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AQUACULTURE ASIA

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AQUACULTURE ASIA

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Lip service to livelihoods

Put simply, 'livelihoods approaches' are about putting people at the centre of development planning. This means learning about the resources that people can command, the choices they make, and the circumstances of their lives. Livelihoods analysis - making use of participatory approaches for learning from individuals and groups within communities - helps to capture a range of views, understand vulnerabilities and influences, and to recognize unbalanced power relations.

You would be hard-pressed to find anyone in development circles (in a broad sense, including various international and government agencies) that doesn't accept that need for livelihoods approaches. You could probably find some that have a different name for it, or who want to add some spin to it (development workers are notoriously finicky about terminology), but few would argue with the basic principle. It's just common sense, and so in these enlightened days, most modern development organizations advocate livelihoods approaches, in one form or another.

However, if you scrutinize the day-to-day activities of the same organizations, it quickly becomes apparent that what many of them actually implement is what you might call a sectoral approach, usually one that reflects the interests or administrative divisions of their own organization – whether it is agriculture, fisheries, forestry, the environment or something else. When used in this context, 'livelihoods approaches' risk becoming organization-centric, rather than truly people-focused.

Nowhere has this been more evident than in the recent tsunami recovery effort. When we suggested to our counterparts in some international agencies that the role of tourism should be considered in livelihood rehabilitation projects for Thai fishing communities, a typical response was "we don't work on tourism", despite its obvious importance to many fishers. They don't; it's true. However, instead of seeking collaboration with agencies that do have a mandate to work on tourism, they chose to ignore it altogether. They went ahead and developed livelihoods projects 'within the fisheries sector'.

Livelihoods approaches are by definition broad and often cross sectoral boundaries. The whole point of a livelihoods approach is to put the real-world situation of people first; it cannot be implemented while clinging to a particular specialization or beauracratic framework, which imposes artificial (and often ridiculous) constraints on the issues that can or can't be addressed.

As the major proponents of livelihood approaches, it is incumbent upon development organizations and donor agencies to foster a more holistic approach that is capable of crossing sectoral boundaries when necessary and that promotes cooperation between agencies, as required by the real needs of the people concerned, as they see them.

If you are serious about leading the livelihoods charge, the first step is to sit on the horse.

Simon Wilkinson

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Notes from the Publisher

"Victim-hood" paralyses

Two messages that we are bringing out from our ongoing work to rehabilitate Koh Yao Noi: One is what the governments hit by the tsunami and CONSRN partners had been emphasizing right from the start: A **'self-help' approach makes for greater resilience and less dependence on aid** to rebound. The other is **the thinking that the people and communities hit by the tsunami are victims should now be exorcised**. There is no gainsaying the importance of self-help, it needs no belaboring. The second issue needs attention. For victim-hood – while it makes good copy or attracts more assistance - paralyses. By definition, anyone who suffers from injury is a victim, needing to be alleviated, ethically, from the suffering and, if inflicted by malice, given redress and justice. One killed or injured by a bomb, divested of property or loved ones by a catastrophe, or fall ill from a debilitating disease – is a victim and morally deserves succor, compassion and/or justice. Even one who contemplates self-destruction is a victim, and should need probably more than anyone else, understanding.

Those who suffered from the Indian Ocean tsunami are, rightly, victims. But they need not be branded as such anymore. Fostering victim-hood could lead to the people accepting their lot as their fate and finding comfort in the notion that nothing they could have done, or would do in future similar straits, could have altered or can alter that fate. It is not a negative virtue to be fatalistic, as most rural people in Asia tend to be. It becomes counterproductive only when a sufferer begins to think that the world owes him, a vew that can be fostered or reinforced by others, especially outsiders, do-gooders and the media playing up the idea that the sufferer is a victim. It is then exacerbated by the promise or the fact of a lot of aid. If the aid is seen simply as a redress to victim-hood, aid becomes an end in itself, rather than as a means to complement the sufferer's own effort to cope and improve his situation. Aid is always most useful when the sufferer shows first that he is going to do something regardless of whether it is given or not. A person descending into self-pity does not do anything to help himself. In that state, aid is useless, even harmful.

The Koh Yao Noi community admirably picked themselves up quickly and set about picking up the pieces and rebuilding, rather than wallowing in self-pity and playing that up to attract aid. When offered money or outside assistance that came with onerous or overly complicated conditions, as if they could not be trusted, they refused. They accepted NACA's assistance on their terms – that the modest money be not given to them but straight to the supplier of materials for cage repair (they supplied community labor to rebuild them) and that the subsequent amount for seed procurement be disbursed by them, as guaranteed loans to members, from out of their community revolving fund. Their four-page loan document is painstakingly handwritten and satisfies conditions that any bank would set, except the need for a collateral; two fellow members sign as guarantors and the process is much quicker and less painful than dealing with credit institutions.

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

As we write, **Rotary International** has teamed up with NACA and the Department of Fisheries of Thailand in the rehabilitation and long-term development of Koh Yao Noi, and in two more tsunami-ravaged island communities identified by a mission that included Hassanai Kongkeo, the former

Members of the Koh Yao Noi Community Based Ecotourism Club with Khun Bhichit Rattakul, former Governor of Bangkok, Khun Hassanai Kongkeo, NACA's Special Adviser, and Khun Bhichai Rattakul, Rotary International Past President.

Governor of Bangkok and NACA's Community Development specialist Dr. Bhichit Rattakul, Rotary International Past President Bhichai Rattakul, and DOF's Paiboon Bunliptanone, this time on the island of Koh Lanta Noi (KLN), the rehabilitation work. DOF Thailand and NACA also implemented a training on good cage culture practices for cage farmers in Koh Yao Noi. It was held at the **Krabi Coastal Aquaculture Centre**. We thank Khun Paiboon, head of the centre, and his staff for organizing the training. An immediate offshoot of the training is the farmers' now wishing to switch to hatchery-bred marine finfish (grouper) seed from their traditional wild caught fish. It means they can now also switch from wild caught trash or bycatch to formulated feed. NACA, DOF and Rotary International are providing assistance for the farmers to procure suitable hatchery-bred fingerlings.

Finally, we welcome the offer to our friends from **Chiba Conference on Environmental Education and Protection (CCEE-EP) of Japan**, a civic group famous for its work in the Tokyo Bay and communities, to join NACA, DOF Thailand and the Rotary International in KYN and now also KLN. CCEE-EP were among the first donors to contribute to NACA's tsunami rehabilitation fund.

"Tehrima Kesih, Pa Fatuchri; Salamat Pulang, Pa Made"

We would like to thank **Dr. Fatuchri Sukadi**, outgoing director general of Indonesia's Directorate General for Aquaculture for bringing Indonesia closer into the NACA family during his term: He worked with Foreign Affairs to place the NACA Agreement at the highest level of government ready for accession. Dr Fatuchri has gone back to the research agency for fisheries to resume working on his first love, aquaculture and fisheries research. During Pa Fatuchri's watch, which began in 2001, we initiated a number of highly productive projects that include: The ACIAR-supported project on capture-culture conflicts in Indonesian reservoirs, which NACA, Deakin University and the DGA are now implementing; NACA's participation in the yearly Aquaculture Program Technical Implementing Unit, which has yielded many ideas for cooperation and brought the numerous and widespread aquaculture researchers in Indonesia in closer linkage and working relations with the network; the recently held and highly successful WAS 2005 in which NACA, FAO, WAS, Aquaculture without Frontiers, UNEP, and other like-minded agencies, the Government of Indonesia organized focused sessions on the development of best aquaculture practices as well as tsunami rehabilitation issues. We appreciate DGA's inviting NACA to participate in the rehabilitation efforts of Aceh and advising us and our associates on how to appropriately go about the work. We wish Pa Fatuchri a continuing productive and successful career as scientist.

We congratulate and welcome back **Dr Made Nurdjana**. Pa Made opted to become a private citizen for a while after many years in government service including being the Director General for Fisheries (he and Pa Fatuchri were appointed almost at the same time in the then newly reorganized Fisheries and Marine Affairs ministry), and before that as Director of the Brackishwater Aquaculture Develoment Centre in Jepara. It is in BADC where the small scale and backyard shrimp hatchery technology was further developed and

Dr Fatuchri Sukadi, outgoing Director General of Aquaculture, at the WAS 2005 conference in Bali in May.

popularized in Indonesia. I met him there in 1995 when he was overseeing the facilities and program expansion of BADC, which has since developed into a highly effective R and D center (recently attaining the status of a premier government institution). Pa Made has spearheaded development work and promotion of sustainable shrimp aquaculture. He had contributed to journals including Aquaculture Asia articles on environmentally sustainable shrimp culture. We look forward to ever-closer cooperation with DG Indonesia under Pa Made's term.

Dr Made Nurdjana.

Peter Edwards writes on

Rural Aquaculture

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Rural aquaculture in Myanmar

Discussing issues in local aquaculture at the workshop.

Although I've worked for almost 30 years in aquaculture in Asia from a base at the Asian Institute of Technology (AIT) in Thailand, I only recently had an opportunity to see inland aquaculture in Myanmar, even though the two countries are neighbours. As I was invited to a participatory workshop on "Tilapia culture in Myanmar: Constraints and potentials" organized by AIT with the Department of Fisheries (DoF) and the Myanmar Fisheries Federation (MFF) in Yangon, 14-15 February 2005, I spent a couple of weeks visiting fish farms as well as the major tourist attractions.

The most striking feature of inland aquaculture in Myanmar is the almost complete absence of a small-scale aquaculture sector, which is such a prominent feature of aquaculture in most other Southeast Asian countries. Although a few small-scale producers are reported to exist, I saw none on two day-long trips to rural areas in Yangon Division in the delta region, in 2 days spent in Mandalay Division in the central dry zone and 2 days in the southern part of Shan State around Inle Lake.

Aquaculture is relatively recent in Myanmar with a history of only 50 years since the introduction of Mozambique tilapia (*Oreochromis mossambicus*) in 1953. As in most other countries, the farming of this species was not successful and the sector today is dominated by culture of indigenous Indian major carps, catla (*Catla catla*), mrigal (*Cirrhinus mrigala*) and especially rohu (*Labeo rohita*) which dominates production. The polyculture may also include silver striped catfish (*Pangasius hypophthalmus*) introduced from Thailand in 1992. More recently the Chitralada strain of Nile tilapia (*Oreochromis niloticus*) has been imported also from Thailand and is rapidly gaining popularity with the availability of sex-reversed fingerlings. It may be included in the polyculture but increasingly is grown in monoculture as it has a shorter culture period than carps and catfish.

There are over 60,000 ha of inland fish ponds producing more than 200,000 tonnes of fish. Most farms are large, consisting of several 1.6-2.0 up to 10-12 ha grow-out ponds. Some farms are as large as 200-680 ha. Nursery ponds are also relatively large, up to 0.8-1.2 ha. About 85 hatcheries, 70% belonging to the private sector, provide seed from induced breeding of carps and catfish, with four producing sex-reversed Nile tilapia. Although a few farms are integrated with feedlot livestock, most use fertilizers only for pond preparation. Feeds traditionally comprise broken rice, rice bran and groundnut cake, but increasingly formulated pelleted feed is used from six feed mills. Fingerlings of 2.5 cm purchased from hatcheries are nursed to 12.5-15.0 cm in 1 year, followed by another year to produce table fish in separate grow out ponds.

Most fish farms are organized into groups of farmers linked to brokers who provide finance, inputs, marketing and social welfare. There are about 200 brokers in the country. Another type of farmer belongs to the "cease fire group", former insurgents who have been provided with land and special privileges by the Government to enable them to set up large-scale agriculture, animal husbandry or aquaculture farms.

Although small-scale producers hardly exist, the poor benefit from employment in input supply, farm labour and marketing. Fish produced on large farms is also an important factor in national food security as wild fisheries are reported to be in decline. An example of employment is a 680 ha farm belonging to the military Union Solidarity Development Association with 168 workers, 70 of whom support families resident on the farm.

There are various possible reasons for the almost total lack of a small-scale farming sector:

- Cultural reluctance to farm fish by devout Buddhist farmers/fishers. According to Shway Yoe in his book *The Burman*, *His Life and Notions* first published in 1882, "fishermen are promised terrible punishments in a future life for the number of lives they take, but popular sympathy finds a loophole of escape for them. They do not actually kill the fish. These are merely put out on the bank to dry, after their long soaking in the river, and if they are foolish and ill-judged enough to die while undergoing the process, it is their own fault". In the Shan State if a big fish is caught, gold leaf is placed on its head and it is then released, so the market there is mainly for small fish.
- Sufficient wild fish available to satisfy farmer/fisher family subsistence. Again in contrast to several other countries in Southeast Asia, an absence of small multipurpose ponds near farming homesteads, dug for fill to raise the level of ground to minimize flooding. Such ponds, traditionally widespread on flood plains and increasingly dug in response to water shortages, also provide a domestic water source and refuge for wild fish. They are usually enlarged when farmers become interested in fish culture, reducing the cost of entry by minimizing the cost of pond construction.
- Policy. When aquaculture was introduced in 1953, it was a component of the national development master plan to provide food for the people. From 1962 until 1988, Myanmar had a socialist central planning system. Although it was replaced by a more market oriented system with the introduction of some market reforms, the State remains strongly interventionist and highly centralized. Rice is considered as a strategic crop with a strict agriculture land use policy for local rice sufficiency.

The rural population is poor and does not culture fish.

Feeding fish on a large-scale farm with agricultural by-products.

Harvesting fingerlings on a large-scale farm.

Close up of harvested fingerlings.

Members of a 31 man harvesting team and the large-size rohu which predominate in polyculture.

The authorities do not allow ponds to be built on land suitable for rice cultivation.

Relatively small farms by local standards occurred before 1988, 1.6-2.0 ha farms with 0.4-0.8 ha ponds; but they became illegal and many were abandoned or filled in. I interviewed an aquaculture technician on a large farm who started to farm fish in 1976 by coverting 2 ha of his 4.8 ha rice farm to ponds. He farmed fish for 5 years before the Government confiscated his ponds and destroyed his aquaculture livelihood.

Strict control over conversion of rice fields into other uses, is one of the major constraints to the more widespread development of aquaculture, especially by the major sector of the population, the small-scale rice farmer/fisher. More than 60% of agricultural farms are < 2 ha so Myanmar is predominantly a country of small-scale farmer/fishers as most catch wild fish on or around their farms.

The introduction of the Law Relating to Aquaculture in 1989 legalized fish farms that had been previously constructed; and made it possible to construct new fish ponds. A person can now apply for lease of land to construct fish ponds in an area defined by the Government for aquaculture, on land currently not being farmed (known as cultivatable land) or on waste land. The Government encourages large-scale agricultural (and aquacultural enterprises) by extending special privileges to State-owned Enterprises, joint-venture organizations, cooperative societies as well as individuals. Such farms are registered in the Land Records Department with a "land use right other than rice" and a licence is also required to farm fish from the DoF. The Land Distribution Committee may allocate low yielding rice land for aquaculture with representatives from the DoF, the Department of Forestry, the Department of Agriculture, the Department of Rural Development and the District Government. Such cumbersome procedure effectively bars small-scale rice farmers/fishers from diversifying their farms by constructing any other than a tiny fish pond of 8 x 17 m (about 128 m^2) which is not licensed by DoF. As one informant commented, it is possible for one group or individual to obtain permission to construct a 1,000 ha fish farm but impossible for 1,000 small-scale farmers to get permission to build 1,000 individual 1 ha ponds on their rice farms.

Silver striped catfish derived from hatchery-based seed harvested from a leasable culture-based fishery.

Myanmar, the largest country in mainland Southeast Asia with abundant land and renewable freshwater resources has the potential to not only feed itself but become one of the principal food exporters of the region. With a population of only about 50 million and about 50% of arable land not currently farmed and referred to as culturable waste land, it has low population pressure compared to most other Asian countries. Before World War 2 it was the world's largest exporter of rice but has been designated by the UN as a Least Developed Country (LDC).

Like many other Asian countries, Myanmar is a rice-fish society with rice and fish as the main dietary staples. Most farmers traditionally grow rice and catch wild fish, especially in the delta region interlaced with waterways. National fish consumption is estimated to be 33 kg per caput in 2003-2004, according to the DoF.

Tremendous increases in food production from agriculture and aquaculture could be achieved by not only increasing the amount of land farmed, as is being pursued by the Government through promoting large-scale farming enterprises, but by diversifying current farming systems, and especially those of the majority of the population, the small-scale farmers/fishers. It is inappropriate policy to consider rice as the sole element in national food security with the exclusion of fish, the other traditional national food. While a mainly rice-based diet can satisfy the nutrition requirements of adults, it is deficient for babies, infants and children who required more energy- and protein-dense food that fish can supply. Besides providing balanced amino acids, fish are also a rich source of minerals and vitamins. Furthermore, farmers would earn more income by diversifying their rice farms to a grow fish as well as rice which would improve their livelihoods.

The small-scale farming sector would require considerable technical, financial and logistic support with input supply and marketing to learn how to farm fish. Although land is owned by the state, farmers and their descendants have long-term leases as tenants to cultivate the land with extremely low annual rents. Thus, households would benefit from making capital improvements to their farms, including ponds.

Nile tilapia are becoming well established in aquaculture although these large specimens were harvested from a self-recruiting population in a leasable culture-based fishery.

Most pelleted feed is transported by boat to fish farms.

As discussed in the workshop, the DoF requires considerable strengthening in terms of human and financial resources to be effective in extension. The MMF could also play a role in dissemination of technology to farmers. Linking small- to large-scale farmers through contract farming with the help of the MFF, most members of which are large-scale farmers, may be a mechanism to help to establish small-scale aquaculture in Myanmar.

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Bundh breeding of carps: A simple innovative technique from district Bankura, West Bengal (India)

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Fish seed, one of the basic inputs for aquaculture, can be produced by several methods of which 'bundh breeding' has been quite common in the Bankura district of West Bengal. 'Bundhs' are vast stretches of low lying lands bounded by embankments that are filled with run off from extensive catchment areas during the monsoon. The sudden influx of rainwater into these systems provides a stimulus for the fish to spawn.

The concept of breeding carps in bundhs began in Bankura as early as 1882[1]. Since Indian major carps breed spontaneously in their natural river habitats, early seed collection from riverine sources was the only option that fish farmers had. The supply of seed was uncertain and unreliable and came mixed with a variety of wild species. These problems provided the impetus for developing a more dependable method of carp seed production. Breeding carps in bundhs has to some extent contributed to both the quality and quantity of fish seed collection in Bankura.

There are two types of bundhs, wet and dry. In Bankura, spawn production from wet bundhs on commercial scale actually started in 1902, whereas breeding in dry bundhs started in 1926[2]. Early workers on spawning of Indian major carps in bundhs included Ghosh and Ghosh[3], Khan[4], Mookherjee *et. al.*[5], Saha *et. al.*[6], Dubey and Tuli[7], Moitra and Sarkar[8] and Chondar[9].

After the hypophysation technique of induced breeding of major carps became a reality in 1957, traditional bundh breeding was modified into bundh-cum-induced breeding to ensure better and more extensive spawning. Present day practices of bundh breeding in Bankura district involve double breeding of Indian major carps. This article mainly deals with the modification of dry bundh breeding in Bankura.

Wet and dry bundhs

Wet bundhs are characterized by undulating terrain generally bounded by high embankments on three sides, with the fourth left open for entry of rainwater from the surrounding catchment. Typically, wet bundhs have a deeper, pond-like depression in the middle that retains water throughout the year, making them suitable for rearing of brood fish. The shallower area surrounding the pond section usually dries up during summer, when they are commonly used for cultivation of agricultural crops. Wet bundhs are constructed on red laterite soil and can be of any shape. The size of central pond varies from 1-2 ha with catchment area ranging from 20 to 100 times greater in surface area. In the monsoon water rushes from catchment area commonly known as 'dhal' to the embanked area, flooding the pond and ultimately passing through the opposite lower end, which is called the 'bulan'. The bulan is protected by a screen or 'cherra' made up of bamboo and straw, which prevents the escape of fishes. The shallow area of the bundh in which the fish prefer to breed is called the 'moan'.

A dry bundh is similar to wet bundh except that it does not have a central perennial pond, and remains totally dry for most of the year, except for the monsoon months. These bundhs can be of variable shape (square to rectangular), typically covering 0.1 to 2.5 ha in area.

The topography of land plays a great role in the construction of dry bundhs. The undulating terrain must provide a large catchment area to facilitate quick filling with runoff after even a short rain, and at the same time provide quick and easy gravity-fed drainage.

Traditional bundh breeding techniques

In wet bundhs, after heavy monsoon showers, silt-laden rainwater from the adjoining catchment area or dhal enters the bundh and floods the central pond. Excess water flows through the outlet or bulan creating a current that helps to simulate riverine conditions. Brood carp migrate from the central pond to the shallow inundated area or moan and spawn.

Dry bundhs require a different technique. After accumulation of sufficient monsoon rainwater in the bundh, mature healthy brood fish from local perennial ponds are introduced for acclimatization without consideration of their weight, number, sex ratio or gonad condition. Spawning normally occurs in dry bundhs after onset of continuous showers for several days, which is evident from splashing and coupling of brood fish. After spawning the bundhs are partially drained and fertilized eggs are collected using fine meshed nets such as 'gamchhas', pilnas, hapas or pieces of mosquito- netting. The fertilized eggs are hatched in small and shallow rectangular earthen pits with plastered mud walls, which are gravity fed by drains from the bundh or any near by pond. Breeding operations are repeated 2-4 times a season. After each breeding operation the bundhs are completely drained and refilled with fresh rainwater before introduction of fresh brood fish.

Advantages and limitations of traditional bundh breeding

Before development of the hypophysation technique of induced breeding, bundhs were the only source of pure (unmixed) carp seed. Moreover collecting seed from bundhs was easier than collecting from rivers. Dry bundhs were better than wet bundhs with respect to spawn production as repeated breeding operations were possible in a single season.

In spite of the advantages there are certain limitations, which did not help in popularization of the technique. The topographical requirements, such as vast stretches of land with a gradual slope, lateritic soil and extensive catchment area required to construct bundhs were limited to certain parts of India. Moreover the extent of success or failure of this technique is highly dependent on the environment. Collection of eggs from large wet bundhs required a number of expert fishers, which are not easily available during monsoon months, resulting in limited production. The hatching percentage can be very poor in case of improvised pits due to irregular water flow, overcrowding of eggs and direct exposure of spawn to intense sunlight.

After the successful introduction of induced breeding of carps through the hypophysation technique in India, certain modifications were introduced in the traditional bundh breeding system.

Modified bundhs of Bankura district

In Bankura, Moitra and Sarkar[8] introduced modified bundh-cum-induced breeding under certain environmental conditions. In this technique two adjacent ponds were constructed along a gradient. The pond at higher altitude was used for collection and storage of pre monsoon rainwater from an upland catchment area and the lower pond was used for breeding purposes. The reservoir and breeding bundh were arranged to facilitate water flow from reservoir to breeding bundhs. Sexually mature brood carp were released into the bundhs in a 1:1 ratio sex ratio. After 10 to 12 hrs of acclimatization 8-20% of the total stock of brood carps were netted and male and female carps were segregated. Female brood carps were administered an initial dose of carp pituitary extract @ 3mg/kg body weight and second dose of 8mg/kg body weight 4-5 hours later. Male carps were administered with pituitary extract @ 3mg/kg body weight at the same time of the second female dose. After administration of pituitary extract the brood carps were released with untreated ones into the breeding pool. Water flow was maintained in breeding bundhs by making adjustments to the inlet and outlet. Spawning started 4-6 hours after administration of second dose of pituitary extract.

