

AQUA CULTURE

A s i a P a c i f i c



Industry review

- **Tilapia in India and Bangladesh**
- **Epidemiology of Streptococcosis in Malaysia**

Benefits of Nursery Phase in Shrimp Farming

Tracking Typhoons and WSSV

Super Intensive Vannamei Shrimp Farming in Sulawesi

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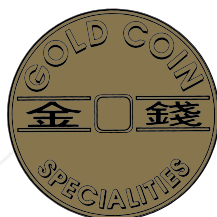


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Farming the red tilapia in Malaysia, picture courtesy of Mohamad Noor Amal Azmai Universiti Putra Malaysia (see page 45)

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Zuridah Merican

CHANGE and CONTINUITY

Commercial shrimp aquaculture started developing in South East Asia in the early 1980s, catalysed by Taiwanese technology and the then insatiable Japan market. Commercial fish farming has a much shorter history. The early aquaculture practitioners were production driven targeting readily found markets. Markets were growing and demand outstripped supply. These early farmers became entrepreneurs, matching products to markets with good prices. Very few, if any, had any formal training in aquaculture. Many were prepared to learn by trial and error, drawing on the expertise and experience from Taiwan. With changes in farming systems came the necessity to acquire new knowledge through technological advances and experiences from successes within and outside the country.

Fast forward 35 years and a sizeable number of the original entrepreneurs are still around, having gone through trials and tribulations. Some however, have begun to bring in their children into the business. In Indonesia and the Philippines, it is satisfying to see that a formidable second generation has emerged, particularly in large family owned conglomerates and small and medium sized family run operations. This is happening to a lesser extent in India, Malaysia and Vietnam. In their late 20s and early 30s, most hold business and economic degrees and to my knowledge, one with a Master's of Science in Aquaculture. These young entrepreneurs are taking over family owned farms and feed mills such as in Vietnam and Indonesia, and their objective is to convert shrimp and fish farming into an industrial business in comparison to that of the older generation who farmed out of passion.

This group is also bringing another perspective into the making money out of science and are more willing to share experiences, successes and failures with their open mind-set. At the same time, the fish and marine shrimp farming business has changed rather drastically. While the parent generation practised aquaculture in a 'trial and error' fashion, the second generation has to move the equilibrium from an art form into that of science. The internet has allowed them to share information with industry peers all

around the world, bringing with it an 'industrial revolution' in aquaculture. The older generation is open to letting their children learn from their own mistakes, barring burning down the house. More importantly, it is a combination of thinking out of the box while using their formal training.

The reasons for emergence of the second generation are varied, ranging from 'groomed to take over' to 'obliged to continue the family business'. Their thought process is to explain the outcomes from the varying input variables and they prefer to execute in a controlled manner to ensure forecast and defined outcomes. While they continue to tap their parents' brains for knowledge and lessons learnt, they should continue to take the opportunity to inject science into the industry.

However, this succession plan is not limited to the farming community but also leaders of the shrimp industry and researchers. In Thailand, grooming of the next generation of technical leaders in shrimp farming has already begun. They are now gaining more exposure at local shrimp meetings. Unfortunately, they also have had to face challenging times, as a result of the early mortality syndrome. However, on the plus side, this required quick learning in order to gain credibility among farmers. At the TARS 2012 meeting in Phuket, Professor Tim Flegel said that the time was right to think about a succession plan for shrimp health research and diagnosis at Centex Shrimp, and today this is underway. Other countries should also start thinking about the opportunities to spur the younger generation to excel. As succession planning in the aquaculture sphere is not normally published, it would be unfair for this magazine to say it is not progressing in other countries.

We feel that this succession plan is moving in the right direction - turning an art into a science through change and continuity.

OUR MISSION

We strive to be the beacon for the regional aquaculture industry.

We will be the window to the world for Asia-Pacific aquaculture producers and a door to the market for international suppliers.

We strive to be the forum for the development of self-regulation in the Industry.



TARS 2015

The fifth of The Aquaculture Roundtable Series (TARS 2015) will be held in Hanoi, Vietnam from August 19-20 2015. It will focus on **Aqua Feeds 2.0: From Farm to Plate**. For more information: visit www.tarsaquaculture.com



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Fish health key to future growth of aquaculture sector in Asia

Fish has an important role in human nutrition and that is why the aquaculture industry needs to ramp up production to meet the global need of 158 million tonnes by 2030. To do this, it has to reduce wastage from mortality by elevating fish health.

In February, at a two-day national seminar on 'Advances in Fish Health' in Malaysia, FAO's Dr Rohana Subasinghe focused on a key aspect in fish production, biosecurity and health management, in his keynote address "Advances in fish health for better food and nutrition security?" The seminar, organised by the Institute of Biosciences, Universiti Putra Malaysia, was attended by more than 100 participants from industry, academia and government. There was a diverse range of presentations by local researchers, ranging from aquatic fish health challenges in farms to using metabolites as biomarkers in disease remediation.

"Fish is actually one of the more sustainably produced foods. Feed conversion ratio (FCR) and nitrogen emission are significantly lower in aquatic production compared to those of terrestrial animal production. Fish is also important for human nutrition as a direct source of long chain omega-3 fatty acids, specifically eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids. In the first 1000-day window of a child's development, these are essential for optimal brain and neural development. In adults, 250 mg of EPA/DHA per day is recommended to reduce the risk of coronary heart disease (CHD) mortality. An alternative source of omega-3 fatty acids can be found in vegetable oils, but conversion to DHA is not easy in humans.

"The recommendation is at least two fish meals/week. In terms of consumption; the FAO target is a minimum consumption of 15 kg fish/person/year. The current global average consumption is 19 kg/person/year. However, the lowest is in Africa at only 2 kg/person/year and this is linked to stunted growth in children. One of the highest consumption rates is in Maldives at 60 kg/person/year."

Subasinghe added, "The debate is also whether to consume small fish or fillet of large fish. It should be noted that the latter has little calcium input into the diet."

On the supply gap, Subasinghe said that aquaculture production in 2013 was 70.2 million tonnes, and in 2014, the FAO estimate was 74 million tonnes with China contributing 61% of this production.

"In 2030, to maintain baseline consumption, the demand will be 159 million tonnes. If we add GDP to this population growth, the demand for fish will be 261 million tonnes. Annual growth in aquaculture production should be 5.6% per annum but it will only be 4% per annum if business continues as usual. We therefore need to increase the rate of growth of aquaculture to be able to meet the supply-demand gap by 2030. Other ways to increase fish supply include reducing wastage and better managing marine fisheries. However, the expected increase in production through these means will be marginal."

Biosecurity and health management

To sustain aquaculture growth, there are many issues, challenges and opportunities. According to Subasinghe, biosecurity and health management should be considered as one of the top priorities among the issues to be addressed for sustaining the sector's growth. Among the requirements in this area include technology and innovations, investment and finance, policy and governance and improved Public-Private-Partnerships.

On where are we now on disease and health management, Subasinghe noted, "We have made serious investments resulting in significant technological developments. We have excellent production systems to keep pathogens away. We have made substantial developments in capacity building at the institutional level, increased awareness and implementation of more stringent trading standards," said Subasinghe.

"But we are still bogged down by disease outbreaks. The estimated annual economic loss is USD6 billion out of a seafood value of USD 100 billion. Why is this? Because we still see transboundary movement of pathogens. In shrimp, we have seen various pathogens causing huge losses. Early mortality syndrome (EMS) has now probably entered the Philippines, whilst India is still fighting white syndrome virus (WSSV). We are trying to find remedies and struggling to contain diseases which are moving from place to place."



Dr Rohana Subasinghe (second left) with Dr Kua Beng Chu (left) and Dr Siti Zahrah Abdullah (right), National Fish Health Research Centre, Department of Fisheries, Prof. Fatimah Md Yusoff, Institute of Bioscience (middle) and Prof Hassan Mohd Daud, Universiti Putra Malaysia (second right).

Where should industry in Asia be?

Subasinghe recounted some success stories in overcoming disease challenges and achieving production gains. Noticeably among these is that of the Norwegian success with its salmonid industry. The production is 1.1 million tonnes and it currently only uses less than 500 kg of antibacterials for disease treatment. Each salmon is injected with 5 vaccines before stocking into grow-out cages.

“Industry in Asia can no longer be complacent. In the past, we just produce and break rules to achieve our goals of high production. There was no thought of responsible farming and sustainability. From past experience it is clear that the producers will always attempt to bridge the supply and demand gap, even forgetting the issues and concerns of sustainable production which leads to serious environmental and social impacts, including disease, which should be avoided at all cost,” said Subasinghe.

As food for thought, Subasinghe added, “Aquatic animal health cannot be considered as a single entity. The aquatic environment is fluid and there is transboundary movement. Our industry is a complex food production sector; it is quite impossible to keep disease out and thus we just need to be vigilant.

Time to rethink

Nearly 70% of aquaculture production comes from small-scale producers and these producers are finding it difficult to survive in a global industry which is becoming more corporate. “Disease costs are too high for the small scale sector to survive. Poverty will drive them to use affordable solutions which could be detrimental for the whole industry. Wherever the farmer is, high mortality, such as with the carp in India and China, is a loss. Reducing losses means increasing productivity.

“What is most important for the future is to develop effective, science-based health management technologies and strategies encompassing the ‘One Health’ concepts. We all need to make a concerted effort to develop capacity among this small-scale production sector, to manage their systems and practices better, and thus reducing the imminent biosecurity risks.”



At the Advances in Fish Health seminar, Dr Chong Chou Ming, Institute of Bioscience, University Putra Malaysia said that in warm water fish such as the groupers, blood clotting is very rapid which make analytical work and disease diagnosis difficult. Warm fish have evolved rapid blood clotting mechanism to prevent disease infection through open wound as spreading of pathogens are more severe and faster in warmer water environments. Institute researchers led Dr Maha Abdullah have developed a new and effective fish blood anticoagulant containing EDTA and trisodium citrate in a ratio isotonic to fish physiology. It has been proven effective with the grouper. Chong also presented on his work on development of monoclonal antibodies against leukocytes of brown marble grouper.

His message to the young scientists and fish health professionals, “As you all reveal your research output during this two-day seminar, it is important to note that any technology that you have should be easily applicable to industry and, in particular, to small scale producers.”

A new method for the detection of AHPND-bacteria (AP4)

The AP4 PCR method was developed entirely by Thai scientists working in Thailand at Centex Shrimp, the Shrimp-virus interaction laboratory, BIOTEC and Aquatic Animal Health Research Center and Charoen Pokphand Co. Ltd. It was also supported entirely by research funding from Thailand.

The advantage of the AP4 method over the previously published AP3 method is that it has 100 times higher sensitivity. Because of its higher sensitivity, the bacterial culture enrichment step needed when using the AP3 with low levels of AHPND bacteria may be omitted. However, the AP4 method should not be considered as a replacement for the AP3 method but simply as an alternative choice for users to choose should they need a more sensitive detection method.

The AP4 method was tested with the same 104 bacterial isolates that were used for validating the AP3 detection method, and the results were identical, i.e., 100% specificity and sensitivity with the 104 isolates but at 100x lower template levels.

Support for the development of AP4 was from the Agriculture Research and Development Agency, the National Research Council of Thailand, the Thai Commission for Higher Education, Mahidol University, Faculty of Marine Technology at Burapha University, the National Science and Technology and Development Agency, the Patani Shrimp Farmers Club, the Surathani Shrimp

Farmers Club, the Thai Frozen Foods Association, Charoen Pokphand Company, SyAqua Co. Ltd. and Thai Union Co. Ltd

As with the previous announcements in this series, the AP4 method is provided for free use in the detection of AHPND bacteria. The new method is available for download at the NACA website, www.enaca.org.

A positive control plasmid for the AP4 method will be sent out to those who are already on their mailing list as recipients of plasmids for the previous AP methods to detect AHPND bacteria. For those not on this list, the plasmid will also be provided upon request to: Dr Kallaya Sritunyalucksana (kallaya@biotec.or.th). To join the mailing list, please visit the AHPND Detection Google Group.

Correction:

In issue January/February, pages 40-41, we inadvertently omitted the original source of this article. Constant Flow Technology: pump automation for aquaculture. The original publication was “Constant Flow Technology - Useful Pump Automation For Aquaculture by Thomas Losordo, Ph.D. and Zack Pickard, Global Aquaculture Advocate 17(5):86-87 (Sep-Oct 2014).

MoU with Vietnam Pangasius Association

In February, the Global Aquaculture Alliance (GAA) signed a memorandum of understanding (MoU) with the Vietnam Pangasius Association (VNPA), in which the two organisations will work collaboratively to advance responsible aquaculture in the pangasius catfish sector in Vietnam and globally through the exchange of information and research. GAA and VNPA agreed to the MoU after January meetings in Can Tho and Hanoi.

“We are delighted to formalise our relationship with VNPA through this MoU. We are looking forward to working together with VNPA to advance responsible practices not only in the farming of pangasius through VietGAP as a stepping stone to BAP certification, but also through the incorporation of responsible practices at the hatchery level and through responsible feed. We are also looking forward to assisting in the development of stronger market ties for BAP-certified pangasius,” said Carson Roper, international business development manager for GAA’s Best Aquaculture Practices (BAP) division.

“VNPA welcomes this MoU as a positive step toward building a more robust Vietnamese pangasius production system,” said Dr Vo Hung Dung, vice chairman and general secretary of VNPA. “Equally important, we welcome the collaborative support of GAA to assist in the application of VietGAP and the BAP certification program. We look forward to build stronger market ties product from VietGAP and BAP-certified pangasius facilities.”

In the MoU, VNPA agreed to help identify and enrol processing plants, farms, feed mills and hatcheries in the BAP third-party certification program to increase the number of BAP-certified facilities in Vietnam. VNPA will also enlist GAA’s assistance and expertise in its efforts of implementing good aquaculture practice standards in Vietnam regarding food safety, environment responsibility, social responsibility and animal welfare.

In return, GAA agreed to help identify market endorsers to further promote responsibly produced Vietnamese farmed pangasius products to retailers and foodservice operators worldwide. GAA also agreed to offer training and seminars to help Vietnamese producers to be able to apply VietGAP and the BAP standards to improve their aquaculture practices.

The Viet Nam Pangasius Association (VNPA) is an association which represents farmers, commercial enterprises engaged in the processing and exporting of pangasius as well as enterprises and other organisations that are active in the field of supporting industry for the Vietnamese pangasius sector. It is not limited in types of enterprises, either domestic or international enterprises are welcome as members. The total number of members of the association in 2014 is 300 members. Most of the members are concentrated in the Mekong delta, the key area of processing and exporting for pangasius in Vietnam.

In Brief

Equity crowdfunding for shrimp farm

In San Diego, entrepreneur and engineer Kim Forssell, chairman of Net Zero Enterprises has harnessed the power of equity crowdfunding to launch his passion project. Forssell will create the first sustainable shrimp farm in the US located in San Diego which costs USD11.4 million. This is now among the top equity-crowdfunded projects in the country. His success also demonstrates how many investors share his passion. Forssell raised more than USD5 million via equity crowdfunding in an offering on Return On Change. Equity crowdfunding allows accredited investors to invest in companies raising cash on platforms like Crowdfunder, with a promise of future returns. Investors are more like shareholders in a company than they are donors.

