri, N.A., K. Suwirya and M. Marzuqi. 2004. Optimum level of dietary protein and lipid for rearing juvenile tiger grouper (*Epinephelus fuscoguttatus*). In M.A. Rimmer, S. McBride and K.C. Williams (Eds.). Advances in Grouper Aquaculture. Australian Centre for International Agricultural Research. Canberra. p.92-94.

Laining, A., N. Kabangnga and Usman. 2004. Dietary optimum protein for tiger grouper (*Epinephelus fuscoguttatus*) diet reared in floating net cages. In M.A. Rimmer, S. McBride and K.C. Williams (Eds.). Advances in Grouper Aquaculture. Australian Centre for International Agricultural Research. Canberra. p.95-97.

Table 1. Weight gain, survival rate and feed conversion ratio (FCR) of tiger grouper fed test diet for 180 days.

Dietary factor	Dietary level (%)	Weight gain (%)[2]	Survival (%)	FCR[3]
Protein	38	127.2^a	72.7^a	1.82^a
	42	122.6^a	79.4^a	1.66^{ab}
	46	117.8^a	70.3^a	1.81a
	50	134.4^a	74.1^a	1.63^{ab}
	54	128.1^a	76.1^a	1.48^b
Lipid	9	131.7^x	74.3^x	1.62^x
	15	120.3^x	74.7^x	1.74^x

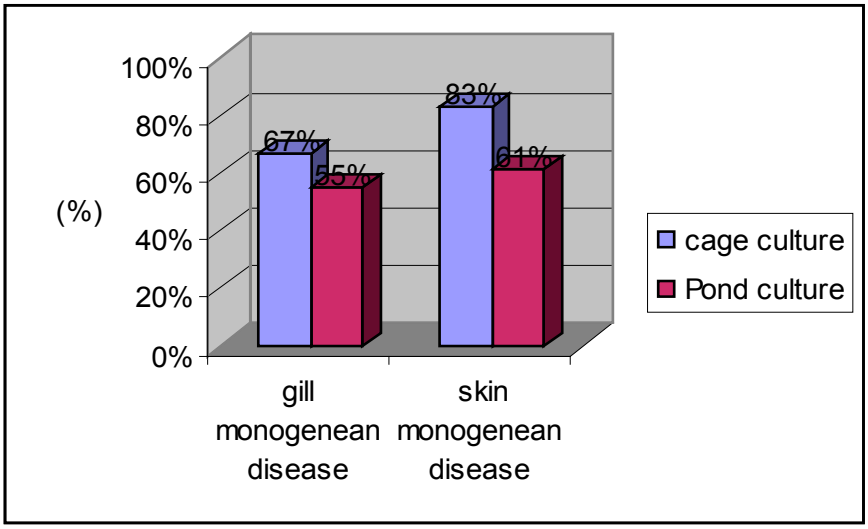
1. Initial weight = 274.7 g. Values in the column followed by the same superscript are not significantly different (P>0.05).
2. Weight gain = (final weight – initial weight) x 100/initial weight.
3. FCR = dry weight feed (g)/wet weight gain (g).

Monogenean disease in cultured grouper (*Epinephelus* spp.) and snapper (*Lutjanus argentimaculatus*) in Khanh Hoa province, Vietnam

Dr Do Thi Hoa, Phan Van Ut
Faculty of Aquaculture, Nha Trang University, Vietnam.

Marine fish culture has developed relatively recently in Khanh Hoa province with several high-value species such as grouper (*Epinephelus* spp), snapper (*Lutjanus argentimaculatus*), sea bass (*Lates calcarifer*), and cobia (*Rachycentron canadum*). However, these have suffered from serious disease issues under culture. Monogenean disease causes heavy losses for farmers. The disease can cause mortalities in cultured groupers and snappers, especially in small size fish (<20cm). Parasitic monogenean disease affecting the gills and skin of marine cultured finfish species have been studied by researchers such as Fris Jonhn, Des Roze (2002), Isti Koesharyani, Zafran, Kei Yuasa, Kishio Hatai (1999), Leong tak Seng (1994) and Yaowanit Danayadol (1994).
In this article, we present several epidemiologic characters of the disease and the monogenean species that are pathogens of the disease in cultured marine fish in Khanh Hoa province, Vietnam. In addition, we also report on tests of chemicals and treatments including formalin, hydrogen peroxide, Hadaclean and fresh water baths.

Prevalence of monogenean disease in skin and gill of cultured groupers and snappers in cages and ponds in Khanh Hoa province (n = 63).



Materials and methods

Data was collected from the local Aquaculture Department on the marine fish cultural areas in the province. For epidemiological investigation, 63 marine fish farms (of which 30 were cage fish culture farms and 33 were pond fish culture farms) were interviewed. In addition, we directly collected diseased and healthy fish specimens in order to examine the clinical signs and causative agents, allowing us to determine the frequency, clinical symptoms, harmful effect, seasonality and which life stages are affected the most. Fish specimens (both healthy and diseased) were collected randomly (8-10 fish/ cage or pond). Overall, 210 fish were collected (of which 55 skin disease samples, 75 gill diseasd samples and 80 healthy fish samples were obtained). Fish were moved to laboratory under aeration. The samples were divided into two groups by size; smaller (< 200g/individuals) and larger (>200g/individuals). Parasitic determination on/in fish was made following the methods of Dogiel, 1929 and Haky, 1993. Monogenean classification based on morphological characteristics. Infectious level of the parasite in fish was assessed based on two indicators:

Infection rate (%) = the amount of infected fish/tested fish x 100

Infection intensity: In skin parasites, the number of parasites per cover glass of skin mucus calculates infection intensity. In gill parasites, the number of parasites per gill sheet calculates infection intensity. The amount of parasites was determined by stereo dissecting microscope.

