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Mycotoxins in aquaculture feeds

Model freshwater prawn farm

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NACA

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

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Health issues are not going to go away

As a relatively new industry the knowledge base of 'modern' aquaculture lags a long, long way behind that of terrestrial agriculture. This is particularly evident in the rate at which 'new' diseases emerge, the latest concern being acute hepatopancreatic necrosis syndrome of shrimp, often known by the catch-all 'early mortality syndrome'. While new diseases still turn up occasionally in terrestrial crops and livestock, in aquaculture it seems like one thing after another. Epizootic ulcerative syndrome and grouper iridoviral disease in fish, whitespot, yellowhead and taura syndrome in shrimp; abalone viral ganglioneuritis and akoya oyster disease in molluscs, just to name a very few.

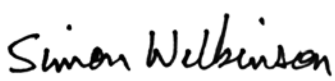
The apparent emergence of aquatic animal diseases probably has a number of contributing factors. For a start, the simple fact is that next to nothing is known about diseases in most aquatic animals because there just hasn't been any reason to look. As soon as you start rearing a new species under captive conditions at relatively high densities pathogens turn up. They may well have been there forever as a natural part of the ecosystem, we just didn't know about it until we started trying to farm a new species under (inevitably at first) sub-optimal conditions.

New diseases can also emerge when pathogens come into contact with new host species, and this is an area where the aquaculture industry bears considerable responsibility. It is a fact that the industry translocates live animals (and with them their pathogens) around the globe with near-zero regard for the health implications. Despite the menagerie of diseases that have assailed the aquaculture industry over the last twenty years and the massive multi-billion dollar losses that are incurred each year, the industry continues to regard quarantine regulations and health certification as inconveniences to be circumvented. Whenever a new infectious disease emerges you can be sure that within two or three years it will have jumped around the world and you can be doubly sure that the local industry will be putting their hands up for government assistance.

This attitude is poor and it needs to change. The cost of preventing entry of a disease agent is usually much lower than that of trying to contain an epidemic or manage a disease once it has become established. It's time the aquaculture industry started taking more responsibility for its actions.

This issue's newsletter features a report on a workshop on the latest health poster disease, acute hepatopancreatic necrosis syndrome, which was held in August 2012. Full audio recordings of the technical presentations from the meeting are available for download from the NACA website at:

http://www.enaca.org/modules/podcast/programme.php?programme_id=9



AQUACULTURE ASIA

CONTENTS

Peter Edwards writes on

Rural Aquaculture

The EU-funded project 'Sustainable and Ethical Aquaculture Trade' (SEAT) in China

This column on the EU-funded Sustainable and Ethical Aquaculture Trade (SEAT) project in Guangdong Province is based on the third and final leg of a journey I made in China in June last year. The column on the first leg, 'Aquaculture in Hubei Province, Central China', was published in Aquaculture Asia Volume XVII, No.3, pp.3-13 and the column on the second leg, 'American Soybean Association field trials in China', was published in Aquaculture Asia Volume XVII, No.4, pp. 3-13. When David Little, the Coordinator of SEAT, learned that I was visiting China, he kindly offered to sponsor my visit to the China part of the project for which I was ably guided by two of the Chinese project team, Liu Liping and Wenbo Zhang from Shanghai Ocean University.

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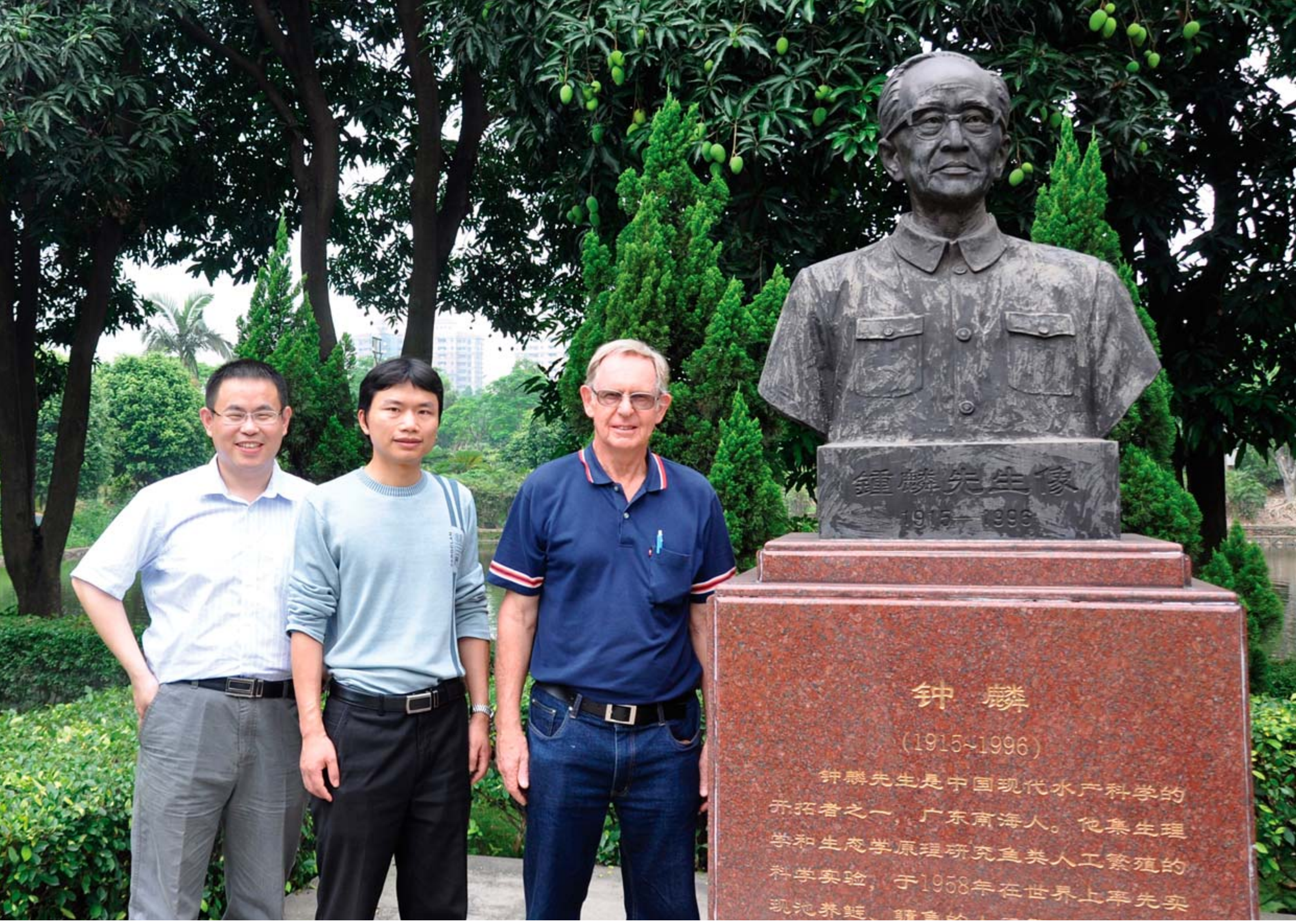
Shunde, vege table cultivation on intensive pond dike.



From left to right, my guides, Wenbo Zhang and Liu Liping at a statue commemorating, Zhong Ling, who first bred Chinese carps in the late 1950's.

The SEAT project is a large-scale collaborative research project under the EU 7th Framework Programme (FP7) that explores the sustainability of trade in aquaculture products originating from Asia. An increasing dependence on aquaculture derived seafood has resulted in the European Union (EU) importing 40 % of its seafood. SEAT is evaluating the sustainability of the aquaculture products being traded from Bangladesh, China, Thailand and Vietnam, and along the entire value chain. The project aims to provide the evidence required to support further expansion of the industry and to ensure that producers are meeting appropriate social and environmental goals and ultimately offering a product that is safe and sustainable. During the visit we looked at tilapia and shrimp, the two commodities being studies in China.

But en-route to the major tilapia and shrimp producing areas of Guangdong Province in Maoming and Zhanjiang , respectively, we visited the Pearl River Fisheries Research Institute in Guangzhou and Shunde District (formerly known as Shunde County) where the famous integrated dike/pond system used to be located.

Pearl River Fisheries Research Institute

We visited the Institute to gain an overview of aquaculture in Guangdong Province. It was an especially interesting visit for me as during a consultancy through NACA over 30 years ago I had the privilege of meeting Professor Zhong Ling who first bred Chinese carps in the late 1950's. Four major carps are farmed in the Pearl River Delta, bighead carp (*Aristichthys nobilis*), grass carp (*Ctenopharyngodon idella*), mud carp (*Cirrhinus molitorella*) and silver carp (*Hypophthalmichthys molitrix*) but not common carp (*Cyprinus carpio*). We were informed that the province has the highest developed fish culture in China, including the culture of tilapia with yields of up to 30 - 38 tonnes/ha. Grass carp remains popular with yields up to 30 tonnes/ha. A major area of R and D for the institute is the development of vaccines against bacteria and viruses for grass carp, with three different vaccines currently being available. Shunde County which we visited next has the most intensive fish culture in China, especially high-value species rather than carps, but disease is a major issue in pond culture because of the high stocking densities. The dike/pond integrated system has declined in part, we were told, because of the government discouraging the use of manure as a pond fertiliser because of food safety concerns as well as farmers wishing to farm high-value species at high density for increased profit although at higher risk.

Shunde, feeding pellets to Brazilian turtle.

Map of farm reorganisation in Jiangyi Village, Shunde District.

Shunde, feeding trash fish to carnivorous large mouth bass.

Shunde, close up of Brazilian turtle.

Shunde District

I reported on the decline of the famous dike/fish pond integrated system in an earlier column (‘From integrated carp polyculture to intensive monoculture in the Pearl River Delta, South China’. Aquaculture Asia 13, 2: 3-7) but could not resist a revisit. While the area has considerable industry and urban development, there were still 12,600 ha of ponds producing about 250,000 tonnes of aquaculture produce in 2010, an average production of about 20 tonnes/ha according to information provided by Wenbo Zhang from the Chinese internet. The total pond area has declined by about half over the past two decades and the average pond size has declined also to 0.5- 0.7 ha. Major species raised intensively are largemouth bass (*Micropterus salmoides*), mandarin fish (*Siniperca chautsi*), marbled eel (*Anguilla marmorata*), soft shell turtle (*Pelodiscus sinensis*) and snakehead (*Channa maculata)*. Yields of snakehead were reported to be as

Maoming small-scale tilapia farm.


Maoming, tilapia grass carp polyculture.

high as 150 tonnes/ha in pellet-fed aerated ponds by our local guide. According to another Chinese news report, 40% of farms were still raising the four Chinese carps in 2010 although we were only taken to visit farms raising high-value species. It was stated that the carp farms were facing financial problems as the pond rental and other costs were rising quickly. Increasing cost of production is no doubt another factor behind the trend towards the intensive production of mostly high-value species as only these can justify the use of the area for aquaculture.

We visited Jiangyi Village in Le Liu Sub-district which was almost all fish ponds; although it was classified as a rice conservation zone, land apparently could be converted from one kind of agriculture to another but not to industrial/urban use. We interviewed three farmers in the village. Unfortunately the first farmer who was raising marbled eel in a single 1.2 ha pond spoke only a local Cantonese dialect which my two colleagues from Shanghai could barely understand. He said that the farm-gate price of eel was high at US$22-32/kg but so was the price of eel larvae at a very high US$6.4 each (with 12,000 glass eels/kg, this is an incredibly high US$76,800/kg). The glass eels were nursed on chironomids with pelleted feed being used for grow-out.

The second farmer interviewed, a driver before he started farming fish 20 years ago, kept requesting us to ask more questions as he said he thoroughly enjoyed being interviewed. He recalled how the area in the past had been covered with sugar cane, mulberry bushes to provide leaves for silk worms and small-scale pig rearing integrated with fish ponds. Fish yields were very low then, only 750 kg/ha. The ponds used to be irregular in size and shape but have been rebuilt according to a government blueprint. The government only subsidised the purchase of aerators and not pond reconstruction but waived tax. The only integration remaining during the visit was small-scale vegetable raising on the dikes of pellet or trash fish fed ponds for domestic and local consumption. The old lady we met tending the vegetables was the mother of the fish farmer. Farms ranged in size from 0.4 ha to 13-23 ha. One farm was over 67 ha but had three stakeholders. As investment in intensive fish culture was very high, even for the smaller farms, only the more experienced farmers remained in business.

This farmer had two 0.67 ha ponds leased from the local village committee in which he was currently raising Brazilian turtle (*Hydromedusa maximiliani*) on pelleted feed for both human food and pets. Production was 30-37.5 tonnes/ha/ 2 year crop but the price had fallen recently from US$5.1-5.8 to $3.8-4.2/kg because of overproduction leading to market saturation. He farmed carps for the first 10 years but changed species because of low profit and even financial loss. He successively changed species from largemouth bass, to soft shelled turtle and then to channel catfish (*Ictalurus punctatus*) before raising Brazilian turtle. He reported that some farms in the area were still raising channel catfish but the species was not good as it could not be raised at very high density and the

Maoming, pigs on pond dike.

price was low. He also reported that snakehead was usually very profitable because of extremely high density of culture even though the farm-gate price was relatively low but last year the price was especially low due to overproduction and market saturation. However, the price of snakehead had risen recently as most farmers in the area had stopped culturing it so presumably more farmers would do so again.

Maoming

We visited a large hatchery, several grow-out farms, a processing plant in the so-called tilapia ‘Golden triangle’ of Maoming as well as markets in Zhanjiang City.