Handheld sensor to sniff out grouper fraud

Scientists at the University of South Florida’s College of Marine Science have developed a handheld sensor capable of detecting fraud in seafood. In a paper published in *Food Control*, they describe the new technology and its application. The instrument assays seafood samples using real-time nucleic acid sequence-based amplification (RT-NASBA). The handheld instrument that purifies and identifies the sample’s RNA is a portable version of the lab-based benchtop model previously developed. It takes less than 45 minutes for completion and can be performed entirely outside of the laboratory. According to the paper’s lead author, Robert Ulrich, fraud involving grouper is prevalent because it is the third most economically valuable seafood product in Florida and there are commercial quotas on grouper catches. The task of identifying true grouper does get complicated because the US Food and Drug Administration allows 64 species of fish to be labelled as “grouper.” In 2012, over 4,000 tonnes of grouper, worth USD 33.5 million, were imported into the US.

IFFO RS Standard New Version

Following public consultation, the IFFO RS Certification Program has launched a new version of its IFFO RS standard for marine ingredient producers. This new version (Version 1.6) will cover, in addition to all the previous parts of responsible sourcing and responsible production, basic social and environmental aspects at the factory level. This new version can be downloaded from the website <http://www.iffonet/iffo-rs-standard> and will be enforced to all producers and certificate holders from May 1 2015. Together with this, the IFFO RS Certification Program has now become a separate legal entity in its own right, with its own multidisciplinary governing board. In order to increase the transparency of the standard and to facilitate a more robust traceability, IFFO has added a list of MSC fisheries to the raw material section of the RS website, which were provided by some of the IFFO RS certificate holders during the application process.

Contaminated Shrimp Imports to US

In March, the US Food and Drug Administration (FDA) released February 2015 data indicating that of the 114 entry lines of seafood refused in February 24 were related to veterinary drug residues. Almost 80%, (19) of the entry lines refused for banned antibiotics such as chloramphenicol and nitrofurans were of shrimp shipped from Malaysia and the FDA listed the names of the seven companies. The rest were from India (4), and one, China. The Southern Shrimp Alliance has compiled FDA data on refusals for shrimp products since 2002. These data show that 2015 had the fourth most refusals of entry lines of shrimp for reasons related to veterinary drug residues since 2002. FDA’s reporting of refusals clearly show that problems with banned antibiotics in shrimp aquaculture have been limited to a small number of countries. Of the 1,025 entry lines of shrimp refused for reasons related to veterinary drug residues since 2002, over 90% (928) were shipped from just five countries: China, Malaysia, Vietnam, India, and Indonesia.



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Super intensive shrimp farming in West Sulawesi

By Poh Yong Thong

How extreme can we push vannamei shrimp culture? In Sulawesi, Bhakty Baramuli showed after three crops, that a high stocking density of 500-1,000 PL/m² is possible

Situated at the northeast of Java and southeast of Borneo, the Indonesian island of Sulawesi is endowed with rich fisheries resources and is surrounded by good quality sea water. Hence the farming of *Penaeus monodon* in Sulawesi is very popular since the 1990's. According to official statistics from the Department of Aquaculture, Ministry of Marine Affairs and Fisheries (MMAF), 15,000 tonnes of monodon shrimp were produced in south Sulawesi in 1996 and this rose to 60,428 tonnes in 2013. For example, PT Bangai Sentral Shrimp, a French shrimp farm of 200 ha was first to establish itself in central Sulawesi. Since the introduction of the vannamei shrimp to Indonesia, its farming has been increasing, mainly in central, south and west Sulawesi. In 2013, total production of this shrimp was 29,408 tonnes (MMAF).

However, Sulawesi's distance from the densely populated Java island results in higher shrimp feed costs and low prices for the harvested shrimp. Feed prices might differ by IDR 2,000 (USD 0.16) per kg and the differences in shrimp prices may range from IDR 6,000 to 10,000 (USD 0.48 to 0.80) per kg. Recently, there is a re-emergence of shrimp farming as a result of the late 2012 rise in shrimp prices due to a shortage in supply. The increase in price and demand is now attracting shrimp farmers back to this remote island. Interestingly, south Sulawesi is reputed with its innovative super intensive vannamei shrimp farming systems, such as that by Dr Hasanuddin Atjo (AAP, 2013). In early November 2014, a visit was made to another interesting super intensive vannamei shrimp farm in west Sulawesi.

Baramuli is the largest producer of postlarvae in west Sulawesi and currently its production is 130 million post larvae (PL) per

month. Relative to south Sulawesi, the western region is a small shrimp production area with a volume of 3,036 tonnes in 2013. Perhaps this is one reason why Bhakty Baramuli, the owner decided to start super intensive farming of vannamei shrimp. The farm has a total of three ponds. Another two ponds are still under construction. At the time of our visit, the farm was running its third crop, after two successful crops where ponds were stocked at a very high density of 1,000 PL/m².

Main features

The ponds are entirely concrete with sizes of about 3,000 m² and depths close to 3 metres. However, sea water is filled up to the 2.2 m mark. Out of the three ponds, one pond uses a total of 48 HP for aeration with 6 paddlewheels of 1 HP and 6 paddlewheels of 2 HP. The total aeration for the pond described in this article is 18 HP. There are also two blowers, each of 15 HP.

“ The pond, as normally practised in Indonesia, has a central discharge system to drain away sludge at least five times a day. ”

In this cycle, post larvae (PL10) shrimp are stocked at 500 to 550 PL/m². The pond, as normally practised in Indonesia, has a central discharge system to drain away sludge at least five times a day. In addition, frequent siphoning is carried out to remove other accumulated matter.

The level of dissolved oxygen is maintained above 4.5 ppm. pH was maintained at 7.6 to 7.9 when shrimp was stocked at 57 days of culture (DOC). Alkalinity was kept at 130 ppm; probiotics and magnesium sulphate were routinely added to maintain water quality. Water was replaced at 70 to 120 cm daily depending on water quality conditions.



At the farm, Pak Bhakty Baramuli (middle) with the author Poh Yong Thong (third left) with farm technicians, chief technician, Budi (second left) and John Miduk, Gold Coin Sulawesi Sales (third right) and Mohd Bima (Area Sales manager, of Gold Coin (right).



Air bubbles are from blowers. Autofeeders are used which is not a common feeding method in Indonesia



Blowers and paddlewheels vigorously aerate and move pond water.

The total number of post larvae stocked in the pond was 1,650,000 and at DOC 57, the feed demand was 525 kg/day. For this cycle, Bhakty used Gold Coin Forte feeds, with 36% crude protein. At DOC 53, shrimp were sampled and averaged 6 g in weight. Each pond uses three auto feeders for feeding.

A previous harvest was 28 tonnes from a 3,000 m² pond. The feed conversion ratio (FCR) was 1.4 for shrimp size of 60/kg (average weight of 16.7 g) and survival rate was 93% after DOC 107.

On 16 December 2014, Bhakty harvested the pond visited. The harvest after DOC 97 totalled 27 tonnes, after three partial harvests. This time, FCR was 1.49 and harvest size was 55/kg (18.2 g) and survival was 97%.

Some comments

Super intensive shrimp farming at above 300 PL/m², has its prerequisites. Foremost, is the requirement of very good quality sea water. The farm should be located in a friendly ecological setting away from other farms. A small number of ponds, not exceeding the carrying capacity of the area is also a prerequisite. **Such a system can be adopted when the operator not only strictly adheres to standard operating procedures, but also possesses a high level of understanding and technical skills in shrimp farming.**

Poh Yong Thong is based in Sabah, Malaysia where he runs a small shrimp farm. Email: poyoto2002@yahoo.com

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In the Philippines, linking WSSV outbreaks and fish kills to typhoons

By Chris Mitchum Ganancial

Such disease outbreaks and fish kills are common dilemmas for grow-out farmers despite being proactive in dealing with such situations. Is there a way we can avoid or even pre-empt it from happening? Yes, according to information from project NOAH by the Department of Science and Technology (DOST).

Typhoons and the Philippines

Typhoons have a great influence on the climate and weather conditions of the Philippines. About 20 typhoons affect the country annually. A great portion of the rainfall, humidity and cloud cover are due to the influence of typhoons. They generally originate in the region of the Marianas and Caroline Islands in the Pacific Ocean, located on the same latitude as Mindanao, the largest island in the southern part of the Philippines. Their movements follow a northwesterly direction, usually sparing Mindanao from being directly hit by the majority of the typhoons. However, lately, this is no longer the pattern.

Mindanao has always been a major producer of the marine shrimp. Since the lifting of the ban in culturing *Penaeus vannamei* in 2007, Mindanao shrimp farmers have embarked on the culture of this shrimp and have been successful with their yearly harvests. In 2012, a series of typhoons hit the island, coinciding with a series of white spot syndrome virus (WSSV) outbreaks in areas where the occurrence of WSSV is not common.

Disease outbreaks

Aside from breaks in biosecurity, investigators link the increase in incidences of WSSV outbreaks as well as fish kills, to abrupt changes in weather conditions: precipitation or rainfall during typhoons, low pressure area (LPA) and change of monsoon season, from southwest "habagat" to northeast "amihan" seasons, and vice versa. These normally happen in the months of May to June (amihan to habagat) and October to November (habagat to amihan).



Figure 1: One feature of Project NOAH (Nationwide Operational Assessment of Hazard) of the DOST (Department of Science and Technology) website is that it can show hourly typhoon tracks such as the tropical cyclone moving towards the northern Mindanao area.

Lately, climate change has become a major factor. The pattern of WSSV outbreaks and cases of fish kills have changed particularly in areas where these adversities are not common. Low pressure and prolonged rain started to occur in some of these areas. This explains why WSSV outbreaks or fish kills may exist throughout the year!

Organic loads and WSSV outbreaks and fish kills

In aquaculture, high loads of organic matter in the pond bottom produce heat due to increased bacteria activity in its decomposition processes. With low pressure, surface water starts to cool down. Water in the surface become heavy (cold water is heavier than warm water) and eventually sinks to the bottom. A displacement happens where toxic gases are released from the bottom causing significant oxygen depletion.

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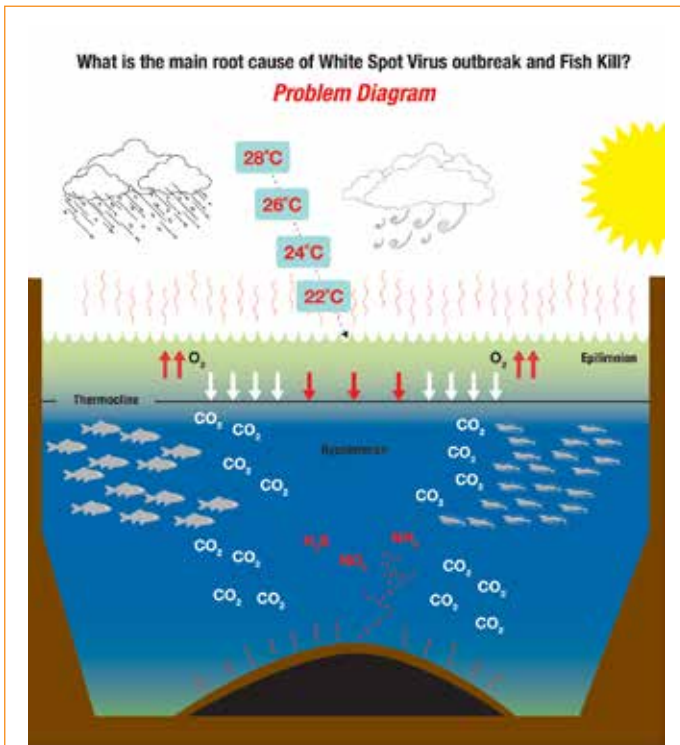


Figure 2: Problem diagram

- Thermal stratification increases accumulation of trapped gases in the hypolimnion, e.g. increased CO₂ toxicity (Aquaculture Silent Killer!, Dr Ra'anan Ariav, AquaVet Ltd. Israel)
- Anaerobic layer (black) of pond bottom soil is thicker than aerobic layer (brown) portion
- Change of weather triggered the release of toxic gases such as ammonia, nitrite and hydrogen sulphide. According to Dr. Chalor Limsuwan, Kasetsart University, Thailand, during low pressure, it is like a bomb just waiting to explode.
- A very stressful condition where shrimp and fish begun to surface and disease outbreak follows, e.g. white spot syndrome virus and fish kills!

When a fish kill happens in Taal Lake, Batangas located in Luzon Island, this is because an overturn happens as cooler water at the surface of the lake becomes heavier and moves down, while warm water rises to the surface. This process causes sulphur and other organic matter on the lake bottom to rise and affect the fish in the cages, as explained by Dr Macrina Zafaralla, a scientist at the University of the Philippines, Los Baños, Laguna.



Fish kill in Taal Lake, Batangas (Photo credit: thefilipinoconnection.net)

“...low pressure area turned the ocean water colder than the milkfish could easily adjust to. That sudden change in ocean water temperature could be the culprit more than anything else.” Fatma Idris, BFAR on the fish kill in cages off coastal Barangay Gwang-Gwan in Mati

Linking typhoons to fish kills

The first tropical depression entering the Philippine Area of Responsibility (PAR) according to PAGASA (Philippine Atmospheric Geophysical and Astronomical Services) in 2014 was typhoon “Agaton” on January 14, 2014. The location of “Agaton” was estimated over 150 km northeast of Hinatuan, Surigao del Sur where affected provinces include Dinagat, Surigao del Sur, Surigao del Norte including Siargao, Agusan del Sur, Agusan del Norte, Davao Oriental and Compostela Valley in Mindanao.

A fish kill incidence was reported in Davao Oriental on January 18, 2014. Fatma Idris, director of the Davao regional office of the Bureau of Fisheries and Aquatic Resources (BFAR) said, “The death of fish in the fish cages off coastal Barangay Gwang-Gwan in Mati was most likely caused by the sudden shift in temperature, from the warm waters to the drop in temperature. The low pressure area turned the ocean water colder than the milkfish could easily adjust to. That sudden change in ocean water temperature could be the culprit more than anything else.” (Source: Business Mirror).

The lowest pressure reading was recorded in Davao Oriental on January 14, 2014 at 1005.74 hPa (Pascals) at 15:30 hours or a drop of 6.8 hPa from the normal or median pressure reading of 1012.54 hPa in the area. The highest pressure reading during this month was 1016.39 hPa on January 11 (Figure 3).

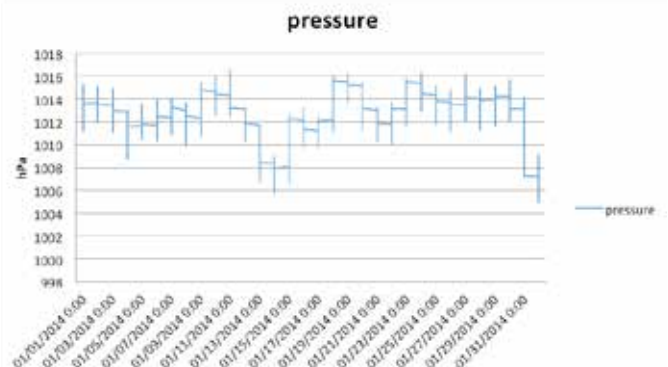


Figure 3: Low pressure trending for January 2014 at Lupon, Brgy. Poblacion, Davao Oriental

“In addition, upwelling normally occurs with deep bodies of water where sunlight usually does not penetrate the lower layer of the water body thus it is devoid of oxygen”, said Jun Coloma, BFAR, Region 3.