For experimental treatment, we used diseased grouper specimens (13–15 cm length). All had been highly infected by monogeneans in the gills with typical clinical signs. The monogenean infection intensity and prevalence before and after treatment were measured to evaluate the effect of the treatment method. Some chemicals were tested such as formalin (200; 250 and 300 ppm), hydrogen peroxide 30% (300, 450 and 600 ppm), Hadaclean (5, 10 and 15 ppm). The tested chemical concentrations for the experiments were based on LC_{50} of every chemical. Each experiment was repeated two times in 120 liter resin tanks. Diseased fish were bathed by chemical solutions for 30 minutes with different concentrations, two times in a week. Health of fish, survival rate, infection intensity and prevalence after chemical treatment were examined and discussed.

Results and discussion

Clinical signs: The diseased fish often displayed lethargic swimming; loss of appetite, and secretion of mucous fluid from damaged gills and skin. If monogenean intensity in skin was high, diseased fish showed ulcerative lesions in skin in final stage of the disease. Conversely, if parasite density was high in the gills the operculum would be swollen, a lot of mucous fluid secreted, and the skin would be dark and in the two cases, mass mortality occurred in small fish (<200g/ind). The parasites in fish skin were flat, oval shape

monogeneans, look like sesame seeds while and the other parasites in fish gills were thin, flexible monogeneans. In the diseased fish, there were no other parasitic pathogens observed in internal organs.

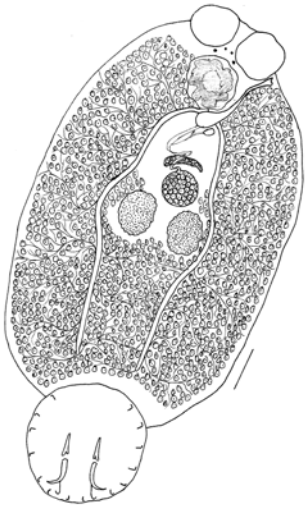
Epidemic character: In marine fish cultured ponds/cages in Khanh Hoa, the frequency of the disease is very high, 71.4% the disease in skin and 60.3% of disease in the gills of fish (with n=63). Outbreak of the disease in marine fish cages was higher than pond culture systems. Investigation showed that occurrence of the disease was year-round but it often concentrated in the dry season (from April to Sept) when temperatures were high (30 – 34°C). The disease affected mainly small fish (less than 200gram per individual).

Causative agent: From skin diseased fish specimens with ulcerative lesions on the bodies (40 groupers and 15 snappers), we detected two parasitic genera belong to class Monogenea. They were *Benedenia* and *Neobenedenia* (Capsalidae) affecting the skin and fins of diseased fish. Of these, *Benedenia epinepheli* were found on the skin of diseased grouper, other species also belong to two the genera, but the names of species were not determined yet. In diseased fish, the infection level of the parasites was very high: prevalence was 100% and the intensity was 5–15 parasites/cover glass of skin mucus. We also detected some species of monogenean in skin of healthy fish samples (n = 80), but infection level was low, prevalence was 16,6%; intensity was 0-1 parasite/cover glass of skin mucus in groupers (n=60) and 15% prevalence; 0-1 parasite/cover glass of skin mucus in snappers (n=20).

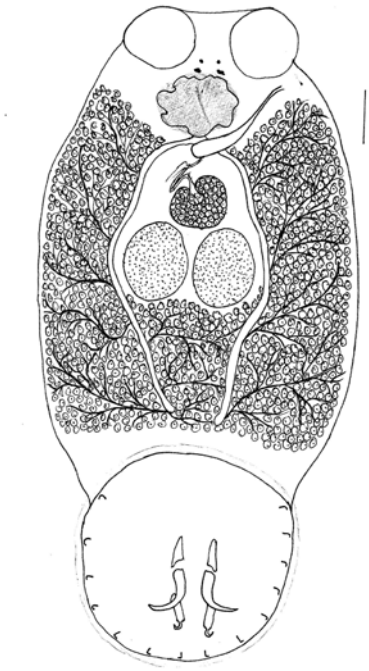
From gill diseased fish specimens (45 groupers and 30 snappers) with swollen operculums we detected some other species of monogenean. They were *Pseudorhabdosynochus epinepheli*, *Pseudorhabdosynochus* sp; *Diplectanum* sp and *Ancyrocephalus* sp; in grouper these had 100% prevalence; intensity was 55-253 parasites/gill sheet; in snapper they had 100% prevalence; intensity was 40-130 parasites/gill sheet. We also found the same species of monogenean in the gills of healthy fish samples (n=80), but at a low level of infection: 33.3% prevalence; 0-6 parasites/gill sheet in grouper and 25%, 1-5 parasites/ gill sheet in snapper. We believe that *Benedenia epinepheli*, *Neobenedenia* spp (Capsalidae) are primarily skin parasites and *Psedorhabdosynochus epinepheli*, *Psedorhabdosynochus* sp, *Diplectamum* sp and *Ancyrocephalus* sp. are primarily gill parasites cauing monogenean disease of cultured marine fish species in Khanh Hoa province.

Treatment: The fish samples used in the experimental treatment were infected with monogenean parasites on the gills. The average infection intensity was 2.5 parasites per gill sheet. We found that formalin 200-250ppm, hydrogen peroxide 100 – 200ppm and Hadaclean 5-10ppm were effective for killing monogenean parasites on the gills of small grouper (13-15 cm) after two bath treatments in a week. The treatment was carried out in conditions of water temperature 28 – 30°C, salinity 30-33% and pH 7.9-8.2. These treatments killed from 85.8 to 100% of monogenea in the gills of diseased fish. The experimental fish were still healthy after the treatment. Our research also showed that formalin at 300 ppm and Hadaclean at 15 ppm could kill 100%