Major informant

Our main informant was Li Rui Wei, Vice Chairman of the Maoming Tilapia Association as well as a shareholder in a large hatchery business who gave us an overview of the tilapia industry. The main problem was the current low price of tilapia due to overproduction as there was declining demand for export due to the global economic crisis. While export of tilapia only began about 20 years ago, it peaked in 2010 with about 80% being exported but at the time of the visit in June 2012 it was believed to be about 50:50, export : domestic consumption.

There are more than 30 tilapia hacheries in Maoming, 10 of which are very large producing 20 million fry and fingerlings annually. Seventy percent of the seed are GIFT and 30% the *Oreochromis niloticus* x *O. aureus* hybrid. The main problem in the hatchery business was declining demand for tilapia seed. Farmers were purchasing fewer tilapia fingerlings as they were either stocking other species in polyculture with tilapia or changing to other species such as grass carp, crucian carp (*Carassius carassius*), channel catfish or freshwater pomfret (*Piaractus brachypomum*).

Tilapia fingerlings of 2-3 cm were mostly stocked at 2-3/m^2 and grow to 500g in an aerated, mainly pellet-fed, single stock/single harvest system in ponds for 5-6 months. The government did not allow cage culture in reservoirs because it causes eutrophication. Yields were at least 15 tonnes/ha/crop.

Previously fingerlings were nursed in another stage to 5-6 cm before grow-out but this has been discontinued because of rising labour costs. Thus, the traditional South China multi-grade system was not now used for tilapia. A major problem in pond grow-out was increasing incidence of streptococcal disease, especially in September when the water quality in the ponds was poor due to increasing eutrophication.

Specialised nurseries which nurse fry to fingerlings are not common with hatcheries as well as large farms doing nursing. I asked whether there is a niche for small-scale farmers to nurse tilapia fry to fingerlings in China but was informed that small-scale farmers only do grow-out although some did nurse 20 years ago. Nursing is so much more profitable than grow-out that there is too much competition for small-scale farmers. Furthermore, nursing requires considerable skill; and the average sized pond of a small-scale farmer of 0.67 ha is too large to nurse efficiently.

We were also informed that there are more than 70 feedmills in Maoming producing several thousand to several hundred thousand tonnes of mainly sinking pellets per year for tilapia. Farmers used to make farm-made feeds but today purchase feed from feedmills. Tilapia pellets cost $576/tonne, considered by farmers to be a high; and an ever rising price due to increasing prices of ingredients such as fish meal and soybean meal which are mainly imported. Farmers were buying less feed because of its high price as well as stocking fewer tilapia so both the intensity of tilapia culture as well as the area of ponds was decreasing.

However, the Vice Chairman thought that tilapia has a bright future because the domestic market has promise. Sea fish was already becoming very expensive in China so consumers may turn increasingly to tilapia as indeed happened in Thailand more than a decade ago. There was a plan to provide tilapia to workers in a Volkswagen factory in Shanghai as well as to develop value-added products. A ‘gourmet festival’ was to be held in Maoming at which tilapia was to be promoted. Clearly the image of tilapia needs to be improved in China to increase domestic consumption. This is especially so for Central and Northern China where tilapia is much less known and appreciated.

Non-integrated pig/fish farm

Although almost all tilapia in Maoming was raised in pellet-fed ponds, we tried to find an integrated pig/tilapia fish farm. We interviewed a farmer with pig sties on his 3.3 ha farm but discovered that he was raising tilapia in pellet-fed aerated ponds; the pond dikes had been leased to two other farmers to raise pigs independently, with the manure removed from the farm and sold as a crop fertiliser. However, the fish farmer had previously raise fish integrated with pigs so we were able to obtain a comparison of pig manured and pellet-fed ponds.

Pig manure and pelleted feed usually gave similar production per cycle, 15 tonnes/ha, although sometimes the production reached 22.5 tonnes/ha with pellets. The major difference is two cycles/year were possible with pellets because of faster fish growth compared to only one cycle with manure. However, even with pellets it was not always possible to harvest two crops/year due to poor quality seed with slow growth and considerable breeding in the pond. A minimum of 300 g was the marketable size of tilapia. Usually 70-80% of the harvest was greater than 500g with 20% weighing 300-500g. Fish less than 300g were sold at only $0.3/kg as turtle feed. Tilapia dominated in polyculture at a stocking density of 4.5/m^2 with a few individuals of bighead carp, grass

Maoming, pig manure collected for crop fertiliser.

Maoming, large-scale tilapia hatchery.

carp and Wuchang fish (*Megalobrama amblycephala*). He had been using this polyculture since he started farming fish 20 years ago. He used to hire two workers to cut grass for the grass carp but could not afford to hire even one worker today because of the increased price of wages even if he could find someone willing to work on the farm because of a shortage of labour.

A major problem starting the previous year was bacterial disease which led to him losing half his crop of fish. The farm-gate price of tilapia of $1.2/kg was below the production price of $1.3/kg for land rent, seed and feed and excluding cost of labour. The highest farm-gate price was US$1.8/kg in 2010.

Large tilapia farm

The 15 ha pellet-fed, aerated farm was being run by a former chicken farmer since 2004 with a 10 year lease for the constructed fish farm of $2,400/ha although the lease had recently been increased by 50%. The water source was reported to be good, from a reservoir. Concrete lined ponds were 4 m deep, ponds with earthen dikes 2-3 m deep. Ponds varied in size but the optimum size was reported to be 1.3 ha. Grass was controlled by buffaloes.

GIFT strain used to be stocked as it was more productive than the traditional hybrid but as the former was more susceptible to disease the farm had stocked the traditional hybrid again. Tilapia were normally stocked at 2-3/m^2 with small numbers of bighead and silver carp to reduce plankton as well as largemouth bass and snakehead to consume tilapia recruits from relatively ineffective sex-reversed all male tilapia stock. As farming tilapia was not now profitable, cost was being lowered by reducing the feeding rate from 2.0 -2.5% to 1.2 body weight/day. FCR used to be 1.5-1.6 but had improved to 1.4 with reduced feeding. Before reduced feeding, yields were 19- 22.5 tonnes/ha/crop but had now declined to 15 tonnes/ha/crop. Fingerlings were raised to 100g in smaller 0.4 ha ponds.

The main problem according to the farmer was total tilapia production in the area exceeding market demand and as a result the cost of production exceeding the farm-gate price.

Processing plant

We were guided around the Maoming Xinzhou Seafood Company by Zhenliang Chen, the General Manager. The plant employed 900 workers to process a total of 40,000 tonnes of shrimp and tilapia annually, with 150 tonne/day of tilapia. The plant had received several types of certification including the BAP certificate from Global Aquaculture Alliance and an EU certificate.

Maoming, large-scale tilapia farm - buffalo is the grass cutter.

Maoming, tilapia processing line.

Maoming, tilapia processing line.

Zhanjiang, live tilapia in supermarket.


Zhanjiang, tilapia on wet market.

Zhanjiang, price of live tilapia, US$1.89 per kg.

Zhangiang area, large-scale shrimp farm.

Markets

We visited a wet market and a supermarket in Zhanjiang City, both of which were selling live tilapia at a similar price of US$1.6 - 2.0/kg depending on size. The price sometimes rose to $2.9 - 3.2/kg when tilapia was in short supply. However, the markets were dominated by marine fish. Other freshwater fish such as bighead carp, crucian carp and snakehead were also being sold and at a higher prices than for tilapia ranging from $2.8- 3.0/kg.

At a high class restaurant where we had dinner, with the fish were displayed live in aerated aquaria, more than 90% were marine species. The only freshwater species available were carps: common carp, crucian carp, grass carp and Wuchang fish. Tilapia was sometimes available although few people ordered it.

Zhanjiang

In contrast to tilapia, shrimp is mainly sold on the domestic market and fetches a good price. One of the farmers told us that they never worry about the market as they can sell all they produce. In fact, China imports shrimp from countries such as Costa Rica and Thailand to meet local demand

Zhanjiang area, medium-scale shrimp farm.

as a high value product for restaurants, to be sold in local supermarkets usually in frozen 5 kg blocks, or to be exported as processed shrimp.

We visited a medium and a large size farm and saw many small-scale farms en-route.

Medium size shrimp farm

Long Tang farm, 3.3 ha in total area with 20 ponds of 1.3- 2.0 ha in size, had one owner and two hired workers. The farm had been built in 2005 on sand dunes with plastic liners to prevent water seepage. PLs of *Penaeus vannamei* were stocked at 100/m^2 in two annual crops of 80-90 days each producing 11-15 tonnes/ha. The ponds were aerated with both paddle wheels and a newly introduced diffuse aeration system, the latter reducing use of electricity somewhat but the farmer unsure whether it increased production alone although use of both systems together was reported to do so. FCR was 1.2. Larger sized shrimp produced in the first crop of 17-25g sold for $19.2/ kg compared to smaller sized shrimp of only 8 g in the second crop which sold for only $6.4/kg. Cost of production was $ 3.8- 4.8/kg.

The only problem was disease 30 days after stocking when the shrimp stopped eating and grew slowly but did not die. Production was the same but the crop took 110 days with a higher FCR.

Large sized shrimp farm

Jiaowei is a 13.3 ha farm built in 1996 on wetland producing shrimp for the local market for the Evergreen brand. The company is vertically integrated with seed, feed, processing and marketing, is certified at every stage, and is linked with INVE. The farm had been redesigned to improve production with 0.2 ha ponds said to be optimal with central drains to remove sludge 7-8 times per day. The farm used to raise *P. monodon* but changed to *P. vannamei* in 1998. They reported that diffuse aeration was no better than using paddle wheels but both together gave better production. In the new smaller ponds they stock at a high density of 200-300 PLs/m^2 and get a production of 15-30 tonnes/ha/crop of shrimp with a size of 12.5-16.6 g with a FCR of 1.2.

Zhanjiang area, small-scale shrimp farm.

Oyster aquaculture for coastal defense with food production in Bangladesh

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The coastal zone of Bangladesh spans across over 47,000 km^2 and is home to over 35 million people, about one-third of the country's total population. The people living in this zone are almost entirely dependent on natural resources and actively rely on coastal shorelines, including around 166,000 km^2 of maritime territory for resources such as fish, shrimp, crab, sea salt extraction, hydrocarbons, and other ecosystem goods and services. At the same time these people are extremely vulnerable to coastal erosion, tropical cyclones and storm surge. In particular, the floods in the monsoon months (May-August) due to heavy rain and storm surge often impact the lives, livelihoods, property and environment, leading to substantial economic losses. Moreover, land loss due to erosion is a chronic problem in many coastal areas and chars/ islands, such as Kutubdia, Sonadia, Moheshkhali, Kalatali and Himchari, frequently affecting poor communities.

Unfortunately, not much has been done to curb erosion or to protect erosion-prone areas, or to develop alternative livelihoods for people likely to be affected. Conventional barrier techniques such as concrete blocks, earthen dikes and sand-filled tubes are generally seen to be the only ways to reduce or reflect wave/current energies. Year after year huge sums of money have been invested to build and sustain these engineering structures as a means of defense against coastal flooding and erosion, often providing only short-term solutions. Projections of future changes in climate indicate accelerated sea level rise, enhanced monsoon precipitation and run-off, increased in cyclone frequency and the possibility of altered sediment dynamics which are likely to worsen an already grim environmental situation. Climate change may prove to be a serious impediment to the economic develop-

The study site at Ali Akbar Dail, Kutubidia Channel, Bangladesh.

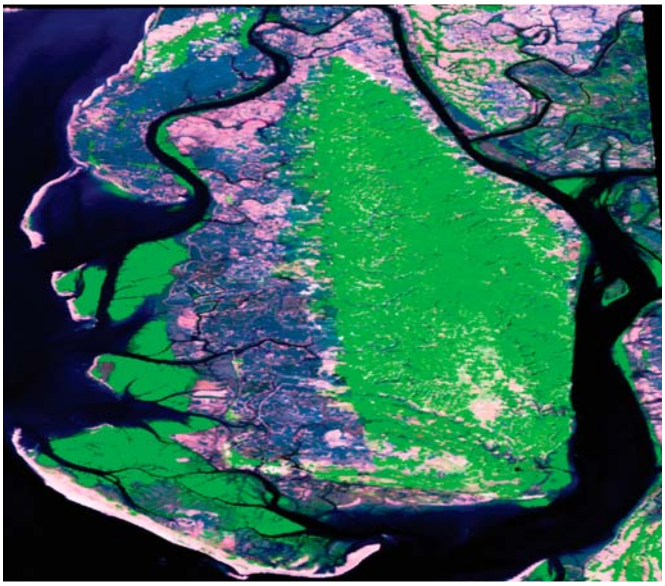
ment of Bangladesh because of its geographic exposure, greater reliance on climate sensitive sectors, low incomes, weaker adaptive capacity and dependence on aid.

Despite their potential as long-term coastal defenses other less expensive alternatives such as beach/shore nourishment, wave barrier fencing, dune grass planting and use of mangroves and artificial reefs to provide shoreline buffers have apparently not being tested anywhere in Bangladesh. Within this context, the concept of 'ecosystem engineering' solutions warrant exploration.

Oysters (*Crassostrea* spp.) are ecosystem engineers that create, modify or maintain habitats and ecosystem processes through their activities the structures that they create. Oysters can be potentially used as ecosystem engineers in providing natural solutions for coastal defense. Oysters are capable of forming conspicuous habitats that influence tidal flow, wave action and sediment dynamics in the coastal ecosystem and, in doing so, reduce hydrodynamic stress and modify the patterns of local sediment transport, deposition, consolidation, and stabilisation processes. Bivalve reefs also provide habitat for numerous species of fish, crustaceans and other invertebrates and can contribute to food security and livelihoods for coastal people. A 'living shoreline' with artificial oyster reefs could be self-sustaining elements for coastal protection and provision of ecosystem goods and services.