Since 2012, with the coordination of BFAR, Bayer Philippines started to document WSSV outbreaks and fish kills and its possible causes. This was published as “Managing fish kill before it happens” in the local Bayer Aqua Newsletter 2012.

Project NOAH of DOST

The documentation of WSSV outbreaks became the monsoon season campaign undertaken by Bayer Philippines in collaboration with DOST-ASTI (Department of Science and Technology- Advanced Science and Technology Institute) and PAGASA. This was carried out in Iloilo, Visayas, from October 2013 to February 2014 to inform shrimp farms on the possibility of WSSV outbreaks. Through the Project NOAH we were able to map low pressure trending and forecast rainfall.

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Historical WSSV outbreaks were also documented through this system. During the second Aqua Lecture Tour conducted by Bayer Philippines with Dr Chalor Limsuwan (Kasetsart University, Thailand) and Dr Apolinario Yambot (Central Luzon State University) in July 2013, a series of seminars were conducted in Manila, Bacolod, Cebu and General Santos City.

Low pressure trending in General Santos City started to decline on July 21 at 988.55 hPa and July 25 at 990.42 hPa at 15:30 hour. Highest pressure was recorded at 996.02 hPa on July 24 with median reading of 992.69 hPa or a drop of 4.14 hPa.

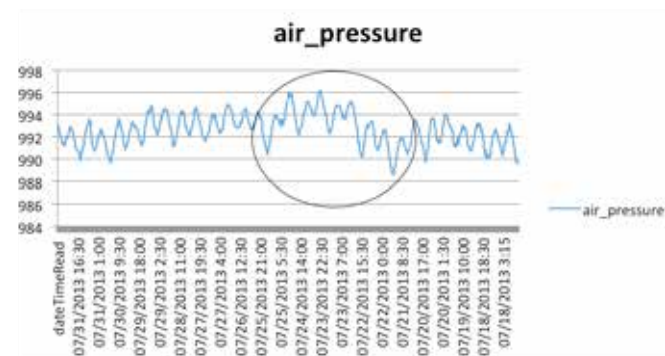


Figure 4: Low pressure trending for July 2013 in Gen. Santos City

The next documented WSSV outbreak which was related to a drop of low pressure was recorded in Sagay City, Negros Occidental during the onset of the change in monsoon season (habagat to amihan) in October 2013.

Low pressure trending in Sagay started to decline on October 11 at 996.95 hPa, October 21 at 1,000.95 hPa, October 24 at 1,000.02. The highest pressure was recorded at 1009.21 hPa on October 16 with median reading of 1003.48 hPa or a drop of 6.53 hPa.

Intensive shrimp farms in Calatagan, Batangas and Zambales growers were also hit by WSSV and possible hydrogen sulphide upwelling during the height of typhoon "Yolanda" (International name: "Haiyan") on November 8 and 9, 2013. Low pressure reading in Calatagan, Batangas and San Felipe, Zambales areas were documented at 995.19 and 997.54 with median pressure reading of 1005.26 and 1,006.91 hPa or 10.07 to 9.37 hPa. respectively (Figure 6).

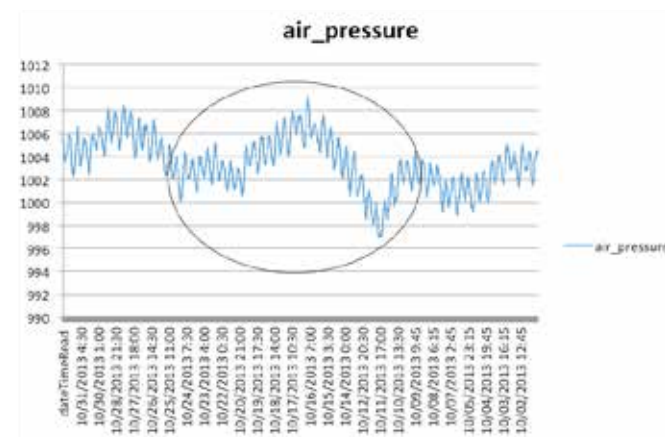


Figure 5: Low pressure trending for October 2013 recorded in Sagay City, Negros Occidental.

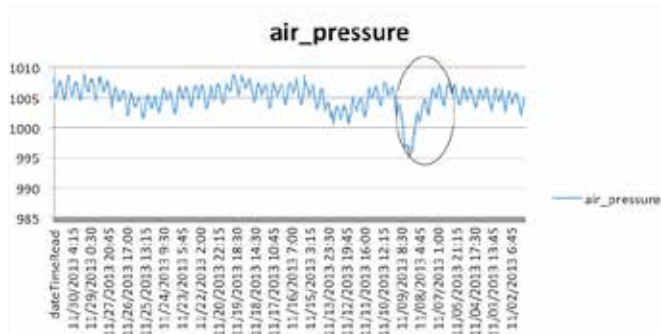


Figure 6: Low pressure trending for November 2013 at San Felipe Zambales

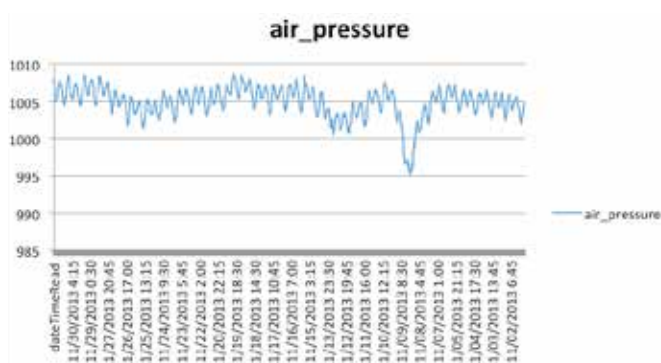


Figure 7: Low pressure trending for the month of November 2013 at Calatagan, Batangas

“ The correlation between atmospheric pressure and air temperature should also be established in aquaculture areas where one can compute how much temperature decrease is needed to initiate convective mixing. ”
Cesar Villanoy, UP-MSI

The latest typhoon to hit Calatagan, Batangas which coincided with incidences of WSSV outbreaks was documented with typhoon "Ruby" on December 8 and 9, 2014. Low pressure readings were 982.2 hPa at 14:00 hours and 981.78 hPa at 04:00 hours on December 8 and 9, respectively. Average low pressure reading in normal days is 990 hPa or a drop of 7.8 to 8.22 hPa.

Moving forward

Hydrometer weather monitoring stations developed by DOST-ASTI have been installed in strategic locations all over the country with the assistance/recommendations of DOST-PAGASA experts. Through the Project NOAH website, rainfall forecast modelling is possible for the next 1-4 hours.

According to Dr Cesar Villanoy, University of the Philippines Marine Science Institute (UP-MSI), temperature is the primary driver in such phenomenon where surface water is cooled down. The correlation between atmospheric pressure and air temperature should also be established in aquaculture areas where one can compute based on the available temperature data and how much temperature decrease is needed to initiate convective mixing.

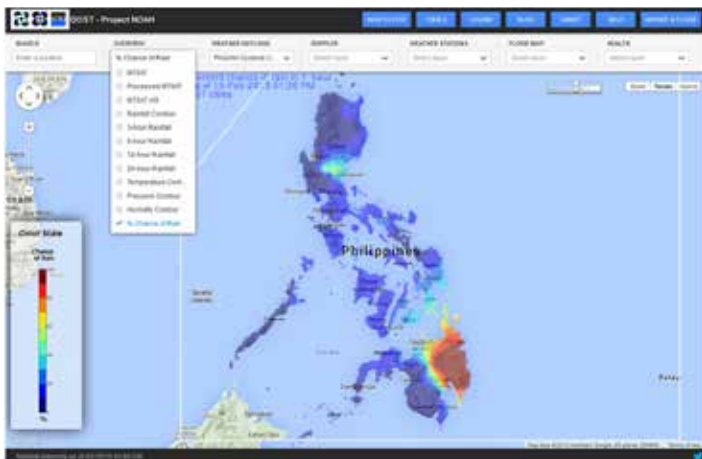


Figure 8: Project Noah website. Colour coded overview of % chance of rain, with brown, red, orange, yellow, yellow green, blue green, light blue, blue, dark blue and navy blue at 100, 90, 80.. 10%, respectively.

“When you have a low pressure event associated with a storm, the event usually happens in a matter of hours (for small storms) or a day or two (for typhoons). When water layers from below move upwards and are exposed to aquaculture organisms, there usually is a lag time before diseases manifest,” said Villanoy.

Daily low pressure trending normally starts to drop at 15:00 and 03:00 hours. Based on the data collected, a drop of 4 hPa and above indicates low pressure has taken place. More studies are recommended on the monitoring of weather conditions, WSSV outbreaks and fish kill occurrences.

However, since we can somehow relate low pressure to a WSSV outbreak and fish kill, we can also pre-empt it!



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Nursery phase in shrimp farming: Benefits beyond EMS

By Fernando Garcia Abad

An evolution in the design of nursery systems for longer duration, higher biomass and larger post larvae, and transfer techniques to maintain health of post larvae.

After years of significant losses with white spot syndrome virus (WSSV) outbreaks, a nursery phase is a common practice in Mexico's *Penaeus vannamei* shrimp farming industry. In the last two years, more integrated groups in South and Central America have implemented a three-phase farming system with intermediary raceways/nurseries at pond site before stocking the animals into grow-out ponds, resulting in increased productivity by 20-30% and lowering production costs.

Stocking post larvae (PL) after a nursery phase (usually >PL45) instead of PL10-12 direct from hatcheries will reduce the duration in the grow-out ponds by 20-30 days and feed conversion ratio (FCR) by 10-30%. In Mexico and Asia, this is now one of the strategies used to mitigate early mortality syndrome (EMS) by stocking larger size post larvae into grow-out ponds.

The three-phase system has its benefits for the whole supply chain. Nursery systems have a constant control of water conditions and shrimp health. There is optimisation and better feeding efficiency. The target is to produce stronger post larvae which have been acclimated to the pond environment. This results in better survival during the first days of culture and minimises exposure to disease vectors. Nursery systems allow more crop rotation in the ponds. Farmers require more post larvae and hatcheries sell more post larvae when producers have more crops.

The system also takes advantage of the compensatory growth capacity well known in the Americas with *vannamei* shrimp. In Mexico, growth of 7-8 g in the first 30 days was achieved with the three-phase system as compared to 3-4 g with regular stocking. The biggest cost in shrimp farming is during the grow-out stage. A shorter cycle means savings in costs for feeds and energy.

However, all of this can be achieved only with the use of proper technology and with full control of the system. In poorly constructed or managed nursery systems, low survivals may result, and weak animals are likely to be transferred to ponds.

“ In the last six years, producers have been adjusting their raceways/nursery systems to be cost efficient with higher biomass. ”

Evolution of nursery systems in Mexico

WSSV together with local weather limitations (Mexico has extreme weather conditions, very high and low temperatures), forced farmers to modify their operational systems. In the last six years, producers have been adjusting their nursery systems to be cost efficient with higher biomass. With high stocking density, these systems require zero water exchange in order to keep all parameters constant. Prerequisites are highly efficient filtration systems, similar to those used in the hatchery. Aside from



Rectangular tanks of 800 to 1000 tonnes in a greenhouse

probiotics to control water quality, regular siphoning is required. The target is healthier and stronger animals before transfer to the ponds.

There has been an evolution in tank shapes for nursery systems in Mexico. Circular tanks from sizes of 50 tonnes in 2008 and 2009 have evolved to raceways of 100 tonnes in 2009 and then to larger raceways of 500 tonnes in 2011. These are now bigger with rectangular tanks of 800 to 1000 tonnes in curved or flat greenhouses.

Control on water quality and feeding

The main criterion is control of water quality. Probiotics are applied according to the target; for example, for organics, it is 3 ppm probiotics for every 72 hours. In the case of control of toxics, it is 2-5 ppm probiotics for every 48 hours and for pathogens in water, it is 2 ppm probiotics for every 72 hours. Pathogens in the animal are targeted with 1-4 g/kg probiotics. However, the protocol of the different probiotics is adjusted depending on the biomass, water quality and animal health conditions. The objective is to maintain optimal conditions in order to keep the animal healthy for it to express the compensatory growth potential when transferred.

In the case of feeding, lower quality feeds with fines will affect water quality and shrimp performance. As such, higher quality hatchery feeds with less fines are most desirable. Producers do not follow a fixed feeding table. Usually, at least 45% crude protein and high energy feeds are fed at 2-hour intervals. Feed amounts are adjusted depending on feed trays, water quality and animal growth.

Transfer techniques

The main bottleneck in the adoption of nursery systems is the implementation of the right transfer technique. Attention is placed on the transfers of post larvae to grow-out ponds. The early transfer techniques had adversely affected survival rates. For short distance transfers to adjacent ponds, 2 kg of small animals of 0.4 to 1g each, were placed in 20 kg sized buckets filled with water saturated with oxygen. The maximum transport time was 5 minutes and mortalities during transportation ranged from 5 to 10%. For longer distances, 75 to 180 animals/litre or 20 to 40 kg of post larvae were transported in 1000 to 2000-litre



External view of greenhouse structures, curve and flat

“ The transfer process has been refined such that the animal does not stay out of the water longer than 30-60 seconds. ”

tanks again in water saturated with oxygen; in such transport conditions, mortality during transport ranged also from 5 to 10%. The degree of early mortality in ponds is directly related to the condition of the animal at time of transfer and stress level during transfer.

Since 2012, modifications in transfer technology led to the use of pumps for more efficient transfers. This reduces stress and mortality during transfers to only 3-5%. The transfer process

Table 1. Average weight and survival rate at different stocking density in raceway nursery systems in Mexico.

Stocking density (PL/litre)	Days	Survival %	Average weight in mg
1.8	57	86	4000
1.8	45	89	2000
2	35	87	1000
4	35	85	800
8	35	80	480
12	35	78	310
22	35	74	250

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Transfer using pumps in Mexico. Clockwise, from top left, harvesting in a greenhouse nursery, juvenile shrimp, transferring shrimp to a well aerated tank for pumping and shrimp moving through the large pipes to ponds up to 3 km from the raceway units. The transfer capacity with pumps is 15 kg per minute.

has been refined such that the animal does not stay out of the water longer than 30-60 seconds. In 2013, the maximum distance for transfers with pumps was to ponds located up to 3 km from the raceway units. The transfer capacity with pumps is 15 kg per minute.

Early transfer affects survival rates in the pond and it is important that transfers are carried out in the morning, late evening or at night. When planning for the transfer, the health condition of the shrimp should be monitored.

Reducing density

A recent development in Mexico is to reduce stocking density to achieve higher weight of post larvae as well as higher survival rates in the raceways. Biomass of 6.9 kg/m³ has been achieved. The average results of weight and survival rate achieved depending on stocking densities and days in raceways are shown in Table 1.