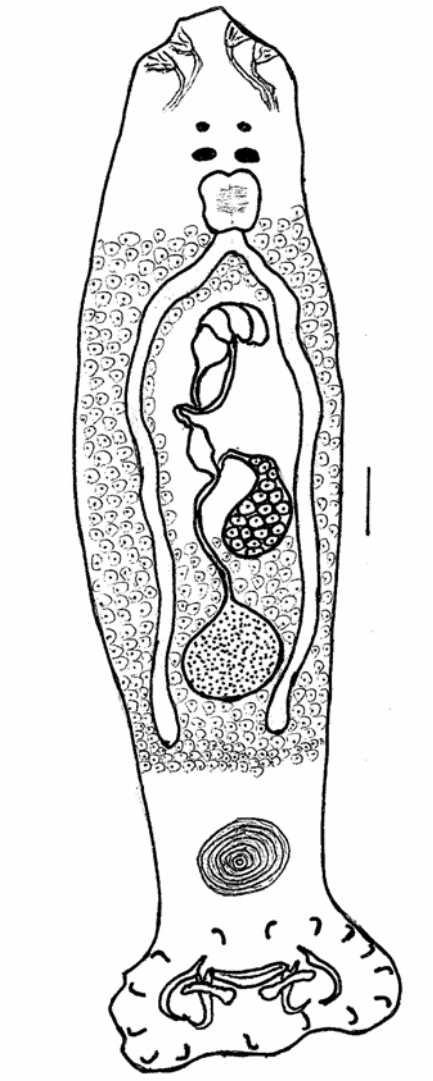
Monogenean species affecting the skin (below) and gills (right) of cultured grouper and snapper in Khanh Hoa, Vietnam



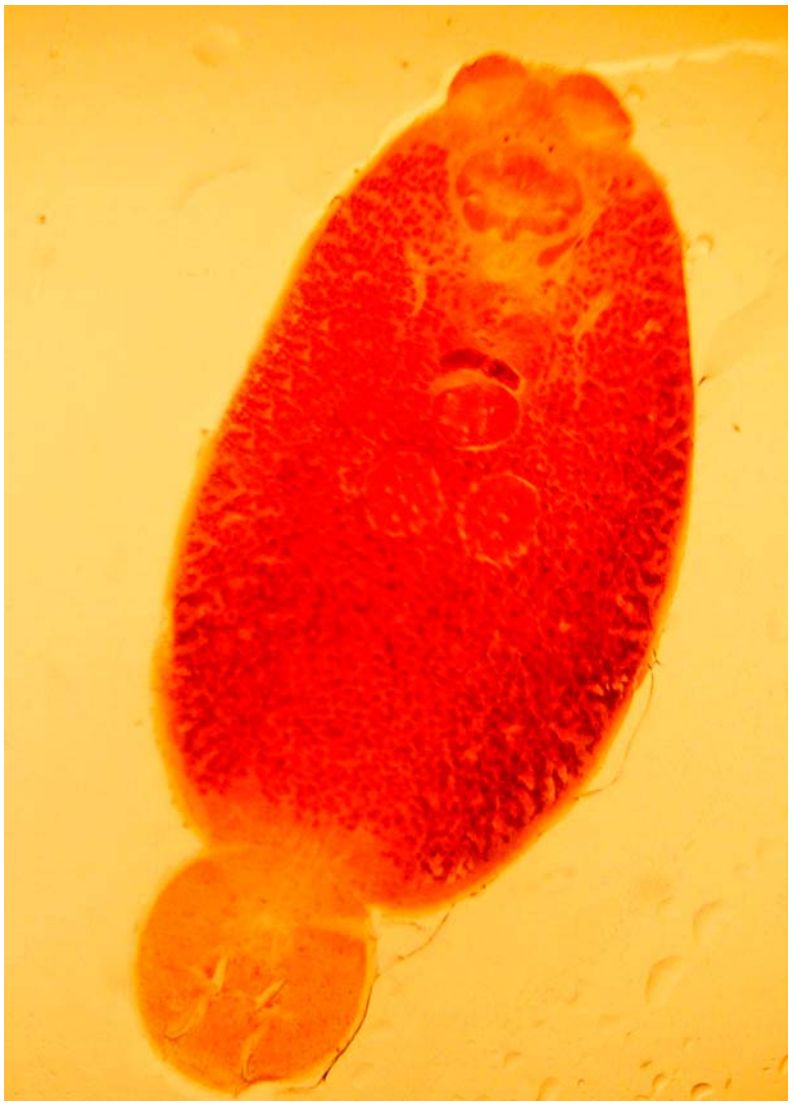
Neobenedenia sp.



Benedenia epinepheli



Pseudorhabdosynochus epinepheli



Neobenedenia sp. with carmine stain.

monogeneans on the gills of fish very quickly, but this concentration impacted badly on the health of fish.

Conclusions

In Khanh Hoa province, monogenean disease often occurrs in cage/pond cultured grouper and snapper. The frequency of the disease is high at 71.4% with disease in skin and 60.3% with disease in the gills of fish (with n =63). Prevalence of disease in cage cultured fish was higher than in pond cultured fish. The disease occurs all year round but is worst during the dry season from April to September, and mainly affects small fish less than 200g in weight. In diseased fish samples, some parasitic genera belong to Monogenea have been detected. *Benedenia* spp and *Neobenedenia* spp (Capsalidae) often parasitized the skin and caused ulcerative lesions on the body of fish. Other genera like *Pseudorhabdosynochus* spp; *Diplectanum* spp and *Ancyrocephalus* spp parasitized the gills causing difficulty in respiration, dark skin, swollen operculum and mortality, especially in small fish.

Using formalin (200–250 ppm), hydrogen peroxide 30% (300–600ppm) or Hadaclean (5–10ppm) to bath diseased fish for 30 minutes twice a week was effective to treat this parasitic disease in grouper.

Acknowledgment

We thank to NORAD project for funding and marine fish cultural farmers in Khanh Hoa. We also thank Ms Brit Hjeltnes come from Noway for helping of us in the research.

Reference

Edward J. Noga, 2000. Fish disease, Diagnosis and Treatment. Iowa State University Press/Ames. 367 p.