Construction with improved technology such as cemented hatcheries with regular water supplies and facilities for handling large quantities of spawn were constructed in order to minimize the loss of hatchlings due to oxygen depletion. Reservoirs were constructed at higher elevation where rainwater was collected and stored for breeding purpose. Small bundhs were constructed below the reservoir so as to facilitate the flow of water with proper inlet and outlet control.

Present status of bundh breeding in Bankura district

Dry bundhs of Bankura district have been further modified according to the needs of fish breeders. Modern bundhs are small, pond like tanks, and a large number are located near riverbanks. Water from the river is pumped out and stored in the reservoirs, which are located at higher elevation than the breeding ponds. When there is not enough water in river due to delayed monsoon, it can be pumped from deep tube wells. Where river water is not available, water from nearby ponds can be pumped into the reservoirs. Fish breeding is no longer limited in the monsoon but starts much ahead in April and continues until August. Water flow from the reservoir to breeding pools or bundhs is regulated through pipelines. Brood fish are collected from local ponds and released in the breeding pools or bundhs. In the evening these brood fishes are administered with fish pituitary extract @ 2 mg/kg body weight as first dose and after 3-4 hours a second dose of 10 mg/kg body weight to the female, and single dose of 2mg/kg body weight to the male. Male and female fish are stocked in a 1:1 ratio. Water flow is regulated in the breeding bundhs by releasing water from the reservoir and excess water flowing through outlets. Breeding generally takes place around six hours after administration of the second dose. Next morning, after completion of breeding, the spent brooders are removed. Fertilized eggs are collected with a special type of mosquito net by disturbing the water column. Egg are collected in large containers called 'handis' and released into the circular cemented hatchery for incubation with constant supply of water. Water is sprinkled over the incubation chamber to increase the oxygen content of water. Hatchlings are collected after two days and released in the small rectangular shallow pools from where they are sold out. The practice of reusing brood fish is very common in these bundhs. Fishes that are bred in April are bred again in June-July. Fish breeders obtain less spawn in pre monsoon breeding than during the monsoon due to the unripe condition of the brood fish.

Most of the modern bundhs are designed in such a way so as to minimize the consumption of electricity. Water flow from reservoirs to bundhs and hatcheries are maintained through gravity feed. The fish farmers are skilled in handling and segregating males and females, and can estimate the weight of brood fishes to calculate the dose of pituitary extract. In addition to the Indian major carps, others such as the silver carp, grass carp, big head and even bata are also induced bred in dry bundhs.

Modified dry bundh breeding is very popular among fish farmers in Bankura district as commercial production of quality seeds is possible even during the dry season, and they are more economical than wet bundhs and hatcheries. Initiatives should be taken to propagate this technique of breeding carps in other parts of the country where suitable. As the success of spawn production from dry bundhs is dependent on proper gonadal maturation of brood fish, so proper care and supplementary feeding are essential to ensure a good spawning response.

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African catfish: A potential candidate species for urban/periurban aquaculture in India

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A view of an African catfish farm near Bangalore.

The African catfish Clarias gariepinus.

Aquaculture is the fastest growing sector of the world food economy. Meat production and wild fisheries growth have arrived to a plateau and aquaculture is the only option left to satisfy the increasing demand for fish protein. World aquaculture production touched 45.7 million tonnes in 2001. Asia, being the hub of aquaculture activities, accounts for more than 85% of total aquaculture production. Most of the farmed fish in Asia comes from the extensive and semi-intensive aquaculture farming systems.

As social transformation accelerates in most developing countries the migration of people from villages to cities in search of a secure livelihood is increasing day by day. For example, the sub-Saharan cities of Africa are growing at an exceptional rate of 5%. If this trend continues then half of the population in this region will be urban by 20201. The trend is also more or less similar in Asia and South America. This creates an ever-increasing pressure on local governments to provide basic facilities such as food, water and shelter. Urban food security depends on the availability of food, the purchasing power of the people and also on the quality of the food.

Production of good quality fish at cheapest possible price is a good way to address the problems regarding urban food security. Aquaculture in urban settings is popularly known as urban aquaculture. It is normally practiced in rivers that are flowing nearby, ponds (natural or constructed for aquaculture or other purposes), coastal bays and sewage lagoons[2]. Daily disposal of wastes from the urban area is a great concern for the urban development authorities. These huge wastes may be diverted for the urban aquaculture for the production of quality protein. This not only assures the nutritional security but also helps to combat pollution and generate employment.

Urban aquaculture in India

Urban/peri-urban aquaculture includes extensive aquaculture practices such as stocking fish in reservoirs and large urban water bodies, followed by recapturing after a period of 1-2 years. Examples of stocking and harvesting fish from urban reservoirs can be seen in cities such as Brasilia, Brazil[3]; Hanoi, Vietnam[4] and Wuhan, China[5]. However, this is not commonly observed in India. Semi-intensive urban aquaculture being pond-based aquaculture, unlike lake and reservoirs, offers farmers a greater control over the culture system and permits better surveillance, enabling producers a better guard against common problems such as theft, predation and sewage pollution. Accounts of semi-intensive pond-based aquaculture in urban settings have been reported from several states of the country. Around Kolkata, urban aquaculture is practiced in ponds covering an area of approximately 3,500 ha and the majority of production is based on wastewater inputs from the big drains of the city. The production from these ponds is expected to be around 18,000 tonnes a year of fish for sale in urban markets, most of which goes into the diets of the low income class[6].

African catfish – can it become a key player ?

Freshwater catfishes are widely distributed throughout the world. They reach their greatest diversity in the continents spanning the equator, namely South America, Africa and Asia. Some catfishes are armored with heavy scales but most are scaleless. They vary in size from tiny parasitic species with a total length of less than 5 mm to giant forms of 30 kg such as some of the Pangasius species and the African sharptooth catfish (*Clarias gariepinus*). Most catfishes prefer the slow-flowing stretches of rivers and lakes, Catfish are typically very adaptable and hardy animals, which can survive out of water for considerable periods of time if

Table 1. Water quality parameters for African Catfish Culture.

Water quality parameter	Parameter and temperature range
Temperature	Survival temperatures 7 -38° C
	Critical min. 6° C
	Critical max 50° C
	Preferred 28 - 30° C
Oxygen	<3.0 ± 0.7 mg/l
Ammonia	<6.5 ± 1.5 mg/l
Salinity	<10.8 ± 0.8 g/l

Table 2. Nutritive Value of African Catfish.

Nutrients	%
Fat	2.5
Protein	17.3
Iron	0.003
Vitamin A and B	(Present but not reported)
Energy	450 Kj/100 g

they remain moist. The African catfish is cultured in African, European and also in some Asian countries. The total production of this fish in the year 2001 was about 7,000 mt7.

Bangalore is one of the largest cities of India with an area of 2,190 sq. km2 and a population of 6,520,000. The farmers residing in periurban areas of Bangalore have shown a remarkable achievement in introducing and cultivating catfishes with their own technology with simple inputs to get an optimum profit.

African Catfish have been used for 'backyard aquaculture' in Raichur district of Karnataka state in India with encouraging results. This activity was carried out under a project in which ditches of only 1 m2 in area with plastic or brick lining are used for culturing the catfishes. The same trials have also conducted with success in Bangladesh. Locally available feed ingredients and kitchen wastes were used as feed for culturing the catfishes8. The same model can also be utilized for urban aquaculture with efficient utilization of slaughterhouse wastes as feed.

How did they succeeded

Fish culture is not so common in and around Bangalore except in some rare incidence of carp culture. But they succeeded in African Catfish culture because of the best utilization of available resources in urban area in an efficient manner. The details are described below.

Efficient usage of slaughterhouse wastes as feed

The farmers of Bangalore utilized the cheaply available slaughterhouse wastes to feed catfishes. They used to feed approximately a 75-100 kg of waste to feed 10,000 fingerlings of 2-3 months in age, gradually increasing as the biomass grows. According to a recent estimate the amount of slaughterhouse wastes produced annually in India is 2,100,000 tons9, most of which is produced in the cities where waste disposal has already become an issue. Wastes from slaughterhouse have created serious environmental problems in some cities. i.e. Gulburga in Karnataka, (Deccan Herald Aug 29, 2003), Chandigarh in Punjab, (The Tribune Feb 22, 2003). African catfish, being an omnivorous fish, feeds on these wastes and converts them efficiently into flesh. Its FCR ranges from 0.90 to 1.1.

Efficient utilization of available water resource

Water stored during the rainy season is a major source for aquaculture activities in the urban farms of Bangalore. Most of the farmers practice only one fish crop of six months duration. They also use the water from the fishpond to irrigate their vegetable and maize crops via gravity feed while fresh bore water is used to fill the fishpond to compensate for the loss due to evaporation and seepage. African catfish is a hardy species and can be cultivated at higher stocking densities in ponds with low water quality in which frequent water exchanges are not necessary. The tolerance limits of water quality parameters for African catfish culture are given below.

From the above table it is assumed that African catfish can grow well in most of the water bodies found in urban areas.

Growth

A pond size of 1000 m2 is ideal in terms of management, feed utilization and production. Fingerlings are normally stocked into the production ponds at an initial density of 100,000/ ha but the recommended stocking density varies according to local conditions.

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Bundh breeding of carps

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References

1. Sannigrahi, H.; Prasad,U. and Qamaruddin (1977) – Seminar, Inl. Fish. Trg. Con. Barrackpore, 1-10.
2. Sarkar, S. K. (1982) – Workshop on the Development Of Inland Fisheries in Orissa through Institutional Finance, FFDA, Balasore (Orissa), 6-8th March.
3. Ghosh, A. C. and Ghosh, S. N. (1922) - Bull. Dep. Fish. Beng. 18: 9.
4. Khan, H. (1942) – J. Bombay Nat. Hist. Soc. 43 (3): 416-427.
5. Mookherjee, H. K.; Mazumdar, S. R. and Dasgupta, B. (1944) – J. Dep. Sci. Calcutta Univ., 11:383-384.
6. Saha, K. C.; Sen, D. P.; Roy Chowdhury, A. K. and Chakroborty, S. K. (1957) – Ind. J. Fish. 4(2): 284-294.
7. Dubey, G. P. and Tuli, R. P. (1961) – J. Bombay Nat. Hist. Soc. 58 (1): 81-91.
8. Moitra, S. K. and Sarkar, S. K. (1973) – Proc, Ind. Sci. Cong. Part III: 549.

Responsible introduction of alien fish and biodiversity in southern Nepal

Tek Bahadur Gurung

The potential social, environmental and economic impacts of introducing exotic or 'alien' species are well documented. Invasive alien species – those that successfully colonize an ecosystem outside of their natural range – are widely considered to be agents of species and biodiversity loss in ecosystems all over the globe[2]. Other negative effects of alien species can include fall in production of commercially important species and substantial costs incurred in control and eradication programs[3].

There is no doubt, however, that introduction of alien species can also bring substantial social, environmental and economic benefits. Many of the world's aquaculture industries – and attendant employment, food security and nutritional benefits - are based on species that are alien to their culture environments.

Introductions are a balancing act where potential risk must be weighed against potential reward. In considering the history of introductions – both helpful and harmful – one issue that stands out above all is the need for decisions to be well informed and carefully considered. The responsible introduction of an alien species requires that it be carried out in a way that will minimize the risk of harm to indigenous biodiversity. Careful planning of introductions, for example through a risk assessment process, can help to identify and minimize the risk of negative impact as well as to maximize the benefits. The Food and Agriculture Organization of the United Nations have published guidelines on a precautionary approach to species introductions[1] that can assist with such planning.

Introductions are carried out for many different reasons[3]. Governments generally introduce species to develop fisheries for commercial, subsistence or recreational purposes; for aquaculture development; or occasionally for biological control. Members of the public frequently release fish for sentimental, aesthetic or religious reasons.

In Nepal, capture fisheries are a traditional source of employment, with fishers among the most poor and deprived sections of society. Fishing is particularly important to several ethnic communities that have, for generations, relied almost exclusively on it for their livelihoods.

Unfortunately, market demand for fish in Nepal cannot be met by capture fishery production alone. Nepal, like many other countries, has introduced exotic fish species to assist in the development of aquaculture, to provide livelihoods opportunities for people, to enhance food security and to reduce over exploitation of native fish stocks[4].

Nepal is famous for its cold snow-covered mountain ranges in the north, but the southern 'Terai' region bordering India, consists of flat, tropical lowlands that have good potential for warm water aquaculture. Aquaculture has been practiced in the Terai for around 40 years. There are some 148 indigenous fish species in the Terai, but aquaculture there is largely based on introduced fishes. It is mainly carried out by marginalized, poor and medium class farmers.

The first recorded importation of exotic fish to Nepal was the introduction of major carps in 1947. Presently, there are an estimated 23 introduced fish species in the country with 18 of those in southern Nepal (Table 1). The predominant fish are three strains of common carp (German, Israeli and Naisis strains), three major carps (which are also native), three species of Chinese carp, tilapia, silver barb and crucian carp. Some of these come close to meeting characteristics often used to designate species as 'invasive' in different parts of the world[5]. Recently cultivation of African catfish (Clarias Gareipinus) has grown rapidly in the southern warmer part and even in mid hills. It is roughly estimated that the trade of African catfish seed in southern Terai is worth 2-4 million Nepalese Rupees (28-56 thousand US dollars) in a season.

The Fisheries Development Directorate of Agriculture Department, Ministry of Agriculture and Co-operatives, is responsible for making decisions on the introduction of exotic fishes, after scrutinizing their environmental suitability. Generally, likely to compete with native stocks or that have exploitative breeding habits are avoided. However, some recent introductions to the southern Terai have taken place through unofficial channels such as traders and other agents.

However, in considering the social impacts of fish introduction and biodiversity conservation, perhaps the most crucial question is to determine who will be benefit: The rich or the poor? The purpose of this review is to evaluate the impact of the responsible introduction of alien fish species on the livelihoods of people and fish biodiversity.

Potential implications of introducing alien fish species

In a seminal work, Bianchini[6] asked "Mankind and biodiversity: Are they compatible". The desperate answer is yes! Biodiversity sustains all of humanity's life-support systems on earth. This is one of the reason that biodiversity has been highly prioritized worldwide. The risks of irresponsible introductions of alien species to conservation of biodiversity include hybridization, habitat and water quality alteration, competition, predation, and disease[7,8]. To date, no significant incidents have yet been reported in Nepal through the introduction of fish, although the outbreak of Epizootic Ulcerative Syndrome (EUS) in southern Nepal in the early 1990s is believed to have been through the movement of live fish seed from neighboring countries.

It is generally agreed that release of exotic fish creates competition with native species for space, food and other resources[9]. The potential impact is far more serious is the exotic species can successfully reproduce and persist in the receiving environment. As examples, tilapia are notorious for their prolific breeding[10], while African catfish are known for voracious predation[11,12]. These fishes can be expected to pose a high risk to some indigenous species due to their feeding, reproductive and life history strategies. However, the outcomes of an introduction are difficult to predict - it is possible that they may coexist with indigenous species due to spatial or temporal variability in habitats[13,14] or strategies for their survivability and existence[15,16]. Successful introduction of an alien fish species is often difficult to achieve. Considerable technical expertise is often required[5,21] and many attempts fail.

Impact of exotic fish introduction: Livelihoods, food security, poverty alleviation and fish biodiversity

Rohu (*Labeo rohita*), Mrigal (*Cirrhinus mrigala*) and Bhakur (*Catla catla*) are indigenous to southern Nepal. However, if they are considered exotic on the basis of the introduced origin of cultured stocks (Table 1), it may be concluded that development of aquaculture sector in the southern Terai, which contributes 80-90% of national aquaculture production, is exclusively through introduced fishes. Tilapia and African catfish, which are popular for aquaculture though often portrayed as notorious species[17,18], may have potential to harm indigenous aquatic biodiversity. It is speculated that popularity of these species among the farmers are due to simplicity in theirs rearing. Carps are attractive due to their rapid growth and economic return but require comparatively large areas for cultivation and relatively complex in their production management cycle. In comparison, tilapia and catfish can be successfully grown in small pits, are easy to culture and support higher production within limited areas.

A general assessment on the status of introduced fish in Nepal indicates that to date there has been no report of a harmful or impact from introduced fishes (Table 2). As warm water species, both tilapia and African catfish become inactive at low temperatures[11] typical of the rivers in the mid-hill region, which in winter fall to 11^{o}C, suggesting that they would not be able to survive or compete with indigenous fishes in the upper regions.

The introduction of alien fish species is often blamed for the loss of indigenous fish biodiversity, for example the African catfish has been blamed for the depletion of 56 fish species in Bangladesh[18]. However, such claims are often made without adequate supporting data, and few authoritative studies are available on the reasons behind the demise of a particular species, which may be caused by pressure from many sources. The relative importance of factors such as habitat modification, disease, climatic variation and pressure from indigenous competitors and predators is often unknown. Studies on life history strategies of introduced vs. indigenous fish may give a different scenario. For example, Nepal has its own highly successful predatory fish species including *Xenentodon cancila, Channa spp, Mastacembelus armatus, Wallago attu, Bagarius bagarius* and *Mystus spp.* Similarly*, Puntius* spp. are prolific breeders in warm southern waters.

There are many studies that have demonstrated a positive impact of fish introduction in terms of generating employment and income or contributing to livelihoods, food security and in reducing vulnerability[6,9,19,20]. At present, the fisheries sector in Nepal produces about 36,000 metric tones of fish[22]. Nearly 50% of national production is through aquaculture, predominantly of

Table 1. List of exotic fishes in southern Nepal.

English name	Fish species	Introduction		Feeding habit
		Year	Main source	
Rohu	*Labeo rohita*	1947	India	Omnivore
Naini	*C. mrigala,*			Omnivore
Bhakur	*Catla catla*			Planktivore
Catfish	*Clarias* spp (?)	Before 1950 (?)	India	Omnivore
German carp	*C. carpio specularis*	1955/56	India	Omnivore
Israeli carp	*C. carpio communis*	1957/58	Israel	Omnivore
Grass carp	*Ctenopharyngodon idella*	1965/66,67/68	India, Japan	Herbivore
Silver carp	*Hypophthalmichthys molitrix*	1965/66,67/68	India, Japan	Planktivore
Bighead carp	*Aristichthys nobilis*	1971	India	Planktivore
Mosambic tilapia	*Oreochromis mosambicus*	Not known	India	Omnivore
Nile tilapia	*O. niloticus*	1983/84	Thailand	Omnivore
Prawn	*Macrobrachium rosenbergii*	1983/84	Thailand	Omnivore
Naisis carp	*C. carpio*	1990	Israel	Omnivore
Fancy carp	*C. carpio*	1990	Japan	Omnivore
Silver barb	*Puntius gonionotus*	1990	Thailand	Planktivore
African catfish	*Clarias gariepinus*	1990 (?)	Not known	Cornivore
Crucian carp	*Carassius carassius*	1990	Japan	Omnivore
Gold fish	*Carassius auratus*	Not known	Not known	Omnivore

Table 2. Assessment of the status of introduced fish into southern Nepal

English name	Fish species	Criteria				
		1	2	3	4	5
Catfish	*Clarias sp (?)*	+	+	+	+	+
Rohu	*Labeo rohita*	+	+	+	+	+
Naini	*Cirrhinus mrigala*	+	+	+	+	+
Bhakur	*Catla catla*	+	+	+	+	+
German carp	*C. carpio specularis*	+	+	+	+	+
Israeli carp	*C. carpio communis*	+	+	+	+	+
Naisis carp	*C. carpio*	+	?	+	+	+
Fancy carp	*C. carpio*	+	+	+	+	+
Grass carp	*Ctenopharyngodon idella*	+	+	+	+	+
Silver carp	*Hypophthalmichthys molitrix*	+	+	+	+	+
Bighead carp	*Aristichthys nobilis*	+	+	+	+	+
Mosambic tilapia	*Oreochromis mosambicus*	+	?	+	+	+
Nile tilapia	*O. niloticus*	+	+	+	+	+
Prawn	*Macrobrachium rosenbergii*	+	+	+	+	+
Silver barb	*Puntius gonionotus*	+	?	+	+	+
African catfish	*Clarias gariepinus*	+	+	+	+	+
Crucian carp	*Carassius auratus*	+	?	+	+	+
Gold fish	*Carassius carassius*	+	?	+	+	+

Criteria

1. Self-reproducing in natural waters and/or easily bred under hatchery conditions.
2. Has increased fisheries productivity.
3. Not known to have introduced exotic diseases.
4. Not reported to endanger indigenous fish species.
5. Not been reported to adversely affect water or habitat quality.

introduced species, which has created substantial employment opportunities. However, domestic supply is still insufficient. Around 2-3 metric tones of fish are imported to the capital, Kathmandu, alone each day[23].

Appropriate strategies on responsible introduction of exotic fish

The 'value' of an introduced fish species is highly dependent on its impact in the receiving environment, and also on the preferences and attitudes of the local people. For example, carps are appreciated food fish in Asia, but in the US they are regarded as trash fish. Trout are highly prized food and sport fish in Australia, despite having a serious impact on some indigenous species through predation. Homestead fish farming of African catfish has been successfully applied in improving household nutrition and reducing poverty in Bangladesh[24]. However, the same species is blamed for severe threat to biodiversity[18]. Therefore, regulatory mechanisms for alien fish introduction and invasive fish species will depend to an extent on the specific requirements and priorities of each country.

At present, legislation to regulate the introduction of exotic fishes to Nepal is inadequate, although the realities of enforcing movement restrictions in a landlocked country with open boundaries are dubious. The most practical way forward may lie in enhancing awareness among farmers and engaging them in development of a code of conduct that will protect the growing aquaculture industry and fish biodiversity at the same time. During formulation of such a code, socio-economic and livelihood analysis should be incorporated into conservation-related decision-making processes[25]. In addition to biological and ecological considerations, human values and socio economic aspects should equally prioritized[26]. With the addition of such perspectives, the fisheries and aquaculture sectors will be better equipped to reduce the risk of exotic species gaining a foothold in Nepal. Law enforcement, facilities for quarantine, education, extension and awareness may reduce the danger of reckless introduction of unwanted fish further.

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References and further reading

1. FAO (1995) Precautionary approach to fisheries Part 1: Guidelines on the precautionary approach to capture fisheries and species introductions. Food and Agriculture Organization of the United Nations.
2. IUCN (2001) Coping with alien and invasive species. IUCN Nepal reports. Kathmandu, Nepal.
3. Welcomme R. L. (1988) International introductions of inland aquatic species. FAO Fisheries Technical papers 294.
4. Rajbanshi K. G (1979) History of fish culture in Nepal (in Nepali). Krishi bimonthly (Falgun/Chaitra). Agriculture Information Division, DoA, HMG, Nepal. Pp 1-6.
5. McKay R. J (1989) Exotic and translocated freshwater fishes in Australia. p. 21-34. In: S.S De Silva (ed) Proceeding of the workshop on introduction of exotic aquatic organisms in Asia. Asian Fish Soc. Spec. publ. 3, 254 p. Asian Fisheries Society, Manila, Philippines.