Beyond EMS and nursery systems

The impact of the EMS/AHPND in Mexico has been severe. Production dropped 60% in 2013 which was very similar to that in Thailand. More problems than normal were attributed to post larvae sources. Some large groups took advantage of their large raceways infrastructure, and changed the production strategy by lowering stocking densities and prolonging the days of culture in the raceways for larger post larvae for stocking. The grow-out cycle in the ponds was further shortened by harvesting smaller shrimp. This became a viable alternative for the Mexican industry, with current shrimp prices and more short cycles with better FCR and a different cost structure.

Some examples from farms in three locations proved that this change in strategy was a valid option in 2014. Post larvae

were stocked in 500 to 1000-tonnes raceways at 0.6 to 1.8 PL/litre. Days of culture ranged from 30-57 days to produce 3.5 to 4.28 g juveniles. Survivals were high at 87 to 90% and FCRs were 1.4 to 1.65 depending on days of culture. In the grow-out ponds, 4 g juveniles grew to 17 g in 30 days at a density of 6 juveniles/m². FCR was low at 0.47 and survival rate was at 85%. In another pond, 4 g juveniles grew to 10.4 g in 14 days and accumulative FCR from raceway was 1.56 with 95% survival.

Asian experiences

These experiences from Mexico were successfully transferred to a Malaysian farm in 2013-2014. Post larvae were stocked in raceways for 25-30 days to produce 1-1.5 g post larvae. These were then stocked into grow-out ponds at a density of 70-80 PL/m². FCR in the raceway was 1.0-1.5 depending on the duration of culture. In the grow-out ponds, shrimp grew to 17-18 g and FCR was 1.3. Survival in the grow-out pond was 90-95%. There is still room for improvement such as adjusting feeding regimes, probiotics protocols, and temperature conditions in order to achieve larger post larvae in the nursery phase and better FCR's in the grow-out ponds.

In Thailand, there were mixed results. There was success at the nursery stage but due to the health condition of the animal during transfer, results were poor in the grow-out stage. Alternative ideas were put in place such as stocking in cages inside the ponds for the first 30 days with no soil contact. This reportedly avoided an EMS outbreak. Another option was separating 20 to 30% of the pond with a net and stocking in this area and releasing shrimp into the whole pond after 20 to 30 days. However with these practices compensatory growth does not happen since the shrimp are in the same pond.



An example of a highly efficient filtration system

In Vietnam, the implementation of nursery systems was hampered by low investment and technology as well as poor biosecurity. One success was reported in central Vietnam but poor animal condition at transfer to ponds did not give good results in grow-out ponds. Poor animal condition was attributed to poor water quality from the use of sub-optimal feeds in the nursery stage.

Conclusion

In challenging times with the presence of new diseases and adverse environmental conditions, the industry needs to change and use new tools. Since the causative agent of EMS/AHPND is a *Vibrio*, nursery systems allow farmers to focus on controlling the *Vibrio* bacteria in a smaller area and delaying exposure to the pathogenic agent.

With high shrimp prices, about 27% higher than in 2000 which was the previous pick on prices, and which is expected to remain high in the next couple of years, farmers in Asia should use this opportunity to invest in and use the proven new technology appropriate for their unique situations. Rather than reinventing the wheel, producers should adopt the Latin American methodology and refine it for Asia. In this way, we can move away from artisanal to more controlled sustainable shrimp farming. The benefits of the implementation of the three-phase shrimp farming also go beyond EMS/AHPND. It improves productivity and reduces costs without additional pressure in the production systems.

Today, prices have come down sooner than expected but still at a reasonable level. The two biggest costs in shrimp farms are feed and duration of culture. The implementation of these systems has a significant direct impact in both parameters and therefore will help farmers to reduce risk and improve their profitability.



Fernando Garcia Abad is Aquaculture Business Development director at Epicore Bionetworks Inc, USA. He has more than 22 years of experience in both academic and production areas of aquaculture. He has held management positions at the three levels in shrimp production; maturation, hatchery and grow-out.

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This article was extracted from a presentation on "Third phase in farms: does it work and how can it work? Benefits beyond EMS/AHPND" presented at the TARS 2014: Shrimp Aquaculture-Recovery • Revival • Renaissance, 20-21 August, Phuket, Thailand. Some updated information has been included.

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Supplemental diets in juvenile production of Nile tilapia

By Santiago Benites de Pádua, Roney Nogueira de Menezes Filho, Maurício Laterça Martins and Mariana Midori Nagata

Targets achieved included improved resistance against diseases, enhanced intestinal integrity and production performance



Juvenile production of Nile tilapia comprises a stage with high economic losses due to disease outbreaks. This initial stage of farming the fish is usually accompanied by intense and frequent handling resulting in stressful conditions that favour opportunistic infections by several pathogens. Therefore, the use of feed additives and supplemented diets to modulate the immunological system constitutes an important alternative for implementation of strategies to improve fish resistance against such challenges in its production.

Recently, we presented the results on the use of Aquate Fish™ (Alltech, USA) during the masculinisation period in fingerlings of Nile tilapia (Pádua et al., 2014). The feed additive, Aquate Fish™ comprises different natural ingredients such as yeast and marine algae, organic minerals and vitamins and has been shown to promote health benefits in farmed fingerlings in hapas in Minas Gerais state, Brazil (Pádua et al., 2014). In a new phase of this validation work, we evaluated this product in other farming conditions in northeast Brazil. For this work, we selected AAT International, a leading juvenile fish producer and supplier to farms in Bahia state. AAT International specialises in fingerling and juvenile production of tilapia in raceways with high water exchange whilst the farming technology at Paulo Afonso Pole Production is intensive grow-out of tilapia in cage net systems at stocking density of 60-150kg/m³.

Validation trials

For this test, a total of 300,000 fingerlings of Nile tilapia (*Oreochromis niloticus*) with mean weight of 2.2 g were distributed in 6 raceways (each of 16.9 m³) with high water exchange (150 times a day) containing 50,000 fish per experimental unit (2 treatments and 3 replicates). There were two treatments:

G1 group: Fish were fed the treatment diet, supplemented with 6 g of Aquate Fish™/kg in extruded feed (Guabi Pirá Mirim® 1.0 mm; and Guabi Pirá Alevinos® 1.7 mm). Top dressing of the additive in oil was carried out at the farm.

G2 group: Fish were fed the unsupplemented diet i.e. extruded feed, Guabi Pirá Mirim® 1.0 mm and Guabi Pirá Alevinos® 1.7 mm.

Fish were maintained in this system for 33 days and then they were classified and redistributed in 8 raceways (2 treatments and 4 replicates) and kept in these raceways for 45 days.

Health evaluation

Parasitological analysis was carried out in situ at 0, 23 and 45 days in which the fish were netted out and samples of skin, fins and gills scrapings were observed under the microscope. On day 0, we collected a total of 60 fish for baseline analysis and 60 fish per treatment were analysed on days 23 and 45. A total of 300 fish were subjected to diagnostic tests. The diagnosis of parasite prevalence rate was calculated as proposed by Bush et al. (1997) and then ranked in the Parasite Intensity Score (working methodology established by Aquivet Saúde Aquática).

At the end of the experimental period, a total of six fish per raceway were collected and necropsied for histopathological analysis. Intestine fragments were fixed in neutral buffered 10% formalin solution for histopathology, embedded in paraffin, sliced in 5 µm thick sections and stained with haematoxylin and eosin. Photomicrographs were made in photomicroscope for anterior and medium intestine morphometry to obtain the following parameters: 1) intestinal height of villi 2) intestinal width of villi and 3) height of enterocytes.

Production performance

A hundred fish were sampled for biometry at 0, 23 and 45 days after feeding with experimental diets. Fish were weighed individually to the nearest 0.1 g using a balance and the length was measured with an ichthyometer. For productive performance, the following parameters were measured: weight gain, specific growth rate (%), survival (%) and feed conversion ratio (FCR).

The data were subjected to a variance analysis (ANOVA) and, when significant, the means were compared by Student's t test ($p < 0.05$).

Ectoparasite diagnosis

The supplementation of Aquate Fish™ in the diet reduced the prevalence rate ($p < 0.05$) of the protozoan ciliate *Apiosoma* sp., as well as monogenean infection by *Gyrodactylus cichlidarum* (*Gyrodactylidae*). No significant difference ($p > 0.05$) was shown in the prevalence of other parasites such as trichodinids or in the Parasite Intensity Score. Nevertheless, in evaluating the prevalence in each sample, a reduced prevalence of monogenean and *Apiosoma* sp. ($p < 0.05$) was found 23 days after feeding (Figure 1).

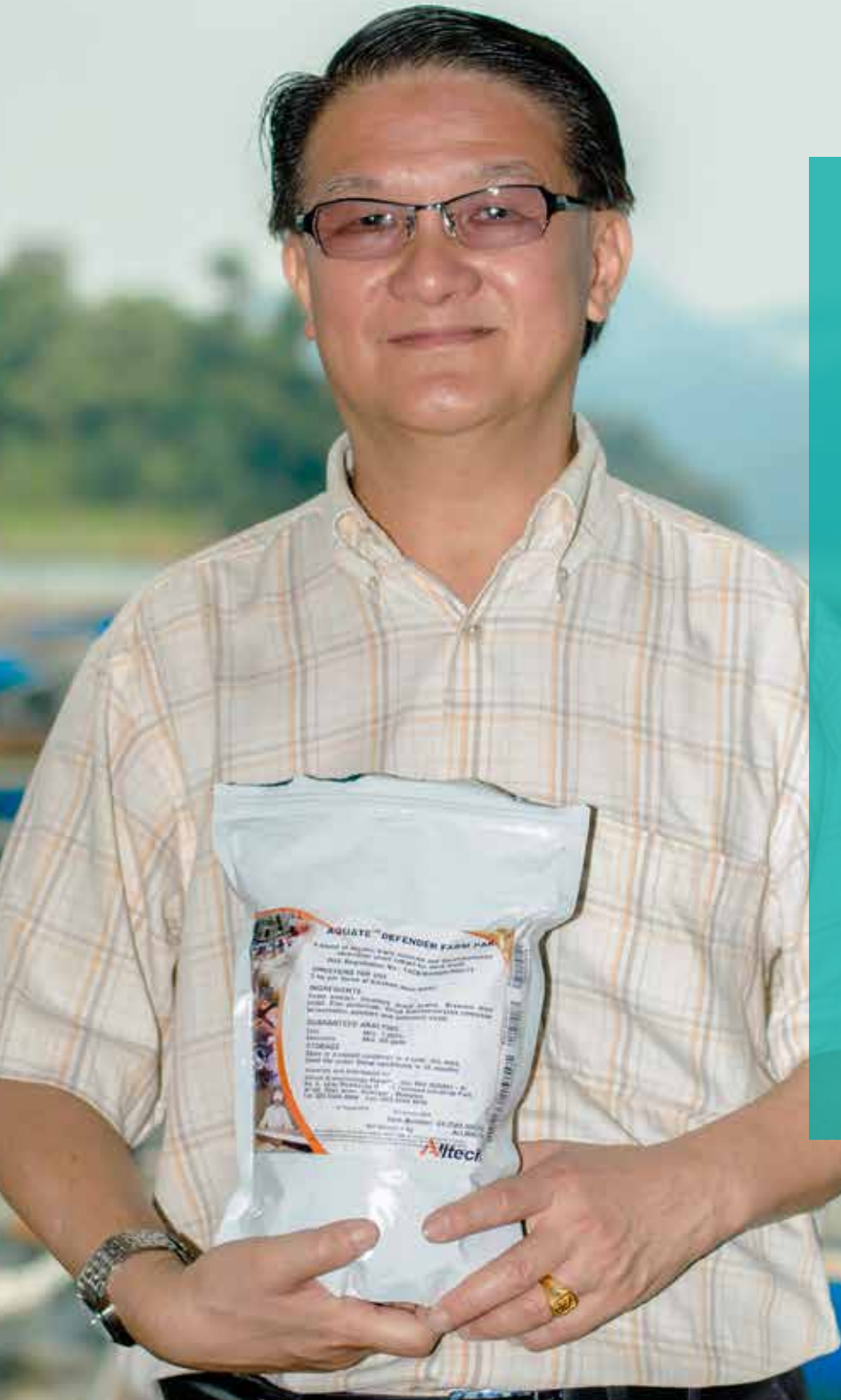
Histopathological analysis

Intestinal morphometry showed significant ($p < 0.01$) increase in the height of intestinal villi in group G1 fish fed the supplemented diet. No difference was found in the width of the villi or the height of the enterocytes (Figure 2).

Production performance

No significant differences ($p > 0.05$) were observed in weight gain or specific growth rate of fish fed the supplemented (G1)

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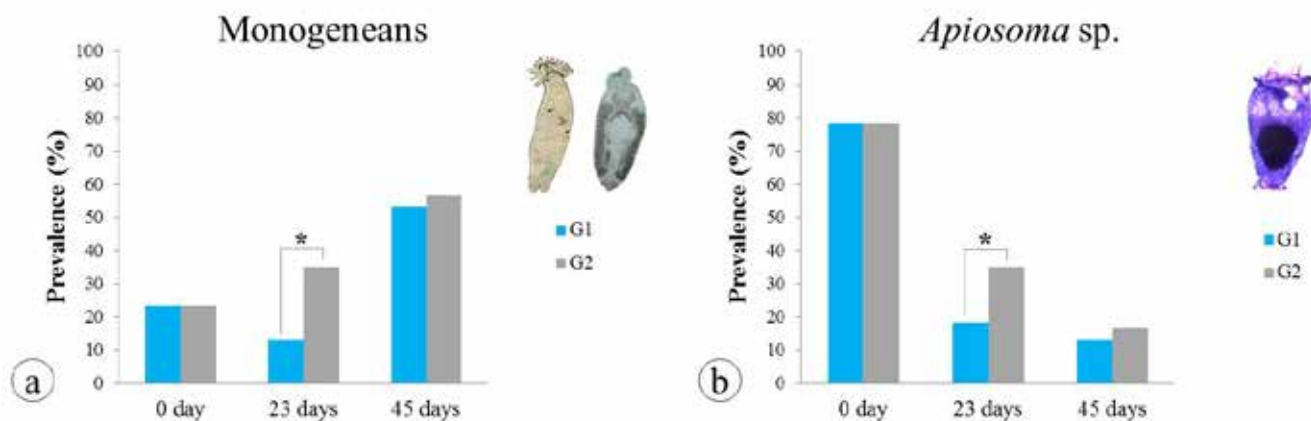
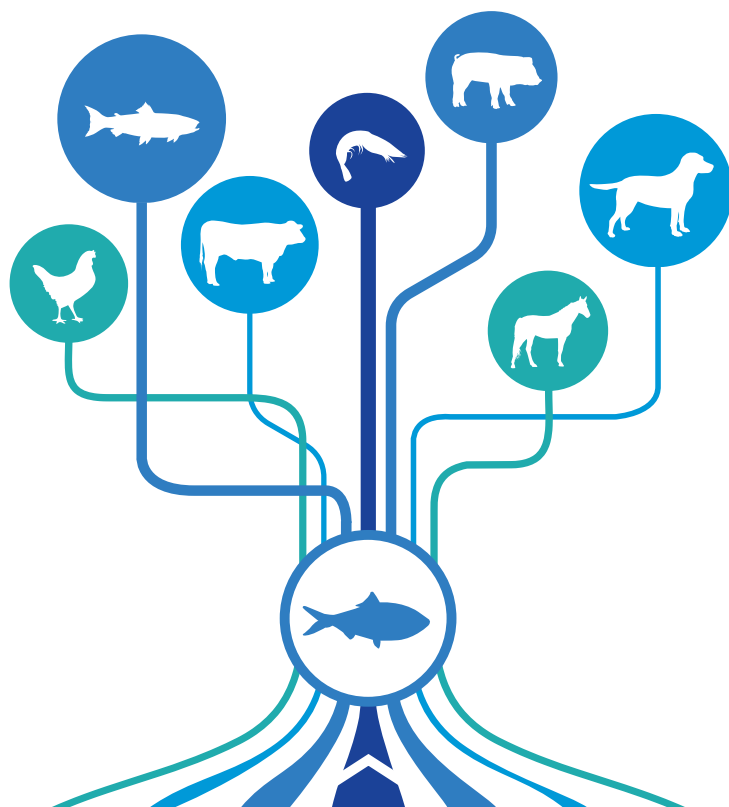


Figure 1: Effects of diets supplemented with Aquate Fish™ on the prevalence of monogenean helminthes (*Gyrodactylidae + Dactylogyridae*) (a) and ciliate *Apiosoma* sp. (b) in Nile tilapia during juvenile production. G1: supplemented diet; G2: unsupplemented diet. Asterisks indicate significant differences by *t* Student test ($p < 0.05$).

and unsupplemented (G2) diets (Table 1). Nevertheless, a significant increase ($p < 0.001$) in the survival rate (Figure 3a), and reduced feed conversion ratio (Figure 3b) was observed and resulted in higher biomass in supplemented fish raceways ($p < 0.05$). Consequently, higher final stocking biomass ($p < 0.05$) was also reported in the group fed the supplemented diet.