Erlinda R. Cruz-lacierda, 2001. Parasitic diseases and pets Health Management in Aquaculture. Aquaculture Department Southeast Asian Fisheries Development Center Tigbauan, Iloilo, Philippines.172pp.

Fris Jonhn, Des Roze, 2002. Parasitic diseases of grouper in Indonesia. Research Institute for Mariculture Gondol, Bali, Indonesia. 13p.

Ian D. Whittington, Bronwen W. Cribb, Tamarind E. Hamwood, July A. Halliday, 2000. Host-specificity of monogenea (Platyhelminth) parasites: a role for anterior adhesive areas International Journal for Parasitology 30. pp.305-320.

Isti Koesharyani, Zafran, Kei Yuasa, Kishio Hatai, 1999. Two Species of Capsalid Monogeneans Infecting Cultured Humpback Grouper *Cromileptes altivelis* in Indonesia. Fish Pathology – The Japanese Society of Fish pathology. Vol. 34. No 3 September 1999, pp.165- 166.

Leong tak Seng, 1994. Parasites and Diseases of cultured marine fin fishes in South East Asia. School of Biological Sciences, Universiti Sains Malaysia. 11800 Minden, Pulau Pinang, Malaysia. 25p.

Leong tak Seng, 1992. Diseases of brackishwater and marine fish culture in some Asian countries. Diseases in Asian Aquaculture I. Fish Health Section, Asian Fisheries Society, Manila, Philippines, pp.223-236.

Marty R, Deveney, Leslie A. Chisholm, Ian D, Whittington, 2001. First published record of the pathogenic monogenean parasite *Neobenedenia melleni* (Capsalidae) from Australia. In Diseases of Aquatic Organisms. Vol. 46: 79-82, 2001.p79-82.

Sharp N.J., Diggles B.K., Poortenaar C.W., Willis T.J., 2004. Efficacy of Aqui-S, formalin and praziquantel against the monogeneans, *Benedenia seriolae* and *Zeuxapta seriolae*, infecting yellowtail kingfish *Seriola lalandi* lalandi in NewZealand. Aquaculture 236 (2004). pp.67-83.

Yaowanit Danayadol, 1994. Culture Grouper Diseases in Thailand. National Institute of Coastal Aquaculture, Kaoseng, Songkhla 90000, Thailand.

Xiang Y. Wu, An X. Li, Xing Q. Zhu and Ming Q. Xie. 2005. Discription of *Pseudorhabdosynochus seabassi* sp.n (Monogenea: Deplectanidae) from *Lates calcarifer* and revision of phylogenetic position of Diplectanum grouperi (Monogenea: Diplectanidae) based on rDNA sequence data. In Folia parasitologica 52: 231-240.

NACA Newsletter

Published by the Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand

ISSN 0115-8503

Volume XXII, No. 4
October-December 2007

Lao culture-based fisheries project gets underway

Meeting with local community in Xinxai Village, Paksan district, Bolikhamxay province.

NACA in conjunction with the Department of Primary Industries, Victoria (DPI, Vic), Australia, and the Department of Livestock and Fisheries (DoLF), Ministry of Agriculture and Forestry, Lao PDR, commenced R & D activities of the project on Culture Based Fisheries Development (CBF) in Lao PDR, funded by the Australian Center for International Agricultural Research (ACIAR). The project is of three years duration and with a budget of AUD$398,000. The project has three major facets:

- Culture-based fisheries trials in reservoir coves and flood plain depressions;
- Breeding and genetic management plan on two selected indigenous species; and
- Capacity building in culture-based fisheries, artificial propagation, and broodstock management using molecular genetic techniques.

The project was inaugurated with a visit to the sites by NACA personnel (Prof. Sena S De Silva and Dr. Thuy Nguyen) and Dr. Brett Ingram of DPI, Vic, followed by an inaugural workshop held in Thalat, Vientiane Province, that included the participation of all DoLF and Provincial and District personnel of the project, and was Chaired by the Lao PDR Project Leader Mr. Bounthong Saphakdy.

During the visit to Lao PDR, NACA personnel also participated in the traditional fish releasing ceremony on the 13th of July in NamHoum reservoir.

Expert Workshop on Aquaculture Certification, Brazil

The Expert workshop on Aquaculture Certification was held 31 July–3 August 2007 in Fortaleza, Brazil. The workshop was the second in a series of expert meetings to assist the development of guidelines for aquaculture certification, with a strong emphasis on aquaculture products from aquaculture producers in the Americas. The workshop involved 57 people from 13 countries in the Americas, Asia, and Europe, and follows from an earlier workshop held in 28-30 March in Bangkok, when the road map and first draft of the international guidelines were developed.

The first day of the workshop consisted by the series of presentations, mainly from the Americas, but also presentations from Vietnam and NACA secretariat on “Aquaculture certification special considerations for the small-scale aquaculture sector” (The list of presentations is available at: http://www.enaca.org/modules/tinyd11/index.php?id=17).

On the second day of the workshop, the draft Guidelines for Aquaculture Certification were presented and reviewed in detail. Much feedback was obtained on the draft, and the consultations continue and the outcomes of the Brazil workshop will be presented at the APFIC regional consultative workshop 18-20 September 2007 in Ho Chi Minh City, Vietnam, and the next guideline review to be conducted at Eighth Asian Fisheries Forum (8AFF) 20-23 November 2007 in Kochin, India.

Strategies for Development of Asian Reservoir and Lake Fisheries Management

The DG of NACA and Mr. Arni Helgason, Country Director, Icelandic International Development Agency (ICEIDA), Sri Lanka Office signed a letter of agreement, on 20th August 07, for the provision of funds for the project, "Strategies for Development of Asian Reservoir and Lake Fisheries Management", at the Ministry of Fisheries and Aquatic Resources (MoFAR), Sri Lanka, witnessed by the Secretary, MoFAR and the Director General of the National Aquaculture Development Authority, Sri Lanka (NAQDA), Dr. D.E.M. Weerakoon. ICEIDA will provide US$ 437,850 over a period of three years to NACA to coordinate the project activities, which would involve five Asian countries. However, some other countries have expressed the desire and willingness to be involved at their own expense. Updates on the project activities will be made on the NACA website and in the newsletter on a regular basis.