6. Bianchini M. L (1995) Species introductions in the aquatic environment: changes in biodiversity and economics of exploitation. Pages 213-222 in D. P. Philip et. al. editors. Protection of aquatic biodiversity. Proceeding of the World Fisheries Congress, Theme 3. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
7. Phillip D. P, D. P. Burkett, J. M. Epifanio, J. E. Marsden (1995) Protection of aquatic biodiversity: Will we meet the challenge? Pages 1-10, In: Proceeding of the World Fisheries Congress, Theme 3. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
8. Rinne J. N (1995) The effects of introduced fishes on native fishes: Arizona, southwestern United States. Pages 149-159. In: D. P. Philip et al. editors. Proceeding of the World Fisheries Congress, Theme 3. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
9. Swar D. B. and T. B. Gurung (1988) Introduction and cage culture of exotic carps and their impact on fish harvested in Lake Begnas, Nepal. Hydrobiologia 166: 277-283.
10. Mair G (2003) Tilapia: A species for Indian aquaculture? Aquaculture Asia. July-September 2003 (Vol VII No. 3). pp. 22. 23.
11. Viveen, W. J. A. R, C. J. J Richter, P. G. W. J van Oordt, J. A. L. Janssen, and E. A. Huisman. (1986) Practical manual for the culture of the African catfish (*Clarias gariepinus*), Directorate General International Cooperation of the Ministry of Foreign Affairs, The Hague, The Netherlands.
12. Hecht T (1996) The culture of *Clarias gairepinus* in southern Africa, with comments on the relative futility of subsistence aquaculture in Africa. Pages 121-135. In :The role of aquaculture in world fisheries. Proceedings of the world Fisheries Congress. Theme 6. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
13. Munday P (2003) Competitive coexistence of coral-dwelling fishes: the lottery hypothesis revisited. *Ecology*: Vol. 85, No. 3, pp. 623–628.
14. Turner G (2004) Ecology of the rocky shore of Lake Malawi: How can so many cichlids species co-exist? Professor George F. Turner, Dept of Biological Sciences, University of Hull, UK.
15. Sanders M (1995) Impacts of predator-prey relationships on harvesting strategies and management. International Conference on the Sustainable Contribution of Fisheries to Food Security, Kyoto, Japan, 4-9 December 1995.
16. McCann K (1998) Density dependent co-existence in fish communities. Ecology. December, 1998, http://articles.findarticles.com/p/articles/mi_m2120/is_8_ 79/ai_53643889/ pg_5.
17. Singh A. K. and A. Mishra (2001) Environmental issue of exotic catfish culture in Uttar Pradesh. Journal of Environmental Biology. 22(3). July, 2001. 205-208.
18. Barua S. P, M. M. Khan, M. Ameen (2000) The status of alien invasive species in Bangladesh and their impacts in the ecosystem. IUCN Bangladesh. House No. 3A; Road No. 28, Dhanmodi, Dhaka 1209, Bangladesh.
19. Tan Yo-Jun and Tong He-Yi (1989) The status of the exotic aquatic organisms in China. p. 35-44. In: S.S De Silva (ed) Proceeding of the workshop on introduction of exotic aquatic organisms in Asia. Asian Fish Soc. Spec. publ. 3, 254 p. Asian Fisheries Society, Manila, Philippines.
20. Gurung T. B. and J. D. Bista (2003) Livelihood improvements through fisheries in the *Pode* community in Pokhara, Nepal. Pages 1-2. STREAM Journal. Volume 2 Number 3 July-September 2003.
21. Piyakarnchana T (1989) Exotic aquatic species in Thailand. p. 119-124. In: S.S De Silva (ed) Proceeding of the workshop on introduction of exotic aquatic organisms in Asia. Asian Fish Soc. Spec. publ. 3, 254 p. Asian Fisheries Society, Manila, Phillipines.
22. DoFD (2003) Country Profile-Fisheries Sector, Directorate of Fisheries Development, Department of Agriculture, Ministry of Agriculture and Co-operatives, Kathmandu, Nepal.
23. Joshi G. R and H. B. Tiwari (1998) Present fish marketing system and potentiality for improvement. In: Proceeding of the national workshop on the "Prospect of Fisheries Development under the Agriculture Prospective Plan" 1998. 4-5 November. Kathmandu, Inland Aquaculture and Fisheries Section, FDD, DOA, MOA, HMG, Nepal. pp 35-41.
24. Martin F, de G. Gertjman (2001): Helping the rural poor through homestead fish culture, Aquaculture Asia, Vol. 6, No. 2:3-5.
25. Bartley D. M. (1995) Policy and socioeconomical aspects of aquatic biological diversity conservation. Pages 88-102 in D. P. Philip et al. editors. Protection of aquatic biodiversity. Proceeding of the World Fisheries Congress, Theme 3. Oxford &
26. De Silva S (1989) Exotics- A global perspective with special reference to finfish introduction in Asia, p. 1-6. In S.S. De Silva (ed) Exotic Aquatic Organism in Asia. Proceeding of the workshop on introduction of exotic aquatic organisms in Asia. Asian Fish Soc. Spec. publ. 3, 254 p. Asian Fisheries Society, Manila, Philippines.

Rural aquaculture in Myanmar

...continued from page 8.

Cultured fish predominate in urban markets.

The relatively recent introduction of Nile tilapia into the country may also facilitate the entry of small-scale farmers into aquaculture as it is a smaller fish with a shorter culture cycle than carps and catfish.

However, small-scale rice farmers will remain excluded from aquaculture without more favourable government policy, to the continuing detriment of the majority of the country's population. The gulf between large-scale entrepreneurs and small-scale farmers/ fishers will remain without an empowering policy environment. Raising the limit on the construction of small-scale fish ponds without a DoF licence from the current 128 m^2 would be a liberating first step. Increasing it to 5,000 m^2 would still only take up 25-30% of the area of a typical 4-5 acre (1.6-2.0 ha) small-scale farm but would provide the farming household with considerably more scope to improve their livelihood through aquaculture and help to lift them out of poverty.

Advice on Aquatic Animal Health Care

Collection and utilization of important data in shrimp farming

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Farm records

Farm records were not widely used in the early days of intensive shrimp farming. Small-scale farmers mostly learned by trial and error or by following the example of more successful farmers. Only some medium and large-scale farms might have maintained records that could be used to guide operational decisions. Later, many farmers saw the importance of records and began to collect data relevant to operation of their farms. These records are now commonly used to compare performance in various crops; forecast production yields; and to reduce crop damage. The important kinds of farm data that should be collected include the following:

General pond data

Pond data including pond size, quantity and date of seed stocking should be recorded. The number of seed should be estimated *after* arrival at the farm otherwise mortality during transportation may not be accounted for, leading to over estimate of feeding requirement and shrimp survival.

Water quality

The important parameters of water quality, which should be recorded in the morning and afternoon each day, include pH, dissolved oxygen and turbidity. Alkalinity, ammonia, nitrite and temperature should be recorded when there is weather change (i.e. heavy rain, sudden warm or cold spell) or at least once a week. Regular monitoring of dissolved oxygen can help optimize use of aerators by determining the period when they are actually required, thus reducing power costs. Continuous monitoring of water quality parameters and study of their correlations will help the farmers to understand their pond ecosystem, and to subsequently forecast environmental changes and take precautionary measures to prevent problems.

Feed

Feed weight per meal and per day as well as accumulated feed should be recorded daily and compiled after every sampling of body weight in order to check feeding efficiency. Calculation of FCR from these records is also used for monitoring feed management. Monitoring of feed consumption by feed sampling trays should be regularly practiced and clearly recorded so that serious problems be identified immediately. For example, if feed consumption is decreasing in the afternoon, a farmer will be alerted and may be able to identify its major cause by examining recent records of water quality. A decrease in shrimp feeding may be caused by extremely high pH and warm water, which accelerates the toxicity of unionized ammonia.

Shrimp growth

Regular sampling of shrimp body weight should be carried out every 7-10 days in order to estimate shrimp biomass in the pond. This shrimp growth monitoring is also useful for comparison with standard growth; for adjustment of feed quantities; and for making decisions on harvesting.

Production cost

If production cost has been regularly recorded, a farmer will be able to update his benefit/loss, which is used for decision making on harvesting or extending culture period to receive optimal benefit. For example, the author provides an example record of a 4 rai shrimp pond having 200,000 seed stocked, after a 70 day culture period, with average weight of 10 g and survival rate during stocking at 80%, as in the following table.

Considering the above three main data (pond, water quality and feed), you can see that water quality and feed consumption are closely correlated. Feed left in the sampling trays increased from 12-16 April as water turbidity increased. Turbid water may be caused by over blooming of phytoplankton or by siltation after heavy rain. However, rain is unusual in April (according to seasonal weather patterns at the farm location) and always causes water pH to fall. From the record, it can be observed that water pH was also high, particularly during the afternoon, suggesting that an excessive bloom of phytoplankton could be the major cause.

The toxicity of unionized ammonia, which is generally accelerated by high water pH and temperature in the afternoon, is likely to have caused the reduced shrimp feed consumption as shown by the amount of feed left on 13 April at the 2pm sampling time. Foam accumulated at one corner of the pond also indicates rising ammonia levels caused by decomposing phytoplankton.

Microbial decomposition of dead phytoplankton and feed waste consumes a lot of oxygen, which can be observed by a fall in dissolved oxygen levels in the early morning. If there is no solution, shrimp feeding may keep falling by 20% as observed in the later dates.

After analysis of the above pond data (i.e. 77 kg feed weight/day or 15-16 kg/meal on day 70), organic load from this over feeding may be one of the primarily causes of the excessive phytoplankton bloom. Calculating from an average shrimp body weight of 10g, it can be estimated that this crop should produce around 1,711 kg of adult shrimp (170,000 pieces) with 85% survival at harvest, which is higher than survival at stocking (80%). Overfeeding in this pond can be confirmed by the comparison with the standard survival rate at day 70, which is generally 60-70%.

To solve this problem, water should be urgently exchanged to reduce phytoplankton, organic matter, toxic ammonia loads and pH in the pond. Feed amounts should be subsequently reduced to 10-11 kg/meal, based on the calculation from a reasonable survival rate of 60-70%. Farmers should also observe feed waste at the feeding areas and pond bottom under feed sampling trays. In general, shrimp prefer not to feed on polluted areas and thus move to feed in sampling trays instead. This causes the over-estimation of shrimp biomass in pond and subsequently miscalculation of feed requirements.

If a farmer understands the mechanisms of pond ecosystems and regularly analyzes the necessary data above, many problems can be avoided by taking corrective action in advance such as water exchange and feed adjustment as soon as the first unusual observations are recorded, in this case in the record on 13 April.

The above example is common in shrimp farming and can be prevented if farmer has proper data continuously recorded. Farmers must also understand the correlation between factors in the pond so that problems can be easily and efficiently solved.

Shrimp Health Management Training Course, Bangkok, 3-8 October 2005

NACA and Alltech Aqua are pleased to announce the next Shrimp Health Management Training Course.

The course will include lectures, practicals, case studies, visits to farms and discussion. The lectures are based on the information contained in the publication "Health Management in Shrimp Ponds".

It is a fee-paying course offered annually with internationally recognized expert speakers, including: Dan Fegan (current President of the World Aquaculture Society and Regional Technical Manager for Aquaculture, Alltech Aqua); Pornlerd Chanratchakool, Technical Manager for Novozymes (with 18 years experience with the Aquatic Animal Health Research Institute of Thailand); Julian Davies; and Prof. Chalore Limsuwan from Kasetsart University. Registration forms and course brochures are available by emailing training@enaca.org. The registration fee is USD550.

Example of data record and application

Pond 1: Area = 4 rai (0.65 ha).
Stock: Amount = 200,000 PL, size = PL15, density = 50 pieces/m^2, date = 1 February 1998, time = 0600 AM, source = NA, survival = 80%

Date	Age	Feed weight (kg)							Water quality						% feed left				Remark
		05.00	10.00	14.00	18.00	22.00	Total	Accumulated	D.O.		pH		Turbidity	Salinity	06.00	10.00	14.00	08.00	
11/4	70	16	15	15	16	15	77	1976	4.2	10	8.3	8.5	35	30	0	0	10	0	
12/4	71	16	15	15	16	15	77	2044	4.0	10	8.4	8.6	35	30	10	0	10	10	
13/4	72	15	16	14	16	15	76	2120	3.6	11	8.4	8.8	30	30	10	0	20	0	Foam
14/4	73	14	16	12	14	14	70	2190	3.2	10	8.4	9.0	25	30	10	10	20	10	Foam
15/4	74	13	15	10	12	12	62	2252	2.8	9	8.4	9.2	25	30	20	10	20	20	Foam
16/4	75	12	15	10	12	12	61	2313	2.6	6.5	9.2	9.2	25	30	20	20	20	20	Turbid

ประโยชน์ของการเก็บและการใช้ข้อมูลสำคัญในการเลี้ยงกุ้ง

พรเลิศ จันทร์รัชชกูล

หากย้อนประวัติของการเลี้ยงกุ้งแบบพัฒนาในประเทศไทย จะพบว่าในยุคแรกๆ เกษตรกรรายย่อยมักจะเลี้ยงกุ้งแบบลองผิดลองถูก หรือมักจะทำตามผู้ที่ประสพความสำเร็จ ส่วนฟาร์มที่มีขนาดปานกลางหรือฟาร์มใหญ่มักจะมีการจัดเก็บข้อมูลต่างๆ มากมาย เพื่อประกอบการตัดสินใจในการจัดการฟาร์ม ซึ่งหากมีการนำมาใช้จะทำให้การจัดการฟาร์มมีประสิทธิภาพมากขึ้น แต่ส่วนใหญ่แล้วมักจะไม่ค่อยได้นำเอาข้อมูลที่จัดเก็บมาใช้เลย หลังจากเกษตรกรส่วนใหญ่เริ่มเห็นความสำคัญของข้อมูล จึงเริ่มมีการเก็บข้อมูลหรือจดบันทึกเพื่อใช้ประกอบการเลี้ยงกุ้งกันมากขึ้นเรื่อยๆ ทำให้การตัดสินใจต่างๆ ถูกต้องมากขึ้น นอกจากนั้นเกษตรกรสามารถนำข้อมูลต่าง ๆ ที่รวบรวมได้มาใช้เปรียบเทียบประสิทธิภาพของการเลี้ยงกุ้งในรอบต่างๆ สามารถคาดการณ์ หรือประมาณผลผลิตในบ่อได้เป็นอย่างดี และยังสามารถุลดการสูญเสียที่จะเกิดขึ้นได้ หากมีการเก็บบันทึกข้อมูลที่สำคัญ และไม่ยุ่งยากอย่างมีประสิทธิภาพ ข้อมูลที่สำคัญๆ ที่ควรมีการจดบันทึก ได้แก่

1. ข้อมูลประวัติบ่อ ขนาดของบ่อ จำนวนลูกกุ้งที่ปล่อย วันที่ปล่อยลูกกุ้ง เป็นข้อมูลที่สำคัญควรบันทึก สำหรับจำนวนลูกกุ้งที่ปล่อยลงในบ่อ ควรจะเป็นจำนวนที่ประเมินจากคุณภาพลูกกุ้งเมื่อมาถึงฟาร์ม ทำให้ทราบจำนวนกุ้งโดยประมาณที่ปล่อยลงจริงในบ่อ ไม่ควรบันทึกจำนวนลูกกุ้งตามที่สั่งซื้อมา เนื่องจากจะทำให้การประเมินอาหารและอัตรารอดผิดพลาดได้

2. ข้อมูลคุณภาพน้ำรายวัน ในการตรวจวัดคุณภาพน้ำรายวัน ค่าที่สำคัญ และจำเป็นต้องจดบันทึกทุกวัน คือ ค่า pH เช้าบ่าย ค่าปริมาณออกซิเจนเช้า–บ่าย น้ำและความขุ่นใสเช้า หรือบ่าย ส่วนค่าความเป็นด่าง แอมโมเนีย ไนไตรท์ อุณหภูมิ เป็นค่าที่ควรตรวจสอบเมื่อมีความจำเป็น หรือเกิดเหตุการณ์ผิดปกติขึ้น เช่น ฝนตกหนัก อุณหภูมิเปลี่ยนแปลงมาก เป็นต้น แต่อย่างไรก็ตามควรตรวจสอบอย่างน้อยสัปดาห์ละ 1 ครั้ง และจดบันทึกให้ละเอียด จึงจะทำให้คาดการณ์ต่าง ๆ ล่วงหน้าได้ การตรวจค่าออกซิเจนที่ละลายน้ำจะมีส่วนช่วยในการประหยัดต้นทุน ค่าพลังงานที่ใช้ในการให้อากาศได้อย่างมาก โดยเกษตรกรสามารถปรับลดหรือเพิ่มการให้อากาศในบ่อตามค่าที่วัดได้ เป็นต้น นอกจากนี้หากมีการตรวจวัดคุณภาพน้ำที่กล่าวมาต่อเนื่องและนำมาหาความสัมพันธ์กันจะช่วยให้เกษตรกรเข้าใจระบบนิเวศน์ในบ่อได้ สามารถคาดการณ์การเหลี่ยนแปลงภายในบ่อเพื่อหาแนวทางการป้องกันปัญหาที่จะเกิดขึ้น

3. ข้อมูลอาหารรายวัน น้ำหนักอาหารแต่ละมื้อ อาหารรวมต่อวัน และอาหารสะสม ควรมีการบันทึกทุกวัน และรวบรวมทุกครั้งที่มีการสุ่มน้ำหนัก เพื่อทำให้ทราบลักษณะการกินอาหารของกุ้งได้ดี ตลอดจนสามารถตรวจสอบประสิทธิภาพของการควบคุมอาหารได้ โดยคำนวณจากอัตราแลกเนื้อโดย ประมาณ การใช้ยอเพื่อตรวจสอบอาหารควรได้รับการบันทึกให้ชัดเจน จะทำให้เกษตรกรทราบแนวโน้มของการเกิดปัญหาล่วงหน้าได้อย่างดี เช่น กุ้งเริ่มกินอาหารน้อยลงในมื้อบ่าย หากมีการบันทึกข้อมูลคุณภาพน้ำร่วมด้วย เกษตรกรสามารุตรวจสอบหาความสัมพันธ์หรือหาสาเหตุของการที่กุ้งกินอาหารลดลงได้ โดยอาจเนื่องมาจาก pH มีค่าสูงมาก ทำให้แอมโมเนียเป็นพิษมากขึ้น เป็นต้น

4. ข้อมูลการเจริญเติบโต ควรมีการสุ่มน้ำหนักเฉลี่ยทุก 7–10 วัน เพื่อประเมินผลผลิตกุ้งที่อยู่ในบ่อ และเปรียบเทียบอัตราการเจริญเติบโตของกุ้งกับการเจริญเติบโตมาตรฐาน และยังใช้ประกอบในการตรวจสอบประสิทธิภาพของการปรับลดเพิ่มอาหารได้ นอกจากนั้นยังช่วยในการตัดสินใจเพื่อจับกุ้งขายในช่วงปลายของการเลี้ยง โดยดูจากอัตราการเจริญเติบโตที่เพิ่มหรือลดลง

5. ข้อมูลค่าใช้จ่าย หากเกษตรกรมีการจดบันทึกค่าใช้จ่ายตลอดการเลี้ยง จะทำให้ทราบถึงต้นทุน–กำไร ใช้ช่วยการตัดสินใจจับกุ้งขาย หรือสามารถเลี้ยงต่อไปเพื่อให้ได้กำไรสูงสุด หรือขาดทุนน้อยที่สุด เป็นต้น

เพื่อให้ผู้อ่านมองภาพได้ชัดเจนขึ้น ผู้เขียนขอยกตัวอย่างข้อมูลจากบ่อเลี้ยงกุ้ง ซึ่งเป็นบ่อขนาด 4 ไร่ ปล่อยลูกกุ้งจำนวน 200,000 ตัว โดยกุ้งมีอายุประมาณ 70 วัน มีน้ำหนักเฉลี่ย 10 กรัม และประมาณอัตรารอดขณะปล่อย 80 เปอร์เซ็นต์ ดังตาราง

เมื่อพิจารณาดูข้อมูลในตารางซึ่งจะแบ่งออกเป็น 3 ส่วนใหญ่ ๆ คือ ข้อมูลบ่อ ข้อมูลคุณภาพน้ำ และข้อมูลอาหาร ซึ่งข้อมูลคุณภาพน้ำและอาหารจะสัมพันธ์กันอย่างมาก ดังจะเป็นว่าปริมาณอาหารที่เหลือในยอช่วงวันที่ 12 – 16 เม.ย. จะเพิ่มมากขึ้นในขณะที่ความขุ่นใสมีค่าลดลง แสดงให้เห็นว่าความหนาแน่นของแพลงค์ตอนเพิ่มขึ้น แต่อย่างไรก็ตามความขุ่นใสดังกล่าวอาจเกิดจากตะกอนดินหลังฝนตกได้อีกสาเหตุหนึ่ง แต่ในกรณีนี้ไม่น่าจะเป็นเหตุผลเนื่องจากไม่มีฝนตกในเดือนเมษายน นอกจากนั้นถ้าความขุ่นใสที่ลดลง

ตัวอย่างตารางบันทึกข้อมูลที่สำคัญและวิธีการใช้ข้อมูล

บ่อที่ 1 ขนาดบ่อ 4 ไร่ จำนวนลูกกุ้ง 200,000 ตัว ขนาด PL 15 ความหนาแน่น 50 ตัว/ตารางเมตร

วันที่ปล่อย 1 กุมภาพันธ์ 2541 เวลา 06.00 น.