During the experimental period we observed that the fish should be fed the supplemented diet for at least 8 days before a significant reduction ($p < 0.05$) in the cumulative mortality was achieved (Figure 4).

During our weekly biometry to feeding rate adjustment, we identified a point that showed a decrease in the mean weight of fish fed the supplemented diet and stabilisation of mean weight of fish fed the unsupplemented diet (Figure 5a). We postulated that this occurred as a result of the carrying capacity of the raceways accompanied by a decrease in dissolved oxygen by approximately 27% in the G1 group that was fed the supplemented diet (Figure 5b). This was due to high stocking density and survival in the group fed the supplemented diet. In addition, during this period an increase in the mortality rate was observed in the G1 group fish (Figure 4).



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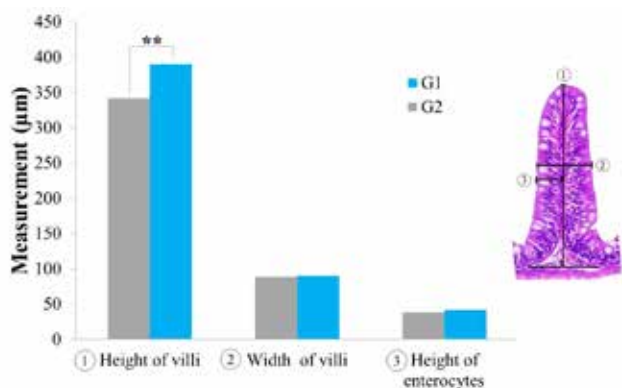


Figure 2: Effects of diets supplemented with Aquate Fish™ on the intestinal morphometry of Nile tilapia during the juvenile production. G1: supplemented diet; G2: unsupplemented diet. Asterisks indicate significant difference by Student's t test ($p < 0.01$).

Table 1. Effects of Aquate Fish™ supplementation during juvenile production of Nile tilapia

Treatment groups	G1 supplemented diet	G2 - unsupplemented diet
Parameters		
Weight gain (g)	14.8±5.5	13.6±5.4
Specific growth rate (%)	6.9±1.1	6.3±1.3
Final biomass/raceway (kg)	422.6±176.9 ^b	348.9±162.6 ^a
Final stocking biomass (kg/m ³)	25.0±10.5 ^b	20.6±9.6 ^a

Different superscripts within the same row indicate significant difference by Student's t test ($p < 0.05$)

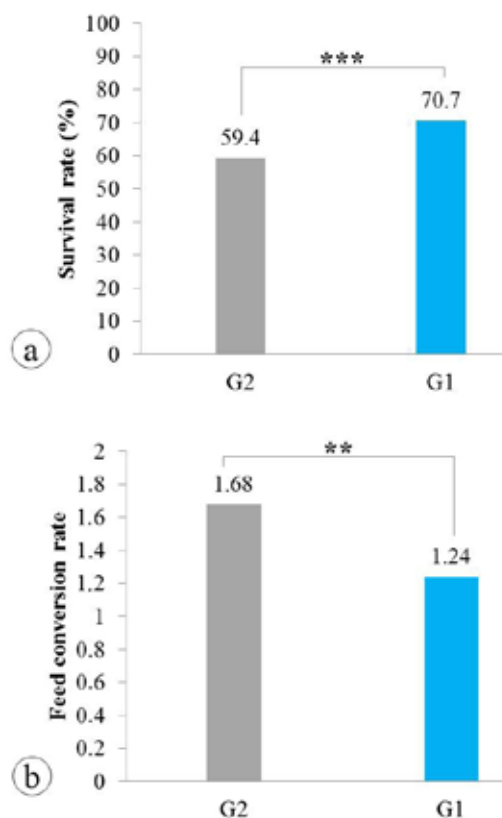


Figure 3: Effects of diets supplemented with Aquate Fish™ on survival rate (a) and feed conversion ratio (b) in Nile tilapia during the juvenile production. G1: supplemented diet; G2: unsupplemented diet. Asterisks indicate significant difference by Student's t test (** $p < 0.01$; *** $p < 0.001$).



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Improvement in health conditions and growth performance

The addition of Aquate Fish™ improved the health condition of farmed Nile tilapia during juvenile production. One of the most important fish responses was the increased resistance against ectoparasites that can favour opportunistic microorganisms and influence the survival rate. Our observation was that enhancing the structure integrity of the anterior and medium intestines may provide better digestion and nutrient absorption. An increase in height of villi was in fact responsible for better absorption reflecting directly on the fish performance.

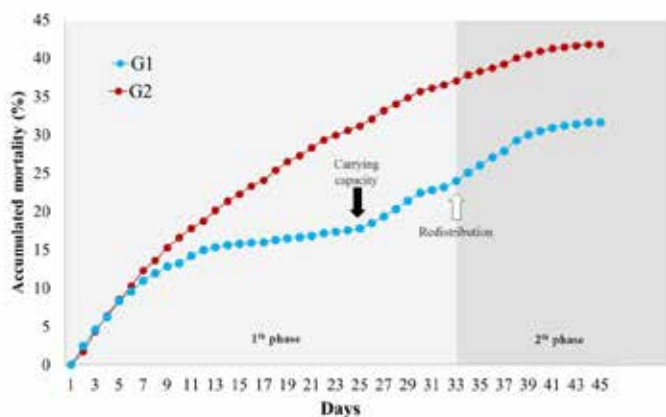


Figure 4: Effects of diets supplemented with Aquate Fish™ on cumulative mortality of Nile tilapia during the juvenile production. G1: supplemented diet; G2: unsupplemented diet.

Based on the increase in the final biomass per raceway and high stocking biomass ($p < 0.05$), fish fed the supplemented diet showed increased weight gain and specific growth rate and survival. Due to their enhanced survival the carrying capacity in the experimental raceways was reached more rapidly than was observed in the group fed the unsupplemented diet. This was responsible for the reduced weight 5 and 6 weeks after feeding. Consequently, the high stocking density and decreased dissolved oxygen provoked unfavourable conditions for the group of fish fed Aquate Fish™ which in turn could be the possible cause of higher mortality. This condition stabilised 5 days after the classification and redistribution to new raceways.

During the experimental period, we observed that 8 days of feeding was needed to obtain reduced mortality ($p < 0.05$). After 25 days of feeding, the survival rate of the group (G2) fed the unsupplemented diet reached only 68.8% while the survival rate of the group fed the supplemented diet reached 94.1%, i.e. a difference of 25.3%. Nevertheless, the challenges caused by the carrying capacity in the raceways and decreased dissolved oxygen were demonstrated as fish fed supplemented diet had 11.3% more survivors ($p < 0.001$). In addition, fish fed supplemented diets showed more efficient feed conversion than fish fed the unsupplemented diet.

Conclusion


In these validation trials we have showed that the supplementation of Aquate Fish™ (6g/kg) to diets promoted increased disease resistance in Nile tilapia against ectoparasites and improved the intestinal integrity resulting in high survival rates. It has also improved production efficiency during the juvenile production of tilapia in raceways.

References are available on request

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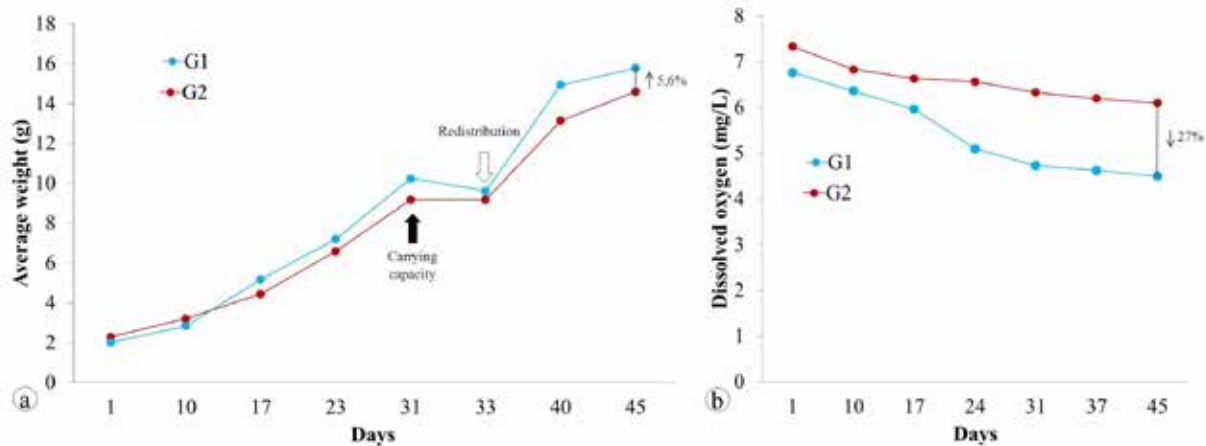


Figure 5: Effects of diets supplemented with Aquate Fish™ on mean weight in the weekly biometry of Nile tilapia during the juvenile production (a) and dissolved oxygen concentration in the water during the experimental period (b). G1: supplemented diet; G2: unsupplemented diet.



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Yeast parietal fractions enhance the immune response of shrimp towards AHPND infections

By Dang Thi Hoang Oanh and Philippe Tacon

Four years ago, the early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND) appeared in shrimp farms in Asia. The disease has devastated the shrimp industry in China, Vietnam, Malaysia and Thailand. This disease is caused by a bacterium *Vibrio parahaemolyticus* which is potentially modified by a bacteriophage agent, causing a toxin secretion (TCP/VIE/3304 report, 2013). In order to prevent this disease, one of the measures taken by the industry is to design specific feeds for the shrimp.

Parietal fractions are isolated from yeasts and contain mannan oligosaccharides, beta glucans, chitin and components that are potential immune-stimulants (Ringo et al., 2012), and they have been shown to prevent bacterial infections. The expertise of Phileo Lesaffre Animal Care business has specifically designed parietal fractions with known and consistent concentrations of these components using a specific strain and optimised production processes including drying.

The aim of this study was two-fold: first to determine the optimum dosages for the parietal fraction Safmannan® to increase the survival of shrimp against the AHPND, and second to test if a short immune-stimulation of two weeks was sufficient.

Experimental setup

White leg shrimp *Penaeus vannamei* juveniles (2-3 g/individual) were spawned and nursed at the shrimp hatchery and nursery of College of Aquaculture and Fisheries, Can Tho University, Vietnam. Shrimp were screened for white spot syndrome virus (WSSV), taura syndrome virus (TSV) and *V. parahaemolyticus* to make sure they are free from these pathogens prior to distribution to experimental aquaria.

The experiment was set up in the wet laboratory at Can Tho University. Experimental glass aquaria (30L in volume) were used. The aquaria contained 70% volume of seawater (25 ppt) with aeration system and temperature control around 28-30°C. Experimental shrimp were stocked at a density of 30 individuals/aquarium. Each treatment was set up in triplicates as detailed in Table 1.

Feeding

The treatment diets were commercial pelleted feed supplemented with the parietal fraction Safmannan® at an inclusion rate of 0.5, 2 and 5 g/kg of feed (Table 1). Shrimp were fed these diets *ad libitum* for two weeks before being challenged with *V. parahaemolyticus*. The control treatment diet was a commercial pelleted feed. These feeds were also fed to the juveniles for the three-week post-challenge tests as detailed in Figure 1.

Bacteria challenge

The bacterial strain, *V. parahaemolyticus* (identified by using conventional biochemical tests, API 20E and PCR) which is responsible for AHPND, was used for the challenge experiment (Nguyen et al., 2014). Strains were stored at -80°C in iso-sensitest broth (Oxoid) containing 25% glycerol. Bacterial

cultures were grown 24 hours in 150 ml of tryptone soya broth (Oxoid) at -28 °C. A 150 ml of bacterial culture was prepared for each tank. The optical density of bacterial cells was estimated using spectrophotometer. Bacterial suspensions were adjusted to the concentrations of 10⁸ cells/ml.

Shrimp were immersed for 15 minutes in bacterial culture with continuous aeration and then both bacterial solution and shrimp were transferred to individual experimental aquarium containing sea water to reduce the bacteria density to 10⁶ cells/ml. Shrimp were observed for 3 weeks post challenge to record mortality and clinical signs. There was no water exchange for 2 days after the challenge. Water exchange was subsequently increased to 20% daily for the rest of the experimental period. Shrimp were fed with normal feeds after the challenge.

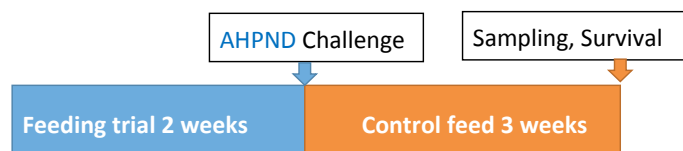


Figure 1: Experimental set up

Table 1. Experimental set up to test the response to EMS/AHPND of juvenile shrimp *P. vannamei* fed with parietal fraction.