EUS identified as cause of fish kills in Africa

According to SciDev.net, scientists have identified the mystery disease that killed fish in parts of the Zambezi River last year.

Researchers have identified the disease as Epizootic Ulcerative Syndrome (EUS), caused by a fungal pathogen. Infected fish develop large sores and die from secondary infections.

The researchers say this is the first known outbreak of the disease in Africa. But they still don't know how the pathogen got into the Zambezi, which flows through eight southern African countries.

The team of scientists included experts from the United Nations Food and Agriculture Organization, Thailand's Inland Aquatic Animal Health Research Institute, and the Network of Aquaculture Centres in the Asia-Pacific.

For the full story, please visit the SciDev.net website at:

http://www.scidev.net/News/index.cfm?fuseaction=readNews&itemid=3727&language=1.

NACA seeks shrimp farm specialists for assignments in Indonesia

NACA is seeking Indonesian and regional aquaculture specialists for short and long-term assignments to assist in an expanding aquaculture rehabilitation program in the province of Aceh, Indonesia. The specialists would be assigned to various upcoming positions within the Aceh program, including management of district shrimp farm rehabilitation projects, extension of better management practices, development of aquaculture farming groups and improvement of market chains for Aceh aquaculture products.

The ideal candidates would have experience in all these aspects, including project management, practical farm management or extension, community organization and shrimp market development. Indonesian language is also desirable, although not essential. Energy and commitment to work closely with communities to achieve successful farm rehabilitation and improve livelihoods is essential. Salaries will be based on NACA salary scales and experience, plus associated travel, insurance and living expenses. Interested candidates are invited to send an email containing a brief overview of experience, together with short CV, including the names of two referees, to etesp@enaca.org.

FDA detains five species of farm–raised seafood from China

The US Food and Drug Administration (FDA) on 28 June 2007 announced a broader import control of all farm-raised catfish, basa, shrimp, dace (a cyprinid), and eel from China.

During targeted sampling from October 2006 through May 2007, the FDA repeatedly found that farm-raised seafood imported from China were contaminated with antimicrobial agents such as nitrofuran, malachite green, gentian violet, and fluoroquinolone.

The FDA states these seafood products from China will be detained at the border until the shipments are proven to be free of residues from illegal drugs for protecting American consumers.

The FDA action includes conditions under which an exporter can be exempted from FDA's detention action by providing specified information to the agency. This information must demonstrate the exporter has implemented steps to ensure its products do not contain these substances and that preventive controls are in place.

Li Changjiang, Minister of the General Administration of Quality Supervision, Inspection and Quarantine, which oversees export and import quality, urged the FDA to let the exports go through after checking the sanitation certificates issued by China Entry-Exit Inspection and Quarantine (CIQ). China also detected many foodstuffs of poor quality among the US exports to the country every year, and those quality problems were properly handled in the principle of cooperation. Likewise, there might be isolated cases of Chinese enterprises exporting products with quality problems to the United States. Therefore, China could not "accept" the US decision to "indiscriminately" detain all aquaculture products.

Ministry of Commerce spokesman Wang Xinpei also urged foreign trade partners to accept Chinese products unless they violated contract terms or local regulations. He explained the requirement for evidence of safety

would inevitably increase export costs and stressed that China had greatly improved the quality of its seafood.

Source: FDA News: http://www.fda.gov/bbs/topics/NEWS/2007/NEW01660.html

InfoYu: http://www.infoyu.net/News-Center/MarketTrade/07-7-2-77.html

7th Symposium on Diseases in Asian Aquaculture

The Fish Health Section of the Asian Fisheries Society has recently opened its official website on the 7th Symposium on Diseases in Asian Aquaculture. This triennial symposium will be held during 22-26 June 2008. FHS invites the countries in Asia-Pacific region to express their interest to host the 8th Symposium on Diseases in Asian Aquaculture. For more information, please visit the symposium website at: http://homepage.ntu.edu.tw/%7Edaaseven/.

Aquafeed Horizons Asia 2008

The preliminary program has been announced and registration has opened for Aquafeed Horizons Asia '08, a symposium to be held March 6, 2008, during Victam Asia 2008, at the Queen Sirikit National Convention Center, Bangkok, Thailand. The symposium is supported by the Thai Department of Fisheries.

"We are honored that Dr. Juadee Pongmaneerat, Senior Expert in Aquatic Animal Nutrition at Thai Department of Fisheries will open the workshop as she did last time in Bangkok", Suzi Fraser Dominy, Publisher of Aquafeed.com, the workshop organizers said. Her keynote address on aquafeed and aquaculture production and policies in Thailand will kick-off a packed day of presentations.

Dr. Dean Akiyama, Senior VP Charoen Pokphand Indonesia, Aquafeed Technology and Dr. Warren Dominy, Director, Aquatic Feed & Nutrition Department, Oceanic Institute, Hawaii will chair the one day meeting that will be strongly technical and will cover feed processing technology and cutting edge ingredient solutions to meet the challenges facing the industry in Asia Pacific.

Topics include:

- Aquafeed and aquaculture production and policies in Thailand
- Pheromone-based feeding attractants for sustainable aquaculture
- Promoting animal health through feed.
- Improving palatability in shrimp feeds.
- Starter diet production technology.
- Ingredient trends and effects on extrusion process.
- Technical advances in extruded shrimp feed.

The symposium, "Aquafeed Horizons Asia 2008", is the third Aquafeed.com conference in association with Victam international, and the second at Victam Asia, the region's leading feed show.

The preliminary program, sponsorship information, registration form and brochure are now available on the conference website at: www.aquafeed.info or contact: conferences@aquafeed.com.