แล่งที่มา x อัตรารอด 80%

		[illegible]							[illegible]						%[illegible]				
[illegible]	[illegible]	05.00	10.00	14.00	18.00	22.00	[illegible]	[illegible]	D.O.		pH		[illegible]	[illegible]	06.00	10.00	14.00	08.00	
11[illegible].	70	16	15	15	16	15	77	1976	4.2	10	8.3	8.5	35	30	0	0	10	0	
12[illegible].	71	16	15	15	16	15	77	2044	4.0	10	8.4	8.6	35	30	10	0	10	10	
13[illegible].	72	15	16	14	16	15	76	2120	3.6	11	8.4	8.8	30	30	10	0	20	0	[illegible]
14[illegible].	73	14	16	12	14	14	70	2190	3.2	10	8.4	9.0	25	30	10	10	20	10	[illegible]
15[illegible].	74	13	15	10	12	12	62	2252	2.8	9	8.4	9.2	25	30	20	10	20	20	[illegible]
16[illegible].	75	12	15	10	12	12	61	2313	2.6	6.5	9.2	9.2	25	30	20	20	20	20	[illegible]
17[illegible].	76																		

เกิดหลังฝนตก ค่า pH มักจะลดลงด้วย แต่ในบ่อนี้พบว่า ค่า pH ของน้ำเพิ่มมากขึ้น โดยเฉพาะในตอนบ่าย จึงน่าจะเป็นสาเหตุมาจากแพลงค์ตอนเจริญเติบโตมากเกินไป

จากผลของ pH มี่เพิ่มมากขึ้นในตอนบ่ายจะทำให้แอมโมเนียที่มีในบ่อเป็นพิษมากขึ้น ส่งผลให้กุ้งกินอาหารลดลง โดยจะเห็นได้ชัดเจนว่า ปริมาณอาหารเหลือในยอจะมากขึ้นในเวลา 14.00 น. ของวันที่ 13 เม.ย. นอกจากนั้นยังพบว่าน้ำเริ่มมีฟองเกิดขึ้น เป็นการแสดงว่าแพลงค์ตอนบางส่วนเริ่มตายและเริ่มเกิดแอมโมเนียจากการย่อยสลายของแพลงค์ตอนดังกล่าว

ขบวนการย่อยสลายของสารอินทรีย์ (จากแพลงค์ตอนและอาหารที่เหลือ) จำเป็นจะต้องใช้ออกซิเจนมากขึ้น ซึ่งในบ่อนี้พบว่าค่าออกซิเจนตอนเช้าเริ่มต่ำลงเช่นเดียวกัน และเมื่อเหตุการณ์ดำเนินต่อไปโดยไม่ได้รับการแก้ไข แนวโน้มของการกินอาหารตอนเช้าก็เริ่มลดลง ขณะที่ปริมาณออกซิเจนก็ลดลงเรื่อย ๆ จนในที่สุดกุ้งกินอาหารลดลงถึงประมาณ 20 เปอร์เซ็นต์

จากข้อมูลดังกล่าว ถ้าลองวิเคราะห์ดูถึงสาเหตุเบื้องต้นที่มำให้แพลงค์ตอนเพิ่มปริมาณได้อย่างรวดเร็วก็น่าจะเกิดจากมีสารอาหารในน้ำมาก ซึ่งอาจจะเกิดจากการให้อาหารที่มากเกินไป เมื่อพิจารณาถึงขนาดกุ้งในบ่อซึ่งมีน้ำหนักถึง 10 กรัม มีการให้อาหารวันละ 77 กิโลกรัม ถ้าประเมินผลผลิต (1,711 กิโลกรัม) และอัตรารอด (170,000; 85%) จะพบว่าสูงกว่าที่ประเมินได้ตอนปล่อยลูกกุ้งซึ่งมีค่าเพียง 80% เท่านั้น แสดงว่าเกษตรกรน่าจะให้อาหารเกินความเป็นจริงไปมาก เพราะโดยทั่วไปขณะที่กุ้งมีอายุประมาณ 70 วัน อัตรารอดน่าจะมีค่าประมาณ 60–70% เท่านั้น (ค่าประมาณในปัจจุบัน) จึงเป็นสาเหตุให้เกิดอาหารเหลือดังกล่าว

วิธีการแก้ไขปัญหาของบ่อนี้น่าจะดำเนินการโดยเร็วที่สุดคือ เปลี่ยนถ่ายน้ำเพื่อลดปริมาณแพลงค์ตอน และเจือจางธาตุอาหารในบ่อ รวมทั้งจะสามารถลดความเป็นพิษของแอมโมเนียลงด้วยการเจือจางและลดค่า pH ของน้ำด้วยการเปลี่ยนถ่ายน้ำได้อีกทางหนึ่งด้วย จากนั้นเกษตรกรควรปรับปริมาณอาหารลง โดยเริ่มประเมินจากอัตรารอดที่ 60–70% ซึ่งจะพบว่าอาหารต่อมื้อควรจะมีปริมาณเพียง 10–11 กิโลกรัมเท่านั้น นอกจากนี้เกษตรกรควรตรวจสอบพื้นที่ที่ให้อาหารและตำแหน่งการวางยออาหารด้วย เพราะถ้าพื้นที่ที่ให้อาหารมีเศษอาหารหรือของเสียสะสมมาก จะทำให้กุ้งไม่กินอาหารที่พื้นและมากินอาหารในยอมากขึ้น จึงทำให้การตรวจสอบอาหารในยอผิดพลาดได้

จากข้อมูลดังกล่าวหากเกษตรกรมีความเข้าใจปัญหาที่เกิดขึ้น และมีการตรวจสอบวิเคราะห์ข้อมูลที่จัดเก็บอยู่ตลอด เหตุการณ์ดังกล่าวนี้สามารถป้องกันได้โดยวิธีการเปลี่ยนถ่ายน้ำและปรับอาหารดังอธิบายข้างต้น โดยที่เกษตรกรจะต้องเริ่มดำเนินการตั้งแต่เริ่มพบเหตุปกติ ซึ่งในที่นี้คือวันที่ 13 เม.ย. เป็นการป้องกันที่ทันเหตุการณ์ ซึ่งจะได้ผลดีไม่เกิดการเสียหายอีกด้วย

ที่กล่าวมาข้างต้นเป็นเพียงตัวอย่างง่ายๆ และเกิดเป็นประจำในบ่อกุ้ง หากเกษตรกรมีการเก็บข้อมูลที่จำเป็นอย่างถูกวิธีต่อเนื่อง มีความเข้าใจในขบวนการต่างๆ ที่สัมพันธ์กันในบ่อแล้วนั้น การป้องกันปัญหาต่าง ๆ ที่จะเกิดขึ้นจะทำได้ง่ายและมีประสิทธิภาพมากขึ้นดังกล่าวข้างต้น

Use of epidemiological methods to limit the impact of white spot disease in *Penaeus monodon* farms of Vietnam and India

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Penaeus monodon clearly showing symptoms of white spot disease.

Introduction

More than a decade has passed since White Spot Disease (WSD) was first recognized in Japan and China (Nakano et al. 1994, Zhan et al. 1998). Since then, a large body of knowledge has been obtained on this disease. White Spot Syndrome Virus (WSSV) was shown to be the necessary cause for the disease (Inouye et al. 1994, Wongteerasupaya et al. 1995) and its genome was completely sequenced (van Hulten et al. 2001). Polymerase Chain Reaction (PCR) protocols were developed for a sensitive diagnosis of the virus (Lo et al. 1996b, Takahashi et al. 1996, Kim et al. 1998, Tapay et al. 1999) and a number of WSSV carriers such as wild crustaceans and a range of other organisms were identified (Lo et al. 1996a, Maeda et al. 1998a, Wang et al. 1998, Otta et al. 1999). Experimental and field studies were conducted and mathematical models were developed to increase the understanding of WSD outbreaks (Limsuwan 1997, Chanratchakool et al. 1998, Kanchanaphum et al. 1998, Peng et al. 1998, Tsai et al. 1999, Withyachumnarnkul 1999, Soto et al. 2001). This information and the knowledge gathered from outbreaks of other viral diseases such as Yellow-head virus (YHV) led to the development of recommendations for farmers to aid them in their efforts to control the disease. Control was to be achieved through attempts to either keep WSSV outside the farming system or to reduce the stressing factors affecting the shrimp. Sensitive diagnostic methods also allowed the detection of WSSV in commodity shrimp

imported in the US (Durand et al. 2000). The infectiousness of the virus was demonstrated and this shed some light on one of the possible routes of virus spread between countries.

Although these studies led the scientific community to progress in its knowledge of both the virus and the disease, the struggle to control WSD at animal, farm, national and regional level is still far from over. Until the late 1990's WSD was a problem limited mainly to the Asian continent. Before 1997 no presentation on WSD had ever been given at an aquaculture conference in Ecuador. However, WSD has now reached a truly worldwide distribution and is arguably the most serious disease problem to have ever affected the shrimp farming community.

In 1996, at a meeting in Bangkok, Thailand, it appeared clear that epidemiology could serve as a tool to control the WSD epidemic and other diseases of aquatic organisms. In 1997, we began conducting epidemiological studies in *Penaeus monodon* farms of south Vietnam and south-west India. Our efforts to control WSD or to limit its impact on shrimp farms are still ongoing today.

In this article we present the studies we conducted and the results so far obtained, hoping that our experiences will aid other farmers and research workers to develop their own control programs using an epidemiological approach.

Study design

Epidemiology provides farmers and research workers with a number of tools for both investigating and controlling diseases. Studies can be designed in several ways and the choice depends generally on characteristics of the disease and of the farming system being investigated. WSD typically strikes rapidly, generally leading to emergency harvest or to almost entire loss of the crop over a short period of time. For this reason, we decided that a longitudinal study design (i.e. following ponds from stocking to harvest) conducted through frequent visits to the pond would have been most appropriate for observing WSD outbreaks and highlighting factors preceding the onset of the disease. Such an intensive monitoring activity allowed the collection of high quality data but had the disadvantage of limiting the number of ponds that could be studied. In Vietnam, 24 ponds were visited twice weekly and, to examine the impact of variables such as temperature, dissolved oxygen (DO) and pH, which were measured twice (i.e. morning and afternoon) on visit days (Corsin et al. 2002). In India, a slightly different approach was used. Ponds were visited once a week and only at a fixed time and this allowed the study of a larger number of ponds (i.e. 70) (Corsin et al. in preparation).

The farming systems in the two countries are also different. In Vietnam, shrimp are grown in the dry season (i.e. from January-February to May-June) in a ditch dug generally around the edges of the pond (Figure 1). During the rainy season the same pond is used for culturing rice on a plateau in the central part of the pond. Generally this system allows up to 1 crop per year. On the contrary the Indian system is more similar to the one that can be found also in other countries and consists of rectangular ponds in which only shrimp crops are cultured. This allows up to three crops per year. The Vietnamese and the Indian systems have some common features. Both are semi-intensive, with stocking density rarely exceeding 20 shrimp/m^2. Very little use of aerators is made and oxygenation and water quality are ensured through regular unscreened water exchange.

Figure 1: Section of the rice-shrimp farming system.

A large number of variables were measured in both studies. These included variables on health of the cultured crop, water quality, management practices and presence of wild animals. Samples of both cultured and wild crustaceans were collected throughout the production period. The presence of WSSV was ascertained using PCR protocols (Lo et al. 1996b, Kim et al. 1998). The relation between the variables measured and the occurrence of WSSV or WSD was assessed using descriptive methods and examining the effect of variables both individually (univariate analysis) and in groups (multivariable analysis).

A definition for white spot disease

Assessing the presence of WSSV to evaluate the association between several variables and the presence of the virus requires a diagnostic method for WSSV. The method selected reveals if a certain shrimp sample is positive or negative for WSSV. Similarly, in order to be able to assess the association between the occurrence of WSD and the variables measured, a definition of WSD is required. Since we were investigating WSD in ponds, the disease had to be defined at the pond level and not at the shrimp level. To many farmers and research workers it might seem clear what WSD is. It is caused by WSSV and it is associated with rapid and large mortalities. However, there are many borderline cases in which a diagnosis for WSD cannot be made easily. For example, ponds might be positive for WSSV but have no detectable mortality. In other cases there might be few shrimp dieing of WSD but this mortality does not reach high levels. Similarly a pond might experience a large mortality but only very low levels of WSSV (e.g. 2-step PCR positive shrimp) are detected. For the above reasons and for the fact that farmers often emergency harvest after detecting even small levels of mortality, we used the data collected in both Vietnam and India to develop a definition for WSD based on both the presence of high levels of WSSV (i.e. 1-step PCR positive) and mortality (i.e. detecting five or more dead shrimp in any one day). This definition however is specific to the system we were studying and cannot be applied to other farming systems without having carried out a proper assessment of its suitability.

Identifying risk factors for WSSV at harvest and WSD

After having categorized the ponds into positive or negative for WSSV or WSD, we could begin assessing which of the several variables measured affected the risk of a pond of experiencing disease (i.e. acted as risk factors for the disease). This was done in a number of ways, looking not only for variables associated with the WSSV or WSD status of a pond at the end of the production cycle, but also for variables associated with a quicker onset of the disease (i.e. shorter production cycle before experiencing WSD).

Assessing the importance of potential WSSV sources and of methods to control WSSV entry in the pond

WSSV is necessary for a WSD outbreak to take place (i.e. is the necessary cause of WSD). For this reason, WSD outbreaks could be controlled if WSSV could be excluded from the production system. However, this is often a difficult task owing to the limited control that farmers have on the production system, which often is operated through regular water exchange and is exposed to several potential sources of WSSV. In order to systematically examine if there was any route of WSSV entry that played a major role in the development of WSD outbreaks many possibilities were considered.

Pond

Firstly, we considered that the virus might have already been present in the pond at the time of stocking. However, in both the studies we conducted in Vietnam and India, this possibility was investigated only to a limited extent, owing to logistic problems (Corsin et al. 2002) or to the fact that wild animals that might have acted as WSSV carriers were detected only in few of the ponds under study. Nevertheless, a lot of data were collected on the practices carried out before stocking to eliminate potential pathogens and virus carriers and on the pond environment before the shrimp were introduced into the pond. Some of the practices carried out by both the Vietnamese and Indian farmers (e.g. drying, soil removal and pond treatment) are well-known practices, which are consistently advised by both researchers and extension workers. Studies conducted in the laboratory showed that drying and chemical treatment can eliminate WSSV infectivity (Chang et al., 1998, Maeda et al., 1998b). In our studies, most of these practices did not significantly affect the risk of experiencing a WSD outbreak. However, applying pesticides (e.g. teaseed cake, neam cake, etc.) before stocking was associated with a reduced risk for WSD. Teaseed cake is toxic mainly to fish. However, it might reduce the risk of outbreaks by acting as a fertilizer (see below).

Shrimp seed

The transmission of WSSV from shrimp brooders to their offspring was hypothesized since the early stages of the WSD outbreak (Mohan et al. 1997). Inclusion bodies were reported in both reproductive organs and eggs of *Penaeus monodon*. However, it appeared that infected eggs did not develop although their ability to infect healthy eggs seemed possible (Lo et al. 1997, Lo & Kou 1998). There is now extensive evidence that WSSV infected broodstock can generate WSSV positive offspring (Hsu et al. 1999, Peng et al. 2001) and the presence of WSSV has been reported in post-larvae (PL) from different species and countries (Kim et al. 1998, APHIS 1999, Mushiake et al. 1999, Withyachumnarnkul 1999, Thakur et al. 2002). Screening of PL for WSSV and a number of practices for the removal of weaker PL (using for example a formalin treatment) were advised to farmers and in some cases these approaches proved successful (Chanratchakool & Limsuwan 1998). In Vietnam we found that stocking PL of poorer quality was associated with a reduced risk of disease and these finding seemed to support the potentially beneficial effect of stressing the PL before stocking (Corsin et al. 2001). However, these results do not prove that stocking WSSV infected PL is associated with an increased risk of experiencing WSD. Several authors gave indication that the WSSV status of the seed was responsible for disease outbreaks (Nakano et al. 1994, Chanratchakool & Limsuwan 1998, Lo et al. 1998, Satoh et al. 1999, Liu et al. 2001). These findings were supported by a field study conducted in an intensive system in Thailand, where the author found an association between stocking 1-step PCR positive seed and experiencing a disease outbreak (Withyachumnarnkul 1999). That study was conducted in a single farm and the effect of WSSV infection in PL was not adjusted for the effect of other variables such as stocking date etc, which might have played an even greater role. Other authors also attempted to assess the effect of stocking WSSV seed on the success of the crop and, although an association between the two was detected, this was not conclusive owing to the fact that PL samples were collected from the pond after stocking (Peng et al. 2001).

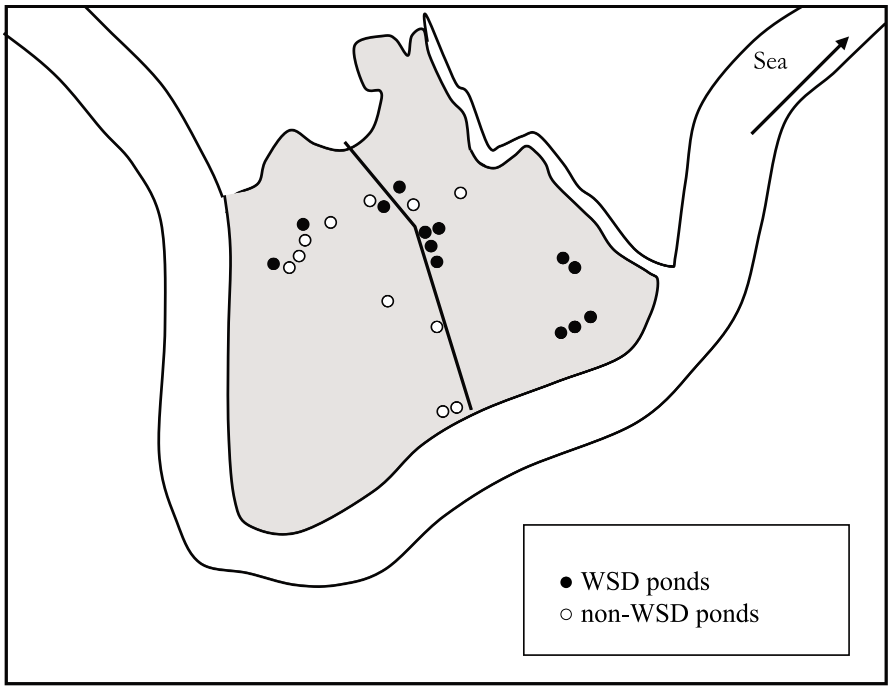
In Vietnam, none of the PL stocked tested positive for WSSV (Corsin et al., 2001). However, the study site experienced a major WSD outbreak that affected 63% of the ponds under study, showing that the devastating effects of WSD cannot be prevented by stocking negative seed. Similarly, during the study we conducted in India, 50% of the ponds stocked WSSV positive PL (Thakur et al., 2002). However, the WSSV status of the PL did not change the risk of a pond of experiencing WSD. Our ongoing work in Vietnam and India is showing that areas stocked with WSSV negative seed have a lower probability to experience WSD outbreaks. These preliminary results seem to indicate that WSSV testing can be effective when applied to whole areas but its effectiveness is limited when only isolated farmers apply it.

Wild animals and water intake

A large number of wild animals have been reported to be potential carrier of WSSV. These were not only shrimp, prawn and crab species but also planktonic organisms and insect larvae (Flegel & AldaySanz 1998). Following these findings, farmers worldwide were advised to remove such potential carriers to reduce the probability of WSSV transmission to the cultured shrimp. Experimental trials were also conducted and the transmission of WSSV from crabs to shrimp through water was demonstrated (Kanchanaphum et al. 1998). Owing to the high stocking density used in that study (i.e. about 15 crabs cohabiting with 50 shrimp per m-2) and the fact that crabs had been infected through injection, which produced an extraordinary high level of infection, the application of this finding to the pond environment is debatable.

In Vietnam, we found that ponds closer to the sea were at higher risk of experiencing WSD (Figure 2) (Corsin et al. 2001). This suggested that WSSV infection originated from marine organisms. However, the presence of some crab species in the first month of production and the size of mud crabs at harvest was associated with a reduced risk of WSSV presence at harvest (Corsin et al. 2001). In the Indian study, we found that WSSV infection in the crabs surrounding the pond was not associated with WSD outbreaks. In addition, we found that observing crabs during production and at harvest reduced the risk of WSD outbreaks (unpublished), therefore confirming the results obtained in Vietnam. These findings however do not lead to a suggestion to stock crabs into the pond. In fact, we can explain the association between healthy shrimp and crabs by hypothesizing a “healthy” pond environment for the growth of crustaceans. Alternatively, WSSV might be responsible for affecting both shrimp and crabs. Regardless of the explanation for these associations, we believe that, at least under less intensive culture conditions, PCR testing of crabs for WSSV might not be very informative for farmers.

Figure 2: Map of the Vietnamese study site showing the location of WSD and non-WSD ponds



In our studies we also investigated the association between the presence of non-crustacean species and WSD. Statistically, we found an association between finding polychaetes or jellyfish during production and WSD. Although the WSSV status of these animals was not determined we believe that these associations should be investigated further.

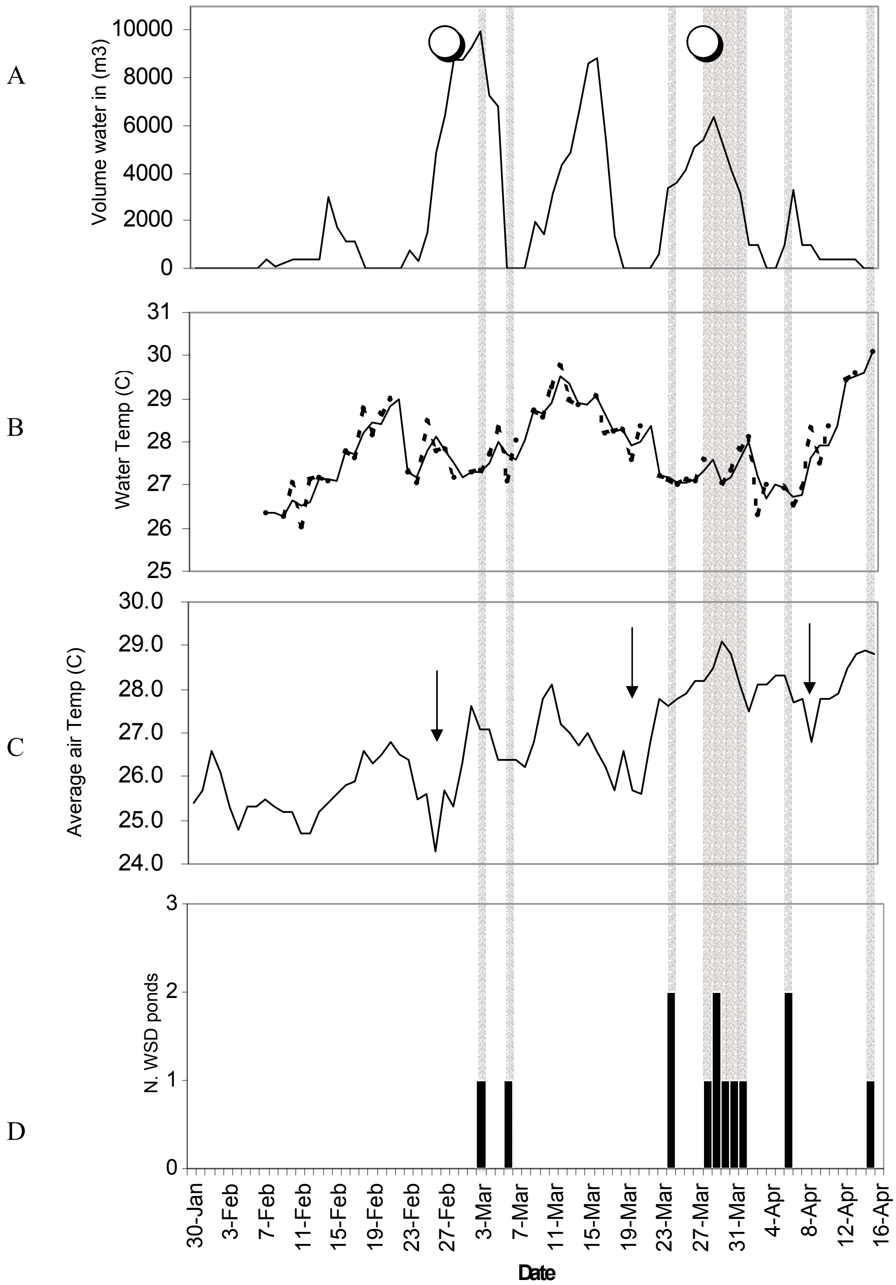
The importance of plankton and inflowing water as carriers of WSSV was also investigated. WSSV in planktonic organisms was detected by a number of authors (Lo et al. 1996a, Ruangsri & Supamattaya 1999). Nevertheless, we do not know of any studies investigating the association between WSSV in plankton and WSD outbreaks.

In India, we detected the presence of WSSV in plankton collected during the production cycle of about 10% of the ponds. However, there was no association between WSSV in plankton and WSD. It was interesting to find that the only 2 plankton samples testing 1-step PCR positive for WSSV had been collected from ponds experiencing high mortalities and with cultured shrimp also testing 1-step positive. Nevertheless, this association does not rule out that the high levels of WSSV in the plankton came from the dieing shrimp.

Inflowing water has been suggested as a vehicle of WSSV infection by several authors (Flegel et al. 1997, Chanratchakool et al. 1998). However, the investigation of this hypothesis is hampered by the technical difficulties in accessing the presence of free WSSV particles in water.

We attempted to identify the importance of water exchange in a number of ways. In Vietnam we observed that WSD outbreaks seemed to follow or coincide with periods of high water intake (Figure 3) (Corsin et al. submitted). Although, this association was present only at neap tide could also be due to a relation between lunar cycle and shrimp moulting, it seems to indicate a possible role of water intake on the development of WSD outbreaks. When data were analyzed on a pond-by-pond basis no association with water exchange was identified. However, this association might have been masked by the complex hydrography of the study area in which it was very difficult to follow inflowing and outflowing water through the network of canals connecting the ponds.