The objective of our project was to investigate the efficiency of various substrates as settlement sites for the collection of natural oyster spat. This was intended as a first step in providing seed stocks that coastal people could use for food, to generate sustainable livelihoods or to initiate development of natural oyster reefs to mitigate coastal erosion associated with climate change.

Geographical location of the experimental sites at Ali Akbar Dail at Kutubdia Channel (above) and Adinath Temple Jetty at Moheshkhali channel of Cox's Bazar (below), Bangladesh.



Adinath Temple Jetty, Moheshkali Channel, Cox's Bazar.

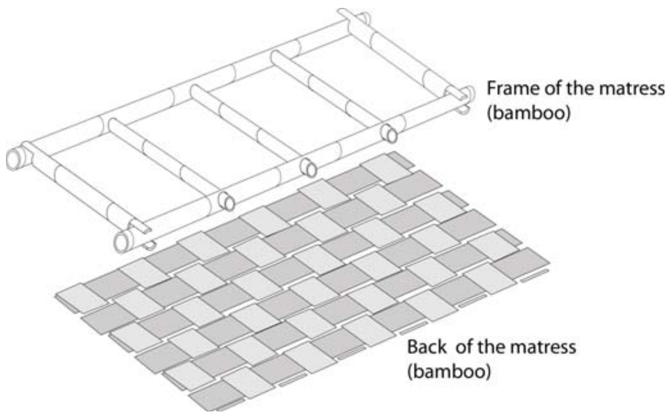
Above, below: Mattress design and local craftsmen orientation for preparation.

Project area

The present study was conducted near Cox's Bazar at the Adinath Temple Jetty, Moheshkhali Channel and Ali Akbar Dail Village, Kutubdia Channel. In these areas oysters naturally settle on hard artificial substrates such as the pylons of jetties and bridges, the sluice gates of saltpans and on concrete blocks built for shoreline protection.

Moheshkhali Island

Moheshkhali Island of Cox's Bazar district under Chittagong division and has an area of 362 km^2 with a population of 220,000. The eastern part of the island is separated from the mainland by the Maheshkhali Channel, which is about 2.1 km in width, become narrower towards the north. The distance between Cox's Bazar (Kostura Ghat) and Moheshkhali (Gorakghata) is about 9.5 km. Salt extraction, agriculture and fisheries are the main activities on the island. The selected site, which is located at the southeast side of the island near the Adinath Mandir Jetty is a relatively small mudflat with small patch of mangrove forest. The forest has been cultivated since the 1970s with the last mangrove plantation in 2012. The soft sediment of the mudflat allows 1.5 to 2.0 metre long poles to be easily pushed into the soil.



Local bamboo materials for mattress construction.

Kutubdia Island

Kutubdia Island lies off Cox's Bazar with an area of 93 km^2 and a population of about 106,000, representing around 18,550 households. The eastern part of the island is separated from the mainland by the Kutubdia Channel, which is around 3.2 km in width. Salt extraction, agriculture and fisheries are the main activities on the island. The experimental site is located at the southeast part of the island, at the coastal village of Ali Akbar Dail. A muddy 150 metre wide tidal flat is present at the site. The shoreline is protected by an earthen embankment coated with 10 cm breadth brick-cement layers.

Approach

Bamboo mattress preparation and installation

Bamboo "mattresses" to hold various test substrates were constructed with assistance from local craftsmen. These essentially functioned as spat collectors. The mattresses were made using local thick-walled bamboo (*Bambusa balcooa*) for the frame and thin-walled bamboo (*Melocanna baccifera*) for the woven mat. Each mattress was divided into four compartments to contain different substrates, namely of dead oyster shell, live oysters, windowpane shell and stone/rubble. The substrate quantities were counted and measured before keeping in the mattress compartment. The prepared mattresses with required substrates were installed in the desired sites.

Data collection

Data were collected fortnightly in each full moon and new moon events from both the experimental sites. Water samples were collected and analysed for selected parameters in the field as well as in the laboratory. Oyster spat densities in each substrate were measured using high resolution photography techniques (Loosanoff et al. 1966; O'Sullivan, 1978; Davenport and Glasspool, 1987 and Hendriks et al. 2005) using a 38cm x 38cm quadrate frame as a dimensional reference scale for growth measurement. Time series photographic analysis of visible oyster spat in same area of every substrate was conducted to count and measure spat density, growth and survival rate. Length and width of oyster spat were measured from the fortnightly snapped photographs. The length measurement represents the longest distance along the anterior-posterior line of the spat shell, roughly parallel to the hinge (Hendriks et al. 2005). The width is the distance from the tip of the umbo to the ventral margin of the spat shell (Loosanoff et al. 1966 and Hendriks et al. 2005). Data were analysed using SPSS, Excel and PAST software.

Landsat satellite imager was analyzed using ENVI and geo-spatial mapping of experimental sites were developed using ArcGIS.

Findings

Water quality

Assessment of water quality at the study sites is summarised in the table below.

Most suitable substrate for oyster spat settlement

The highest settlement of oyster spat was observed on the windowpane shell substrate at both Ali Akbar Dail Village (180 spat/m²) and Adinath Mandir Jetty (208 spat/m²) during the second week of the experiment. Spat settlement was observed in live oyster shell at both sites, dead oyster shell at Adinath Temple Jetty and stone/rubble at Ali Akbar Dail Village in the the 8th week of the experiment.

To assess the performance of different substrates for spat settlement Principal Component Analyses (PCAs) were executed. Spat abundance data during different sampling periods on different cultch materials were used to display PCA. Only axes 1 and axes 2 were plotted for Adinath Mandir Jetty, as they accounted for 54% (λ=102.90) and 36% (λ=69.59) respectively of the total variability in spat abundance. The relative length of the vectors indicates that, windowpane shell has the best performance as a substrate for spat settlement, followed by live oyster shell and dead oyster shell. Similarly, for Ali Akbar Dail Village axes 1 and axes 2 were also plotted, as they accounted for 58.78% (λ=95.30) and 33.50% (λ=54.32) respectively of the total variability in spat abundance. The relative length of the vectors indicates that, windowpane shell has the highest performance in respect of spat settlement followed by stone, dead oyster shell and live oyster shell.

Table 1. Sampling schedule for data collection and monitoring.

Date	Moon's phase	High Tide	Low Tide
May 06	Full	10:18	17:36
May 21	New	10:44	17:28
June 04	Full	10:05	17:29
June 19	New	10:30	17:11
July 04	Full	10:39	18:10
July 19	New	10:46	17:45
Aug 02	Full	10:30	17:56
Aug 17	New	10:24	17:31
Aug 31	Full	10:18	17:33
Sep 16	New	10:23	17:46
Sep 30	Full	10:32	17:35
Oct 15	New	09:56	17:15

Substrate mattresses ready for installation.

Survival and growth of spat

Extensive post-settlement mortality was recorded amongst spat over the 24-week experimental period, predominantly due to relatively low salinity and high siltation caused by heavy rainfall and high river discharge in monsoon months. By the end of the experiment survival across the two sites ranged from 7-28 spat/m^2 on windowpane shell, 14 spat/m^2 on live oyster shell, 0-21 spat/m^2 on dead oyster shell, and 7-14 spat/m^2 on the stone and rubble substrates.

Photographic measurement of the shell size (length and width) of oyster spat was carried out as estimator of growth. Over a 24-week time frame, the length of spat among different substrates grew from 0.4-0.5 cm initial length to 3.4-3.5 cm final length, with initial length growing from 0.6-0.8 cm to around 3.6 cm. Shell increments typically provide information on growth of oyster from hatching to maturity.

Factors limiting spatfall and their survival

The failure of natural spatfall and settlement would be the most important single factor affecting the establishment of oyster reefs. In this connection, several factors were identified which might limit spat settlement and their survival in the Moheshkhali and Kutubdia Channels.

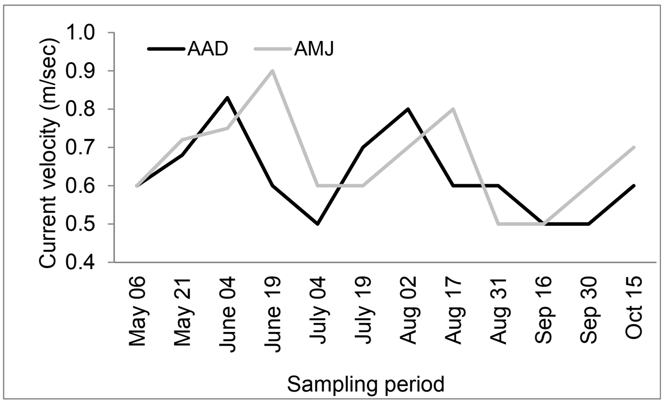
Damage to the bamboo mattress and substrate caused by extreme weather events was responsible for the reduction of spat numbers at both sites. As per local expert opinions, the bamboo structures (frame and mattress) were considered durable, economically viable and locally obtainable. However, the field data indicated that the bamboo materials were not durable when exposed to seawater and they were

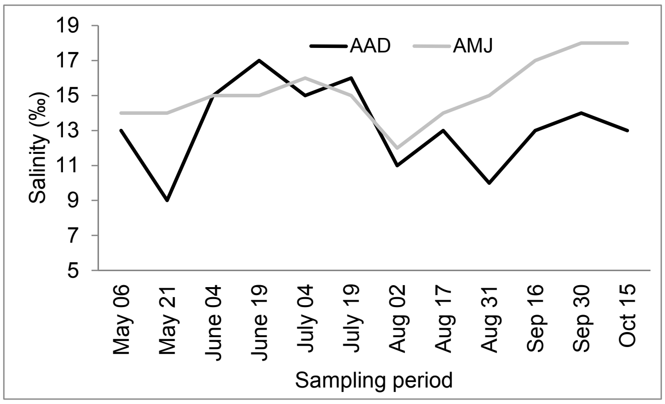
Bamboo mattress with four different substrates at Kutubdia Island.

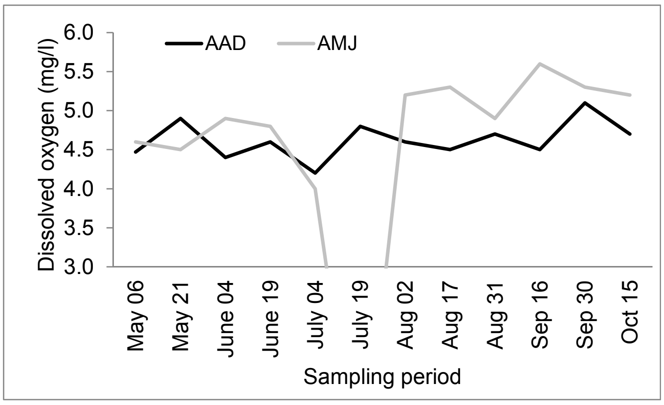
Table 2. Water quality at the study sites.

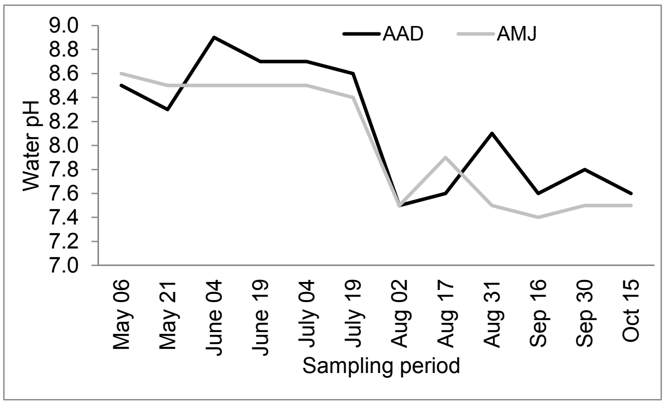
Parameter	Adinath Temple Jetty	Ali Akbar Dail Village
Water temperature	25-32°C (mean 28.4°C).	25-31°C (mean 28.3°C).
Salinity	9-17 ‰ (mean 13 ‰)	12-18 ‰ (mean 15 ‰).
pH	7.5-8.9 (mean 8.16.)	7.4-8.6 (mean 8.0).
Dissolved oxygen	4.2-4.9 mg/l (mean 4.6 mg/l).	4.0-5.6 mg/l (mean 4.9 mg/l).
Current speed	0.5-0.8 m/s (mean 0.63 m/s).	0.5-0.9 m/s (mean 0.7 m/s).
Tidal magnitude	3.6-4.3 m (mean 4 m).	3.5-4.7 m (mean 4 m).
Wave height	3.4-8.5 cm (mean 4.8 cm).	2.5-11.5 cm (mean 5.4 cm).
Primary productivity	0.8-1.6 mg C/L/day (mean 1.2 mg C/L/day).	0.5-1.8 mg C/L/day (mean 1.3 mg C/L/day).
Total dissolved solids	2.05-2.94 g/l (mean 2.63 g/l).	2.64-3.33 g/l (mean 2.89 g/l).
Total suspended solids	1,950-4,630 mg/l (mean 2,984 mg/l).	1,650-2,653 mg/l (mean 2,042 mg/l).

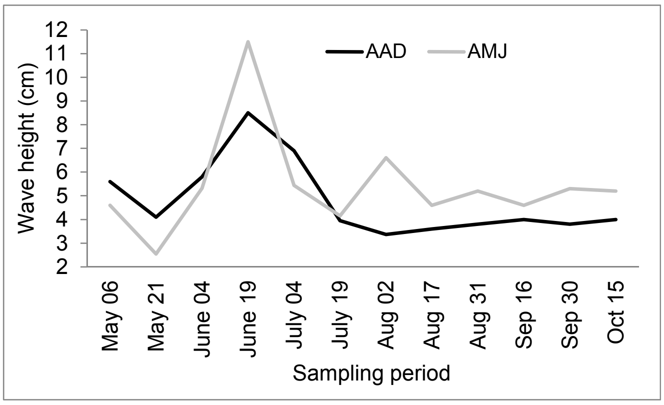
Hydrological characteristics of Moheshkhali Channel (AMJ) and Kutubdia Channel (AAD) at Cox's Bazar coast.