An evaluation of the role and impacts of alien finfish in Asian inland aquaculture

A research paper authored by NACA personnel (*), in conjunction with two others (Sena S. De Silva, Thuy T. T. Nguyen*, Nigel W. Abery, Upali S. Amarasinghe in the international journal Aquaculture Research (Volume 37, pp1-17, 2006) is the second most downloaded publication of that journal within the last 36 months.*

Abstract

Asia dominates global aquaculture production accounting for over 80 % of the total and the mainstay in Asian aquaculture is finfish. Over the years, Asia has experienced a number of inter-continental and intra-continental transfers/ introductions/ translocation of finfish species, between nations and watersheds, beyond their natural range of distribution, primarily for aquaculture development. In this article all such species are referred to as alien species. An attempt is made to evaluate the importance of the production of alien species in selected Asian nations, using statistics of the Food and Agriculture Organisation. Also, negative effects, if any, based on literature surveys, of alien species in relation to displacement of indigenous species, and on biodiversity and or genetic diversity together with associated pathogen transfers are evaluated. The major alien species, based on their significance to Asian inland aquaculture considered, are the tilapias, catfish, Chinese and Indian major carps, and common carp. It is estimated that currently alien species account for nearly 12% of the cultured finfish production (2.6 million t) in Asia, valued at US$ 2.59 billion, and the contribution exceeds 40% when Asian countries excluding PR China are taken into consideration. Inland finfish aquaculture in some Asian nations, such as Indonesia and the Philippines, is predominated by alien species, and in some others, e.g. Bangladesh and India the contribution from alien species has been increasing steadily. It is suggested that overall alien finfish species have done little ecological harm to native flora and fauna. However, in the wake of increasing anthropogenic development taking place in watersheds the resulting environments are often made unconducive to indigenous species but not to some alien species, thereby potentially and indirectly making the latter invasive.

Scientists join fight against frog diseases

CSIRO is collaborating with other Australian research institutions, and conservation groups, to identify new and emerging diseases affecting frog populations in Far North Queensland. CSIRO Livestock Industries' Australian Animal Health Laboratory (AAHL) in Geelong, the Frog Decline Reversal Project, Inc's (FDR project) Cairns Frog Hospital, Sydney's Taronga Zoo and James Cook University (JCU), will combine their research expertise and technologies to diagnose new frog diseases detected recently by the FDR project.

Funded by the Australian Government Department of the Environment and Water Resources, the three-year Amphibian Disease Project was initiated by FDR Project founder, Deborah Pergolotti.

"Since we began rescue and rehabilitation activities in 1998, we have discovered several new and undescribed disease issues in Far North Queensland amphibians including high levels of cancer, and die-offs and malformations in frogs and cane toads," Ms Pergolotti said.

According to AAHL's principal frog researcher, Dr Alex Hyatt, these diseases, or syndromes, have never been seen before and may present a threat to the long-term survival of native frogs.

"Frogs with specific syndromes will be screened by veterinary pathologists from AAHL, the JCU's Anton Breinl Centre and Taronga Zoo's Australian Registry of Wildlife Health (ARWH) to identify what pathogens are present, if they are infectious, and which are responsible for death and deformity," Dr Hyatt said.

JCU's Professor Rick Speare said the Project's integration of specialist skills and equipment will avoid unnecessary duplication and should provide a cost-effective procedure for identifying new frog diseases.

To initiate a record of diagnostic pathological results for these diseases, a Diagnostic Imaging Network System (DINS) - developed at AAHL in collaboration with Arcitecta Pty Ltd - will transfer images to a central database accessible to veterinary pathologists across Australia.

According to ARWH curator, Dr Karrie Rose, there are currently no efficient interactive databases like DINS in operation.

"Collectively the project will pioneer a new national way of handling diseases from the wild which, if proven successful, could be used as a model to initiate a broader diagnostic network in Australia for other wildlife," Dr Rose said.

Dr Hyatt said the new amphibian syndromes emerging in Far North Queensland are not the first diseases to have threatened Australia's frog populations. "In the late 1990s, Australian scientists discovered a debilitating frog fungus called chytrid fungus (*Batrachochytrium dendrobatidis*), which has been responsible for species extinctions and local population losses around the globe. Our experience with the chytrid fungus taught us that if you find a disease or virus early enough you have a much better chance of controlling it," he said.

Artificial propagation of snow trout *Schizothorax zarudnyi* by Iranian experts

Locally known as 'Hamoon Mahi' in Iran, this species of carp (Cyprinidae) belongs to the subfamily Schizothoracinae, better known as the 'snow trouts'. These species are commonly found in cool water bodies through Iran and Afghanistan. The maximum recorded weight in Iran is 10 kg.

Attempts to artificially propagate this species were started by Zabihy and his colleagues from 2001 onwards, initially leading to production 147,000 eyed eggs by the Iranian Fisheries Research Organization (IFRO) and Iranian Fisheries Organization (IFO). Research has continued to March 2007, with successful production of more than 500,000 eyed eggs and 300,000 larvae through use of synthetic hormones and hypophysis extract to facilitate the propagation process.

The recent successful effort has been financed as part of an international project Aquaculture Development in Sistan-Baluchestan 2005 – 2008 funded by the Italian Ministry of Foreign Affairs, Italian Cooperation (General Directorate Development Cooperation), UNDP (United Nation Development Program), SHILAT- IFO (Iranian Fisheries Organization), CIRSPE (Italian Research and Study Centre for the Fishery). The Iranian centres cooperating in this project were the Iranian Fisheries Research Organization (IFRO), Iranian Fisheries Organization (IFO), Fisheries of Sistan-Baluchestan, Offshore Fisheries Research Center and the Coldwater Fishes Research Center (CFRC).

For more information about the project contact Mr M. Zabihi, mansoorzabhy@yahoo.com, zabihi@ifro-cfrc.net.

NACA keynotes three international meetings

The DG of NACA, Professor Sena S De Silva was called upon to deliver three keynote addresses at three important meetings in the course of August.