Figure 3: Temporal pattern of daily total of water intake and full moon (A), water temperature (B) and daily average air temperature (C) in relation to the occurrence of WSD outbreaks (D). Dotted and continuous lines in figure B indicate the values measured and a 2-day moving average respectively.



Feed

The potential infection of shrimp by feeding WSSV infected tissues has been demonstrated by several authors (Chou et al. 1998, Sahul Hameed et al. 1998, Momoyama et al. 1999). In more traditional farming systems wild shrimp and crabs are still used to feed cultured shrimp. In Vietnam we found that feeding high amounts of wild shrimp was associated with an increased risk of WSD. However, this might also be due to the effect of feeding wild shrimp on the pond water quality, which was also associated with outbreaks (see below).

Commercial feed was also used by both Vietnamese and Indian farmers. In Vietnam we found an increased risk for WSSV infection when a certain brand of feed was used, although WSSV could not be detected from a sample of feed pellets (Corsin et al.

2001). In India, 43% of the ponds fed WSSV positive commercial feed to the shrimp (Corsin et al., 2002a). Certain companies were more likely to supply WSSV positive feed than others indicating either a higher use of WSSV infected feedstuff, or the carrying out of less aggressive feed processing practices. Although no significant association between WSSV status of the feed and WSD was identified, we believe that an effort should we made by feed companies to reduce the inclusion of WSSV positive material in the feed.

Other sources of infection during production: Fomites and the role of biosecurity

It is well known that pathogens can be introduced through fomites (i.e. non-infected vehicles such as nets and personnel). Improvements in the farm-level biosecurity to reduce this risk have been advised by a number of authors (Lotz 1997, Mohan et al. 2002b). In the Indian study, we found an association between sharing personnel between ponds and WSD, therefore supporting the need for introducing measures to limit the spread of WSSV infection between ponds.

Assessing the effect of variables which lead to the precipitation of WSSV infection into a WSD outbreak

We have seen how open systems are extremely vulnerable to WSSV introduction. In India, more than 95% of the ponds under study tested WSSV positive at harvest indicating that, at least in that system, culturing shrimp in the absence of WSSV is very unlikely. In this situation, it is possible that preventing the precipitation of WSSV infection into a WSD outbreak is equally if not more important than limiting virus entry into the system.

The precipitation of WSSV infection can be associated with a number of variables affecting the virus, the shrimp or the WSSV transmission between shrimp. Separating those variables into one of these three categories is not always easy and the effect of some variables on more than one of these levels cannot be ruled out.

Factors affecting the virus

To date, there is no definitive evidence of any substance capable of affecting WSSV without affecting also the cultured shrimp. Similarly, water quality variables such as salinity, pH, etc. would inactivate the virus only by reaching levels that would be very unlikely in shrimp ponds (Chang et al. 1998, Maeda et al. 1998b). These results were confirmed also by field investigations, conducted by us and other authors, where no significant association between WSD and water quality variables could be found (Ahmad et al. 1999; our unpublished results).

Factors affecting the cultured shrimp

Until recently, there was no evidence of the ability of crustaceans to mount an immune response against viral infections. However, studies conducted using both human (Bangrak et al. 2002) and shrimp (Venegas et al. 2000, Wu et al. 2002, Song et al. 2003) viruses showed that the crustacean immune system does indeed react to the presence of viruses although many questions still remain unanswered on the mechanisms through which shrimp respond to infection. If shrimp can react to viruses, there might be a number of factors that, by affecting the cultured shrimp, influence the risk of WSSV infection to precipitate into a WSD outbreak.

Shrimp health as a factor influencing the likelihood of WSSV infection precipitating into a WSD outbreak has been suggested by several authors and shrimp farmers worldwide check routinely PL before stocking in an attempt to reduce the risk for WSD. In both our Vietnamese and Indian studies PL health did not increase the risk of WSSV infection or WSD outbreaks (Corsin et al. 2001, Corsin et al. 2003). However, PL health might play a more significant role in more intensive systems. Furthermore, the lack of association observed in our studies does not rule out the importance of shrimp health during production on the occurrence of WSD. In Vietnam, in fact, ponds with smaller shrimp during the production cycle were more likely to be 1-step WSSV positive at harvest (Corsin et al. 2001). Although this association could be a cause rather than an effect of WSSV infection, the role of general health in exacerbating WSSV infection and making it precipitate into WSD cannot be ruled out.

In order to assess the role of shrimp health on the occurrence of WSD, we investigated also the importance of bacterial diseases. Surprisingly, we found that ponds with signs of bacterial infection at harvest were at lower risk of experiencing WSD and this observation was consistent in both Vietnamese and Indian studies (Corsin et al. 2001); unpublished results from India). The reason for this is not yet clear, but we are investigating this further in order to shed some more light on the disease process.

The association between potential shrimp stressors and WSD was also investigated. It is well known that stress can affect the shrimp immune system (Takahashi et al. 1995). Based on this data and on circumstantial evidence, at an earlier stage of the outbreak, stressing factors such as temperature and osmotic shocks were suggested as risk factors for WSD (Chou et al. 1995, Flegel & AldaySanz 1998). The importance of stress was later confirmed by experimental studies where pereiopod excision and spawning were responsible for the precipitation of WSSV infection (Peng et al. 1998), (Hsu et al. 1999).

In Vietnam, we did not identify any association between WSD and salinity, alkalinity or other water quality variables that might have played a role as stressing factors. However, we observed that outbreaks were preceded or coincided with higher pH and unionised ammonia (unpublished). Although, these results are not conclusive of the role of these variables as stressors, they support the importance of water quality in determining WSD outbreaks.

If stress plays indeed a role in the occurrence of WSD, we would expect the application of substances that limit the impact of stress to be associated with a reduced risk of outbreaks. Some authors suggested that feeding vitamins increases the resistance of shrimp to stress and bacterial infections (Merchie et al. 1997, Merchie et al. 1998). In both Vietnam and India we found that ponds in which vitamins were fed to the shrimp were less likely to experience a WSD outbreak (Corsin et al. 2001); unpublished results from India). Since this observation was consistent in two different farming systems, we believe in a potential beneficial effect of feeding vitamins for the control of WSD outbreaks.

The use of immunostimulants in "defending" shrimp from WSD was also investigated. There are several studies supporting the efficacy of these substances against WSSV infection (Rao et al. 1996, Song et al. 1997, Itami et al. 1998, Takahashi et al. 1998, Chang et al. 1999, Takahashi et al. 2000). However, the field-based study we conducted in India, contradicted the above observation deriving primarily from experimental trials and, although our results cannot be generalized to other farming systems, they suggest caution in considering immunostimulants effective preventive measures against WSD.

In order to investigate the relation between factors affecting the cultured shrimp and WSD outbreaks we need to understand also the relation between WSSV and the shrimp. A study conducted in South America suggested that WSSV kills shrimp by acting on mechanisms that regulate cell death in the shrimp (i.e. apoptosis) (Granja et al. 2003). This study showed also that shrimp cell death induced by WSSV occurs at higher level when shrimp are held at lower temperatures. This was a follow up study of an earlier trial in which the authors showed an association between lower temperature and WSD (Vidal et al. 2001, Granja et al. 2003). This observation had already been made under field conditions. In our Vietnamese study, in fact, WSD outbreaks coincided with or were preceded by lower water temperatures or drops in air temperature (Figure 3) (Corsin et al. submitted). The application of these findings for the control of WSD is limited owing to the difficulties in controlling water temperature in pond-based farming operations. However, these results show how epidemiological field observations and experimental trials can both contribute to the knowledge of a disease process in an attempt to control outbreaks.

Factors affecting the WSD epidemic within the pond

The distinction between WSD in a single shrimp and a WSD outbreak in the pond is very important. In fact, there might be situations in which some shrimp die of WSD but this mortality does not degenerate into an outbreak leading to the loss of a large proportion of the crop. For WSD to develop into a pond-level outbreak, the disease needs to be transmitted from one shrimp to the other. If transmission is somehow inhibited, shrimp would die without infecting other shrimp. Transmission of WSSV between shrimp can occur in several ways among which infection through the water (Chou et al. 1995, Chou et al. 1998, Venegas et al. 1999, Wu et al. 2001) and through the ingestion of infected tissues (Chou et al. 1998, Sahul Hameed et al. 1998, Momoyama et al. 1999, Wang et al. 1999), (Soto & Lotz 2001) seem to be the most important.

From a transmission point of view, we can interpret some of the associations reported above (e.g. the effect of temperature or pH) as affecting the transmission of the virus between shrimp by, for example, reducing or increasing its ability to survive in the pond water. This example highlights some of the difficulties in conducting epidemiological studies. Therefore, in most cases, only potential explanations for those relations can be provided. There are however cases in which the effect of a variable in determining disease is clearer. This is the case of stocking density. It is intuitive that the closer animals are kept to each other, the easier the transmission of a disease between them will be. This association has been observed in diseases of both people and animals.

In Vietnam we found that the two ponds that first experienced WSD had the highest PL stocking density among the ponds under study (Corsin et al. submitted). Similarly, higher stocking density during production was also associated with an increased risk of experiencing a WSD outbreak and the role played by stocking density was confirmed in the Indian study (unpublished). These results indicate that there is a higher risk of experiencing WSD if shrimp are kept at higher density and suggests the need for limiting shrimp density in order to prevent outbreaks.

In addition to stocking density, there are other variables that might affect transmission. Potentially, one of these could be the availability of natural production into the pond. In Vietnam we found that ponds with higher levels of chlorophyll b had a lower risk of experiencing WSD (unpublished). Similarly, in India the application of fertilizers either before stocking or during production reduced the risk of disease and this effect was greater when more kinds of fertilizer were applied. We cannot be certain of the mechanism though which natural production and fertilization affect WSD occurrence. They might play a role in affecting the disease transmission by providing alternative sources of food, therefore reducing cannibalism between shrimp. Alternatively they might reduce the stress level of the stock by providing a shed to the pond bottom. Either way, fertilization of the pond during pond preparation and during production proved beneficial in reducing the risk of WSD and this association should be investigated also under other farming conditions and in other countries.

Predicting and accurately identifying WSD outbreaks

In order to limit the impact of WSD we saw how epidemiology can help to identify risk factors for outbreaks. The impact of WSD, however, can also be limited by informing farmers of an approaching outbreak in their pond or by providing farmers with tools for correctly identifying a disease outbreak. To provide such information to farmers we assessed the presence of WSSV at different stages of the production cycle. In India, six weeks after stocking we collected a sample of 100 shrimp and tested them for WSSV. The presence of WSSV was recorded in shrimp from 41% of the ponds. However, detecting WSSV did not affect neither the overall production of the pond nor its risk of experiencing a WSD outbreak.

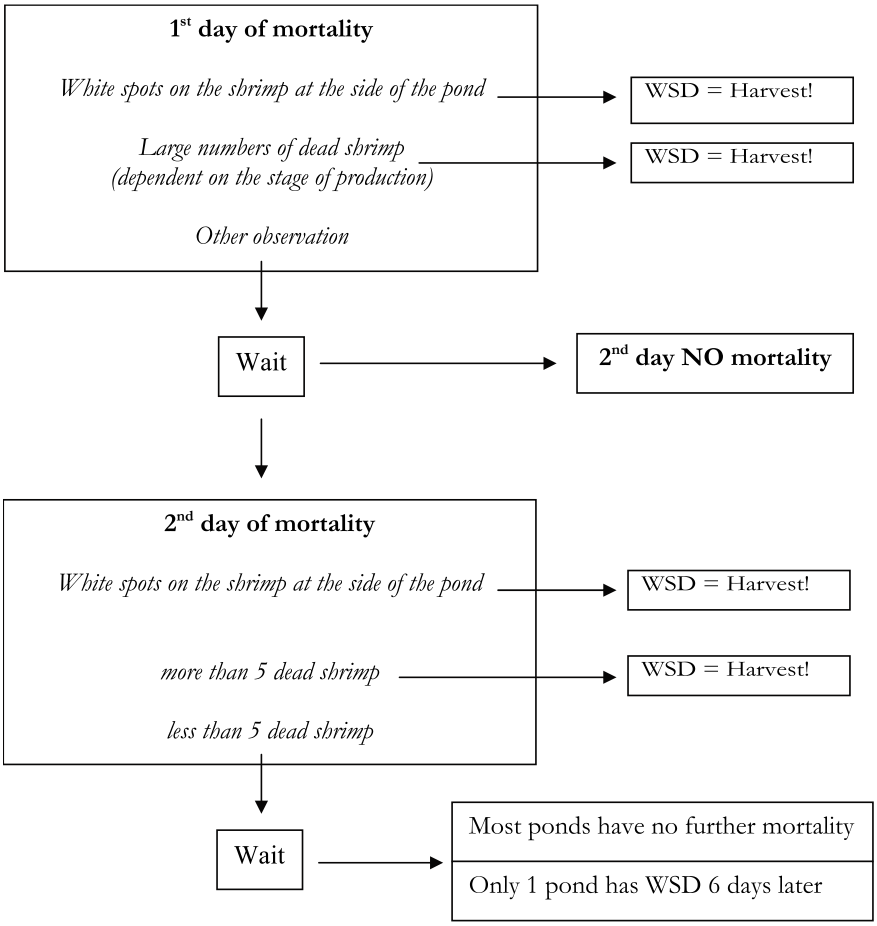
Dead or moribund shrimp were also collected from the sides of the pond by farmers and examined for the presence of white spots in the carapace and WSSV using both histology (which detects WSD at the shrimp level) and PCR (Mohan et al. 2002a). The results obtained from dead or moribund shrimp were predictive of the WSD status of the pond, although the performance of the different methods varied greatly (Table 1).

Using these results we developed a simple decision-making tool to enable Indian farmers to accurately diagnose a mortality event into a WSD or a non-WSD outbreak, therefore limiting the huge losses associated with late harvest of WSD ponds or early harvest of non-WSD ponds (Figure 4). This decision-making tool made use of variables easily observable by farmers, i.e. the number of dead shrimp observed daily and the presence of white spots in the dead shrimp. When applied retrospectively, this tool proved correct on 94% occasions. In addition, to further support the farmers' decision-making process we also calculated that, in average, an Indian farmer would start making a profit after 10 weeks of production. This information together with the decision-making tool has a huge potential in limiting losses caused by an inaccurate diagnosis of WSD.

Table 1. Sensitivity and specificity of different assessments conducted on dead or moribund shrimp for identifying WSD and non-WSD ponds

Method	Sensitivity % of WSD ponds identified by the method	Specificity % of non-WSD ponds identified by the method
White spots	66%	94%
Histology	93%	75%
1-step PCR	67%	86%
2-step PCR	88%	54%

Figure 4: Decision-making tool for helping Indian farmers to correctly recognize if a mortality event is or is not a WSD outbreak.



Conclusion

The studies we conducted in Vietnam and India show how the application of epidemiological methods can contribute not only to the understanding of the disease process, but also to the control of WSD by preventing disease outbreaks or limiting their impact. These results were however derived from investigations conducted in semi-intensive ponds located in two relatively small geographic areas. Some of our findings might indeed be applicable also to other farming systems. However, we believe that epidemiological investigations should be conducted also in other countries and under other farming conditions in order to generate results that are more appropriate to different culture systems.

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References

Ahmad MU, Islam MN, Rahman MH, Hossain MA (1999) Environmental parameters and incidence of white spot disease in Penaeus monodon (Fab.) farming. Bangladesh Journal of Fisheries Research [Bangladesh J. Fish. Res.]. 3:55-62

APHIS (1999) Outbreak of shrimp viral disease in Central America: situation report, Animal and Plant Health Inspection Service

Bangrak P, Graidist P, Chotigeat W, Supamattaya K, Phongdara A (2002) A syntenin-like protein with postsynaptic density protein (PDZ) domains produced by black tiger shrimp Penaeus monodon in response to white spot syndrome virus infection. Diseases of Aquatic Organisms 49:19-25

Chang CF, Su MS, Chen HY, Lo CF, Kou GH, Liao IC (1999) Effect of dietary beta-1,3-glucan on resistance to white spot syndrome virus (WSSV) in postlarval and juvenile Penaeus monodon. Diseases of Aquatic Organisms 36:163-168

Chang PS, Chen LJ, Wang YC (1998) The effect of ultraviolet irradiation, heat, pH, ozone, salinity and chemical disinfectants on the infectivity of white spot syndrome baculovirus. Aquaculture 166:1-17

Chanratchakool P, Limsuwan C (1998) Application of PCR and Formalin Treatment to Prevent White Spot Disease in Shrimp. In: Flegel T (ed) Proceedings to the Special Session on Shrimp Biotechnology 5th Asian Fisheries Forum. BIOTEC, Chiengmai, Thailand, p 287-290

Chanratchakool P, Turnbull JF, Funge-Smith SJ, MacRae IH, Limsuwan C (1998) Health Management in Shrimp Ponds. Third Edition, Vol. Aquatic Animal Health Research Institute, Bangkok

Chou HY, Huang CY, Lo CF, Kou GH (1998) Studies on transmission of white spot syndrome associated baculovirus (WSBV) in Penaeus monodon and P. japonicus via waterborne contact and oral ingestion. Aquaculture 164:263-276

Chou HY, Huang CY, Wang CH, Chiang HC, Lo CF (1995) Pathogenicity of a baculovirus infection causing white spot syndrome in cultured penaeid shrimp in Taiwan. Diseases of Aquatic Organisms 23:165-173

Corsin F, Padiyar PA, Madhusudhan M, Turnbull JF, Mohan CV, Hao NV, Iqlas A, Morgan KL (in preparation) A population based description of a Penaeus monodon production system (Karnataka, India) affected by White Spot Disease. Aquaculture

Corsin F, Phi TT, Phuoc LH, Tinh NTN, Turnbull JF, Hao NV, Mohan CV, Morgan KL (submitted) White Spot Disease in Penaeus monodon a case definition and description of an epidemic. Aquaculture

Corsin F, Thakur PC, Padiyar PA, Madhusudhan M, Turnbull JF, Mohan CV, Hao NV, Morgan KL (2003) Relationship between WSSV and indicators of quality in Penaeus monodon post-larvae in Karnataka, India. Diseases of Aquatic Organisms 54:97-104

Corsin F, Turnbull JF, Hao NV, Mohan CV, Phi TT, Phuoc LH, Tinh NTN, Morgan KL (2001) Risk factors associated with White Spot Syndrome Virus infection in a Vietnamese rice-shrimp farming system. Diseases in Aquatic Organisms 47:1-12

Corsin F, Turnbull JF, Hao NV, Mohan CV, Phi TT, Phuoc LH, Tinh NTN, Morgan KL (2002) Problems and solutions with the design and execution of an epidemiological study of White Spot Disease in black tiger shrimp (Penaeus monodon). Preventive Veterinary Medicine 53:117-132

Durand SV, Tang KFJ, Lightner DV (2000) Frozen commodity shrimp: Potential avenue for introduction of white spot syndrome virus and yellow head virus. Journal of Aquatic Animal Health 12:128-135

Flegel TW, AldaySanz V (1998) The crisis in Asian shrimp aquaculture: current status and future needs. Journal of Applied Ichthyology 14:269-273

Flegel TW, Boonyaratpalin S, Withyachumnarnkul B (1997) Progress in research on Yellow-head Virus and White-Spot Virus in Thailand. In: Diseases in Asian Aquaculture III. Fish Health Section - Asian Fisheries Society, Manila, Philippines, p 285-296

Granja CB, Aranguren LF, Vidal OM, Aragon L, Salazar M (2003) Does hyperthermia increase apoptosis in white spot syndrome virus (WSSV)-infected Litopenaeus vannamei? Diseases of Aquatic Organisms 54:73-78

Hsu HC, Lo CF, Lin SC, Liu KF, Peng SE, Chang YS, Chen LL, Liu WJ, Kou GH (1999) Studies on effective PCR screening strategies for white spot syndrome virus (WSSV) detection in Penaeus monodon brooders. Diseases of Aquatic Organisms 39:13-19

Inouye K, Miwa S, Oseko N, Nakano H, Kimura T, Momoyama K, Hiraoka M (1994) Mass mortalities of cultured kuruma shrimp Penaeus japonicus in Japan in 1993 - electron-microscopic evidence of the causative virus. Fish Pathology 29:149-158

Itami T, Asano M, Tokushige K, Kubono K, Nakagawa A, Takeno N, Nishimura H, Maeda M, Kondo M, Takahashi Y (1998) Enhancement of disease resistance of kuruma shrimp, Penaeus japonicus, after oral administration of peptidoglycan derived from Bifidobacterium thermophilum. Aquaculture 164:277-288

Kanchanaphum P, Wongteerasupaya C, Sitidilokratana N, Boonsaeng V, Panyim S, Tassanakajon A, Withyachumnarnkul B, Flegel TW (1998) Experimental transmission of white spot syndrome virus (WSSV) from crabs to shrimp Penaeus monodon. Diseases of Aquatic Organisms 34:1-7

Kim CK, Kim PK, Sohn SG, Sim DS, Park MA, Heo MS, Lee TH, Lee JD, Jun HK, Jang KL (1998) Development of a polymerase chain reaction (PCR) procedure for the detection of baculovirus associated with white spot syndrome (WSBV) in penaeid shrimp. Journal of Fish Diseases 21:11-17

Limsuwan C (1997) Reducing the Effects of White-Spot Baculovirus Using PCR Screening and Stressors. AAHRI Newsletter 6:1-2

Liu LC, Chung B, Su C (2001) SPF culturing strategy of L. vannamei on small scale, non-integrated farms: successful cases report in Taiwan and China, Vol. Asian Fisheries Society, Unit A, Mayaman Townhomes 25 Mayaman Streeet UP Village, Quezon City Philippines

Lo CF, Chang YS, Cheng CT, Kou GH (1998) PCR Monitoring of Cultured Shrimp for White Spot Syndrome Virus (WSSV) Infection in Growout Ponds. In: Flegel T (ed) Proceedings to the Special Session on Shrimp Biotechnology 5th Asian Fisheries Forum. BIOTEC, Chiengmai, Thailand, p 281-286

Lo CF, Ho CH, Chen CH, Liu KF, Chiu YL, Yeh PY, Peng SE, Hsu HC, Liu HC, Chang CF, Su MS, Wang CH, Kou GH (1997) Detection and tissue tropism of white spot syndrome baculovirus (WSBV) in captured brooders of Penaeus monodon with a special emphasis on reproductive organs. Diseases of Aquatic Organisms 30:53-72

Lo CF, Ho CH, Peng SE, Chen CH, Hsu HC, Chiu YL, Chang CF, Liu KF, Su MS, Wang CH, Kou GH (1996a) White spot syndrome baculovirus (WSBV) detected in cultured and captured shrimp, crabs and other arthropods. Diseases of Aquatic Organisms 27:215-225

Lo CF, Kou GH (1998) Virus-associated white spot syndrome of shrimp in Taiwan: A review. Fish Pathology 33:365-371

Lo CF, Leu JH, Ho CH, Chen CH, Peng SE, Chen YT, Chou CM, Yeh PY, Huang CJ, Chou HY, Wang CH, Kou GH (1996b) Detection of baculovirus associated with white spot syndrome (WSBV) in penaeid shrimps using polymerase chain reaction. Diseases of Aquatic Organisms 25:133-141

Lotz JM (1997) Viruses, biosecurity and specific pathogen-free stocks in shrimp aquaculture. World Journal of Microbiology and Biotechnology 13:405-413

Maeda M, Itami T, Furumoto A, Hennig O, Imamura T, Kondo M, Hirono I, Aoki T, Takahashi Y (1998a) Detection of penaeid rod-shaped DNA virus (PRDV) in wild-caught shrimp and other crustaceans. Fish Pathology 33:373-380