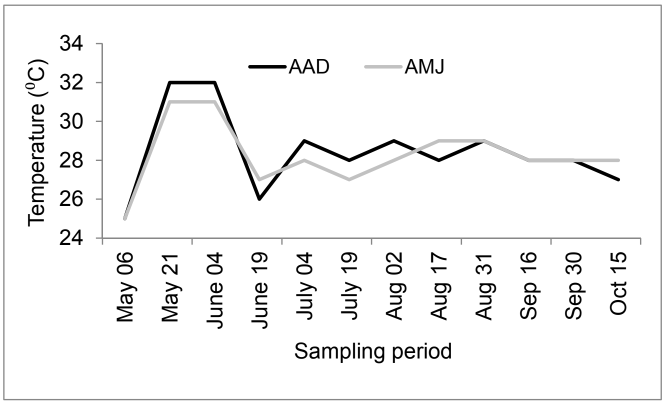












easily damaged by heavy rainfall, flash floods, wave-current force and storm surge. Thus, repairs to the mattresses, reinforcing of poles and nets were common tasks in the trial phase and ultimately might limit spatfall.

Competition for settlement space was also a factor limiting the spatfall. Several fouling species such as sea anemones, snails, and barnacles were seen on the substrates just after installation of mattresses (this reduced the space available to oysters), resulting in sporadic and reduced oyster spat settlement. We did not collect data on predation of spat by crabs which were commonly seen on the intertidal beds, sea birds or starfish. Predation may also be a significant factor limiting spat recruitment.

Another important factor observed were smothering events of 2-5 cm of sediment during heavy rainfall and high river discharge in monsoon months (particularly July and September in 2012), which lead to considerable death of

Sediment deposition on substrates at AMJ of Moheshkhali channel.

Field measurement of water parameters at Moheshkhali Island.

the settled spat population. Moreover, there was sediment deposition on cultch materials at different times which might have inhibited spatfall and at the same time delayed natural settlement. Vertical installation of settlement substrates may lead to enhanced spatfall.

In the monsoon months particularly, other factors such as increased suspended sediment, reduced salinity and increased turbidity may also affect spatfall and subsequent survival. Moreover, an increase in currents and wave action was observed during extreme weather events, and thus increased water flow rate and wave-current exposure might interfere with settlement of spat or affect survival.

Discussion

Appropriate substrates can promote molluscs spat settlement in oceanic ecosystems (Alagarswami et al. 1983; Rose, 1990; Holliday, 1996; Taylor et al. 1998). The calcium content of windowpane shell, live oyster shell and dead oyster shell may provide a chemical cue for spat settlement (Tanyaros, 2011). Higher performance of windowpane shell for spat settlement was reported by Hossain et al (2004) at Moheshkhali Channel. Afinowi (1984) found mean oyster seed densities about 100 spat/m^2 in the Niger delta, where Alvarenga and Nalesso (2006) found oyster spat densities 7-20/m^2 from southeastern Brazil, and Seale and Zacherl (2009) recorded 1-11 spat/m from the California, followed by 0.4-14 spat/m^2 by Buitrago and Alvarado (2005) from the Venezuela.

The results on the settlement, growth and survival of spats indicate that the selected field sites at Moheshkhali and Kutubdia channels are suitable for natural spatfall and for oyster growing. The required environmental conditions at two sites appear to be favourable for oysters. However, several factors such as increased suspended solids and low salinity due to heavy rainfall and higher river discharge in monsoon months, and high water flow rate and wave-current forces in extreme weather events might affect successful spatfall and their survival in the experimental sites. Competition for settlement space with other species, especially by barnacles, sea anemones and snails, was also a factor limiting the natural spatfall. In brief, there is local stock of oysters in the two sites and given suitable substrates on the soft bottom it is possible to develop oyster reefs for food, employment or as an element of coastal protection.

Oysters are ecosystem engineers; one or a few species can contribute to reef habitat formation in coastal ecosystems. Oyster reefs are important in regulating local faunal populations as well as community dynamics. Substrates with a high vertical relief can provide oysters a means of avoiding an oxygen-depleted bottom and burial in areas with high sedimentation rates (Breitburg et al. 2000). The extent to which reef structures are found in areas of suitable oxygen concentrations also greatly affects the spatial distribution, behaviour, and survival of associated fisheries (Breitburg 1999). Oysters can contribute to improved water quality. Newell (1988) calculated that prior to 1870, the oyster population of Chesapeake Bay could filter the entire volume

Oyster spat settlement on windowpane shell at Adinath Mandir Jetty, Moheshkhali channel.

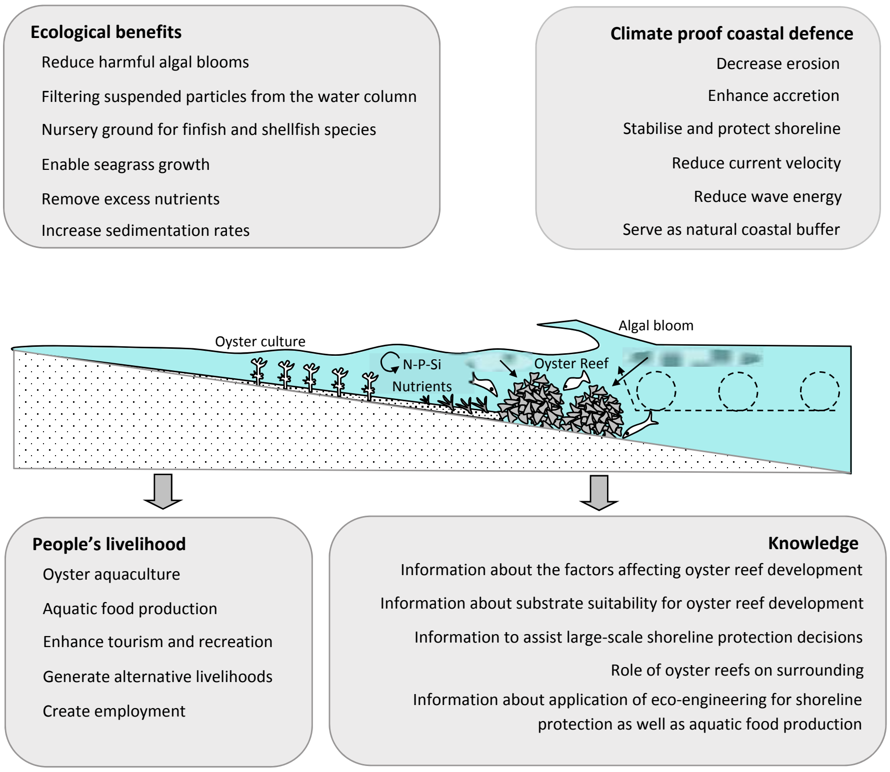
Table 3. Oyster spat settlement on different substrates at the Kutubdia (AAD) and Moheshkhali (AMJ) project sites.

Sampling period	Location	Substrate types and spat density (individuals/m²)			
		Windowpane shell	Live oyster shell	Dead oyster shell	Stone/Rubble
Week 2	AAD	180	0	0	0
	AMJ	208	0	0	0
Week 4	AAD	173	0	0	0
	AMJ	194	0	0	0
Week 6	AAD	139	0	0	0
	AMJ	139	0	0	0
Week 8	AAD	125	90	0	111
	AMJ	111	139	111	0
Week 10	AAD	111	76	111	97
	AMJ	111	111	111	0
Week 12	AAD	42	35	28	28
	AMJ	48	48	55	0
Week 14	AAD	28	28	28	21
	AMJ	48	35	42	0
Week 16	AAD	21	28	28	21
	AMJ	35	35	42	83
Week 18	AAD	21	28	21	14
	AMJ	35	35	35	55
Week 20	AAD	14	21	14	14
	AMJ	28	35	35	42
Week 22	AAD	14	14	7	7
	AMJ	28	28	28	21
Week 24	AAD	7	14	0	7
	AMJ	28	14	21	14

of the bay in 3.3 days, while the reduced oyster populations of the Chesapeake Bay in 1988 required 335 days (Coen et al. 1999).

Unfortunately, shorelines are among the most degraded and threatened habitats in the world because of their sensitivity to sea level rise, storms and increased utilisation by humans. Although the introduction of hardened structures may adequately mitigate shoreline retreat and coastal erosion, the ecological damage that result from their presence can be substantial. For sustainable shoreline protection the creation of naturally occurring biogenic habitats, also known as 'living shorelines', has garnered attention over the last decade. A living shoreline with oyster reefs could potentially feature multi-component connectivity with mangroves and sea grass succession. Benefits of such an approach can include mollusc farming, fisheries recruitment, enhancement of biodiversity, reduced erosion and attenuation of waves. These can contribute towards the resiliency of coastal communities, improved food and nutrition security, diversified income generating options and strengthened livelihoods.

Living shoreline components with anticipated benefits.



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Importance of mycotoxins in aquaculture feeds

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Mycotoxins are a diverse group of toxic secondary metabolites produced by certain moulds when they grow on agricultural products. They do not belong to a single class of chemical compounds, and they differ in their toxicological effects. Some mycotoxicoses, the toxic manifestations of mycotoxins in humans or animals, have been known for hundreds of years, for example ergotism.

Mycotoxins are not only hard to define, they are also challenging to classify and may have hepatotoxic, nephrotoxic, neurotoxic or immunotoxic effects. Cell biologists put them into generic groups such as teratogens, mutagens, carcinogens, and allergens. Organic chemists have attempted to classify them by their chemical structures for example lactones, coumarins; biochemists according to their biosynthetic origins such as polyketides or amino acid-derived; physicians by the illnesses they cause such as St. Anthony's fire, stachybotryotoxicosis; and mycologists by the fungi that produce them (e.g., *Aspergillus* toxins, *Penicillium* toxins).

None of these classifications is entirely satisfactory. Aflatoxins for example may be hepatotoxic, mutagenic, carcinogenic, difuran-containing, polyketide-derived *Aspergillus* toxin. Zearalenone is a *Fusarium* metabolite with potent estrogenic activity; hence, in addition to being called (probably erroneously) a mycotoxin, it also has been labeled a phytoestrogen, a mycoestrogen, and a growth promotant.

The importance of mycotoxins to aquaculture and animal agriculture first became apparent during the early 1960s with outbreaks of aflatoxicosis in young turkeys in the United Kingdom and hatchery-reared rainbow trout (*Onchorynchus mykiss*) in the United States. In both cases the origin of aflatoxicosis was aflatoxin-contaminated feed (peanut meal for turkeys and cottonseed meal for trout). Other mycotoxins described since then include ochratoxin A, deoxynivalenol, T-2 toxin, zearalenone, moniliformin, cyclopiazonic acid and fumonisin.

Aspergillus. Photo: by Multimotyl, Wikimedia Commons (distributed under Creative Commons Share-Alike license).

Major mycotoxins

Aflatoxins

The four major aflatoxins are called B1, B2, G1, and G2 based on their fluorescence under UV light (blue or green) and relative chromatographic mobility during thin-layer chromatography. Aflatoxin B1 is the most potent natural carcinogen known and is usually the major aflatoxin produced by toxigenic strains. It is also the best studied: in a large percentage of the papers published, the term aflatoxin can be construed to mean aflatoxin B1. However, well over a dozen other aflatoxins (e.g., P1. Q1, B2a, and G2a) have been described, especially as mammalian biotransformation products of the major metabolites.

Aflatoxins are difuranocoumarin derivatives produced by a polyketide pathway by many strains of *Aspergillus flavus* and *A. parasiticus*; in particular, *A. flavus* is a common contaminant in agriculture. *A. bombycis*, *A. ochraceoroseus*, *A. nomius*, and *A. pseudotamari* are also aflatoxin-producing species, but they are encountered less frequently. From the mycological perspective, there are great qualitative and quantitative differences in the toxigenic abilities displayed by different strains within each aflatoxigenic species. For example, only about half of *Aspergillus* flavus strains produce aflatoxins, while those that do may produce more than 106 µg/kg.

While rainbow trout are very sensitive to the presence of aflatoxin in their diets, with as little as 0.4 ppb (µg/kg of diet) dietary aflatoxin producing heptocellular carcinoma (HCC) in 14 percent of trout over a period of 15 months, warm water fish do not appear to be as sensitive to dietary aflatoxin. In an aquarium study, channel catfish (*Ictalurus punctatus*) fed diets containing up to 275 ppb total aflatoxins from moldy corn for 12 weeks showed no reductions in weight gain or survival (more than 97 percent of fish survived for all dietary treatments, including the controls). In a pond experiment, catfish fed a practical diet containing 50 percent moldy corn and at least 88 ppb aflatoxin for 130 days showed no reductions in pond productivity, feed efficiency, or hematocrit values in comparison to catfish fed diets containing 50 percent clean corn and 1 ppb aflatoxin. In a recent study, channel catfish were fed practical diets that contained up to 135 ppb aflatoxin from moldy corn for 10 weeks and subsequently challenged with the catfish pathogen *Edwardsiella ictaluri*, which causes enteric septicemia of catfish (ESC). At 21 days post-challenge, these fish did not have higher mortality than catfish fed the control diet (0 ppb aflatoxin). Channel catfish appear to be able to detoxify dietary aflatoxin. Tilapia (*Oreochromis nilotica*) did have lower weight gains, poorer feed conversion (FCR) values, and lower hematocrit values when fed diets containing 2,500 ppb or more aflatoxin. A diet with 250 ppb aflatoxin did not produce these responses. Other research showed that tilapia had reduced growth rates when fed a diet with 1,880 ppb aflatoxin for 25 days, but not when fed a diet with 940 ppb aflatoxin. Therefore, both channel catfish and tilapia appear to be much less vulnerable to aflatoxin than rainbow trout.