Name of treatment	Safmannan® (g/kg feed)	Application to shrimp	Treatment of Shrimp
S500	0.5	Product mixed in shrimp diet	Challenge with <i>Vibrio</i> *
S2000	2	Product mixed in shrimp diet	Challenge with <i>Vibrio</i> *
S5000	5	Product mixed in shrimp diet	Challenge with <i>Vibrio</i> *
Negative Control	0	Normal shrimp diet, no product	No challenge
Positive Control	0	Normal shrimp diet, no product	Challenge with <i>Vibrio</i> *
Safmannan® control	2	product mixed in shrimp diet	No challenge

(*) *V. parahaemolyticus* infected by the phage

Data collection

After the performance of the test the following parameters were analysed: (1) gross signs of AHPND; (2) survival rate (%) after 21 days post challenge; (3) total haemocyte count; (4) prophenoloxidase (PO) activity and (5) respiratory burst activity. All the data were analysed by using Excel and SPSS programs.

Gross signs of EMS

Gross signs and hepatopancreas (HP) of experimental shrimp at 3 days post challenge are shown in Figures 2 and 3. Shrimp in the control group (negative control and Safmannan® control) looked apparently healthy with good HP and full gut content (Figure 2).



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Figure 2: Control shrimp look apparently healthy. A: Negative control; B: Safmannan® control



Figure 3: Gross signs and HP of shrimp in positive control (challenged with *V. parahaemolyticus*)

However, infected shrimp in the positive control and other tests which were challenged with EMS showed typical gross signs of EMS including abnormal and lethargic swimming behaviour, animals are relatively weak, with soft shell, gut with discontinuous content and the HP became darkened or pale colour (Figure 3). A few shrimp sank to the bottom of the aquarium.

Histological examination

Healthy shrimp from the control group and moribund shrimp from challenged groups were collected and subjected to histological analysis. As a result, shrimp that were apparently healthy had healthy HP with E, B, R and F cells (Figure 4), whereas, shrimp that had displayed typical histopathology of AHPND including dysfunction of hepatopancreatic cells, lack E, B and R cells, exhibit HP tubule epithelium sloughing and significant proximal haemocytic inflammation (Figure 5). Histopathological lesions were similar to typical EMS pathology described by Lightner (2012) and Loc et al. (2013).

Survival at 3 weeks post challenge

At 3 weeks post challenge, the positive control group (normal feed and challenge with *Vibrio*) had a significant lower survival rate in comparison to the remaining groups (Figure 6). We did not see any significant difference in survival of shrimps in the negative control and Safmannan® control (fed with normal feed mixed with parietal fraction and no *Vibrio* challenge). The survival in these groups ranged from 90.3-90.7%. In groups fed with the parietal fraction, there was a significant difference with the positive control treatment but no difference in survival between shrimp receiving treatments at 2 g/kg feed and 5 g/kg feed whereas, a significant difference was observed between treatment 0.5 g/kg feed and 5 g/kg feed.

In general, shrimp fed with the products had higher survival rates after being challenged with *V. parahaemolyticus* compared to the control (without feeding the products but challenged with *V. parahaemolyticus*). The survival rate of infected shrimp treated without the product dropped to 38.9% on the 21st day of the

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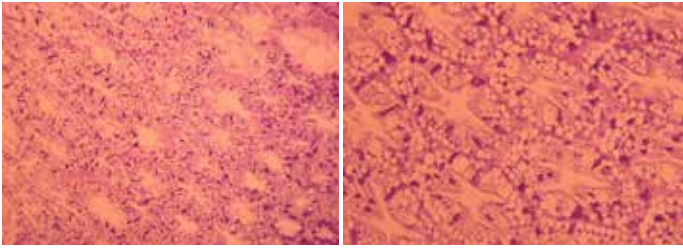


Figure 4: Healthy HP of experimental shrimp (20X and 40X)

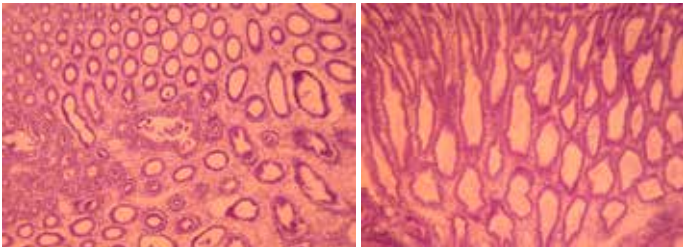


Figure 5: HP of infected shrimp collected from experimental tanks. Dysfunction of hepatopancreatic cells, lack of E, B and R cells. HP tubule epithelium sloughing, significant proximal haemocytic inflammation (10X & 20X).

challenge, which was significantly lower than that of Safmannan®-treated shrimp (survival rates ranged from 54.2% – 63.9%).

Total haemocytes count

At different sampling times

No significant difference was found in total haemocyte count (THC) of experimental shrimp in all the tested groups except for

groups which were fed with normal feed and challenged with *Vibrio*. There was no significant difference in THC before feeding and before challenge. However, THC decreased significantly after the challenge test.

Between treatment groups

There was no significant difference in THC of experimental shrimps in different tests before feeding, and before and after challenge (Figure 7).

Prophenoloxidase

At different sampling times

We did not see any significant difference in PO in negative control shrimp group before feeding, before being challenged and at sampling time. However a significant decrease was observed in PO of experimental shrimp in positive control after being challenged compared to shrimp before feeding and before being challenged. We can also see a significant increase in all treatment groups after feeding.

PO in shrimp fed Safmannan® control significantly decreased at sampling time compared to shrimp after two weeks feeding but this was not different when compared to PO in shrimp before feeding the products. We can then suggest that stopping feeding of the product brought back the PO levels to their original values. In treatment groups challenged by EMS, the PO values also dropped, but in S2000 and S5000 they remain high and were not different from the values before feeding (Figure 8).



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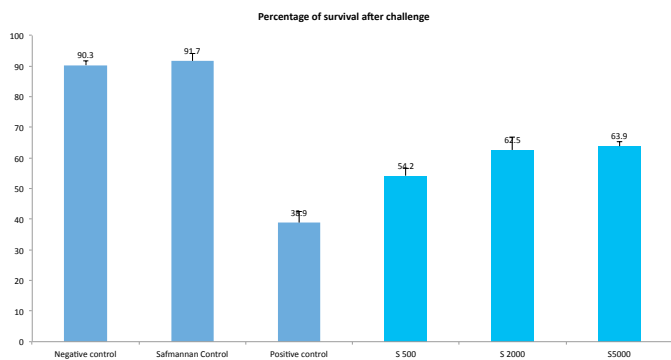


Figure 6: Survival percentage of shrimp at 3 weeks post challenge (mean \pm SD). Small letter denotes a significant difference between treatments using one-way ANOVA ($P < 0.05$).

Between treatment groups

This trial shows that the parietal fraction significantly increases PO activities in all treated groups compared to control groups. We also see that after an AHPND challenge, the parietal fraction at all concentrations tested maintained higher values compared to the positive control. We did not see any difference in respiratory burst between groups and sampling times in this trial.

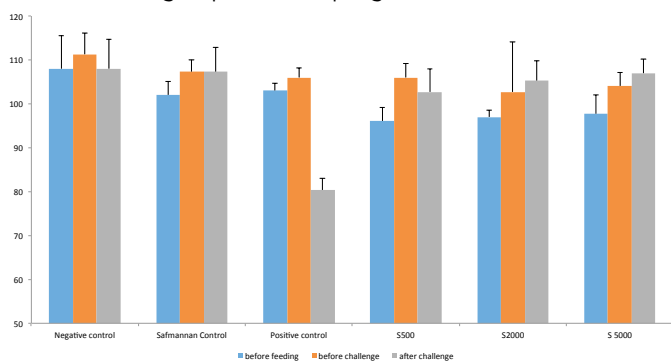


Figure 7: Total haemocytes (10^2 tb/mm³) in experimental shrimp with different sampling time intervals. Mean (\pm SD, are not significantly different by One way ANOVA)

Conclusion

The results showed that Safmannan® can maintain high total haemocyte counts after an AHPND challenge. It also maintains

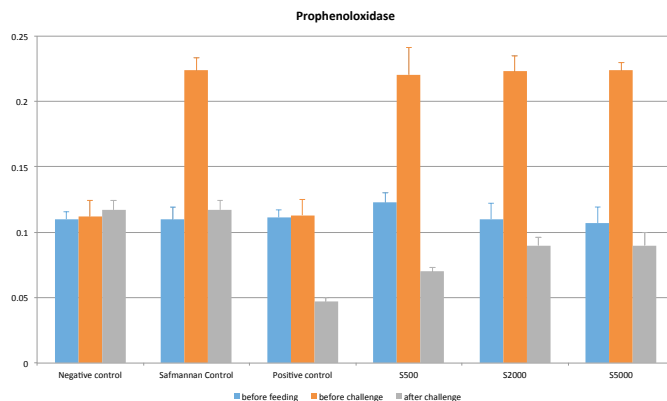


Figure 8: Prophenoloxidase activity (units/min/mg protein) in experimental shrimp at different sampling time intervals. Mean (\pm SD). Small letter denotes a significant difference between treatments after challenge using one-way ANOVA ($P < 0.05$). Asterisk shows differences between sampling times ($P < 0.05$).

higher prophenoloxidase activities, hence increasing the survival of shrimp. It was also shown during this trial that the parietal fraction can have a rapid action on the immune system of shrimp as a two-week feeding program was sufficient to increase survival of shrimp. We can therefore conclude that this product can be a good candidate to be included in feeds to protect against EMS/AHPND.



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Fish health management challenges in marine fish aquaculture in Southeast Asia

By Leong Tak Seng

Against bacterial pathogens, an effective fish health management strategy is vaccination of fry at the hatchery or on-farm

The global demand for high quality seafood products continues to rise but output from wild-capture fisheries is not sufficient to meet the demand. Output of capture fisheries has reached their maximum capacity in many parts of Asia. This leads to the rapid growth of aquaculture; an increasing number of marine fish species is being cultured in a high density environment where the fish are exposed to environmental stress, provided with artificial feeds and exposed potentially to new diseases.

Consequently, there emerges a spread of an increasing array of new diseases in various fish species. Effective disease management is an important key factor to profitability. Recently, viral pathogens are considered serious disease challenge in aquaculture. These pathogens may have been established in the culture system for a long time, but have only been identified recently.

Viruses belonging to the families *Iridoviridae* and *Nodoviridae* have emerged as new disease threats. There are no efficacious treatments of viral pathogens identified in fish cultured in Southeast Asia. Once the fish are infected with virus, not much can be done, and the development of effective vaccines for virus identified remains elusive. This short article examines other recent fish health and disease challenges in marine fish aquaculture in Southeast Asia (SEA).

Climatically, Southeast Asia (SEA) offers a wide range of subtropical and tropical environment which are conducive for aquaculture production. The region is also situated close to China which has large growing markets. Marine aquaculture was first established in SEA, particularly in Malaysia in the early 1970s. At that time, there were no proper frameworks for the establishment of marine aquaculture, which was started by coastal fishermen, who kept live fish in cages before selling them to restaurants or in fish markets.

The explosive increase in marine aquaculture began in the earlier 1980s when large numbers of hatchery-produced Asian seabass fry were available for aquaculture production. Then in the late 1980s and early 1990s, a large variety of fry of various marine fish species was successfully produced in hatcheries in Taiwan and Indonesia. A large number of these hatchery-produced fry were imported into SEA countries for culture in floating cage systems. The high density stocking environment resulted in the emergence of serious diseases which subsequently caused huge economic losses to fish farmers. The causative pathogens for these diseases were not established during that period of rapid expansion of marine aquaculture. There was a lack of fish disease expertise and capability of laboratories for fish disease diagnosis.

“ Placing multi-fish species into such a system resulted in fish hosts being infected with pathogens not seen in the fish host natural habitat. ”

Main pathogens

A recent publication of “Parasites and Diseases of Warm Water Marine Finfish in Floating Cage Culture” provides comprehensive information on various parasites and diseases in multi-marine finfish species cultured in floating cage environment during their production cycle. This information on parasites and diseases was gathered between 1983 and 2010 at Goh Siong Tee Marine Products Sdn Bhd’s fish farms at Bukit Tambun, Penang, Malaysia. Monitoring studies had shown that fish cultured in these cages were infected with a large variety of parasites and bacteria. The main pathogens causing fish diseases in floating cage system during their production cycle can now be summarised in table 1.

Table 1. Pathogens and disease patterns in cultured marine fish in floating cage culture systems

Production Cycle	Initial stocking	Grow-out phase			
	First quarter (i.e 3 months) <10 - 100g	Second quarter (i.e. 6 months) 100 – 300g	Third quarter (i.e. 9 months) 300 – 500g	Fourth quarter (i.e. 12 months) 500 – 800g	After 12 months > 800g
Disease caused by	Virus: Nodavirus and Iridovirus				
	Parasites: protozoans: <i>Cryptocaryon irritans</i> and <i>Trichodina</i> spp. and blood fluke: <i>Cruoricola lates</i> , <i>Pearsonellum corventum</i> and <i>Cardicola</i> sp.				
	Leeches: <i>Zeylanicobdela arugamensis</i> Copepods: <i>Caligus</i> spp.				
	Monogeneans: <i>Pseudorhabdosynochus</i> spp., <i>Diplectanum</i> spp., <i>Haliotrema</i> spp., <i>Benedenia</i> spp. <i>Neobenedenia</i> spp., and <i>Laticola latesi</i>				
	Bacteria: <i>Tenacibaculum maritimum</i> , <i>Vibrio</i> spp. and <i>Streptococcus</i> spp.				
The thickness of the black bar indicates severity of infection and disease outbreak at that grow-out phase of the production cycle.					

The floating cage system is a reservoir for a large variety of pathogens. Placing multi-fish species into such a system resulted in fish hosts being infected with pathogens not seen in the fish host natural habitat. With this knowledge of potential pathogen in a cage culture system, how can the implementation of fish health management strategies in such a system prevent potential disease outbreaks?

General observation at fish farms indicated the frequent occurrence of serious disease outbreaks in the first and third quarter of placement of fish in cages during the production cycle. From the table above, pathogens causing these serious disease outbreaks could be assigned into two groups, namely: Group 1 consists of external pathogens (protozoans, monogeneans, leech and copepod crustaceans) and Group 2 consists of internal pathogens (blood fluke, virus and bacteria).

During the first quarter of the production cycle, large numbers of fry die off within a short period after stocking in the cages. These disease outbreaks were caused by virus and protozoans. These pathogens would have infected the fry at the hatchery



Streptococcus infected fish may show different symptoms as shown in the following photos. Top, from left, crimson snapper, mangrove snapper, golden snapper. Bottom, from left, yellowspotted grouper, yellow-spotted grouper and estuary grouper.

stage and very unlikely from pathogens reservoir within the fish culture system.

External pathogens

Fish that survived the initial disease outbreak could be infected with the reservoir of pathogens present in the cages. The external pathogens, diplectanid and dactylogyrid monogeneans infect and attach on the gills whereas capsulid monogeneans attach on

the body surface. Unpublished data indicated that infected fish with diplectanid and dactylogyrid monogeneans tend to develop immunity as the fish grow.

These monogeneans population tends to regulate their density within the gill filaments and do not cause disease problem. However, the population of capsulid monogeneans, particularly *Neobenedinia* spp tends to increase exponentially especially during adverse environmental and poor culture conditions. The

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feeding and attachment of monogeneans injure fish, resulting in secondary infection of bacteria. Infected fish also are irritated by the monogeneans causing them to rub against the side of the net resulting in ulceration on the body surface. No medicated treatment is effective on diplectanid and dactylogyrid monogeneans which are protected by the gill operculum. Although freshwater treatment is effective for capsulid monogeneans, the treatment process is very tedious and re-infection occurs within a short period after the treatment.