Maeda M, Kasornchandra J, Itami T, Suzuki N, Hennig O, Kondo M, Albaladejo JD, Takahashi Y (1998b) Effect of various treatments on white spot syndrome virus (WSSV) from Penaeus japonicus (Japan) and P-monodon (Thailand). Fish Pathology 33:381-387

Merchie G, Kontara E, Lavens P, Robles R, Kurmaly K, Sorgeloos P (1998) Effect of vitamin C and astaxanthin on stress and disease resistance of postlarval tiger shrimp, Penaeus monodon (Fabricius). Aquaculture Research 29:579-585

Merchie G, Lavens P, Sorgeloos P (1997) Optimization of dietary vitamin C in fish and crustacean larvae: a review. Aquaculture 155:165-181

Mohan CV, Corsin F, Thakur PC, Padiyar PA, Madhusudhan M, Turnbull JF, Hao NV, Morgan KL (2002a) Usefulness of dead shrimp specimens to study the epidemiology of white spot syndrome virus (WSSV) and chronic bacterial infection. Diseases of Aquatic Organisms 50:1-8

Mohan CV, Corsin F, Turnbull JF, Hao NV, Morgan KL (2002b) Farm level biosecurity 5th Symposium on Diseases in Asian Aquaculture. 24-28 November 2002, Gold Coast, Australia

Mohan CV, Sudha of the causative virus (PRDV) from receptaculum seminis of spawned broodstock. Fish Pathology 34:203-207

Nakano H, Koube H, Umezawa S, Momoyama K, Hiraoka M, Inouye K, Oseko N (1994) Mass mortalities of cultured kuruma shrimp, Penaeus japonicus, in Japan in 1993 - epizootiological survey and infection trials. Fish Pathology 29:135-139

Otta SK, Shubha G, Joseph B, Chakraborty A, Karunasagar I (1999) Polymerase chain reaction (PCR) detection of white spot syndrome virus (WSSV) in cultured and wild crustaceans in India. Diseases of Aquatic Organisms 38:67-70

Peng SE, Lo CF, Lin SC, Chen LL, Chang YS, Liu KF, Su MS, Kou GH (2001) Performance of WSSV-infected and WSSV-negative Penaeus monodon postlarvae in culture ponds. Diseases of Aquatic Organisms 46:165-172

Peng SE, Lo CF, Liu KF, Kou GH (1998) The transition from pre-patent to patent infection of white spot syndrome virus (WSSV) in Penaeus monodon triggered by pereiopod excision. Fish Pathology 33:395-400

Rao AVP, Panchayuthapani D, Murthy A, Ajithkumar BS (1996) Resistance to diseases in tiger shrimp, Penaeus monodon through incorporation of Glucan in feed. Fish. Chimes 16:41-42

Ruangsri J, Supamattaya K (1999) DNA Detection of Suspected Virus (SEMBV) Carriers by PCR (Polymerase Chain Peaction). In: Oates CG (ed) 37. Kasetsart University Annual Conference. Text & Journal Publication Co., Kasetsart, Thailand, p 82-94

Sahul Hameed AS, Anilkumar M, Raj MLS, Jayaraman K (1998) Studies on the pathogenicity of systemic ectodermal and mesodermal baculovirus and its detection in shrimp by immunological methods. Aquaculture 160:31-45

Satoh J, Mushiake K, Mori K, Arimoto M, Imaizumi K, Nishizawa T, Muroga K (1999) Occurrence of PAV (Penaeid acute viremia) in seed production of kuruma prawn. Fish Pathology 34:33-38

Song YL, Liu JJ, Chan LC, Sung HH (1997) Glucan-induced disease resistance in tiger shrimp (Penaeus monodon). Developments in Biological Standardization 90:413-421

Song YL, Yu CI, Lien TW, Huang CC, Lin MN (2003) Haemolymph parameters of Pacific white shrimp (Litopenaeus vannamei) infected with Taura syndrome virus. Fish & Shellfish Immunology 14:317-331

Soto MA, Lotz JM (2001) Epidemiological parameters of white spot syndrome virus infections in Litopenaeus vannamei and L-setiferus. Journal of Invertebrate Pathology 78:9-15

Soto MA, Shervette VR, Lotz JM (2001) Transmission of white spot syndrome virus (WSSV) to Litopenaeus vannamei from infected cephalothorax, abdomen, or whole shrimp cadaver. Diseases of Aquatic Organisms 45:81-87

Takahashi Y, Itami T, Kondo M (1995) Immunodefense System of Crustacea. Fish Pathology 30:141-150

Takahashi Y, Itami T, Maeda M, Suzuki N, Kasornchandra J, Supamattaya K, Khongpradit R, Boonyaratpalin S, Kondo M, Kawai K, Kusuda R, Hirono I, Aoki T (1996) Polymerase chain reaction (PCR) amplification of bacilliform virus (RV-PJ) DNA in Penaeus japonicus Bate and systemic ectodermal and mesodermal baculovirus (SEMBV) DNA in Penaeus monodon Fabricius. Journal of Fish Diseases 19:399-403

Takahashi Y, Kondo M, Itami T, Honda T, Inagawa H, Nishizawa T, Soma GI, Yokomizo Y (2000) Enhancement of disease resistance against penaeid acute viraemia and induction of virus-inactivating activity in haemolymph of kuruma shrimp, Penaeus japonicus, by oral administration of Pantoea agglomerans lipopolysaccharide (LPS). Fish & Shellfish Immunology 10:555-558

Takahashi Y, Uehara K, Watanabe R, Okumura T, Yamashita T, Omura H, Yomo T, Kawano T, Kanemitsu A, H. N, Suzuki N, Itamil T (1998) Efficacy of Oral Administration of Fucoidan, a Sulfated Polysaccharide, in Controlling White Spot Syndrome in Kuruma Shrimp in Japan. In: Flegel T (ed) Proceedings to the Special Session on Shrimp Biotechnology 5th Asian Fisheries Forum. BIOTEC, Chiengmai, Thailand, p 171-174

Tapay LM, Nadala ECB, Loh PC (1999) A polymerase chain reaction protocol for the detection of various geographical isolates of white spot virus. Journal of Virological Methods 82:39-43

Thakur PC, Corsin F, Turnbull JF, Shankar KM, Hao NV, Padiyar PA, Madhusudhan M, Morgan KL, Mohan CV (2002) Estimation of prevalence of white spot syndrome virus (WSSV) by polymerase chain reaction in Penaeus monodon postlarvae at time of stocking in shrimp farms of Karnataka, India: a population-based study. Diseases of Aquatic Organisms 49:235-243

Tsai MF, Kou GH, Liu HC, Liu KF, Chang CF, Peng SE, Hsu HC, Wang CH, Lo CF (1999) Long-term presence of white spot syndrome virus (WSSV) in a cultivated shrimp population without disease outbreaks. Diseases of Aquatic Organisms 38:107-114

van Hulten MCW, Witteveldt J, Peters S, Kloosterboer N, Tarchini R, Fiers M, Sandbrink H, Lankhorst RK, Vlak JM (2001) The white spot syndrome virus DNA genome sequence. Virology 286:7-22

Venegas CA, Nonaka L, Mushiake K, Nishizawa T, Muroga K (2000) Quasi-immune response of Penaeus japonicus to penaeid rod- shaped DNA virus (PRDV). Diseases of Aquatic Organisms 42:83-89

Venegas CA, Nonaka L, Mushiake K, Shimizu K, Nishizawa T, Muroga K (1999) Pathogenicity of penaeid rod-shaped DNA virus (PRDV) to kuruma prawn in different developmental stages. Fish Pathology 34:19-23

Vidal OM, Granja CB, Aranguren F, Brock JA, Salazar M (2001) A profound effect of hyperthermia on survival of Litopenaeus vannamei juveniles infected with White spot Syndrome Virus. Journal of the World Aquaculture Society 32:364-372

Wang Q, White BL, Redman RM, Lightner DV (1999) Per os challenge of Litopenaeus vannamei postlarvae and Farfantepenaeus duorarum juveniles with six geographic isolates of white spot syndrome virus. Aquaculture 170:179-194

Wang YC, Lo CF, Chang PS, Kou GH (1998) Experimental infection of white spot baculovirus in some cultured and wild decapods in Taiwan. Aquaculture 164:221-231

Withyachumnarnkul B (1999) Results from black tiger shrimp Penaeus monodon culture ponds stocked with postlarvae PCR-positive or -negative for white-spot syndrome virus (WSSV). Diseases of Aquatic Organisms 39:21-27

Wongteerasupaya C, Vickers JE, Sriurairatana S, Nash GL, Akarajamorn A, Boonsaeng V, Panyim S, Tassanakajon A, Withyachumnarnkul B, Flegel TW (1995) A non-occluded, systemic baculovirus that occurs in cells of ectodermal and mesodermal origin and causes high mortality in the black tiger prawn Penaeus-monodon. Diseases of Aquatic Organisms 21:69-77

Wu JL, Namikoshi A, Nishizawa T, Mushiake K, Teruya K, Muroga K (2001) Effects of shrimp density on transmission of penaeid acute viremia in Penaeus japonicus by cannibalism and the waterborne route. Diseases of Aquatic Organisms 47:129-135

Wu JL, Nishioka T, Mori K, Nishizawa T, Muroga K (2002) A time-course study on the resistance of Penaeus japonicus induced by artificial infection with white spot syndrome virus. Fish & Shellfish Immunology 13:391-403

Zhan WB, Wang YH, Fryer JL, Yu KK, Fukuda H, Meng QX (1998) White spot syndrome virus infection of cultured shrimp in China. Journal of Aquatic Animal Health 10:405-410

The STREAM Column

You need a story

"Forget about PowerPoint and statistics," writes Robert McKee, one of Hollywood's top writing consultants, whose students have written, directed and produced hundreds of hit films including *Forrest Gump, Erin Brockovich, The Color Purple, Gandhi, Monty Python and the Holy Grail* and others. McKee says, "To involve people at the deepest level you need a story."

Others agree: the *Harvard Business Review*, the *Financial Times of London* and *Computer World* have all carried pieces recently about the art of telling tales. Business fiction now plays a prominent and increasing role in the lists of best-selling books – *Who Moved My Cheese?* has already generated more than $100 million in revenue.

Story telling is not a new idea. Nearly 2,400 years ago in ancient Greece Aristotle (who learned under Plato and was tutor to Alexander the Great) characterized the story (see the box).

Aristotle said that stories are ...

"… that which has a beginning, middle, and an end.

A beginning is that which does not itself follow anything by causal necessity, but after which something naturally is or comes to be. An end, on the contrary, is that which itself follows some other thing, either by necessity, or as a rule, but has nothing following it. A middle is that which follows something as some other thing follows it. A well-constructed plot, therefore, must neither begin nor end at haphazard, but conform to these principles."

Five elements of a classic story are:

1. A central character that the listener cares about
2. A catalyst compelling the central character to take action
3. Trials and tribulations (in business speak: decision points and setbacks)
4. A turning point
5. A resolution

So what is a role for the ancient and modern art of telling a story as we think about managing aquaculture and fisheries in Asia?

To describe the role of aquaculture in people's lives

It seems that both halves of our brains respond to storytelling, the left to the timing and organization of a story and the right to its artistic and creative characteristics. Stories play upon artistic needs of humans and stir up emotions and responses. They are thus a useful way to describe the role of aquaculture in people's lives, changes in their circumstances, new ventures and adventures, the reality of being or not being poor, the struggle for entitlements.

There is a section in the STREAM Virtual library dedicated to such stories, which you can download from: http://www.streaminitiative.org/Library/stories/index.html. Available stories include:

The Kandhkelgaon Story

This is the third story featuring the role of aquaculture and fisheries in the livelihoods of poor people in eastern India. This story describes how women who could no longer make a living from weaving turned to aquaculture. Success came, not just through income generation, but also by reducing the cost of being poor, by achieving access to more financial products like life insurance and savings. The story highlights the influences that constrain and enhance development, including the value of social capital, the struggle for entitlements, and the sheer bravery and entrepreneurial spirit of people who are poor.

Empowerment is a laudable term - here's an example of what it can 'look like'

In rural West Bengal, needy but talented people are working together to develop small-scale fish farming in seasonal water tanks to improve their livelihoods. By forming a federation of Self-Help Groups they are providing and drawing in the support services they need.

A Story about Poverty Alleviation through Improved Aquatic Resources Management in Asia

This story is about an FAO-funded project which ran for 24 months from May 2003 through April 2005, in support of poverty alleviation through improved aquatic resources management. The project builds on the FAO Code of Conduct for Responsible Fisheries (CCRF), and its call for action towards responsible aquatic resources management, and the World Food Summit declaration about the potential contribution of aquaculture and aquatic resources to poverty alleviation and food security.

Networking for Rural Development - A closer look at the evolution of communications in the STREAM Initiative

This story outlines the growth and development of the STREAM Initiative, from the recognition by NACA that there existed a need to better support the information and communication needs of poorer people of Asia-Pacific, to the development of four poverty-focused themes: Livelihoods, Institutions, Policy Development and Communica-

People tell significant change stories at a village-based monitoring and evaluation workshop in Kaipara, West Bengal, India.

Significant change stories

Guidance is given only about how to write Significant Change Stories; the content can be anything.

In the story – information about the nature of the change: Who or what has changed? In what way? A story based on evidence rather than opinion will be more useful. What tells you that the change has happened? What have been the effects of the change? Include enough detail to make it understandable by someone not familiar with your life or work and to make it possible to follow up later to see if the change has continued.

In the explanation – Why is this particular change significant? Why was this chosen over any other potential change stories? Who made this choice? What difference has this change made or is it likely to make and for whom? This is the most important part of the account, as it enables other people to judge the significance and relevance of what might otherwise be 'just a story'. It's fine if this account is subjective; in fact, one would expect it to be so. The important thing is for the values and concerns it represents to be made explicit.

tions. The report focuses particularly on the theme of Communications, outlining the concepts and ideas behind STREAM's Communications Strategy, its national Communications Hubs and One-stop Aqua Shops and how these are playing a role in helping people to access the information and services they need. The report also serves as a useful introduction to the way STREAM works, its network, and the linkages this provides throughout Asia-Pacific. [PDF 567KB].

The Kaipara Story

A closer look at the benefits of working together, the evolution of a federation of aquaculture Self-Help Groups and a One-Stop Aqua Shop in rural West Bengal. [PDF, English 383 KB, Bengali 209 KB, Oriya 1.18 MB].

The Jabarrah Story

In September 2003, members of the STREAM Initiative had the opportunity to return to Jabarrah, a rural village in West Bengal, India, where the DFID Eastern India Rainfed Farming Project (EIRFP) had been working with local communities for more than eight years, where DFID NRSP have been experimenting with integrated aquaculture and where STREAM recently filmed a case study as part of its project to promote pro-poor policy lessons. [PDF English 271 KB, Oriya 190 KB].

To Help with Monitoring and Evaluation

June 2005 sees the Fourth STREAM Regional Conference in Hanoi, which is a key annual event in the monitoring and evaluation system of the initiative. While the left sides of our brains will be focusing in on our logical frameworks, their timing and organizational elements and the Objectively Verifiable Indicators we have set ourselves, the right sides will be occupied with people's stories of significant change.

Everyone is invited to decide what they think is a significant change, or the one most significant change about their life or their work as the subject of a story (see the box). A change can be big or small, positive or negative, and could affect an individual, a small group or an entire organization. What choosing one or perhaps two stories will enable, however, is for at least some of the achievements to be brought alive and considered in more detail than can be done in the rest of the monitoring and evaluation system.

Components of the STREAM M&E System comprise the STREAM Logframe, with indicators of the process and progress of change, project logframes for eight of the projects currently on-going, and hundreds of Significant Change Stories from stakeholders. To find out more about how the system works please see http://www.streaminitiative.org/MonitoringandEvaluation.html.

Stories can be persuasive, descriptive and a source of learning. They are a time-honored means of communicating. If you use storytelling in your work, or have comments about the stories described here, please tell us about them.

We openly invite your comments and feedback related to the STREAM Column, which can be relayed to:

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Aquaclubs: The way forward for shrimp health and quality management at village level

Arun Padiyar, NACA

Mr. G. Narayana Murthy, Farmer leader, Mogaltur sharing his experience with farmers of Tundurru village Aquaclub.

The shrimp farming industry in India has faced numerous problems since commercial shrimp farming began in early 1980s with small-scale farmers always the most affected. Increasingly, they find it difficult to produce a profitable crop because of disease related losses and the slump in market price. Most farmed shrimp is destined for export and as a result farmers have to struggle hard to meet the quality and safety requirements of international markets. In addition, there is a growing trend in importing countries to demand high quality and safe shrimps grown in eco-friendly and socially acceptable ways. Unless Indian farmers respond positively to importing country standards and requirements they will lose out to shrimp farmers in other countries who are more proactive. This is already happening and should serve as an early warning to the industry in general and to small-scale farmers in particular. It is a big challenge for small-scale farmers to address these issues and it is often beyond their individual capacity to find practical solutions. Their only hope is to address these burning problems collectively through a cooperative approach. Lessons learnt in the ongoing MPEDA/NACA project in Andhra Pradesh in association with the Australian Centre for International Agricultural Research (ACIAR) and the Indian Council for Agricultural Research (ICAR), strongly indicate that collective approach is the best way forward. This article examines the current problems facing the industry, constraints faced by small-scale farmers, the concept of a collective approach through formation of aquaclubs, their benefits and mechanisms to sustain them.

Current problems and issues

The important current problems and issues in the shrimp sector, in particular, those faced by the small-scale farmers, are devastating disease outbreaks, price slumps and fluctuations and increasingly stringent quality and safety requirements.

Disease is a major problem

Disease is still a big threat to farming communities. The main reasons for disease outbreaks include:

- Purchase of poor quality seeds at very low prices.
- Little attention to implementation of better management practices in hatcheries and farms. In less biosecure farming systems of India good management actions taken by individual farmers may not always result in good returns to the farmer concerned.
- Lack of cooperation among farm clusters in collectively managing their farming activities. Inadequate/inappropriate management plans implemented by other farmers in the vicinity can nullify the good management actions taken by individuals.
- Careless handling of disease outbreaks, for example by not informing neighbours about disease problems, draining water from affected ponds to common creek, delays in harvesting diseased ponds leading to cross-contamination.

Being transparent, sharing information and collectively exercising responsibilities can bring substantial benefit to all farmers in a cluster. Shrimp cooperatively produced from such clusters can confer other benefits to farmers, such as greater market power.

Decreasing price trend is a discouragement to the shrimp sector

For some time there has been a clear decreasing trend in the market price for shrimp internationally. The main reasons for this are:

- Increasing supply as more countries have become involved in shrimp farming.
- In China, Vietnam and Thailand, which are the major shrimp producing countries, most of the farmers shifted to *P. vannamei* (white shrimp) shrimp from black tigers (*P. monodon*). This species has a lower production cost and can give higher yields, leading to market competition, although it is difficult and uneconomical to grow them beyond 20 g size (5 count).
- Antidumping duties imposed by USA on shrimp from 5 countries, including India.

Dr. Krishnaiah, Commissioner of Fisheries, Andhra Pradesh, addressing the Mogaltur Aquaclub farmers

- Increasingly stringent conditions required by importing countries, such as:
- High quality (freshness) and safe shrimp without chemical residues.
- Trace-ability across the whole production chain starting with broodstock and including hatcheries, farms, processing plants, to the final selling point.
- Shrimps grown in an eco-friendly and socially acceptable manner.

At this moment, although the price trend is very discouraging, farmers may be able to sell quality shrimps for a premium price. Several years ago market price was primarily determined by supply, but now the international market is orienting towards quality, which is now also an important factor.

MPEDA/NACA programme in India

The MPEDA/NACA project started during 2001 in Andhra Pradesh. The main objectives were to find the important risk factors for shrimp disease outbreaks, develop better management practices to control disease and improve yield and encourage farmers to form Aquaclubs to implement better management practices (BMPs) at village cluster level. In 2001, a massive survey was conducted on 365 randomly selected shrimp farms in Nellore and West Godavari districts and disease risk factors were identified. In 2002, risk management practices (BMPs) were demonstrated in 10 ponds of 5 farms in Mogaltur, Losari and Tippaguntapalem villages. The results were very much encouraging to farmers and to the study team. In 2003, a village demonstration programme was conducted in Mogaltur village. BMPs were implemented in 108 ponds of 58 farmers in one cluster by forming an Aquaclub. As a result there was significant improvement in yield, reduced disease problems, lower cost of production and higher quality shrimp production free from chemical residues. Farmers disciplined themselves in farming practices under their Aquaclub rules and guidelines, which included a prohibition on the use of antibiotics.

In 2004, the village demonstration concept was extended to six neighbouring villages around Mogaltur, West Godavari. Seven aquaclubs were formed. Technical assistance was given to 130 farmers of these aquaclubs to implement the BMPs in 254 ponds (435 acres). There was an increase in seed requirement due to Aquaclub formation and this helped us to introduce a new concept for procuring high quality seed: Contract hatchery seed production. Both farmers and hatchery owners found great benefits from this system. Maintenance of management record books in hatcheries and farms gave the Aquaclubs the opportunity to establish better contact with exporters to follow-up the traceability system. The farmers' confidence in shrimp farming improved a lot, and there was increased cooperation from farm service providers, including feed companies, to Aquaclubs, which helped to develop mutual trust among the different players in the industry.

In 2005, the MPEDA/NACA programme is extending its village demonstration programme in 20 villages of West Godavari Disricts, and also in Orissa, Tamil Nadu, Karnataka and Gujarath states.

What is an aquaclub?

An aquaclub is formed by a group of farmers whose farms are closely situated together in a cluster or locality of a village. The club provides a mechanism for farmers to organize themselves in planning and managing their crop activities and to solve their local problems.

Benefits from aquaclub formation

The main benefits farmers experience from aquaclubs are:

- Regular sharing of knowledge and awareness of Better Management Practices among farmers.
- Proper advanced planning of crops by group, which is a basic requirement for a high rate of success and sustainable yields.
- A collective approach to tackling common problems, including local environment protection.
- Cooperation in starting the crop at one time thus avoiding continuous stockings and harvests.
- Cooperation in selecting/testing and buying seeds at competitive prices, which can include establishment of a contract hatchery seed production system.
- Cooperation in 'on-farm' common nursery management thus assuring better quality seeds to the smallest farmers.
- Cooperation during water supply and draining especially during disease outbreak period to reduce risks of disease spread.
- Ability to easily implement new market requirements across the club at short notice. For example, farm management record keeping in all the ponds and even in hatcheries for traceability systems.
- Government support can be more easily attracted.

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Indigenous fishing techniques practised by the tribes of Arunachal Pradesh (north east India)

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Arunachal Pradesh, 'the land of the dawn-lit mountains' is a beautiful area of low hills and high mountains, exotic flora and fauna, and spectacular scenery. It is inhabited by 28 major tribes with 110 sub-tribes and was designated as the 12th mega biodiversity region of the world at the Rio Earth Summit, 1992. The state occupies an area of 83,743 km^2 out of which, about 79,00 km areas i.e. 94% forms the Himalayan part.

Arunachal Pradesh is a land of rugged grandeur with mighty gorges and fifteen major fast-flowing rivers, which together provide more than 2,000 km of perennial riverine resources snow fed from the Himalaya. The largest among these rivers is Siang (*Dihing*) called *Tsangpo* in the Tibet Autonomous Region of China. It flows into the mighty Brahmaputra River, the second largest in India after joining with the Dibang and Lohit rivers at Sadiya in the plain of Assam[1].