Citrinin

Citrinin was first isolated from *Penicillium citrinum* prior to World War II; subsequently, it was identified in over a dozen species of *Penicillium* and several species of *Aspergillus* (e.g., *A. terreus* and *A. niveus*), including certain strains of *P. camemberti* (used to produce cheese) and *A. oryzae* (used to produce sake, miso, and soy sauce). More recently, citrinin has also been isolated from *Monascus ruber* and *M. purpureus*, industrial species used to produce red pigments.

Wheat, oats, rye, corn, barley, and rice have all been reported to contain citrinin. With immunoassays, citrinin was detected in certain vegetarian foods colored with *Monascus* pigments. Citrinin has also been found in naturally fermented sausages from Italy. Although citrinin is regularly associated with foods, its significance for fish health is unknown.

Ergot alkaloids

The ergot alkaloids are among the most fascinating of fungal metabolites. They are classified as indole alkaloids and are derived from a tetracyclic ergoline ring system. Lysergic acid, a structure common to all ergot alkaloids, was first isolated in 1934. The clavines have ergoline as a basic structure but lack peptide components; the lysergic acid alkaloids include ergotamine and lysergic acid amide (ergine).

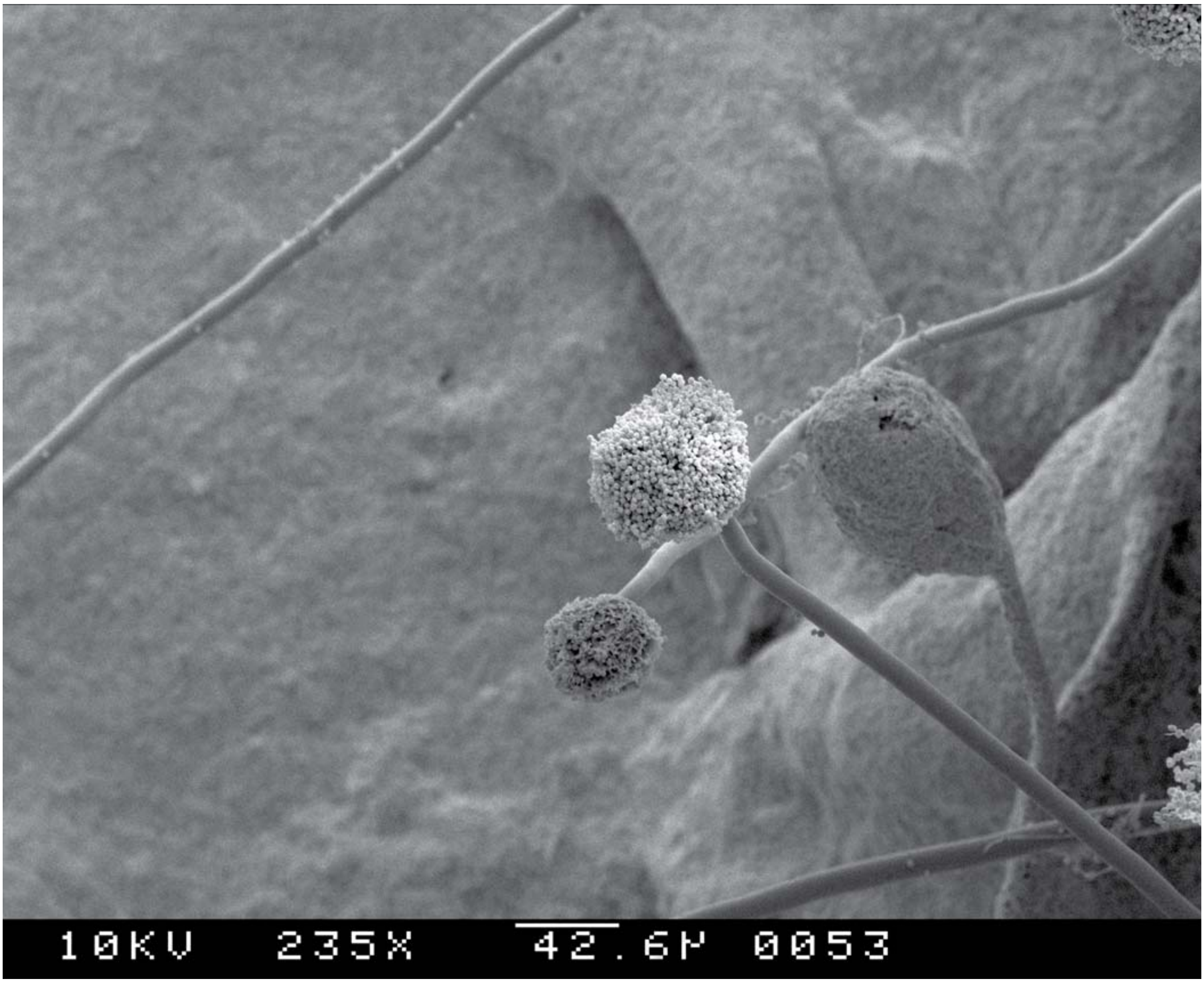
These compounds are produced as a toxic cocktail of alkaloids in the sclerotia of species of *Claviceps*, which are common pathogens of various grass species. The ingestion of these sclerotia, or ergots, has been associated with diseases since antiquity. An Assyrian tablet dated to 600 B.C.E., referring to a “noxious pustule in the ear of grain,” is believed to be an early reference to ergot. Two forms of ergotism are usually recognised, gangrenous and convulsive. The gangrenous form affects the blood supply to the extremities, while convulsive ergotism affects the central nervous system.

Fumonisins

Fumonisins were first described and characterised in 1988. The most abundantly produced member of the family is fumonisin B1. They are thought to be synthesised by condensation of the amino acid alanine into an acetate-derived precursor. Fumonisins are produced by a number of *Fusarium* species, notably *F. verticillioides* (formerly *F. moniliforme = Gibberella fujikuroi*), *F. proliferatum*, and *F. nygamai*, as well as *Alternaria alternate* f. sp. *lycopersici*. These fungi are taxonomically challenging, with a complex and rapidly changing nomenclature which has perplexed many non-mycologists (and some mycologists too). The major species of economic importance is *F. verticillioides*, which grows as a corn endophyte in both vegetative and reproductive tissues, often without causing disease symptoms in the plant. *F. verticillioides* is present in virtually all corn samples. Most strains do not produce the toxin, so the presence of the fungus does not necessarily mean that fumonisin is also present. Although it is phytotoxic, fumonisin B1 is not required for plant pathogenesis.

Ochratoxin

Ochratoxin A was discovered as a metabolite of *A. ochraceus* in 1965 during a large screen of fungal metabolites that was designed specifically to identify new mycotoxins. Shortly thereafter, it was isolated from a commercial corn sample in the United States and recognised as a potent nephrotoxin. Members of the ochratoxin family have been found as metabolites of many different species of *Aspergillus*, including *A. alliaceus*, *A. auricomus*, *A. carbonarius*, *A. glaucus*,



Aspergillus at X 235 magnification. Photo: MWolfin, Wikimedia Commons.

A. melleus, and *A. niger*. Because *A. niger* is used widely in the production of enzymes and citric acid for human consumption, it is important to ensure that industrial strains are non-producers of toxins. Although some early reports implicated several *Penicillium* species, it is now thought that Penicillium verrucosum, a common contaminant of barley, is the only confirmed ochratoxin producer in this genus.

Ochratoxin A (OA) can cause kidney damage in livestock. In a study of the effects of dietary OA on channel catfish, fish fed 4 ppm (mg/kg of diet) OA in a practical diet gained less weight than control fish and experienced obliteration of the exocrine pancreatic tissue, which is associated with the hepatic portal vein. These catfish had no lesions on the renal tissue of the posterior kidney. Channel catfish that consumed practical diets containing 2 or 4 ppm OA and were subsequently challenged with the pathogenic bacteria *E. ictaluri* had greater mortality than control catfish.

Patulin

Patulin, 4-hydroxy-4H-furo[3,2c]pyran-2(6H)-one, is produced by many different molds but was first isolated as an antimicrobial active principle during the 1940s from *Pe. patulum* (later called *P. urticae*, now *P. griseofulvum*). The same metabolite was also isolated from other species and given the names clavacin, claviformin, expansin, mycoin c, and penicidin. However, during the 1950s and 1960s, it became apparent that, in addition to its antibacterial, antiviral, and antiprotozoal activity, patulin was toxic to both plants and animals, precluding its clinical use as an antibiotic. During the 1960s, patulin was reclassified as a mycotoxin.

Patulin has also played an important role in the study of the classical biochemistry of polyketide biosynthesis. The first cell extract for a fungal polyketide synthase involved studies on a 6-methylsalicylic acid synthase from the species then called *P. urticae* (now *P. griseofulvum*).

Trichothecenes

The trichothecenes constitute a family of more than sixty sesquiterpenoid metabolites produced by a number of fungal genera, including *Fusarium*, *Myrothecium*, *Phomopsis*, *Stachybotrys*, *Trichoderma*, *Trichothecium*, and others. The term trichothecene is derived from trichothecin, which was the one of the first members of the family identified. All trichothecenes contain a common 12,13-epoxytrichothene skeleton and an olefinic bond with various side chain substitutions. They are commonly found as food and feed contaminants, and consumption of these mycotoxins can result in alimentary haemorrhage; direct contact causes dermatitis. Trichothecenes are classified as macrocylic or nonmacrocyclic, depending on the presence of a macrocylic ester or an ester-ether bridge between C-4 and C-15. The nonmacrocylic trichothecenes in turn can be subclassified into two groups: type A, which have a hydrogen or ester type side chain at the C-8 position, and include T-2 toxin, neosolaniol, and diacetoxyscirpenol, while the type B group contain a ketone and include fusarenon-x, nivalenol, and deoxynivalenol. *Fusarium* is the major genus implicated in producing the nonmacrocylic trichothecenes.

The trichothecenes are extremely potent inhibitors of eukaryotic protein synthesis; different trichothecenes interfere with initiation, elongation, and termination stages. Trichodermin was the first trichothecene shown to inhibit peptidyl transferase activity. Subsequently, it would appear that while all trichothecenes inhibit peptidyl transferase by binding to the same ribosome-binding site, they exert different effects which can be correlated with different functional groups. The 12,13-epoxide group is essential for inhibition of protein synthesis; reduction of the 9,10 double bond reduces toxicity.

Zearalenone

The zearalenones are biosynthesized through a polyketide pathway by *F. graminearum*, *F. culmorum*, *F. equiseti*, and *F. crookwellense*. All these species are regular contaminants of cereal crops worldwide.

Zearalenone (6-[10-hydroxy-6-oxo-trans-1-undecenyl]-B-resorcyclic acid lactone), a secondary metabolite from *F. graminearum* (teleomorph *G. zeae*) was given the trivial name zearalenone as a combination of *G. zeae*, resorcylic acid lactone, -ene (for the presence of the C-1′ to C-2 double bond), and -one, for the C-6′ ketone. Almost simultaneously, a second group isolated, crystallised, and studied the metabolic properties of the same compound and named it F-2. Much of the early literature uses zearalenone and F-2 as synonyms; the family of analogues are known as zearalenones and F-2 toxins, respectively. Nevertheless, the word toxin is almost certainly a misnomer because zearalenone, while biologically potent, is hardly toxic; rather, it sufficiently resembles 17β-estradiol, the principal hormone produced by the human ovary, to allow it to bind to estrogen receptors in mammalian target cells. Zearalenone is better classified as a nonsteroidal estrogen or mycoestrogen, sometimes it is called a phytoestrogen.

Mitigation of mycotoxins in fish feeds

Complete elimination of mycotoxin contamination seems to be practically impossible. However, risks associated with mycotoxin contaminated commodities can be reduced by integrated mycotoxin prevention and control management. The most effective and practical procedure include good culture practices, use of resistant crops (developed through new biotechnological processes), biological control, physical removal of damaged or incomplete kernels/seeds, chemical inactivation such as ammoniation procedure and use of additional chemical agents normally used in industrial processes (nixtamalisation). However, more information is needed to develop decontamination treatments, also to determine the safety of the final processed products and also the prevention of recontamination during storage.

Contaminated grains and feeds may contain a wide variety of different mycotoxins of differing chemical characteristics including heat stability, solubility, and absorbent affinity. Human exposure to the contaminants should be considered without affecting the marketability of the product i.e. processors and consumers risk. Risk of mycotoxin contamination in food exists from the crop grown in the field until the final product is consumed. One of the approaches for reducing the levels of mycotoxins in food supply can be to encourage the diversion of moulds and contaminated grains to non-food use or processing industries which recover one or more mycotoxin free products. In this case also we have to consider the relationship between concentration of mycotoxins in the ration fed to meat and the concentration of mycotoxins or its metabolites that appear as residues in muscle, adipose and tissue organs.

There are adsorbents that bind feed-borne mycotoxins to prevent them from being absorbed by fish after consumption. These binders fall into two main classes: 1) hydrated sodium calcium aluminosilicate (HSCAS) clays and 2) modified fractions of the single-cell yeast organism *Sacchromyces cerevisiae*, or common bakers' yeast. The clays seem to work well with aflatoxins, but are less effective with other mycotoxins. The yeast preparations appear to be effective on a broader range of mycotoxins. Neither type of binder has been extensively evaluated in fish feeds. Agents that are purported to bind mycotoxins should be tested on the mycotoxin of interest to be certain that effective binding occurs and that the binder is safe for the intended species of fish. The cooker-extrusion process of feed manufacturing, which applies heat, reduces the level of aflatoxins in channel catfish feeds. In catfish pond experiments, preparing floating feeds containing aflatoxin-contaminated corn by cooker-extrusion technology reduced the level of aflatoxin by more than 60 percent.