Bacterial pathogens

Three bacteria pathogens, *T. maritimum*, *Streptococcus* spp and *Vibrio* spp have been identified to cause serious disease outbreaks. *T. maritimum* causes serious scale-drop disease in Asian seabass but to a lesser in the extent crimson snapper. All cultured fish species are susceptible to *Streptococcus* spp infection and infected fish may show different symptoms as shown in the photos 1-6 depending on species.

However, very often, all three bacteria pathogens could be found concurrently infecting fish during an outbreak. Recently, bacterial vaccines (Aquavac® *Vibrio* for vibrio infection, Norvax® Strep Si for *Streptococcus iniae* and Icthiovac®™ for *T. maritimum*) are available for the bacterial pathogens infecting marine cultured fish. Seabass vaccinated with Norvax® Strep Si showed better survival rate and fewer outbreaks of scale-drop disease in Indonesia. The vaccine, Icthiovac® TM for *T. maritimum* is not available in the Southeast Asia market. Also there are a number of feed additives which not only improve the growth and survival rate of fish, but also reduce the density of capsulid monogeneans population in infected fish.

Based on the availability of the above information scattered in various publications, an attempt should be made to regularly vaccinate fish fry with available bacterial vaccine as a fish health

“ A fish farm owner should purchase vaccinated fry from a supplier or if he has a hatchery, to vaccinate his fry before placing them in his cages. ”

management strategy for profitable aquaculture. The vaccination program should be undertaken twice, once by immersion when fish fry are less than 10 g and by injection when fish are less than 100 g in the hatchery before placing the vaccinated fish in the cages. A fish farm owner should thus purchase vaccinated fry from a supplier or if he has a hatchery, to vaccinate his fry before placing them in his cages. The farm should use pellet feed with feed additives incorporated into the feed.



Dr Leong Tak Seng is a consultant on marine fish diseases in farms as well as on environmental impact assessment in Malaysia. As a recognised expert in fish diseases, Leong has carried out extensive research on fish parasites and fish farm management in floating cage systems. He was professor of parasitology at University Science

Malaysia (USM) from 1975 to 1998 and was also the project leader of the Fish Disease Research Group. He was also visiting professor to various universities and institutes in the Asian region, Australia, UK and Canada. Email:leongtakseng@gmail.com

Parasites and Diseases of Warm Water Marine Finfish in Floating Cage Culture

87pages, October 2014
ISBN 978-967-13028-0-4,
Author: Leong Tak Seng,
Published by: Leong Tak Seng,
Penang, Malaysia.

In his preface, the author laments that fish farmers, in particular Malaysian fish farmers, do not realise that intensive culture in floating cages has many problems and one of them is disease. New

fish farm set up or newly introduces fish species tend to have no problem with disease. However, disease outbreaks tend to occur more often after 3 to 5 years after farm set up or with the introduction of new fish species. The frequent infectious and non-infectious disease outbreaks are important constraints to the mariculture industry in Asia.

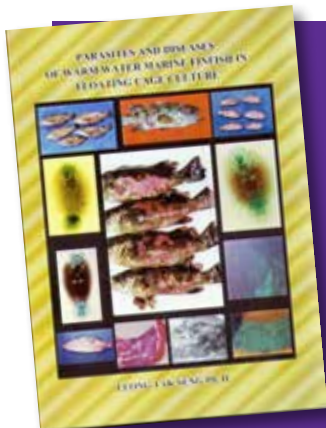
The purpose of this well illustrated book is to fulfil the need for readily available information on parasites and diseases in cultured marine fish species. The observations on the parasite fauna, clinical symptoms of diseases, and identification of pathogens in marine fish cultured in floating net-cages in Asia-Pacific region recorded in this book are compilations of many years (1983 - 2013) of epidemiological and monitoring studies on the parasites and bacterial pathogens. Leong added that one has to work alongside fish farmers on their

farms to observe disease outbreaks and to follow-up many of the disease outbreaks that have occurred.

There are five main chapters in this book, starting with an introduction on cage culture practices in the region and the diversity in cage culture systems and species. The chronology of cage culture practises in Malaysia is followed by that of diseases in farms in Penang, Malaysia where the author did most of his research. Complete with drawings and photography on parasites and signs of infections in various fish species, chapter 2 deals with parasitic diseases. Chapter 3 on bacteria disease also has a review on the pathogens causing tail rot and scale drop in the Asian seabass in Thailand as well as Malaysia. Miscellaneous diseases such as ulcerative disease in mangrove snapper, swimbladder disease and skeleton deformation are covered in chapter 4.

The final chapter is on fish health management and the author emphasised that although multispecies cage culture is important for economic survival of small family run farms, it is an accumulator of pathogens. The chapter is particularly useful for such small farms to reduce disease outbreaks. The author cautioned that the book is not the standard text for disease control, but is a guide to fish farmers and laymen who are interested in knowing more on parasites and diseases in marine net-cage aquaculture. The book is targeted for fish farm supervisors/managers or aquaculturalists who intend to use floating cages for rearing marine fish. The information in this book is also useful to fish health consultants, microbiologists, parasitologists, fish pathologists, managers and directors of diagnostic laboratories.

The book is priced at USD30.00 and is available from the author email: leongtakseng@gmail.com



Recent advances in the understanding and mitigation of EMS/AHPND

By Wing-Keong Ng

As multidisciplinary research sheds more light on the characterisation, detection and mitigation of the disease, a concerted and coordinated effort by all stakeholders to network and share information will further benefit the shrimp aquaculture industry



The Ninth Symposium on Diseases in Asian Aquaculture (DAA9) was held in Ho Chi Minh City, Vietnam from 24 to 28 November, 2014. It was attended by close to 355 delegates from academia and the aquaculture industry from 32 countries. This symposium series is held once every three years in different parts of the Asia-Pacific region by the

Fish Health Section of the Asian Fisheries Society. DAA9 was co-organised by the Department of Animal Health, Ministry of Agriculture and Rural Development (MARD), Vietnam.

Delegates to the symposium were updated on the latest developments in aquatic animal disease-related research through a total of 2 keynote, 97 oral and 150 poster presentations. Oral and poster presentations covered a variety of aquatic animal

species including shrimp, lobsters, abalone, crabs, fish, etc., and the various bacterial, viral and parasitic diseases that affect their culture. As is the tradition of this series of symposiums, there are no concurrent sessions and all delegates attend the same highly informative oral presentations and ensuing discussions over the course of 5 days. The symposium was divided into several sessions such as biosecurity compliance, parasitic diseases, shrimp EMS/AHPND, fish viral disease, shrimp WSD, fish immunology, tilapia and catfish diseases, shrimp immunology, marine aquatic diseases, diagnostics and husbandry and management.

The Fish Health Section of the Asian Fisheries Society has grown from strength to strength since its official formation in the year 1989. The first DAA symposium (DAA1) was held in Bali, Indonesia in 1990 and since then a successful series of eight other DAA symposiums, including the present one, have been held in different countries. The destructive aquatic diseases encountered in the Asia Pacific region such as the epizootic ulcerative syndrome in fish during the 1980s, white spot disease (WSD) in shrimp in the 1990s and the recent early mortality syndrome (EMS) in marine shrimp have contributed much to the proliferation of research and the immense need to network and share information among aquatic animal health professionals in the region. It is very heartening to see Asian-based researchers excelling in research and gaining international recognition for their work in advancing the knowledge of many of these

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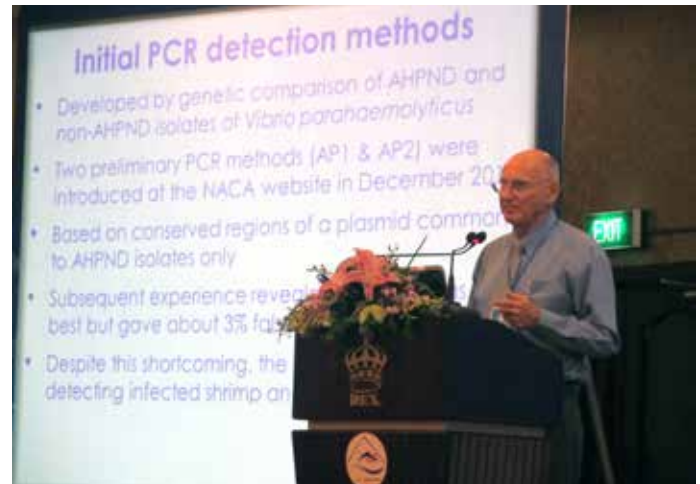
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Dr Chadag Mohan, WorldFish Center (right) was the Fish Health Section Chairperson (2011-2014) and Dr. Nguyen Van Long, Department of Animal Health, was the Secretary of the local organising committee; both instrumental in organising the DAA9 symposium.



Professor Timothy Flegel started the session on shrimp EMS at DAA9. Together with Professor Chu-Fang Lo, they developed the AP1, AP2 and AP3 assays which led to rapid detection of EMS in shrimp.

emerging and lingering diseases encountered in the aquaculture industry. Congratulations to the organising committee of DAA9 for making this yet another successful and highly informative symposium. The next symposium (DAA10) is scheduled to be held in Bali, Indonesia under the coordination of Dr Agus Sunarto (CSIRO).

The most recent disease to greatly affect the sustainability and profitability of global shrimp aquaculture is the acute hepatopancreatic necrosis disease (AHPND) or more often referred to as EMS. It was therefore not surprising that this was the most attended session during the DAA9. Due to the current intense interest in EMS, both from a research and commercial perspective, I will only highlight the latest advances in research that was presented on this topic during the symposium. However, this is in no way a complete coverage of what was presented but highlights information that I find interesting or new. A total of 26 presentations (17 oral and 9 posters) were specifically addressing EMS at this symposium.

The spread and detection of EMS in farmed shrimp

Significant shrimp production losses were encountered in China in 2009 due to EMS which spread sequentially to Vietnam (2010), Malaysia (2011), Thailand (2012) and Mexico (2013). The session on EMS/AHPND at the DAA9 started off with Professor Timothy Flegel (Mahidol University, Thailand) and followed by Professor Donald Lightner (University of Arizona, USA) who both gave an overview of the historical background to the detection and characterisation of this new disease. It is now well known that EMS causes massive sloughing of epithelial cells of the shrimp hepatopancreas which results in early mortality usually within the first 30 days after pond stocking of shrimp post larvae.

Since March 2013, through the research of Loc Tran (Nong Lam University, Vietnam) who at that time was a PhD student at Lightner's laboratory, the causative vector of EMS was identified as a unique strain of the bacteria *Vibrio parahaemolyticus* (Vp). Subsequent research conducted in the laboratories of Flegel, Professor Chu-Fang Lo (National Cheng Kung University, Taiwan) and Lightner has identified a large episomal plasmid carried by Vp as the source of the EMS-causing toxins released by this unique strain of bacteria. Plasmids are small circular DNA that is physically separate from and can replicate independently of chromosomal DNA within the bacterial cell.

The EMS-causing plasmid has since been isolated and its genome sequenced. Once its genome was known, specific polymerase chain reaction (PCR) based methods were developed by Lo in cooperation with Flegel to detect EMS from infected shrimp samples and the primers (strands of nucleic acid that serve as a starting point for DNA synthesis) for this were released to the public in December 2013.

The PCR detection methods based on two pairs of primers are called AHPND Primer set 1 (AP1) and AHPND Primer set 2 (AP2). Subsequent testing of AP2 in detecting EMS suggested 96% accuracy with occasional false positive PCR test results. In his presentation, Flegel highlighted an improved AP3 detection method (based on toxin gene) which resulted in 100% accuracy when tested on 104 EMS-infected samples. The related primers have been made available for free since 18 June 2014 at the website of the Network of Aquaculture Centres in Asia Pacific (NACA). Using technology transferred from the University of Arizona, a commercial PCR test kit for EMS is also currently available.

Using PCR assay methods, Mary Maningas (University of Santo Tomas, Philippines) in her poster presentation reported the detection of EMS-causing Vp in both *Penaeus vannamei* and *P. monodon* from three farm sites in Central Luzon of the Philippines. It would seem that her study is the first to confirm the spread of EMS to the shrimp farming industry in the Philippines in 2014. In his poster presentation, Iftikhar Ahmad (Department of Fisheries, Malaysia) reported that of the 15 confirmed (via biochemical and histopathology methods) EMS samples, the primers AP1, AP2 and AP3 was not able to give a positive PCR test result while the commercial detection kit (EMS-2 from IQ2000) showed 13.3% positive. The researchers reported that there may be two major groupings of Vp in Malaysia but the reason why none of the isolates were positive against the primers AP1, AP2 and AP3 is currently not known.

To further complicate the interpretation of data from PCR detection methods for EMS, Professor Kwai-Lin Thong (University of Malaya, Malaysia) presented new evidence that Vp may not be the only *Vibrio* species capable of causing EMS histopathology. She detailed how one particular AP1, 2, 3 and IQ2000 PCR-positive bacteria strain was more closely related to *Vibrio sinaloensis* (85% homology) based on whole genome sequencing.

In her presentation “*Vibrio parahaemolyticus* associated with shrimp mortalities in India do not have characteristics of AHPND strains”, Dr Indrani Karunasagar (Nitte University, India) reminded delegates of the complexity of Vp pathogenicity as well as its dynamic genome drawing parallels to human and mammalian pathogenic *vibrios*. When interpreting PCR results from EMS-infected samples, she suggested that non-Vp bacteria may also show positive AP1, AP2 and AP3 test results since the toxin gene is located on a plasmid which is a transmissible genetic element.

She further reiterated that Vp EMS-causing strains that showed positive PCR results may be non-toxicogenic as the expression of the toxin gene on the plasmid is controlled by many factors. She then provided evidence from phenotypic, genotypic and genomic analysis that the shrimp disease outbreaks in the east coast of India at the end of 2013 was due to vibriosis rather than EMS.

The premise that the acquisition of new genetic material by horizontal transfer may play a pivotal role in shaping the Vp genome was further cemented with evidence presented by Dr Varaporn Vuddhakul (Prince of Songkla University, Thailand). She detailed how all 129 isolates of clinical and environmental Vp obtained from 2008 to 2014 in southern Thailand tested negative with AP2 and AP3 but very recent 33 isolates from five EMS infected shrimp farms located in the same area were tested positive for both primers. She reported that the DNA profiles of the Vp EMS isolates were distinct from the Vp of the clinical and environmental isolates. She postulated that the causative agent of EMS might have originated from one clone of Vp already



Professor Donald Lightner and Dr Loc Tran being interviewed by Vietnamese media at the site of DAA9. Both were instrumental in discovering the initial causative agent of EMS.

present in the area that subsequently developed into different serotypes with a unique O antigen.

Based on these latest developments, it would seem somewhat premature at this stage to categorically identify Vp as the direct causative agent of EMS in farmed shrimp. Evidence points to a transferable plasmid that is able to encode certain toxigenic factors which cause the rapid disintegration of the shrimp hepatopancreatic structures leading to early mortality.