Physiographically, Arunachal Pradesh can be divided into three distinct zones on the basis fish production prospects: (i) The lower altitude zone up to 300 m (tropical); (ii) the middle attitude zone up to 1200 m (sub-tropical); and (iii) the high altitude zone above 1200 m (temperate zone). While the foothills and plains bordering Assam and Nagaland offer warm water conditions, the high gradient hills above 1200 m are considered an alpine zone and are ideally suited for cold-water fisheries.

Altitude is a major factor in the climatic variations of the state and this in turn affects the kinds of fish species that are found in different habitats. The hot, humid climate of the foothills is suitable for warm water species including catfishes, featherbacks, mahseers and exotic carps. The middle gradient up to 1200 m, which becomes progressively colder, dryer and less humid, sustains a mixture of warm and later cold-water fisheries as altitude increases. The extremely cold alpine climate exists in the lesser and higher Himalayan region above 1200 m altitude, and supports stream and lake fisheries for snow trout species such as *Garra* spp., *Noemacheilus* spp., *Glyptothorax* spp. and occasionally lesser barils. The fishery resources are widely distributed with around 30% in the high altitude zone and the rest being evenly distributed in the middle and low altitude zones.

Climate, fishing technique and gears

Arunachal Pradesh receives heavy rainfall from both the northeast and southwest monsoon. The average rainfall of the state is 2,658 mm and relative humidity is usually around 80%-90% favoring luxuriant growth of vegetation and proliferation of biological diversity. Due to the steep topography of the terrain the area is highly susceptible to flooding[2].

Fishing practices in the area can be divided into individual and group fishing techniques. Collective fishing is carried out by all members of the community, men and women, young and old. Some traditional fishing practices in the area are described below:

A fisherwoman carrying a local trap or 'porang'.

Women collectively applying local plants as fish poisons, and using 'porang' traps.

Porang system

The word *porang* means a roughly woven bamboo basket with a conical shape. The *porang* system prevails in Simang river because it is cheap and easy to build, with the added advantage that it is relatively environmentally friendly. *Porang* are made out of locally available materials (bamboo and cane). It is roughly woven so it usually does not trap small and immature fish, and can only trap one or two fish at a time. Fish remain alive in the trap, so they will not decompose if not collected for a day or two. *Porang* do not impact greatly on untargeted species. There are three kinds of *Porang*:

Tarii Liknam

The word *Tarii* means a kind of *porang* in which a stone is fastened at the base and a series of thorn canes are arranged inside the conical shaped *porang* in opposite direction to prevent escape. The word *liknam* means placing. The stone is used to weight the device so that it will sink. This enables it to be set in any direction and in both shallow and deep water. A very long cane rope is stretched across the river and both the ends of the rope are fastened on either side of the bank. Another long rope is fastened in the middle of the stretched cane. At one end of the cane a simple boat made of bamboo is fixed that can be moved to and fro by pulling the fastened rope. In this way, a fisherman on the boat can operate the apparatus with the help of bamboo hook. Winter is most appropriate time to use this gear as that is the time when the water in this region is clear and transparent.

Rayok Tonam

The rayok is the simplest of all the porang system. Tonam means to install. It is the most commonly used method and if one goes along the banks, hundreds of such porang are seen fixed in position. It is supported and fixed in position with stones to prevent the water currents from washing it way.

Hurii Ognam

The *hurii* is also a conically shaped *porang* but it is quite large in comparison to other two. *Ognam* means to 'hang with rope'. Groups of people jointly practice this method of fishing in the months of May and June when the volume of water in the river is at its maximum. This kind of fishing is normally only carried out for one or two hours as it is carried out during the specific period when fish are involved in potamodromous migration.

Hitong Poyup

Hitong poyup is a small hut near the bank of the river where the collected fishes are smoked or dried over a fire. One can see many such huts along the bank of the river. People stay in these huts temporarily for convenience when the fish are to be collected from the traps frequently.

Hikong Konam

Hikong konam means 'basketing by women'. The main tool used in this method is *'narang'* a conical shaped basket made of cane. This is mainly done by women either alone or in groups. The basket is kept fastened in between the fisher's legs and a stone is used to scare the fish towards the basket, which is then quickly lifted. The catch is put into a small basket called *'hokyap'* hung at the back of the waist. This method is generally used in small streams, catching a few small fishes and shrimp. *Narang* are generally prepared by elderly people.

Lipum

Lipum are holes dug in the side of a riverbed and left as such, covered with a large stone. The fish move to inhabit the excavated area, making it easy for fishers to later catch them. A similar method called *ok* is sometimes used by making pits in the riverbed. These are filled with material to make them look natural and create a refuge. The fishers then drive the fish from all corners of the river towards the pits, where they are more easily captured.

Chibok penam (Hill Miri)/ Hibok Pennam (Adi)

This is a method to catch fish from the riverbed. A dam is constructed of sand and stone to divert flow from one side of the river. The water on the downstream side of the dam decreases and then becomes waterless, making it easy to retrieve stranded fish.

Takom

Takom ganam is one of the most important methods used to catch fish in the river or from a stream. A weir is built across the channel from wood, bamboo, mud, sand and stone. *Takom*, a sort of basket is tied in place facing downstream of the weir so that when a fish jumps to cross it falls into it and is captured. Another similar method is used to catch fish from the corner of the weir. A *sin* - a kind of bamboo made device is used to capture leaping fish.

Nyibu

The *nyibu* is a spear used to kill or catch a fish. Hands and cloth are used to catch small fish in the river or stream. The fishers stir up the mud to make the water muddy and blind their targets. Just after capture the fish are grasped in the teeth of the fisher so that it cannot escape. In winter, when the fish are numb with cold, the fishers may catch them with their hands, which is actually easier than the other methods.

Raju

Raju are another kind of bamboo-made basket used to catch shrimp. It is also used to keep the catch of fish.

Rip Binam

Rip *binam* is basically a kind of fishing rod normally used to catch rip fish with a worm as bait. A small piece of wood is used as a float to indicate a strike by the fish.

Natural plant toxins

Naturally occurring plant toxins are sometimes used to catch fish, particularly in winter. Fish poisons can be obtained from the bark of the *tenir* and *ris* trees, from the fruit of *taag chaa* trees mixed in equal proportions with the roots of *ripik* trees. A poison may be prepared from one or a mixture of these plants. The other important poison plants used by the indigenous tribes of Arunachal Pradesh are *Aesculus assamica (Tom sin), Amphuneuron extensus (Rubdik), Polygonum hydropiper (Boku eeh),Zanthoxylum hamiltonii (Nyishi and Tagin tribes).*

The bark, the fruit and roots are beaten into the water to release the intoxicating substances. Poisoning is usually carried out in conjunction with *Chibok penam* water diversion activities as described above, normally later on when the water volume has been reduced, making the poison more effective. The fishermen have to wait only two to three hours after poisoning the water, then they shout and beats the surface of the water continuously along with the other fishermen. The whole method is called *Tom*.

Traditionally the collectors would sing and shout for good luck while collecting the ingredients for fish poison from the forest, but this practice is dying out. Modern fishing methods such as hand nets and fishing rods are replacing the traditional ways. It is good to welcome new things but this causes anguish somewhere in the heart to these people[3, 4, 5]. However, traditional traps made of bamboo splits are still used to catch fish. They are known by different names in different districts –Edil Porang (Adi), Chipe, Langpu, Naagi, Achop, Chilemingna, etc. (Mishing tribe and so on)[6].

Paddy–cum–fish culture

This integrated system is popular in the state especially in the high attitude zone, which assures more return per unit arable land than from paddy cultivation alone. Often two crops of fish are raised along with a single crop of rice over a period of 3-4 months. Normally this kind of culture is carried out where there is a regular supply of irrigation water and the rainfall is fairly high. Flat land or paddy fields with uniform contours are hardly available in this hilly state, so most paddy is cultured on terraced hills. For fish culture, a single trench is excavated along the middle of each plot with a width of around 45-60 cm and a depth of 60-70 cm depending on the volume of water to be retained and density of fish to be cultured. The excavated earth of the trench is used to raising the height of the embankment of the paddy plots to hold nearly 0.80 meters depth of water. The trench is connected to the irrigation channel and both the inlet and outlet are guarded with bamboo screens.

The paddy fields are fertilized with domestic sewages, ash from paddy roots and other wastes. and made ready by April – May. Having prepared the plot, a local deep-water variety of paddy is sown during May with the onset of the monsoon using the transplantation method. Fish seed are added some 20-25 days after sowing the paddy. The water of the plots are raised to a depth of 30-40 cm and stocked with common carp or mirror fry at a density of 1,500 to 2,500 seed per hectare. The water level is gradually increased to take account of the growth of the fishes. Pesticide normally cannot be used and the fish are not normally fed. Fish are harvested after about three months by blocking the main irrigation channel and lowering the level of water. With the fall of level of water the fish congregate at the outlet of the channel, which is slightly deeper than the main channel. From there the fishes are either scooped with the bamboo gear or hand picked. Fish production varies from 150-200 kg/ha. The paddy crop is allowed to grow for another 30-40 days and harvested with a production ranging from 1,500 kg to 2,500 kg/ha[7].

The people of Arunachal Pradesh are still largely using their indigenous methods to catch fish or culture them. No single aquaculture practice is suitable due to the diverse climatic conditions in this state. However, conventional aquaculture techniques developed elsewhere in the country could be applied with modifications to suit locally available species and conditions.

References

1. Daimari, P., 2003, Ecology and Fishery Potential of Some Selected Rivers in Arunachal Pradesh, Unpublished Ph. D. Thesis, Gauhati University, pp. 10-11.
2. Barthakur, M., 1986. "Weather and Climate of North-East India", *North Eastern Geographer*, Vol. 18 (1&2): 20-27.
3. Chutia, R. & 2003. "*The Hill Miris of Arunachal Pradesh*", Spectrum Publication, Guwahati: Delhi, pp. 22-25.
4. Dutta, P., 1959, Fishing. *The Tangsas (NEFA)*, pp. 22-24.
5. Shukla, B.K., 1965, Fishing. *The Daflas of Subansiri Region (NEFA)*, pp. 33-34.
6. Nath, P., Riba, T. and Das, D., 2001, "Community's Participation in the Conservation of Fish Germplasm in Arunachal Pradesh: A Focus, Resarun", *Journal of the Directorate of Research*, pp. 87-88.
7. Nath, P. and Dey, S.C., 2000, *Fish and Fisheries of North Eastern India (Arunachal Pradesh)*, pp. 193-197.

Aquaclubs: The way forward

...continued from page 34.

- Stronger collective bargaining power to aquaclub farmers to purchase farm inputs (feed, lime etc) and to sell the shrimps.
- Networking of aquaclubs in a district or state can help farmers to start their own branded shrimps to gain customer loyalty.

Essential elements for an aquaclub to form and sustain

Essential requirements in establishing an aquaclub are to:

i) Have a leader or coordinator from farmer community of a cluster who is well accepted by all the members.
ii) Member farmers should have strong common interest. For example, avoid spread of disease, improve the production, marketing of shrimps etc.
iii) Compulsory implementation of key farming practices such as purchase of high quality seeds and other farm inputs, stocking during fixed periods, ban on draining of disease affected pond water etc.
iv) Organize regular aquaclub meetings (weekly/fortnightly/monthly) to review the situation, exchange ideas and plan activities.
v) Aquaclub farmers should be help to each other to solve problems.

Way forward

Unity among farmers and cooperation among hatcheries, farmers, feed and other input suppliers, processors, exporters and concerned government institutes is key to the success of everyone in the shrimp industry. If the industry has to survive, grow and make good profits, everyone must work together cooperatively without exploiting each other. The focus should be on speedily meeting customer demands rather than blaming customers for never ending demands. Aquaclubs are a promising model for farmers to work together, solve their problems and help the industry to meet market demands.

Asia-Pacific Marine Finfish Aquaculture Network

Magazine

SKRETTING

Mass seed production of sand sea bass (*Psammoperca welgenensis*) at the Regional Center for Mariculture Development (RCMD) in Batam, Indonesia

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NACA

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Meet the sand sea bass

Sand sea bass is a tropical species found in Indonesian waters, known locally as *ikan mata kucing* ('cat eyes'). Its body shape is much like the Asian seabass although it is darker in colour, which is why it is also known as as *gelam* or *kakap hitam* (black sea bass) on Batam-Riau Island. Sand sea bass are a much smaller, reaching a maximum weight of 1kg. They are protandrous hermaphrodites, maturing first as males at around 75-100g then changing sex with mature females appearing at around 150g. Sand sea bass are a demersal species with a schooling habit.

Although the sand sea bass is still abundant in Indonesian waters, especially around Batam, wild stocks are likely to come under increasing pressure as high demand has seen its market price increase, which is likely to lead to more intensive fishing efforts. At the time of writing, the price of live sand sea bass in Singapore is around

Sand sea bass broodstock.

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Indoor hatchery with larvae rearing tank.

S$ 15/kg. Anticipating a decline in wild stocks, RCMD have been developing techniques to produce sand sea bass seed as basis for supporting an alternative, farmed supply.

Broodstock management and breeding

Broodstock can be obtained both from wild capture and from fish on-grown in net cages. As many as 10 fish/m^3 are kept in circular fiberglass tanks of five ton capacity, with sex ratio of 1 male : 1 female. A flow-through water system is used during the rearing period with around 400% water exchange per day in the broodstock tanks. Broodstock are fed 5% of their body weight daily in fresh trash fish and threes times per week with squid. Vitamin C and E are also given once per week to help stimulate gonad maturation.

Environmental manipulation is also conducted to stimulate broodstock to spawn. In RCMD, sand sea bass broodstock spawn naturally every month, following a lunar rhythm and in most cases, spawning occurs over a period of 2–5 days. Spawning takes place at night, mostly around 22.00–24.00. The fecundity is normally around 50,000 – 100,000 eggs per female.

Larval rearing

Fertilized eggs are collected from spawning tanks and transferred into aquaria for incubation. During incubation, the eggs are treated with

Outdoor hatchery and nursery tank.

Sand sea bass larvae.

acriflavine at 5 ppm as a prophylaxis against bacterial infections. Incubation takes around three hours, with eggs then transferred to aerated larval rearing tanks, which are rectangular and of 10-ton capacity. Eggs are stocked in the larval rearing tanks at around 40-50 per m^3. Normally, 90-95 % the eggs will hatch after around 17 hours.

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Persian Gulf fish culture in Iran – pointers for success

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Unlike most other Asian countries, aquaculture is not a traditional practice in Iran. The first documented aquaculture activity was in 1927 and the first warm water fish farm began operation in 1961. Due to the social, agricultural and climatic characteristics of Iran, fish and other aquatic organisms have not been a common part of the traditional diet of the people, except in coastal areas. However, with a high population growth rate of 3.2%, fish is becoming increasingly important as a cheap source of quality animal protein, supplementing limited livestock based protein.

The Persian Gulf

The Persian Gulf, one of the warmest in Asia, has an area of 232,850 km^2, which stretches 930 km from the Arvandrood River to the Sea of Oman with an average width of 288 km. The average water depth is 38m, with a maximum of 280m. Water temperatures range between 12.3°C and 40°C, and salinity between 37 to 50 ppt. The average water temperature in the Sea of Oman is lower, ranging from 19.8°C to 23°C, because of the greater water depth and its connection to the open ocean.

Marine fish culture from the Persian Gulf is in its infancy in Iran. According to Professor Agius of Fusion Marine International, of all the Near and Middle East countries, Iran bears an unique coastline that offers unparalleled opportunities for marine fish farming. Development of Iran's marine fish aquaculture industry has begun at an opportune moment now that the relevant technology has been applied and proven in Kuwait and Bahrain. This factor significantly enhances the prospect of success.

National interests

Aquaculture research priorities and programs for finfish were laid during 1997-98 for the Khuzistan research center (Ahvaz), Iranian Fisheries Research & Training Organization (IFRTO)[2]. Iran has identified fish aquaculture as a high priority sector for stabilizing and increasing fish production, more specifically to raise apparent per capita fish consumption to 6.5kg[3], which is still well below the world average per capita fish consumption of 13.5kg[4], as seafood has traditionally been a low choice-preference in the Iranian diet.

Cage and pen culture systems have been introduced for feasibility studies on the culture of Caspian salmon, rainbow trout, sturgeon, carps and fourteen species of marine finfish[5]. With the development of fish feed technology, fish health management and a better understanding of site selection criteria

Sea cages at Qeshm

and the interactions of aquaculture with the aquatic environment, it is envisaged that these systems will have a significant role to play in contributing to the socioeconomic well-being of coastal communities and the expansion of Iranian aquaculture.

The aquaculture objectives of the Government of Iran are: Transfer of aquaculture technology to Iran; preparation of preliminary work for breeding programs with marine fish; reaching global markets and creation of a motivation for marine fish culture and decrease of production cost by localization of technology and increase in per capita fish consumption.

Captive grouper stocks.

Potential

Iran has enormous potential to develop its marine finfish resources through modern technology. A government assessment of prospects for sea cage aquaculture development along the Iranian coastline has targeted development of an 8,000 ton industry in the Caspian Sea, and a staggering 25,000 tons in the Persian Gulf and Sea of Oman.

Major nominated candidates for cage culture are silver pomfret *Pampus argenteus*, milkfish *Chanos chanos*, cobia *Rachycentron canadum*, Asian sea bass *Lates calcarifer*, rabbit fish *Siganus canaliculatus* and *seabreams Sparidentex hasta* (‘sheim’) and *Acanthopagrus latus* (‘sobiaty’) Five companies have so far gained principle licenses for cage culture in the Persian Gulf, according to Shilat, the Iranian Fisheries Organization.

Site surveys were carried out at Qeshm island in the summer of 2000, and with the assistance of a Nordic company, Shilat has studied the potential for marine fish farming in the Northern coast of Persian Gulf and Oman Sea. Their results showed good potential for cage culture in strategic areas. A comparative tabulation of growth biomass has been indicated for potential marine finfish candidate species in Iran (table 1).

Candidate species

As aquaculture expands worldwide to meet the growing demand for seafood, species with favourable culture characteristics such as seabream and cobia will certainly be considered as prime candidates for commercial production in Iran. Groupers, cobia, snappers and rabbit fish have good attributes for growout in cages such as their preference for forming schools and ability to adjust to captivity. Cobia initially feed on benthic animals in nature, but are easily trained to consume formulated feed pellets. Grouper and sheim are reasonably tolerant to handling and overcrowding unlike sobiaty. Both sobaity and sheim reared from 1g to maturity in cages are less stressed and produce higher quality eggs and larvae more easily than wild broodstock. Cobia farming in particular has high potential for large volume industrial production due to its amazing growth (32 g to 8 Kgs in 11.4 months at optimal feeding and temperature[6]). Polyculture of shrimp and milkfish has also shown good results with lower FCR[7]. European seabream *Sparus aurata* has high potential as a culture species for the winter months, reaching 450-550g in a year under offshore cage culture conditions in UAE and Oman.

Nearby Kuwait has an excellent record of scientific development of aquaculture technology for groupers, rabbit fish, blue-fin and yellow-fin seabreams and ecologically adapted hatchery breeding of European sea bream and sea bass *Dicentrarchus labrax*[9], particularly through the Kuwait Institute for Scientific Research, which has an international reputation for warm water finfish aquaculture research and extension.

Research needs

More work ought to be done on cobia and silver pomfret nursery areas to identify major influences on natural recruitment levels and their distribution, wild spawning and growth patterns, and to refine commercial-scale technology for culture of these species. As one of the species with highest potential, research on breeding cobia could prove critical to the future development of Iranian marine fish farming Industry. There is also interest in utilizing bream *Abramis brama* in polyculture systems[3], but this species has shown poor tolerance to low oxygen. Further efforts are needed to find a more suitable stock or to domesticate or genetically improve the local bream to adapt it for polyculture conditions[5]. Morphological changes during the early life stages of king fish and snappers in the wild are currently poorly understood, and applied research is required to develop commercial hatchery techniques for both these and silver pomfret, to allow sustainable production of cheap, high-quality fingerlings. Iran has considerable inland saline ground water resources, whose suitability for aquaculture of rabbit fish and other brackish water species is yet to be investigated.

Nutrition is another area where research could bring substantial benefits to Iran’s fledgling marine finfish aquaculture industry. High-quality customized vegetable protein diets need to be formulated for herbivorous species such as rabbit fish, and nutrition-

Table.1 Growth biomass indications for potential candidate species in Iran

Species	Stocking size	Stocking density	Culture Period	Final weight
Grouper *Epinephelus coioides*	50g	30-40/m^3	7-8 months	500-700g
Sobaity *Sparidentex hasta*	1.5g	25/m^3	12 months	500-700g
Sheim *Acanthopagrus latus*	1.5g	25/m^3	12 months	350-700g
Rabbit fish *Siganus canaliculatus*	3.5g	25/m^3	11 months	300-350g
Asian Sea bass *Lates calcarifer*	100g	40/m^3	6-7 months	550- 600g
Cobia *Rachycentron canadum*	30 g	4-6/m^3	11-12 months	6-8 kg

ally efficient feeds are also required for sheim, as current farming trials show slower growth rates during the early culture period (5 to 200g).

Constraints

There is no significant stock enhancement of finfish in the Persian Gulf due to the lack of knowledge and facilities for breeding marine fish. While aquaculture of bream and perch are underway, these are largely experimental trials or on a pilot scale. Studies on the eggs and larvae of marine finfish in Iran have stemmed only from the consideration of fisheries management rather than from aquaculture.

Ultimately the rapid growth of marine finfish aquaculture in Iran will depend on the specific seafood requirements of the market. Price is determined by many factors such as consumer eating habits, regulations, competition and choice in products. Iranian seafood consumers are very sensitive to price changes, and high prices, particularly for farmed vs wild product, will reduce the interest of people in purchasing unfamiliar seafood.

The government had been holding fish exhibitions, fish cookery training courses and broadcasting documentaries that promote aquaculture for domestic fish consumption. However, the limited number of excellent sites suitable for intensive marine fish farming in Iran may restrict the size of the industry initially.

Outlook

Recently, culture of high-value or highly desired marine finfish such as cobia, grouper and sobaity have attracted the attention of Iranian investors. New investments are on the rise along the Bushehr and Qeshm coastline for cage farms with interesting signs of development. Private entrepreneurship and favourable international cooperation with France are helping to develop finfish culture in Iran. Technology purchased from experienced regional consultants (Kuwait, Bahrain) by national investors and also joint-ventures with technologies brought by foreign partners across the seas are crucial for growth in this sector.

Although trials to produce new marine finfish species are ongoing in most of Europe, no real replacement candidate has been found for the European sea bream and sea bass, which are currently experiencing a price slump. Mass production of new candidate species at a cost-effective price will determine the scale of development success in warm water marine finfish culture. Within Shilat, there is increasing interest in enhancement of wild stocks through release of hatchery-reared juvenile fish.

With commercially-proven trials for blue-fin and yellow-fin sea bream in the warmer Middle East waters, and considering their status as preferred species in Arab countries[10] and stable pricing, these species may be viable alternatives for Iran too. One strong recommendation is to strengthen the research coordination at national and international levels where there are such overlapping interests to fill gaps in knowledge in need-based areas.