The effect of moldy feeds, and the mycotoxins and other chemical substances they produce, on the growth and health of cultured fish is not well understood. In fact, the identity of the many chemical substances feed-associated molds produce may not be complete. Because so little is known, it is prudent to prevent fish feeds from becoming moldy and to refuse to purchase feeds and feed ingredients that are moldy, even if they are offered at a discount. If stored fish feed has become moldy, do not use it until it has been evaluated for mycotoxin contamination. Good feed storage practices and rotation of stocks are important to reduce mold development.

Conclusion

Mycoses are the best-known diseases of fungal etiology, but toxic secondary metabolites produced by saprophytic species are also an important health hazard. The term mycotoxin is a term used to describe pharmacologically active mold metabolites characterised by toxicity to vertebrates. They fall into several chemically unrelated classes, are produced in a strain-specific way, and elicit some complicated and overlapping toxigenic activities in sensitive species that include causation of cancer, inhibition of protein synthesis, immunosuppression, skin irritation, and other metabolic disturbances. Mycotoxins usually enter the body via ingestion of contaminated foods, but inhalation of spores and direct skin contact are also important routes.

It is difficult to prove that a disease is a mycotoxicosis. Molds may be present without producing any toxin. Thus, the demonstration of mold contamination is not the same thing as the demonstration of mycotoxin contamination. Moreover, even when mycotoxins are detected, it is not easy to show that they are the responsible agents. Nevertheless, there is sufficient evidence from animal models and human epidemiological data to conclude that mycotoxins pose an important danger to human and animal health, albeit one that is hard to pin down. The incidence of mycotoxicoses may be more common than suspected. It is easy to attribute the symptoms of acute mycotoxin poisoning to other causes, and it is not easy to prove that cancer and other chronic conditions are caused by mycotoxin exposure. In summary, in the absence of appropriate investigative criteria and reliable laboratory tests, mycotoxicoses will remain diagnostically daunting diseases.

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A model modular farm for size grading and monosex culture of freshwater prawn

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Freshwater prawn or 'scampi' farming has achieved remarkable expansion both in terms of culture area and overall production in recent years with the adoption of more intensive farming techniques. Scampi farming began using traditional methods with low stocking densities and minimum management but has emerged into a major economic activity with the adoption of semi-intensive farming practices. Although many attempts have been made by farmers to maximise production through different culture strategies, only a few techniques have seen widespread commercial adoption.

Macrobrachium rosenbergii is a dimorphic species. Males grow faster than females, thus the production potential of an all-male crop is economically attractive. As the presence of the slower-growing females also reduces the growth of males, so they should be separated where possible. Recent reports[1] indicate that all-male culture is 63.31% more profitable than the mixed culture, while our own studies[2] found all-male production to be 30% higher than that of mixed populations. Prawns can be separated manually based on the presence of gonopore at the base of the 5th walking leg. The presence of appendix masculine at the 2nd swimming leg is also an identification character for males. The stage at which segregation is carried out and the method of manual sexing greatly affect the total production from monosex culture. Many of the farmers in Andhra Pradesh are going for a later segregation of the sexes (six to seven months after stocking) and the females and larger males are removed from the pond and sold to market without further rearing. This reduces the opportunity for the harvested individuals to attain their maximum potential size. Only the remaining males are grown for two to three months in the pond as all- male culture.

Size grading of nursery reared juveniles (about 1 gram) prior to pond stocking has been found to increase both mean harvest size and total pond production, thereby enhancing economic viability. This is done to separate the fast growing individuals in the nursery population since they suppress the growth of others. Removal of these individuals gives the smaller prawns a chance to achieve their growth potential. It also reduces socially induced differential growth. Juveniles from the graded upper fraction of the population develop into larger orange clawed males and blue clawed males at a much higher frequency than non-graded populations stocked at the same density[3]. Moreover the income from the larger prawns has been found to be nine times higher as that obtained from lower fraction in a short grow out period[4]. Size grading can be done by using finfish bar graders or by seine nets with a particular mesh size.

The present paper elaborates the requirements and the procedure to be adopted for enhancing the scampi production by adopting the advantages of size grading and monosex culture together in a sustainable way. This farm serves as a good model for the modular system for scampi farming.

Modular farm

The modular farm design consists of two nursery ponds, three transition ponds and one grow out pond spread over a total area of 1.5 ha area. The culture system is purely based on size grading and monosex culture.

Nursery ponds

Two nursery ponds of 1000 m^2 each can be stocked with post larvae @ 30 /m^2. The post larvae procured from hatcheries can be reared for 45 days. The nursery ponds can be provided with artificial substrates as cover. During the nursery rearing about 60-80 % survival from post larvae to juvenile can be realised.

Transition ponds

The harvested juveniles can be size graded into three fractions and stocked into separate transition ponds of 2,500 m^2 each at a stocking density of five juveniles per square metre. They can be reared for 60 days to attain a size of around 10 to 15 grams. At the end of rearing the prawns can be collected using seine nets and the male prawns segregated

Table 1. Calendar of Activities.

Crop / pond	Stocking	Stocking material	Features	Harvesting
First crop schedule				
Nursery	1 March	PL 20	45 days nursery rearing followed by size grading of prawns to larger/ medium/ small juveniles	15 April
Transition	15 April	Larger/ medium/ small juveniles in separate ponds	Shifting of males to grow out ponds after 60 days leading to the initiation of all female culture	15 June
			First harvest of females (<40 g) after 120 days rearing	15 August
			Final harvest of females (< 50 g) after 150 days rearing	15 September
			15 days crop holiday till next stocking	
Grow out	15 June	Males from transition ponds	All male culture for 135 days	
			First harvest of blue claw males after 75 days of grow out	1 September
			Second harvest of blue claw males after 105 days of grow out	1 October
			Final harvesting of prawns after 135 days of grow out	1 November
			One month crop holiday till next stocking	
Second crop schedule				
Nursery	15 August	PL 20	45 days nursery rearing followed by size grading of prawns to larger/ medium/ small juveniles	1 October
Transition	1 October	Larger/medium/small juveniles in separate ponds	Shifting of males to grow out ponds after 60 days leading to the initiation of all female culture	1 December
			First harvest of females (<40 g) after 120 days rearing	1 April
			Final harvest of females (< 50 g) after 150 days rearing	1 May
			15 days crop holiday till next stocking	
Grow out	1 December	Males from transition ponds	All male culture for 135 days	
			First harvest of blue claw males after 75 days of grow out	15 February
			Second harvest of blue claw males after 105 days of grow out	15 March
			Final harvesting after 135 days of grow out pond	15 April
			Two months crop holiday till next stocking	

Macrobrachium.

and stocked into one grow out pond with the females returned to the transition ponds to prevent breeding. The transition ponds henceforth serve as an all-female culture pond. Culture of females continues for approximately 90 days. However, after 60 days of culture the largest females of 40 grams and above can be harvested and rest grown on for one further month to final harvest. This system ensures the availability of good size females and can be used for breeding purposes with due regard to avoid inbreeding. Since the stock does not contain berried females the harvest commands good market price for export.

Grow out pond

The males obtained after segregation from the transition ponds can be stocked in a grow out pond of around 5,000 m^2 at a density of two individuals per square metre with a total culture period of around 150 days. After 75 days of culture the pond may be seined and blue clawed prawns selectively removed for harvesting, with the procedure repeated at 30 day intervals. This measure helps in conversion of all orange clawed prawns to the larger and more valuable blue claws and pond production can be effectively enhanced. The final harvest after 150 days of culture can be done by complete draining of the pond.

Use of artificial substrate

The production and survival of prawns can be increased by using artificial substrate and hiding places[5]. It is generally observed that farmers in Andhra Pradesh erect triangular shaped hide outs using coconut leaves in the nursery ponds. However, it is equally important and advantageous to use such substrates in transition and grow out ponds to enhance survival and production. The addition of substrates increases the surface area in the water column and permits higher stocking densities. It also reduces the fighting behaviour and provides more space for each prawn, reducing the adverse impacts of territorial behaviour. Provision of artificial substrate enhances the survival rate and increases the yield of market-able stocks in commercial ponds[6]. In a pond trial[7] artificial substrates were found to enhance production by 24% and the survival of prawns by 10%.

Advantages of a modular farm

The modular farm described above is suitable for commercial scale farmers with moderate investments. The most important advantage of the system is that one farm can run two or more modules with continuous harvesting and seed stocking all year round, opening the possibility of running two crops of scampi culture per year with minimum investment. The detailed farming calendar for two crops a year is given in the table below. Moreover it provides sufficient time interval between the crops to perform all the necessary pre-stocking managements such as drying, liming and fertilisation of the pond. This system facilitates production of good size mature females which can be sold to hatchery operators or used in selective breeding programmes.

In Andhra Pradesh, farmers practise all-male culture after 60 days of nursery rearing. The nursery-reared juveniles are hand sexed and only male juveniles are selected and stocked into the grow out ponds for further rearing. Juvenile females are discarded or sold at a very low price resulting in a substantial loss of prawn biomass and also the cost of the inputs involved in production at the hatchery and nursery phases for the same. The present system ensures efficient utilisation of juvenile females, which exhibit more homogenous growth, for production of quality brood stock for further seed production.

The increasing area under scampi cultivation and intensification of production requires a huge quantity of quality seed for farming. As per recent reports[8] the early elimination of females from monosex culture ponds has led to a scarcity of good quality brooders for hatchery operations. It is disheartening to note that the production rate of freshwater prawns has fallen from 1,000 kg/ha in 2004 to 543 kg ha in 2007, although the total farming area in India has increased[9]. At this critical juncture the proposed modular farming practises can provide a silver lining in dark clouds.

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Angelwing clam (*Pholas orientalis*) future assured after Thai DOF's breeding success

Tanate Poomtong

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Prachuab Khiri Khan Coastal Fisheries Research and Development Center, part of the Coastal Fisheries Research and Development Bureau of the Department of Fisheries, Thailand has succeeded in breeding and nursing the Angelwing clams (*Pholas orientalis*). The survival of this clam, highly sought after in Thailand for culinary purposes, has been secured in their natural ocean habitat at Pun-tai-norasing village, Samut Sakon Province. To honor His Majesty the King Bhumipol's birthday, approximately 50,000 hatchery reared angel wing clams were released into their original habitat on 5 December, 2012.

Following the massive floods of 2011 a huge quantity of freshwater flowed into the Gulf of Thailand. This particularly affected the inner gulf at Samut Sakon and Samut Songkram Provinces, where there is plenty of slow moving aquatic life such as angelwing clams, razor clams and other shellfish. The angelwing clam, which is the symbol of Samut Sakon Province, is now expensive now because it has become a consumer delicacy. Fresh angelwing clam costs 150-200 baht per kg (US$ 5-7) in local fish markets, and when dried, about 800-1,000 baht per kg (US$ 26-33). Angelwing clam collection offers jobs and provides income to local fishermen who can't afford to invest in costly fishing gear. People who dive to collect angelwing clams for their livelihood, along with conservationists, are concerned and worried about the condition of the clam populations, as angelwing clams are becoming increasingly difficult to find.

The Thai Department of Fisheries (DOF), as the responsible government agency, wants to contribute to enrichment of marine life resources. DOF has invested in research and breeding of the angelwing clam in order to help restore the clams to their natural habitat.

Prachuab Khiri Khan's Coastal Fisheries Research and Development Center is the first government agency in Thailand that has succeeded in breeding and nursing angelwing clams, with the first batch produced in February 2012. At the beginning of the research it was difficult to achieve satisfactory results, however, and much work had to be done to improve the nursing techniques. The survival rate has reached 7% now yielding around 100,000 juvenile angelwing clams 8-9 mm in size.

The research and activities conducted by DOF to breed the angelwing clam in captivity was not only a good deed carried out for our beloved King but it was also intended to strengthen the confidence and spirit of cooperation between all stakeholders.

DOF is planning a long term programme to release juvenile angelwing clams from hatchery to natural habitats in cooperation with participating communities, as a joint conservation measure. The principal measures include data collection, public relations and hearings, improving habitats, hatching and releasing clams, setting up community regulations and agreements concerning fishing such as limitations on allowed fishing periods, fishing gear and techniques. It is fundamentally important to conserve and sustain the natural habitat as "seed bed" for this bivalve mollusc in suitable locations.

Right: Angelwing clam, Pholas orientalis. Photo by Yosri, Wikimedia Commons (distributed under Creative Commons By-NC 2.0 license).

Ompok bimaculatus (Bloch, 1794), an emerging species for diversification of aquaculture in Tripura, north-eastern India

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Ompok bimaculatus, commonly known as Indian butter catfish or pabda (locally) belongs to the order Siluriformes and family Siluridae. It is seen infrequently in the international ornamental fish trade, where it usually called two-spot glass catfish due to a round black blotch above and behind the base of the pectoral fin and another at the base of the tail. This fish occurs naturally in streams and rivers with sluggish to moderate movements. Shallow rivers with a water depth of 0.5 to 1.5 m, often muddy and musky, are the best known natural habitats of this fish, although they are also found in canals and inundated fields, into which they move during the flood season. In south Indian states butter catfish has been recorded in both fresh and brackish water environments. It is considered as a delicious food fish across its natural range which includes much of India, Bangladesh and Pakistan in both fresh and smoked forms. Butter catfish is listed as an endangered species in India due to declines in its abundance and distribution. Recently the species has gained the attention of farmers of Tripura, a state of north-eastern India due to its high prevailing market demand.