He delivered a keynote address entitled, "Role of Aquaculture for Food Security in the Asia Pacific Region: Prospects & Constraints" at the Indonesia-Aquaculture, 2007, held in Bali, 31st July to 03 rd August attended by over 700 delegates, followed by the keynote address, "Meeting the Demands and Challenges of Globalization of Trade in Aquaculture: The Role of a Regional Inter-Governmental Body " at the meeting of the World Aquaculture Society, Asia-Pacific Chapter, held in Hanoi, Vietnam 05th to 08 th August, attended by over 1000 delegates from 30 countries, and finally, at the Tilapia 2007, held in Kula Lumpur, Malaysia, 23rd to 27th August, entitled," Tilapias in Asia: Are They Alien or Considered "Naturalized? ", attended by 350 participants from 39 countries.

All of the above keynote addresses (power points) are available in the respective web sites of the above meetings as well as in www.enaca.org. It is important to note the diversity of the issues addressed that is indicative of the breadth of expertise available to NACA, which in turn has been an great advantage for the organization to forge ahead in regional and global issues related to aquaculture development.

Culture, capture conflicts project review, Indonesia

The review of the project FIS/ 2002/111, "Culture, capture conflicts: sustaining fish production and livelihoods in Indonesian reservoirs", funded by the ACIAR of which the Principal Investigator is the current DG of NACA was independently reviewed between 03 to 08th of September. It is understood that the reviewer was satisfied with the work achieved and is likely to result in an extension phase for effecting the implementation of the co-management plans developed to ensure sustainability of the cage culture activities of the three reservoirs, namely Saguling, Cirata and Jatilnuhur in West Java and to improve the livelihoods of the artisanal fishers of the three reservoirs. It is expected that the lead agency for the next phase will be NACA, which will work in conjunction with Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries, Government of Indonesia.

Stakeholder meeting with artisanal fishers of Cirata Reservoir.

Sign up to the coldwater aquaculture Yahoo! Tech Group

An electronic discussion group has been established to facilitate communication amongst stakeholders in coldwater aquaculture. The group is maintained by the NACA Regional Lead Centre for Coldwater Aquaculture, the Coldwater Fishes Research Centre of Iran.

The main goals of this discussion group are to collect and share information on scientific research projects, activities and programs in the field of coldwater aquaculture, fisheries, biodiversity and related matters that are underway in NACA member countries. Through sharing of information on their activities, participants across the region will be able to stay abreast of new developments, locate international partners, collaborate in collection and sharing of data, and avoid duplication of effort. The discussion group is hosted through the Yahoo! Tech Group facility, and features an email newsgroup, file and photo repository, calendar of events and member directory.

The NACA Regional Lead Centre for Coldwater Aquaculture group invites all interested parties and individuals to sign up to the group and participate in the sharing of information on research activities in every corner of the region. For this purpose, it would be appreciated if new members could submit a detailed profile on their past and present activities, and share useful information via the group's facilities, which are accessible through the links in the menu bars. Please note that the group information sharing facilities are only accessible to members of the group (membership is of course, free). To sign up as a member of the discussion group, please visit: http://tech.groups.yahoo.com/group/naca_leadcenter_iran/ and click on the 'Join This Group!' button. If you would like further information, please contact Mr Ali Farzanfar at afarzanfar@yahoo.com.

Website publishing and administration training, Vietnam

The fourth training course on website publishing and administration was held at the Research Institute for Aquaculture No. 3 in Nha Trang City from 8-15 August. The four trainees were Mr Nguyen Hung Quoc (RIA 3), Ms Vu Thi Le (RIA 3), Mr Vu Xuan Dung (RIA 2) and Mr Phan Ngoc Huynh (RIA 3, currently working on a project involving the Mekong River Commission).

The course covered planning, design, construction and maintenance aspects of website management, as well as a basic grounding in backup procedures and internet security, which are critical aspects of sustainability in the internet world. The training course used the XOOPS Content Management System as a reference web-publishing tool. XOOPS is a free open source software product that is written and expanded by an online community of programmers, webmasters, designers and users, who share their work and their experience for common benefit.

Both RIA 2 and RIA 3 plan to rebuild their websites using the XOOPS system, joining RIA 1 and the College of Fisheries at Can Tho University, which were participants in previous training courses. The use of a common system will enable staff of the different institutes to share their experience and collaborate in further development of their websites, as well as facilitating information exchange.

Left to right the RIA 2 and RIA 3 webmasters: Ms Vu Thi Le, Mr Nguyen Hung Quoc and Mr Vu Xuan Dung.

Network of Aquaculture Centres in Asia-Pacific

Mailing address:
P.O. Box 1040,
Kasetsart University
Post Office,
Ladyao, Jatujak,
Bangkok 10903,
Thailand

Phone +66 (2) 561 1728
Fax +66 (2) 561 1727
Email: info@enaca.org
Website: www.enaca.org

NACA is a network composed of 17 member governments in the Asia-Pacific Region.

Aquatic Animal Diseases Significant to Asia-Pacific: Identification Field Guide

NACA and the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) are pleased to release a new health-related field guide. The result of a collaborative activity among a number of fish health experts from various organizations in the Asia-Pacific region, it is aimed at improving the ability to diagnose diseases of significance to aquaculture and fisheries in the region.

NACA appreciates the leadership provided by DAFF in developing and publishing this field guide. It drew extensively from the experiences and previous and ongoing research activities in health management in Australia and other countries in Asia and thus joins the growing body of practical knowledge published for Asia-Pacific aquaculture and fisheries. This field guide provides fisheries and aquaculture managers, recreational fishers, border protection staff, environmentalists, students of aquatic animal health, and fisheries management with a reference guide to support decisions on aquatic animal health. The regional field guide covers all diseases listed in the Quarterly Aquatic Animal Disease (QAAD) reporting system which includes all OIE listed diseases plus diseases of regional concern.