References

1. Azari, T.Gh. 1984. Principle of fish farming. Ministry of Agriculture, Iran. Vol.1, pp.30-38.
2. FAO, 1997. Survey and analysis of aquaculture development research priorities and capacities in Asia – by FAO and NACA, Nov. 997. FAO circular no. 930, FIRI/C930, 263 pp.
3. Rana, K. and Bartley, D.M. 1998. Iran promotes aquaculture development. FAO Aquaculture News letter, No. 19, August 1998, pp.26-30.
4. Anonymous. www.caspianenvironment.org/biodiversity/iran/ first.htm.
5. Anonymous. FAO report on a regional study and workshop. www.fao.org/docrep.field/003/AC279E/AC279E14.htm.
6. Shakouri, M. An overview on status of aquaculture in Iran. (Source: www.iranfisheries.net/english/articles).
7. Su, M.S., Chien, Y.H. and Liao, I.C. 2000. Potential of marine cage culture in Taiwan: Cobia Culture, In: Cage culture in Asia, Proceedings of the First International Symposium on cage aquaculture in Asia. Liao, I.C. and Lin, C.K. (Eds.) pp. 97-106. Asian Fisheries Society, Manila and World Aquaculture Society – South East Asian Chapter, Bangkok.
8. Al-Husaini, M. 2003. Fishery of shared stocks of the Silver Pomfret, Pampus argenteus, in the northern Gulf a case study. Paper presented at the Norway-FAO expert consultation on the Management of shared fish stocks, Bergen, Norway, 7-10 Oct. 2002, FAO Fish. Rep. 695.
9. Kitto, M.R. and Gelmar P. Bechara 2004. Business aquaculture in Kuwait - challenges and solutions. World Aquaculture, June 2004, vol. 35, no.2. pp.58-60.
10. Kitto, M.R. 2004. Sobaity – The Arab's choice. Fish Farming International File, Nov/Dec. p.24-25.

Marine finfish health issues of relevance to Australia and the region

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Harvesting barramundi (Asian seabass) from sea cages, Northern Territory.

In 2003-2004 the total Australian fisheries gross value of production was A$2.2 billion, of which aquaculture provided about 34%. Marine finfish aquaculture forms an important component of aquaculture production in Australia. In South Australia the sea-cage farming of southern bluefin tuna (*Thunnus maccoyii*) was the most valuable aquaculture industry with a gross value of production of A$242 million. Pearl production is probably now second in value to tuna, while the Tasmanian based Atlantic salmon (*Salmo salar*) industry comes third with a gross value of A$115 million. The next most valuable marine finfish aquaculture industry is probably barramundi (*Lates calcarifer*) farming - but barramundi farms are a mixture of marine and freshwater systems, and it is not easy to separate the statistics. The largest barramundi farm is a marine sea cage farm in the Northern Territory, which intends to increase production to over 1,000 tonnes (see .http://www.abare.gov.au/pdf/Barramundi.pdf for information on barramundi farming). The full Australian fisheries statistics are available for free download from http://abareonlineshop.com/.

Marine aquaculture activity has been supported by the active involvement of both government and industry with respect to fish health issues. Those affecting Australia are much the same as elsewhere in the region. The activities fall into three categories:

- Those activities associated with planning and policy;
- Issues associated with disease outbreaks and
- Routine surveillance and monitoring for disease.

Planning and policy

Australia has invested heavily in planning and policy activities associated with fish health. The success of the 'AQUAPLAN' or National Strategic Plan for Aquatic Animal Health between 1998 and 2003 has been followed by a new plan (AQUAPLAN 2005-2010). This new strategy, which has been endorsed by the Australian states and territories, outlines the objectives, projects, emergency preparedness and response arrangements for the management of aquatic animal health in Australia. There are seven key strategies within AQUAPLAN:

- Enhanced integration and scope of aquatic animal health surveillance in Australia.
- Harmonisation of approaches to aquatic animal health in Australia.
- Enhancement of the aquatic animal emergency disease preparedness and response framework.
- Education and training in the aquatic animal health sector.
- Welfare standards for aquaculture.
- Appropriate use of therapeutics for aquatic animal health management.
- Aquatic animal health as part of ecologically sustainable development.

While focussed on Australia's needs, it is certain that these strategies will produce outputs of value to the region.

The Fisheries Research and Development Corporation, which is the leading Australian agency concerned with planning, funding and managing fisheries research and development, has also funded a new aquatic animal health subprogram. The sub-program web page is at http://www.frdc.com.au/research/programs/aah/index.htm and is well worth a browse. The subprogram will hold a scientific conference on aquatic animal health in Cairns 26-28 July 2005.

Australia also has a national aquatic animal health technical working group who provide technical advice on animal health issues and which is responsible for the development of, amongst other things, the Australian and New Zealand Standard diagnostic procedures. There are only a few at present - these can be found (for free) at: http://www.scahls.org.au/.

Disease outbreaks

Issues associated with disease outbreaks have, thankfully, been rare. *Streptococcus iniae* has proved problematic for barramundi culture, particularly those farms exposed to freshwater run-off. Nodavirus in barramundi and other species has also been a problem. A recent national workshop determined that histology was probably still the most cost effective method of screening juvenile fish (<30 days) for nodavirus, though an effective nested PCR is available. However, it is not always possible to detect nodavirus by non-destructive means in potential broodstock, and false negatives are a problem. The full report on the development of the nested PCR and its validation, together with the development of an immunohistochemistry test (IHCT) and an indirect immunofluorescent antibody test (IFAT), can be purchased on-line from the FRDC website: *N J Moody Aquatic Animal Health Subprogram: development of diagnostic tests for the detection of nodavirus. FRDC Report 2001/626.*

Routine surveillance and monitoring

All of the Australian states and territories with marine aquaculture industries carry out surveillance and monitoring for aquatic diseases in partnership with industry. The results of this activity can be seen in the quarterly reports sent to NACA http://www.enaca.org/modules/mydownloads/viewcat.php?cid=78

Surveillance and monitoring is not carried out uniformly across all industries and all diseases but, because of the number of different tests and the costs involved in maintaining expertise in different test methodologies, surveillance and monitoring tends to be targeted at those industries and diseases for which data is required in support of movements within Australia and exports to overseas countries. For example, Tasmania invests heavily in surveillance and monitoring in support of the salmonid industry while Western Australia, which is generally too warm for salmonids, spends more effort on the mollusc and crustacean diseases that are important to the state. Queensland, the Northern Territory and Western Australia (the northern states of Australia) also have developed a memorandum of understanding to share disease information and expertise when required. There are also national initiatives to set up a more formal network of diagnostic laboratories that could share the diagnostic load and assist each other with quality assurance and new test development. This laboratory network concept will be developed as part of the national AQUAPLAN strategy. Watch the FRDC subprogram website, and the SCAHLS website for more information as this initiative develops.

Diseases of cage-cultured marine fish in Korea

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Olive flounder (*Paralichthys olivaceus*) and Black rockfish (*Sebastes schlegeli*) account for more than 70% of total production of marine finfish aquaculture in Korea. Other species such as red seabream (*Pagrus major*), Grey mullet (*Mugil cephalus*), Rock bream (*Oplegnathus fasciatus*), Sea perch (*Lateolabrax japonicus*), make up the other 30 % of total production. Thus, disease outbreaks up to date have been most frequently reported from those two species.

Over the last few years, reports of bacterial disease have been increasing in marine finfish aquaculture as the industry grows. The incidence of mixed infections (disease involving more than two causative agents) is also increasing in Korean aquaculture; two species of bacteria are commonly found from diseased fish and sometimes bacterial and parasitic disease occur together.

Edwardsiella tarda infection is the most problematic bacterial disease in olive flounder aquaculture. *E. tarda* infection can occur throughout the year as olive flounder is usually cultured in indoor recirculating systems, which can maintain water temperature above 20°C. Mixed infections with *Streptococcus* spp. or *Lactococcus* spp. also frequently occur, leading to high cumulative mortalities. Almost 40 % of bacterial infections in Korea are due to these two bacteria. Fortunately, vaccines have recently become available, hence it may be possible to prevent this disease in future.

Other bacterial diseases such as *Flexibacter maritimus, Vibrio anguillarum, Vibrio ichthyoenteri* infections are also common, and due to the increasing prevalence of antibiotic-resistant strains, they can sometimes be very difficult to treat.

Scuticociliatosis is probably the most serious obstacle in olive flounder culture in Korea. Several species have been implicated as the causative organisms of the disease; *Uronema marinum, Miamiensis avidus*, and *Philasterides dicentrarchi*. At first, the disease was thought to be restricted to spring, when the water temperature is between 14-17°C, and only olive flounder fry were known to be susceptible. However, since the late 1990s, the disease has been observed to occur throughout the year. Moreover, the age of host fish and the number of species known to be susceptible has also increased. Several treatments have been successfully applied to treat early stages of scuticociliatosis including formalin, yellow mud and ketoconazole. In the case of heavy infections, there seem to be no effective treatment. Other less notorious, but commonly found parasites affecting marine fish aquaculture in Korea are *Microcotyle sebastis, Benedenia hoshinai, Cryptocaryon irritans, Trichodina* spp.

Iridovirus infection is a serious pest in marine fish aquaculture in Korea. Since its first report in 1998, iridovirus has been reported from south coast to the east and west coasts of Korea. Rock bream culture has been affected most seriously and mass mortalities frequently occur, sometimes in excess of 90%. Other species such as black rockfish and sea perch also seem to be susceptible to the infection, though to a lesser degree. These situations cause huge economic loss. Although research is still in progress, vaccination is reported to be effective for controlling iridovirus infection under experimental conditions. Immunostimulants such as beta-glucan also seem to be effective for reducing mortalities.

One of the problems of marine finfish aquaculture in Korea is that the incidence of disease is increasing, whether this is due to changes in management practices, changes in pathogens or simply due to increased awareness and reporting by a growing industry is not entirely clear. However, mixed infections and introduction of new diseases does appear to be increasing. Other problems such as insufficient quarantine process are also the obstacles against the prompt countermeasures.

The National Fisheries Research & Development Institute (NFRDI) operates a Mobile Hospital for Fish Disease every year, to prevent spread of infection and educate local farmers about disease prevention. Developments in vaccine research are promising; in addition to edwardsiellosis, vibriosis and iridovirus infection, vaccines for lymphocystis and streptococcosis are being researched in Korea, which will hopefully assist the industry to improve health management in future.

Mass seed production of sand sea bass

...continued from page 39.

The larvae are fed rotifer (*Brachionus* sp), *Artemia* and artificial diets as they progress through the rearing cycle. After 12 days, water exchange in the rearing tanks is maintained at about 10 – 20% per day, and this is increased up to 40% by day 30-45. The survival rate of the larvae during this stage is around 50 – 60 %. At the moment RCMD can produce more than 500,000 sand sea bass larvae per cycle.

Nursery

After the sand sea bass seed reach 2.5-5cm in length, or normally after 45 days rearing period, they can be transferred to nursery tanks, for which we use rectangular fiberglass tanks of 2 ton capacity, equipped with aeration and flow-through water exchange systems. Seed are stocked in nursery tanks at a density of 1,000 seeds per m^3. The juveniles are fed *ad libitum* with artificial diets three times per day (morning, afternoon and late afternoon). Grading must be conducted in every two weeks during the nursery stage. Careful attention to hygiene is important to prevent disease. Waste is siphoned from the tank bottoms one hour after feeding.

Collaborators

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

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Departemen Kelautan dan Perikanan

Universitas Sam Ratulangi Manado

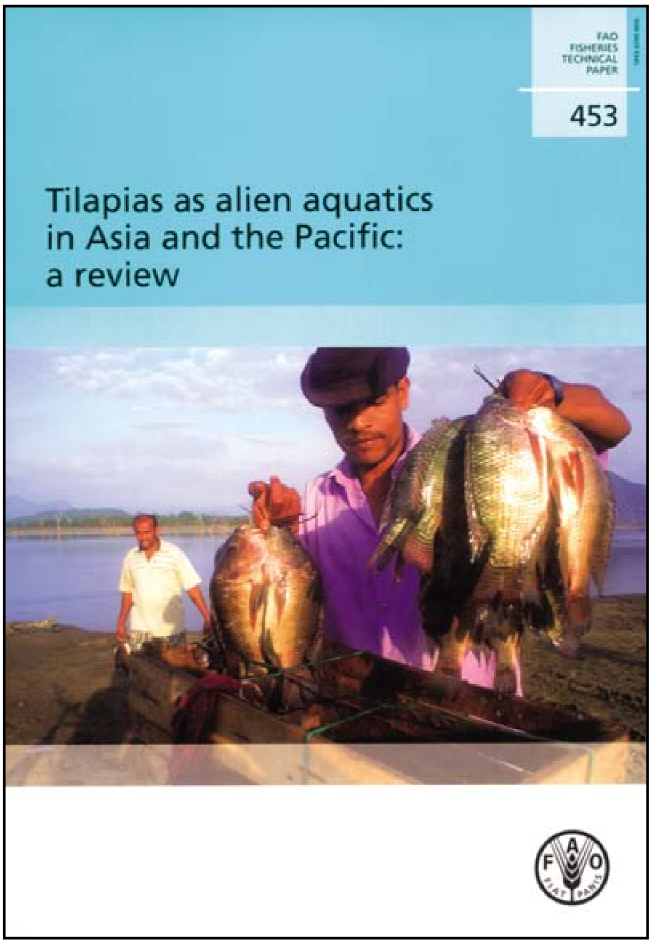
Department of Fisheries Malaysia

CSIRO

SEAFDEC

What's New in Aquaculture

Tilapias as alien aquatics in Asia and the Pacific: A review



By Sena De Silva, Rohana Subasinghe, Devin Bartley and Alan Lowther.

Tilapias play a significant role in global aquatic production through aquaculture, culture-based fisheries and capture fisheries. Although native to Africa, since their introduction to Asia, tilapias have been established in many countries and have contributed to increased aquatic food production, economic development and rural livelihoods. However, concerns that tilapias adversely impact native aquatic biodiversity have been expressed in literature and policy documents. Considering the socio-economic importance of this group of fish and the concerns raised regarding their negative impacts, particularly in Asia, this book was prepared to review the status of tilapias in the region and to address these issues. The aim is to provide a usable reference on the status of tilapias in Asia and the Pacific and to stimulate rigorous examination of the benefits and risks of using this group of alien species in fisheries and aquaculture.

The book is available as FAO Fisheries Technical Paper No. 453, ISBN 92-5-105227- 1. You can download a copy for free from the FAO website at: http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/007/y5728e/y5728e00.htm.

Australian animal diseases significant to Australia

An easy-to-use field guide that helps identify aquatic animal diseases is now available on CD-ROM. This is an update of the first version originally published as the book Aquatic Animal Diseases Significant to Australia: Identification Field Guide. The new CD updates information on diseases listed in the first edition, reflecting increased understanding and improved diagnostic capability.

The CD aims to be a reference guide that helps these people make speedy and informed decisions regarding a range of aquatic animal health issues. It draws heavily on images to help people quickly recognise the possibility that they might be dealing with a serious disease, and includes a list of contacts in each State and Territory that people can report a disease finding to, as well as diagnostic links for fish pathologists and veterinarians.

The field guide was produced by the Australian Government's Department of Agriculture, Fisheries and Forestry (DAFF) together with industry, research institutes, States and Territories, and the Fisheries R&D Corporation. Copies of the field guide CD-ROM are available by contacting aah@daff.gov.au, or you can browse it online through the Disease Watch website http://www.disease-watch.com/documents/CD/index/index.htm.

For further information: Contact: David Crisafulli 02 6277 7270 or 0400 144 483. E mail: david.crisafulli@affa.gov.au.

African catfish for urban aquaculture

...continued from page 12.

After six weeks the stocking density is reduced and the fishes are graded according to size. Under optimal conditions the fish grow to an average market size of 700 to 800 g in 8 months with an average yield of 40 tons/ha/annum. However, farmers in Bangalore are getting an average of one kg size in 5-6 months with a stocking density of 70,000/ha.

Good market demand

The primary driving force behind the development of many urban aquaculture activities is the high demand for aquatic products in urban markets. Farmers engaged in urban aquaculture have a number of advantages over rural producers, such as their proximity to markets so that they or their intermediaries are able to deliver fresh/live products regularly to consumers, potentially securing a market premium12. Most of the farmers in and around Bangalore are happy with a farm gate price of Rs 27 per kg (US$0.58). Besides this, smoked and dried products of this fish have a good international market value.

Aquaculture activity as an additional income provider

Most of catfish farmers in Bangalore are practicing catfish culture as an additional income-generating source beside their regular agricultural activities. In an estimate it is suggested that urban aquaculture around Kolkata had created direct employment for 8,000 people. and around 20,000 are indirectly employed in associated sectors related to this activity10. As the migration to the cities is increasing day by day, such activities create much needed employment opportunities.

Other social benefits

The contribution of urban aquaculture to food security for poor households and communities has not been widely considered. However, there is a growing recognition that in some areas it may play a significant role. Products from aquatic systems, particularly fish, are important in ensuring the health and nutrition of many poor people who are prone to nutritional deficiency diseases. It is reported that in Bangladesh, fish consumption makes a significant contribution to the nutrition of poor people[11]. The nutritive profile of African catfish is given below.

This indicates nutritive value of catfish as good as any other quality animal protein. The fat content is also less so it can become a part of nearly anyone's diet.

The local production of these catfishes has caused a drastic reduction of market price from Rs 120 to Rs 40. This is mainly due to reduced transport cost, which in turn helps poor people to get quality protein at an affordable price.

Regulation of urban/peri-urban African catfish aquaculture activity

State fisheries departments and the aquaculture authority can jointly regulate the urban/peri-urban African catfish aquaculture activities. Some suggestions regarding the regulation of these activities are discussed below.

1. Strict guidelines must be adopted and enforced to keep the fish in their culture ponds.
2. Specifications for construction and maintenance of enclosures should be emphasized to minimize the escape of fishes from the enclosures.
3. Culture ponds should be isolated so that there should not be any risk to natural ecosystem.
4. Fish culture may be restricted only to non-monsoon months.
5. Brood stock management and breeding programmmes are to be done with strict vigilance and care.
6. The best scientific advice must be used while evaluating the risk factors posed to native fauna by possible escapees.

Conclusion

The negative publicity concerning this species has restricted its usage in urban aquaculture, with its favorable characteristics often overlooked due to some management problems. Strict guidelines, their implementation and monitoring of culture activities of this species would be highly beneficial to urban aquaculture. There should be thorough discussion on African catfish as a candidate for urban aquaculture. If we dream to produce the 'Broiler fish' perhaps this is the species of choice.

References

1. WRI, 1999, Urban Environment , World Resource Institute, Washington D.C.
2. Sawio J Cumulus (1994) CFP REPORT 10- urban aquaculture sustainable Dar Es Salaam project, IDRC, Canada
3. Starling, F.L.R.M. 1998. Development of biomanipulation strategies for the remediation of eutrophication problems in an urban reservoir, Lago Paranoa, Brazil. PhD Thesis, University of Stirling, UK. p. 226.
4. Sy, D.Y. and T.D. Vien. 2002. The role of aquaculture in pollution-remediation in Tay Lake and Truc Bach Lake of Ha Noi. Paper submitted to the RUAF email conference on Appropriate Methods for Urban Agriculture, 4-16 February 2002.
5. Liu, J. and Q. Cai. 1998. Integrated aquaculture in Chinese lakes and paddy fields. Ecological Engineering 11, 49-59.
6. Bunting, S.W., Kundu, N. and Mukherjee, M. . 2002. Situation analysis: production systems and natural resource management in PU Kolkata. Sterling, UK: Institute of Aquaculture, University of Sterling
7. FAO 2003 Year book of fisheries statistics 2001. Food and Agricultural organization of United Nations Rome 2003.
8. Murray F., 2000. Small scale farmer managed aquaculture trials in Raichur district, Karnataka state, India, "Mid-term progress report and back to the office report 4". Aquaculture in small scale farmer managed irrigation systems. DFID Aquaculture Research programme,(ARP) Project R7064.
9. Technology Information Forecasting & Assessment Council (TIFAC), (2001) Utilization of Slaughter House Wastes for the Preparation of Animal Feed, TLBP.
10. Kundu, N. 1994. Planning the Metropolis, a Public Policy Perspective. Calcutta, India: Minerva Associates Ltd.
11. Thilsted, S.H., N. Roos and N. Hassan. 1997. The role of indigenous fish species in food and nutrition security in Bangladesh. Naga 20(3-4), 82-84.
12. Bunting S. W and Little D. C Annotated bibliography of Urban Aquaculture Resource center for urban agriculture and forestry.

6th Symposium on Diseases in Asian Aquaculture (DAA VI), 24-27 October, Colombo, Sri Lanka

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

http://library.enaca.org/PDF/DAA_VI_First_Announcement.pdf.

Training course on Fish Quality Assurance, November/December 2005, India

An international training course on Fish Quality Assurance will be held at the Fisheries College and Research Institute of Tamil Nadu Veterinary and Animal Sciences University, India. The course will be four weeks in duration, and will be held towards the end of 2005 in November-December.

Lectures will cover quality assurance, total quality management (TQM), HACCP, GMP, SSOP, SCP, ISO 9000 standards, USFDA regulations, EU hygienic regulations, microbial hazards, microbial quality indices, marine toxins, chemical hazards, biochemical quality indices, instrumentation, recent trends in fresh fish preservation.

Practical sessions will cover microbial laboratory procedures, safety, plant hygiene, sanitation studies, enumeration of different indicator organisms, isolation and identification of seafood borne bacterial pathogens, estimation of biochemical quality indicators and fat degradation products, testing of antibiotic residues, determination of pesticide residues, histamine analysis, analysis of sulfite residues, testing of available chlorine and active iodine in sanitizers, packaging of fresh fish in dry ice and gel ice, vacuum and modified atmospheric packaging of fresh fish, and gas composition determination in MAP packs using a gas analyser.

Field visits will include fish landing centres, fishing harbours and a seafood processing plant (EU approved).

For more information, contact ttn_jerosh99@sancharnet.in or download the course prospectus http://library.enaca.org/PDF/quality-assurance-05.pdf.

7th Indian Fisheries Forum, 7-12 November 2005

Indian fisheries and aquaculture have become an important economic activity in the country as also a potential sector for diversification and value addition in farming. With the blend of traditional know how and new sciences, efficiencies have been enhanced, fish yields have been increased and the blue revolution is becoming a reality. New paradigms however are emerging in the context of the WTO regime that would operate from beginning 2005, pertaining to trade and profitability, environmental sustainability, water management, species diversification, movement of aquatic animals and so on. It is again time to take stock of our achievements, capabilities, challenges as well as opportunities. The Main objectives of the 7th Indian Fisheries Forum are to:

- Provide a scientific platform to deliberate on research accomplishments and to identify the R & D needs in the sector
- Provide opportunity to hear experts in strategic fields and interact
- Develop strategies for bringing in awareness on environmental issues and socio-economic benefits for better technology transfer
- Understand modern techniques of resource management
- Encourage young scientists to undertake need based and resource specific research
- Address the problem of resource constraint in the expansion of fish production activity
- Participate/visit exhibition/Trade show/Aqua show to understand recent developments in field of science, technology, equipments etc.,

For more information, email cvasu@7iff2005.org or visit http://www.7iff2005.org/.

Fisheries and Sustainable Development Symposium, Iran, 9-10 November 2005.

The Department of Fisheries Sciences and Technology in Islamic Azad University of Ghaemshahr (IAUG), IRAN, along with National partners, announce the Fisheries and Sustainable Development Symposium (FSDS), to be held 9-10 November 2005 in Iran. The symposium will be held in English and Persian languages.

Sessions will include: Fish and Shellfish Aquaculture, Fish Biology and Ecology, Fishing Technology, Processing and Preservation of Fish Product, Biochemistry and Physiology of Fish, Feeding and Fish Nutrition, Fish Genetics Breeding and Biotechnology, Stock Assessment and Fish Disease.

- Deadline for Papers: August 6, 2005
- Submit papers in Times New Roman 10 point font, Word 2000 or above.

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