Induced breeding and larval rearing

The fish attain maturity weight of 30-40 g at the end of first year of its life. Males mature earlier than females. Fertilisation is external and spawning occurs once a year during the monsoon months, June through to August.

Butter catfish are hatchery bred in Bihar, West Bengal and north-eastern states such as Tripura using pituitary gland extract, ovaprim and ovatide as inducing agents. In Tripura, fish of 35-100 g and more than one year in age are used as broodstock. Ovaprim is injected at a dosage of 1-1.5 ml/kg body weight for females and 0.5-1.0 ml/kg body weight for males. Females are stripped for spawning 8-10 hours after hormonal injection. The numbers of eggs produced varies from 3,000-4,000 per female weighing 30-50g. Milt is collected from males by surgically removing their testes and macerating them. This is mixed together with the eggs using a feather for their fertilisation. The eggs are subsequently washed thoroughly with clean water and transferred into a masonry tank with clean water for hatching.

Constant aeration is necessary. Embryonic development starts 30 minutes after fertilisation and the eggs begin to hatch after 23-25 hours of fertilisation. Suitable water parameters for the larvae are: 22-28°C, alkalinity 120-150 mg/litre and dissolved oxygen in the range of 3-5 mg/litre. Initially the water level of the container to which the fertilised eggs are placed maintained at 3-4 cm and gradually increased to 15-20 cm after one week. Absorption of yolk-sac takes place in three days. From the early seedling stage the fish is highly cannibalistic, thus stocking density should be reduced. Grading to remove the faster growing 'shooter' fry should be done on alternate days to maintain a uniform size and minimise mortality. A preliminary experiment on stocking density-dependent growth and survival of larvae in ICAR's Tripura centre corroborates that the larvae can be reared at low densities in stagnant water conditions and considering the value of larval growth, survival and overall weight gain, a stocking density of 6 larvae/litre has been identified as the maximum for larval rearing of *O. bimaculatus* under hatchery conditions. The larvae show a preference for live foods from day four and they accept zooplankton up to fifteen days in age. Mixed zooplankton are good food for early stages of the fish while rearing in a laboratory, as there they seen to grow up 10-15 mm during two weeks of rearing period. They show little change in food preference and Tubifex is good food for further rearing. They grow to 40-50 mm in 5-6 weeks. From fry stage onwards their feeding habit is seen

Ompok bimaculatus fingerlings.

to be relatively relaxed, taking catfish pellets, prawns, earthworms, mussels in addition to consuming most live, frozen and dried foods. The average size of fry is 1-2 cm in length and 0.6-2.0 g in weight. Fry attain 5-6 cm and 3-5 g after a rearing period of 40 days, a good size for stocking in grow-out ponds. Adults are cannibalistic and predatory in habit. The highest growth achieved was among fingerlings fed live mola carplet and flying barbs as prey. In growout ponds, they feed upon their natural diets which include vegetable food, small fish like mola carplets, flying barbs, crustaceans and molluscs.

Rearing and husbandry

Studies conducted by the ICAR's Tripura centre showed that managing Indian butter catfish in captivity is not difficult. The fish is fairly peaceful and shy for its size during the day and so should be provided with plenty of hiding places in the form of driftwood, PVC pipes, or other material suitable as shelter, although it will eat any smaller fish it can fit into its mouth. The fish have razor sharp vomerine teeth in two patches which are absolutely harmless to human beings. It is a hardy fish and tolerates varying water quality conditions. Fingerlings respond well to water with pH of 6.0-8.0, low or medium hardness (4-28 dh) and temperatures of 20-26°C. The preferable depth in growout ponds is 2 metres. The fish can attain a maximum length of 450 mm. This being one of the larger species of catfish; it is not recommended to grow these along with comparatively smaller sized fishes as they will most likely be eaten. It is desirable to provide some suitably-sized hiding places in the pond concerned. Being a messy eater, aeration or water exchange is must as this fish leaves a lot of waste.

Commercial prospects

Considering high market price, delicious flavour and nutritional properties there seems to be significant potential for standardising technologies for the seed production and farming of butter catfish in Tripura. Seasonal water bodies of

Tripura would be ideal systems for producing table-sized fish. Small floating cages made of locally available, low-cost materials could also be used and the species is suited for incorporation in composite fish culture. A preliminary experiment at ICAR's Tripura centre showed that three species of Indian major carps i.e. *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* are well compatible with this catfish and a total production of over 1,000 kg of fish/ha/180 days could be achieved at a species composition of 40% catla, 30% rohu, 15% mrigal and 15% butter catfish at a stocking density of 4,000 fish/ha. Another attractive proposition would be to use butter catfish in predator-prey culture systems using mola carplet (*Amblypharyngodon mola*) and flying barb (*Esomus danricus*) as forage species. To meet the demand for this fish an intensive and vertically integrated ornamental fish-rearing unit consisting of broodstock ponds, seed production centers, and fry- and fingerling-rearing units complete with transportation and marketing facilities could be set up to supply fingerlings. In addition, small-scale household systems could also take up seed production of this catfish for supplying fry to both the food and ornamental production systems. The growing demand for butter catfish could justify setting up commercial farming systems in Tripura. Attention from government agencies as well as entrepreneurs is needed to develop the culture of this species, which could generate employment in rural communities of the region in addition to valuable foreign exchange.

Conclusion

O. bimaculatus is a highly priced, delicious and well preferred fish because of its unique texture with soft bones, good taste, higher nutritional value and invigorating effect. The price of the fish is in the range of US$ 6-18 per kg as it is highly sought after in Tripura. However, wild stocks of butter catfish are in decline due to its indiscriminate fishing during the breeding season and the adverse impact of pesticides and erosion from agriculture causing pollution and siltation of its habitat, so much so that the species is now considered locally threatened. To promote its conservation butter catfish has been declared as the State Fish of Tripura.

In aquaculture it has not received much attention due to an insufficiency of gravid stock for experimentation and also because of a shortage of information regarding its breeding potential, larval rearing and culture technology. Recently the breeding technology has been standardised in Tripura at Lembucherra fish farm and attempts are underway to standardise the rearing and culture techniques. Tripura State produced over 36,000 fingerlings of this fish during 2010-2011. Seed has been stocked in farmers' ponds and the results of this effort are eagerly awaited. Being a catfish its culture techniques are quite different from carp farming. In this context research work is in progress by ICAR's Tripura centre in collaboration with Department of Fisheries, Tripura to standardise the technology and for further refinement of the same, in keeping with the view that this highly valued catfish is an endangered species.

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11th Meeting of the Asia Regional Advisory Group on Aquatic Animal Health

Participants in the 11th Advsory Group meeting.

The 11th Meeting of the Asia Regional Advisory Group on Aquatic Animal Health (AGM 11) was held at Maruay Garden Hotel, Bangkok, Thailand on 21-23 November 2012. The meeting marked a decade of existence of AG in the region (officially established on November 2001), and was attended by the following members and co-opted members:

- Dr. Jie Huang (OIE AAHSC, China).
- Dr. Simona Forcella (OIE, France).
- Dr. Hnin Thidar Myint (OIE Regional Representation for Asia and the Pacific, Tokyo, Japan).
- Dr. Weimin Miao (FAO-Regional Representation in Asia and the Pacific, Bangkok, Thailand).
- Dr. Ingo Ernst (DAFF Australia).
- Dr. Edgar Amar (SEAFDEC Aquaculture Department).
- Dr. Kjersti Gravningen (private Sector, PHARMAQ Vietnam).
- Dr. Wensheng Lan (Shenzhen Exit and Entry Inspection and Quarantine Bureau, AQSIQ, China).
- Prof. Timothy Flegel (Centex Shrimp, Mahidol University).
- Dr. Supranee Chinabut (AAH Expert, Thailand).
- Dr. Somkiat Kanchanakhan (IAAHRI, Thailand).
- Dr. Eduardo Leano, Dr. CV Mohan, Mr. Simon Wilkinson and Dr. Ambekar Eknath (NACA).
- Dr. Siow Foong Chang (MSD Animal Health, Singapore).
- Dr. Temduong Somsiri (Director, IAAHRI, Thailand).

Dr. Ingo Ernst was re-appointed as the Chairperson of AG for 2012 and 2013, with Dr. Somkiat Kanchanakhan as Vice-Chairperson. Commemorating the completion of 10 years of AG, Dr. CV Mohan presented highlights of AG accomplishments in terms of improving the aquatic animal health management in the region.

During the three day meeting the group reviewed the disease situation in Asia, considered the recent changes made to OIE global standards, revised the list of diseases for listing in the regional Quarterly Aquatic Animal Disease (QAAD) reporting system, assessed the progress made against the various elements contained in the Asia Regional Technical Guidelines on Responsible Movement of Live Aquatic Animals, updated the list of regional disease resource centers, and developed recommendations and action points for the consideration by the NACA Secretariat and Member Governments.

One of the highlights of the meeting was the inclusion of the new emerging shrimp disease acute hepatopancreatic necrosis syndrome (AHPNS) in the QAAD list of diseases. This will require member governments to report any outbreak of the disease for the quarterly disease surveillance report commencing on the first quarter of 2013. Finalisation of the OIE-NACA WAHIS Regional Core was also discussed, and full implementation of this regional online reporting of aquatic animal diseases is targeted by January 2013 at the earliest.

The full report of the meeting is available for download from the NACA website at:

http://www.enaca.org/modules/library/publication.php?publication_id=1095

Aquaculture community mourns Prof. M.C. Nandeesha

I regret to inform that our dear friend Prof. M.C. Nandeesha passed away on 26 December. On behalf of NACA I would like to express our condolences to his wife and family. It is a very great loss for the aquaculture community, his friends and students.

Nandeesha's sincerity and commitment to development ideals and social justice was legendary. Many aquaculture scientists and officials at the highest levels of government began their careers with a scholarship secured on their behalf by Nandeesha. He was instrumental in initiating aquaculture development in Cambodia, played a key role in putting gender issues on the table through the Asian Fisheries Society, and was an active supporter and volunteer for the charity Aquaculture without Frontiers. He was a regular columnist for Aquaculture Asia Magazine and great friend and supporter of NACA over many years.

Seldom have I met anyone with such conviction, sincerity and dedication in any field of endeavour. Never afraid to speak his mind, if he thought the system was doing an injustice he would tackle it. If only we had more people like him, the world would be a better place.

I request his friends and supporters to consider making a donation to reduce the burden of his medical expenses on his family, as per the message below.

The Editor.

Dear Friends

As you are aware Prof. M.C. Nandeesha had a massive heart attack on 23rd November 2012 and is currently undergoing treatment at Apollo Hospital, Greams Road, Chennai, Tamil Nadu, India. Though his condition was improving during the initial period of treatment, he developed multiple organ complications after 2nd Dec, 2012 and his condition became critical. Currently, he is on Extracorporeal Membrane Oxygenation (ECMO) machine and on dialysis.

Till today, excluding doctors' fees, the hospital expenditure has reached more than Rs 24 lakhs (~ US$ 45,000) and his daily hospital bills are approximately more than I (one) lakh rupees/day. Once, his condition gets stabilized,

the doctors have advised to go for transplant which will cost more than Rs 30 lakhs (~ US$ 58,000). Hence, in anticipation of the existing and anticipated huge hospital bills, I request your kind help, in this regard.

The details mentioned above are of the joint account of Dr. M.C. Nandeesha and myself (which will be operated by B.Rajeswari Dayal; i,e Mrs. Nandeesha). If any queries please contact Prof. B.A. Shamasundar (bashamasundar@gmail.com) or Rajeswari Dayal (mcnraju@gmail.com).

With regards

B. Rajeswari Dayal

Bank name:	Union bank of India
Bank address:	Madhavaram Branch, no. 1. G.N.T. Road, Chennai, PIN - 600060, Tamil Nadu, India
Account No.	332902010721340
IFSC Code:	UBIN0533297
SWIFT code:	UBININBBASOW – followed by the account number
Account holder name:	Dr. M. C. Nandeesha. and B. Rajeswari Dayal

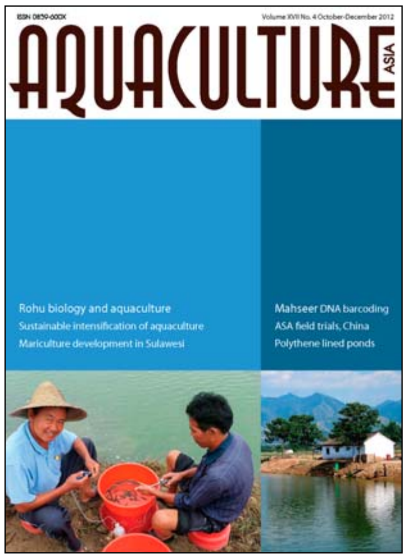
Got a story for Aquaculture Asia Magazine?

We are looking for interesting stories about aquaculture development in the Asian region, particularly in terms of the human aspects of development – the people involved and the changes it has made to their lives and communities.

We would particularly like to hear from colleagues in South-east Asian countries, whose work is often under-represented in aquaculture publications.

If you have a story to tell please email it to magazine 'at' enaca.org, along with some large, high-quality photographs of your subjects. Please prepare articles in line with our Guidelines to Authors, which you can download from:

http://www.enaca.org/modules/wfdownloads/viewcat.php?cid=66



Workshop on aquaculture certification in Asia - status, challenges, opportunities and way forward: 26 June 2013, VietFISH conference, Ho Chi Minh City, Vietnam

Rationale

While much attention has gone to internal consistency of certification schemes – and in doing so, setting a benchmark for legitimacy and credibility – less attention has been given to the consequences that these schemes hold for aquaculture producers around the globe, especially for small-holders that form the backbone of the south-east Asian aquaculture industry. The need for supporting producers to understand and comply with certification rules is becoming increasingly important, not only for the benefit of the producers but indirectly for European consumers that heavily rely on imported products to cover the increasing gap between demand and local production. As European markets seek greater volume of environmentally or 'responsibly' certified product from these industries it becomes crucial that producers are able to comply with production standards and thereby maintain access to these markets.