The guide is published in CD format and copies are available to government and research staff in NACA member countries on request. However, a CD image has been made available for download from the NACA website that you can use to create your own, and you can also browse the CD live on the NACA website – visit:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=5&lid=842.

VIETNAM
INDIA
THAILAND

MOANA

NEW GENERATION OF BLACK TIGER SHRIMP

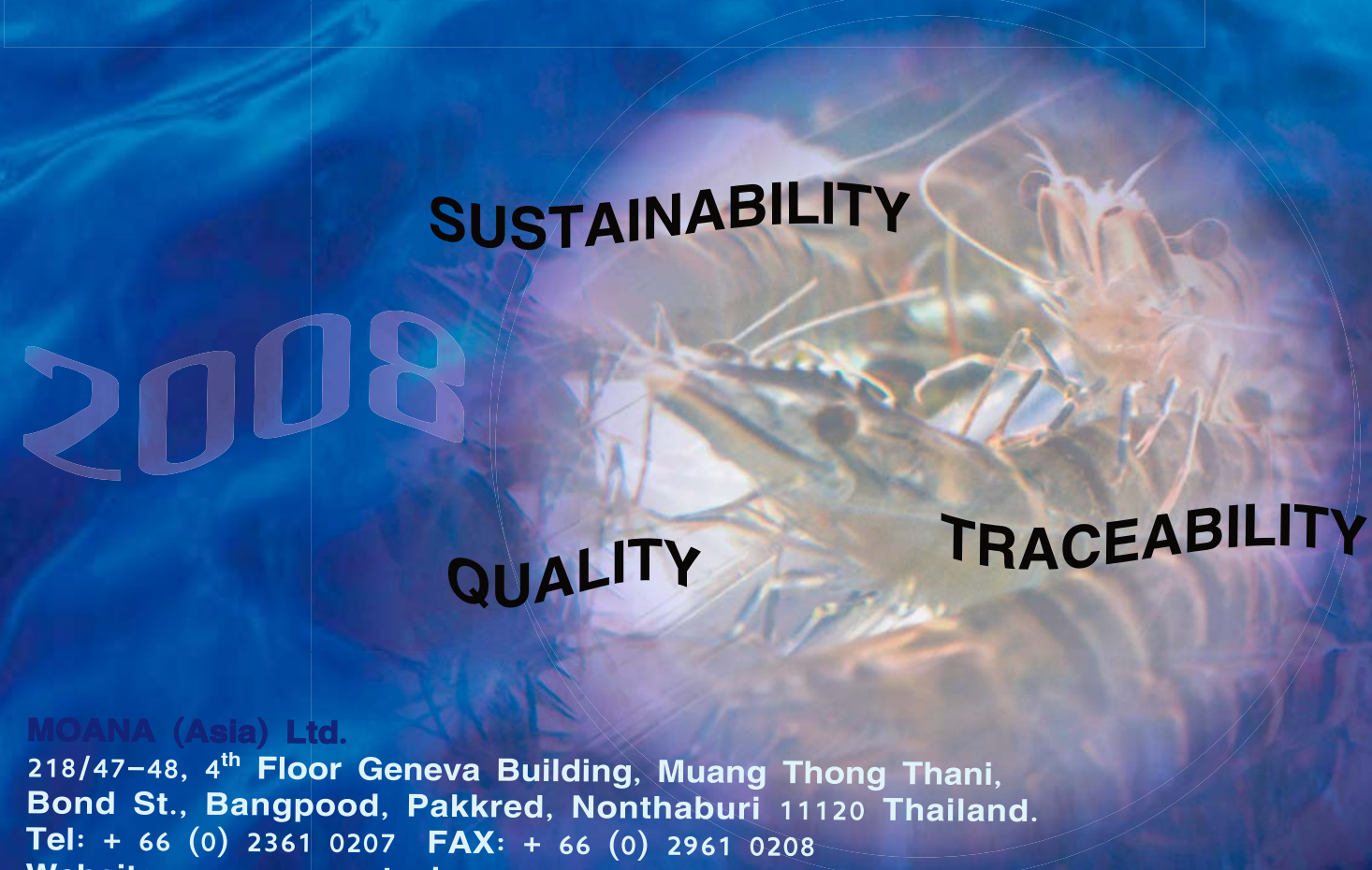
AFTER YEARS OF FOCUSED DEVELOPMENT,

THE COUNTDOWN HAS BEGUN...

...WE OFFER A NEW GENERATION OF

BLACK TIGER SHRIMP

MOANA is the leading aquaculture company in the development and supply of genetically improved and disease free seed of **Black Tiger Shrimp** *(Penaeus monodon)*. **MOANA**'s innovative approach through pedigree-based selective breeding (non-GMO) fills today's need for sustainable production and fully traceable supply of high quality seed throughout the value chain.



MOANA (Asia) Ltd.
218/47-48, 4th Floor Geneva Building, Muang Thong Thani,
Bond St., Bangpood, Pakkred, Nonthaburi 11120 Thailand.
Tel: + 66 (0) 2361 0207 FAX: + 66 (0) 2961 0208
Website: www.moanatech.com

The natural way.

Biomin®

BIOMIN Aqua Specials

The demand for solutions, which can offer producers safe and economical production of aquatic animals is rising.
To cope with the demand, BIOMIN has launched a new range of aquaculture products including probiotics, nutra-ceuticals, premixes and pond treatments for shrimp hatcheries as well as pond grow out.

- **STARTgrow**
  A Probiotic premix for Shrimp hatcheries
- **GROWout**
  A Probiotic premix for Shrimp pond grow-out
- **PONDlife**
  A Probiotic premix for Pond treatment in shrimp grow-out

For more information surf
www.aqua.biomin.net

BIOMIN Laboratory Singapore Pte. Ltd.
3791 Jalan Bukit Merah #08-08, E-Centre@Redhill, Singapore 159471
Tel: +65 6275 0903, Fax: +65 6275 4743

www.biomin.net