The workshop will bring relevant stakeholders together for a one day workshop to deliberate on various issues and initiatives mentioned above, review the present status, and identify future opportunities to progress the concept of quality assurance and certification in a way that will be beneficial to consumers, producers, traders, retailers and national governments.

Target audience

Key stakeholders from importing (EU) and exporting (Asia) countries will get the opportunity to understand and appreciate the ground realities of aquaculture production and trade and the role of certification programs in promoting responsible aquaculture. This means: experts on aquaculture certification, representatives of Asian producers and exporters, European importers, policy makers.

Background

Modern society at large and consumers in particular are increasingly looking for commodities that are sustainably produced, safe, and meet national and international requirements and standards that address various pillars of sustainability and also cover broader areas of equity and ethics in both products and production process. Compliance to these requirements are seen as approaches to promote responsible and sustainable aquaculture practices and also mitigate the true and perceived negative impacts of aquaculture.

Various quality assurance programs are being implemented in Asia Pacific to promote responsible and sustainable aquaculture. Market forces are being increasingly seen as potential tools to push the industry towards sustainability and reward those that comply.

Quality assurance provided by the competent authority of a sovereign country to trading partners covers aspects of compliance to food safety (Codex Alimentarius) and aquatic animal health (OIE) standards under the WTO-SPS agreement and international trading obligations. In addition, responding to market driven initiatives and requirements, many governments are developing (or have developed) and are implementing commodity-specific public certification systems that cover compliance to both mandatory and voluntary requirements/standards (e.g. Thai GAP, Viet GAP).

Recognising certain limitations and weaknesses in the public certification systems and responding to market driven requirements, several third party private certification systems such as the Aquaculture Stewardship Council, Organic, Aquaculture Certification Council, GlobalGAP and Naturland, have been developed and are being widely promoted. In recent years there has also been a growing trend of responsible direct sourcing by retailers without the involvement of public/private certification standards such as by Tesco Lotus and Marks and Spencer. All these systems have good intentions and are catering to the present day market requirements. Despite the good intentions of these programs and the market opportunities they bring with them, there are several issues and unanswered questions that need to be carefully addressed to ensure that quality assurance programs for aquaculture products and production process are credible, that the costs and benefits are shared evenly along the supply chain and that the interests of poor and vulnerable farmers are protected. Only then can certification programs can be seen to contribute to aquaculture sustainability.

Programme

Speakers & panel to be confirmed.

9.00 – 9.30 Opening

Ghent/WU/CTU/NACA/FAO/Thailand Department of Fisheries

9.30 – 10.45 Producer compliance constraints

Over the last years, several projects and initiatives have emerged to upgrade the production practices of aquaculture producers. Examples are the government-led "best management practice" programs, aimed at supporting smallholders to meet global market requirements, including certification, through a cluster-based approach. More recently introduced are aquaculture improvement programs to support small farmers to progress through a program of improvement ending in certification. Group certification approaches are also being developed and tested across commodities and countries to enable small farmer inclusive certification programs. An overview will be presented including the successes and limitations of such initiatives to reduce compliance constraints of producers. This will be followed by a discussion with representatives from both public and private certification schemes about their attempts to help producers overcome their constraints to complying with certification standards.

Presentation: NACA (Dr. CV Mohan)

Panel discussion: Experts from public and private certification systems

11.00 – 12.15 Value chain arrangements

Much attention has been given to the so called 'business case' for producers to comply with standards if there is no apparent economic incentive for improving production practices. The costs and risks to invest in certification can be high. European importers and exporters have their own capacity and strategies to push suppliers to invest in certification. Contracts and partnerships are commonly used to coordinate the expectations of both ends of the value chain when working towards certified products. One way of understanding the issues between actors in the supply chain is to identify existing value chain arrangements between different scales of production. This session will present an overview of the challenges and opportunities for existing and new forms of coordination between processors, exporters, importers and retailers.

Presentation: Dr Flavio Corsin from IDH

Panel discussion: EU importers and exporters, direct sourcing companies, academia

13.00 – 14.15 Auditing practices

Third party certification schemes are based on auditing practices that are greatly different to legislative regulation and compliance. Hazard Analysis and Critical Control Point (HACCP) based internal control systems for aquaculture are well developed for industrial scale aquaculture production but remain less well developed for small holder production systems. Constraints to meeting auditing requirements include poor literacy and management skills. However, from the side of auditors, alternative 'risk-based' control mechanisms (as seen in other certification schemes, e.g. FSC and MSC) may also be relevant for aquaculture production. A presentation and discussion is aimed to understand what approaches might overcome some of the procedural constraints to small holder involvement and further the business case for their involvement in certified value chains.

Presentation: Dr Simon Bush / Dr P. Vandergeest

Panel discussion: Certification bodies and auditors / farmer cooperative

14.30 – 15.45 Benchmarking certification

The FAO Technical Guidelines on Aquaculture Certification, endorsed by the 29th session of the COFI in Feb 2011, provide advice on developing, organising and implementing credible aquaculture certification schemes. As a follow up, the FAO with support from the EU will be convening an expert consultation in December 2013 to develop an evaluation framework to assess conformity of public and private certification schemes with the Aquaculture Certification Guidelines. In response to the FAO certification guidelines, some public/private certification schemes have taken steps to reorganise their respective schemes to be in conformity with the guidelines. Other initiatives such as SFP and SSI are undertaking benchmarking exercises to promote some degree of harmonisation and equivalence among various certification standards. This session brings together key organisations to look at the future of benchmarking aquaculture standards.

Presentation: FAO

Panel discussion: SSI, SFP, Certification bodies public and private

16.00 – 17.00 Future steps

Patrick Sorgeloos, Ghent University

Expected outputs

- Documentation of aquaculture certification status in AP (who is certifying what, numbers, volume, supply chain info).
- Sharing information between different initiatives and identifying opportunities for collaboration.
- Identifying researchable issues, conceptualising fundable projects.
- Identifying models for technical service provision to producers to participate in certification programs.
- Identifying opportunities for better communication between EU and Asia or buyers and producers.
- Workshop report with recommendations.

Organising committee and hosting

The workshop will be hosted by the Vietnam Association of Seafood Exports and Producers during the Vietfish Conference in Ho Chi Minh City, Vietnam. The organising committee members are:

- N.T. Phuong (Can Tho University, Vietnam).
- Ambekar E. Eknath, CV Mohan (NACA, Thailand).
- Simon Bush, Marieke Douma (Wageningen University, The Netherlands).
- Patrick Sorgeloos, Jean Dhont (Ghent University, Belgium).
- David Little (SEAT project, Stirling University, UK).

Regional training course on Broodstock Management in Aquaculture, Vietnam 27 May – 1 June 2013

Although Asian aquaculture has grown rapidly the rate of growth is declining. One factor contributing to this decline is a decrease in the quality of seed stocks of many of the major species cultured. Unlike agriculture, genetic improvement programmes for aquaculture are in their infancy and genetic management of broodstock is an issue that is routinely neglected. Improved varieties are the exception rather than the norm and very few hatcheries have personnel trained in broodstock management. All too often, broodstock are based on small imported founder populations that have been maintained in captivity for many generations without any management at all.

In the region one of the major weaknesses of the sector lies in the fact that science of broodstock management is not well understood and rarely applied in practice. Neither is it a component of the curriculum in courses on aquaculture in tertiary institutions. In most countries in the region there is a dearth of capacity in broodstock management principles and practices, hatchery personnel almost always concentrating on paying more attention to the immediate needs of producing seed stocks required, but less so on its quality and or on aspects of preserving the genetic diversity of the parental stocks and the manner in which the best results could be obtained, in respect of quality of seed stock in each production cycle.

Capacity building in broodstock management is urgently required. NACA and the Fisheries Training Programme of the United Nations University jointly have therefore launched a project in collaboration with Nha Trang University, Vietnam, Deakin University, Australia, the Department of Primary Industries, Victoria, Australia, and Holar University, Iceland to develop and test a short training course on principles and practices of broodstock management in aquaculture.

The first run of the training course will be conducted from 27 May to 1 June 2013 at Nha Trang University for selected participants from 6 to 8 Asian countries. The course organisers will provide financial support (travel and subsistence allowance) to a minimum of the 10 most promising nominees from NACA member countries. In addition, up to 10 places will be made available on a paid basis (US $1,200) for other interested parties.

Eligibility for sponsorship

The sponsored positions in the course are open to technical personnel who meet the following requirements:

- Currently employed in hatchery management.
- Minimum of five years' experience in hatchery management.
- Working in facilities of NACA member governments.

For more information, including application details, please download the course prospectus from:

http://www.enaca.org/uploads/temporary/naca-broodstock-training-course.pdf

Network of Aquaculture Centres in Asia-Pacific

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NACA is a network composed of 18 member governments in the Asia-Pacific Region.

Video recordings from workshop on sustainable intensification of aquaculture released!

Some good news: The days of having to physically attend a NACA workshop to access the presentations are over!

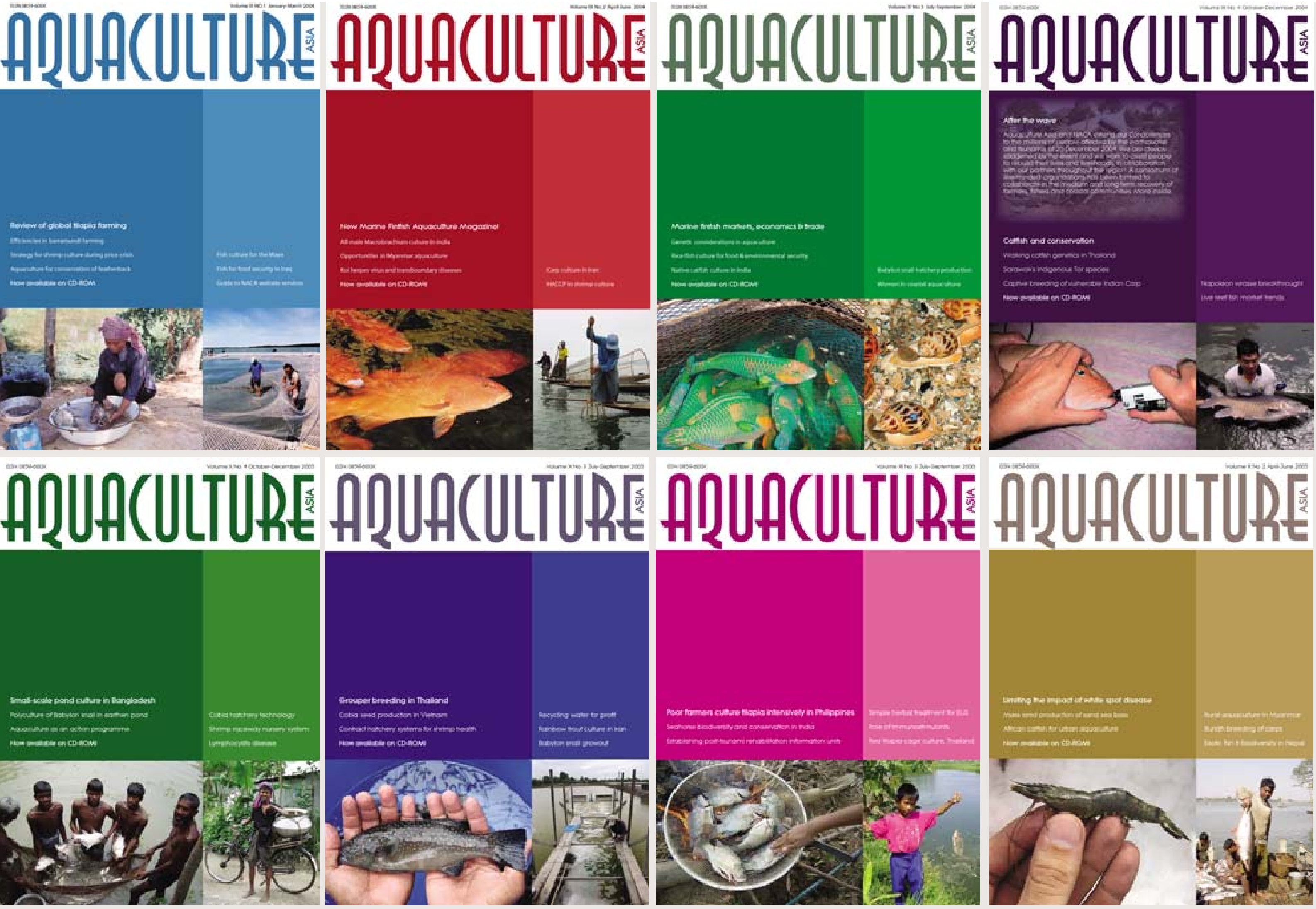
We have been started making video recordings of technical presentations delivered at our workshops, which you can watch online any time you like, wherever you are. This is intended to free everyone from the tyranny of distance and make the material available to the entire network.

The videos generally consist of a screen recording made during a Powerpoint presentation, with accompanying audio, so you can watch the presentation exactly as it was delivered on screen.

Audio-only files are also available for those who prefer to listen or who have limited internet bandwidth. The recordings are available through the 'Podcasts' section of the NACA website, and you can subscribe to our feed with your favourite podcasting client.

The first batch of eleven videos comes from the recent workshop on Sustainable Intensification of Aquaculture in the Asia-Pacific, which was co-organised by FAO, APFIC and NACA. Check it out at:

http://www.enaca.org/modules/podcast/programme.php?programme_id=10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