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Professor Kwai-Lin Thong and Eng-Huan Ung collaborated on research on EMS in Malaysia and both gave oral presentations at the symposium.

Plasmids and toxins

Fundamental molecular biology research conducted by Lo and her team revealed that all EMS-causing strains of Vp contained a unique plasmid which they called plasmid pAV1 which has 69,436 base pairs. She then presented data to show that pAV1 contained an operon (a cluster of co-regulated genes coding for functionally related proteins) that encoded homologues to the *Photobacterium* insect related (Pir) toxins, PirA and PirB. *Photobacterium* is a group of gram-negative bacteria that are known to secrete toxins, including insecticidal toxins that exhibit cytotoxicity in insect midgut cells. It is now confirmed that the EMS-causing strain of Vp carries a plasmid having similar Pir genes. Lo and her team further showed that the ability of Vp to cause EMS is completely obliterated by experimental deletion of the plasmid-encoded PirA and PirB genes.

Similar findings were also reported by Lightner, Sasiwipa Tinwongger (Tokyo University of Marine Science and Technology, Japan) and Eng-Huan Ung (Biovalence Ltd. Malaysia) independently of each other. Tinwongger reported that the PirA and PirB toxins consisted of 110 and 438 amino acid residues, respectively. Lightner indicated that the molecular mass of the PirA and PirB toxins are 13 kDa and 50 kDa, respectively.

The direct cause of the hepatopancreatic tissue damage seen in EMS-infected shrimp has now become clear; it is caused by a secreted protein-based toxin rather than by the Vp bacteria themselves. When conducting reverse gavage injection of Pir toxins into shrimp, Lo presented histopathological data which showed that PirA caused only minor histological disruptions but injection of PirB alone was capable of inducing all the characteristic EMS symptoms in shrimp.

The exact mechanism of action of these toxins is still being researched but like its insecticidal counterpart, PirA and PirB from Vp also form a binary complex (PirAB). Structural analysis of the two toxins revealed that the Vp PirAB protein is very similar structurally to crystal proteins, which are another type of toxins produced by *Bacillus* bacteria that have insecticidal toxicity. Ung reported that zonula occludens toxin (ZOT-protein, a protein that increases the permeability of small intestine mucosa by opening intercellular tight junctions), was also found in many EMS-causing Vp bacteria strains and speculated on its potential co-role in causing hepatopancreatic epithelial cell sloughing.

Mitigation of EMS

Shrimp disease control at the farm level warrants an integrated health management plan which will involve not only the elimination or reduction of the pathogen but also manipulation of the culture environment and the immune defense system of the shrimp. Flegel pointed out that unlike viruses, for example the white spot disease in shrimp, EMS bacteria cannot be fully controlled by elimination of carriers. Prevention of white spot syndrome virus transmission was largely successful with the introduction of shrimp post larvae from specific pathogen free (SPF) stocks thereby eliminating viral carriers.

However, the causative agent of EMS is free-living bacteria, and as pointed out by several speakers, can persist in marine waters and sediments for an extended period even in the absence of carriers. Furthermore, we now know that the direct causative agents of EMS are the Pir toxins encoded from a plasmid which are highly mobile genetic elements. Flegel recommended that closed shrimp culture systems with enhanced biosecurity protocols be implemented to address the spread of EMS in global shrimp farming systems.

Professor Patrick Sorgeloos (Ghent University, Belgium) recommended new microbial management strategies in the culture systems to minimise disease risks. Management of the water microbiota to decrease opportunistic pathogen pressure such as the use of algae-rich greenwater systems, tilapia co-culture, biofloc systems and recirculation systems were recommended as potential strategies.

Dr Victoria Alday-Sanz (National Aquaculture Group, Saudi Arabia) in her survey of shrimp farm management practices in Latin America noted that when shrimp were suspended in cages in EMS infected ponds, no mortality was observed and indicated that the pond bottom might be the main risk factor in the spread of EMS. Pond bottom drying, ploughing and liming were not effective in eliminating EMS transmission and she suggested removing the first layer of soil on the pond bottom as a possible strategy.

Other risk factors included overfeeding and water pH. She also indicated that since mid 2014, the EMS situation in Mexico has been improving due to the use of postlarvae from imported broodstocks from Ecuador, Panama and Nicaragua. Furthermore, the use of a nursery phase to grow the postlarvae up to 4 g before pond stocking also helped in reducing eventual shrimp mortality. Visanu Boonyawiwat (Kasetsart University, Thailand) reported that the source of postlarvae exhibited the strongest association



Professor Indrani Karunasagar was part of the team that drafted the "Risk assessment of *Vibrio parahaemolyticus* in seafood" for WHO and FAO in 2011 which relates to the safety of bivalves and fish consumption, and her research work now includes EMS in shrimp.



Professor Chu-Fang Lo (left) together with Dr Han-Ching Wang (second left) and students from National Cheng Kung University have embarked on a comprehensive research on the identification of the EMS-causing toxins using the latest molecular biology tools.

with increasing prevalence of EMS in Thailand and recommended nursing postlarvae in hapas, augmenting with natural foods and probiotics as preventive measures.

Any measure that can block the cytotoxic effects of Pir toxins will greatly decrease the impact of EMS to shrimp farming. To this end, Lo presented preliminary research work in silencing the Pir toxin receptors. Another innovative approach is to inject the isolated Pir toxins into chicken eggs to produce immunoglobulin Y (IgY), the major antibody found in chickens. The isolated IgY was then used to coat shrimp feeds which were fed to shrimp before being challenged with EMS-causing Vp. Preliminary results seem to indicate that this may be potentially useful as a feed additive. Upon my inquiry after her presentation, she indicated that there is a need to find the most cost-effective way to incorporate the synthesised antibodies of the various Pir toxins into commercial shrimp feeds and she is currently working with industry partners to accomplish this. Due to proprietary issues, she indicated that further information could not be disclosed at this time.

Loc Tran presented preliminary data on feeding trials with vannamei shrimp fed with various probiotics, immunostimulants, quorum quenching additives and herbal extracts. Some of these were commercial products while a few were novel but due to non-disclosure agreements signed with various companies, the specific nature of these additives could not be revealed during his presentation. When challenged with EMS-causing Vp, shrimp fed with some of these functional feed additives showed promising results with one herbal extract imparting 100% protection against EMS infection while many others did not result in any significant improvement in preventing shrimp mortality.

Dr Mathias Corteel (INVE Technologies) reported in a poster presentation the effectiveness of a proprietary phytochemical mix that improved disease and stress resistance in shrimp hatcheries. Data were provided showing the dose dependent effectiveness of the phytochemicals in suppressing the growth of Vp. The high commercial interests in finding potential feed additives to mitigate EMS in farmed shrimp has resulted in many researchers working with industry partners but having to withhold revealing potentially sensitive research data.

Nevertheless, Beng-Chu Kua (Department of Fisheries, Malaysia) in her poster presentation revealed that the extracts of betel leaves when incorporated into shrimp feeds were able to impart higher shrimp survival compared to the control group

when challenged with EMS causing Vp. This was partly attributed to the anti-microbial properties of the betel leave extract.

The exact mechanism of how many of these feed additives work in mitigating EMS is currently still under intensive research. Feed additives have many different unique properties and some may work by eliminating the bacteria populations, neutralising the toxins released, boosting shrimp immune response, quorum quenching (inhibiting cell-to-cell communication mechanisms) or combinations thereof.

In his presentation, Dr Chumporn Soowannayan (National Science and Technology Development Agency, Thailand) reminded the delegates that in nature, bacteria live in communities as bacterial biofilms. Living in structured biofilm communities enable bacteria to proliferate more rapidly, transfer genetic material, acquire resistant genes and virulence factors, and improve their survival in hostile environments. More than 80% of all microbial infections involve biofilms. Since EMS infection is through the oral route, he hypothesised that gut colonisation by EMS bacteria would take the form of biofilms attached to the chitinous cuticular lining. The Pir toxins are then released in the gut and enter the hepatopancreas. If EMS pathology is indeed related to biofilm formation in the gut, then any dietary intervention that inhibits or disrupts Vp biofilm formation may offer protection against EMS infection.

Concluding remarks

The characterisation, detection and mitigation of the EMS outbreak in shrimp farming are still very much an evolving science. Multidisciplinary input from scientists in various research specialisations should be encouraged. As new research information emerges, our understanding of the disease improves which allows us to implement counter measures to deal with its transmission. What is needed is a concerted and coordinated effort by all stakeholders to network and share information for the benefit of the shrimp aquaculture industry. Research findings on mitigation measures should be seriously looked into by government policy makers to establish national strategies and policies to minimise the impact of EMS in shrimp production.

Field extension workers must be mobilised to translate scientific knowledge into information that shrimp farmers can easily understand so that sustainable farm-level management practices can be put in place to deal with this disease. It will be interesting to see what further progress in the fight against EMS will be made in the next three years when we converge to meet at the next DAA symposium in Bali, Indonesia.



Wing-Keong Ng is Professor of Aquaculture Nutrition at Universiti Sains Malaysia, Penang, Malaysia. His special interest is in developing functional feed additives for fish and shrimp to enhance sustainability and profitability of aquaculture. His current research interest includes dietary interventions for mitigation of EMS in farmed shrimp. Email: wkng@usm.my

Trending the tilapia in India

By B. Laxmappa and P. Suresh

The Kerala and Andhra Pradesh governments encourage its farming and NFDB is providing subsidies to entrepreneurs

World tilapia production has been booming during the last decade, with output doubling from 0.83 million tonnes in 1990 to 3.9 million tonnes in 2012. Its production is estimated to increase to 8.89 million tonnes by the year 2020. Commercially, tilapias are the second most important group of farmed fish after the carps. China is by far the largest consumer and producer of tilapia. Tilapia is sold live as well as fresh or frozen and as whole fish, fillets, gutted, gutted and scaled, skinless and boneless. The United States is the world's single largest importer of tilapia.

The tilapia in India

India is a vast country in terms of natural resources and is considered as one of the mega-biodiversity countries in the world. The Indian mainland is drained by 15 major, 45 medium and over 120 minor rivers, besides numerous ephemeral streams. The diverse river system in India harbours one of the richest fish germplasm resources in the world. Official records show that *Oreochromis mossambicus* was first introduced to India from Sri Lanka in 1952 and thereafter stocked in several reservoirs of southern India for production enhancement. Tilapia now forms a part of the fish fauna in the Godavari, Krishna, Cauvery, Yamuna and Ganga Rivers.

The Nile tilapia *Oreochromis niloticus* was introduced to India in 1987 and its commercial aquaculture expanded in the southern region of the country. In 1995, Vorion Chemicals Ltd., Chennai claimed high production of hybrid red tilapia popularly called golden tilapia. However, for some unknown reason, the production collapsed. The culture of the Nile tilapia particularly in Andhra Pradesh, Orissa and West Bengal is now gearing up and the fish is now distributed to many states particularly in the coastal areas.

Farmed tilapia are typically hybrids between the *O. niloticus* and other closely related species native to Africa. *O. niloticus* is one of the easiest and profitable fish to farm, in part because they are omnivorous and can be fed a diet derived exclusively from plants. *O. niloticus* and other fish that feed on vegetable matter offer a



Harvest of Nile and red tilapia

much more ecologically sound and environmentally friendly means of providing fish for the rural poor. Tilapia escapees from aquaculture facilities occur frequently due to recurring floods or through inadvertent releases.

Presently in the Ganges and Krishna River systems, the proportion of tilapia is about 10-20% of the total fish species. There are many unpublished data on the presence of tilapia in the reservoirs of Tamil Nadu, rivers of Telangana and some other states of India. In the Kolkata Wetlands, some farmers are producing mono-sex tilapia on a commercial scale in waste waters. In Andhra Pradesh, about 1000 acres (405 ha) are devoted to tilapia farming. The tilapia has the potential to be an important aquaculture species in India, particularly with rising demand for fish.

In India, only four fish farmer groups; M/S Indepesca Pvt. Ltd., Mumbai, M/S CP Aqua (India) Pvt. Ltd., Chennai, M/S Aresen Bio Tech, Vijayawada and M/S Ananda Aqua Exports (P) Ltd., Bhimavaram, both in Andhra Pradesh, have the permission from the Ministry of Agriculture, Government of India for the seed production and farming of tilapia. The Rajiv Gandhi Centre for Aquaculture (RGCA), the R & D arm of the Marine Products Export Development Authority (MPEDA) is also included in the group. In accordance with the guidelines for the hatchery operation and farming of tilapia, developed by the sub-committee under the national committee on the introduction of exotic aquatic species into Indian waters, the preferred culture is of monosex Nile/GIFT/golden tilapia in monoculture systems.

Guided farming

Tilapia is farmed widely in the whole of Asia with the exception of India. A more recent development is that the Government of India is slowly allowing its farming for other farmers but with specific guidelines. Farms have to obtain a permit or license from the authorities to carry out the farming. Farming is allowed only with monosex male fish of Nile tilapia or its hybrids. Monosex culture is advantageous because of faster growth and larger and more uniform size of males. Minimum stocking sizes are 10 g for pond rearing and 50 g for cage culture. The maximum stocking density in ponds is 5 pieces/m² and each farm should not be more than 4 ha in size.



Harvest of *O. mossambicus*

Cage culture is permitted in reservoirs where there is an established stock of tilapia. In cages, use of floating feeds with a minimum protein content of 25% is encouraged. In recirculation aquaculture systems, the stocking should be limited to 150 pieces/m². The guidelines also specify biosecurity measures to prevent escapees. In the case of hatcheries and nurseries, permits are also required and they may only use broodstock from approved foreign and Indian suppliers.

An introduction of tilapia into Indian culture systems is advantageous because its farming can be economical and eco-friendly. As the demand for fish is increasing, diversification of species in aquaculture by including more species for increasing production levels has become necessary. In about 20 countries, lead by China, Egypt, Indonesian Philippines, Thailand and Brazil, the tilapia is already a major farmed species. In India, *O. mossambicus* has been widely cultured in states including Kerala, Andhra Pradesh and Odisha for the last 30 years. The Marine Products Export Development Authority (MPEDA) also plans to culture Nile tilapia in Kerala and Andhra Pradesh.

RGCA organised a one day international seminar on tilapia aquaculture and trade, "India Tilapia Summit 2014" in December in Andhra Pradesh. Its objective was to popularise and promote tilapia as a candidate species for aquaculture (see box).

Prospects

The potential for tilapia aquaculture in India is tremendous. In Vijayawada, Andhra Pradesh, RGCA has started production of tilapia seedstock, since three years ago, based on a technology adopted from the WorldFish Center in Malaysia. This is the genetically improved farmed tilapia (GIFT) technology which

is based on traditional selective breeding programs to improve commercially important traits. The centre already has a stock of around one million seed and is capable of meeting the demand from other states.

The Kerala and Andhra Pradesh governments recently issued orders allowing the farming of Nile tilapia. To encourage entrepreneurs, the National Development Board (NFDB) is also providing financial subsidies for tilapia culture in the country. In the future, we foresee that the tilapia species will be the aquatic broiler chicken, providing consumers with a cheap source of fish protein in India.

References are available on request



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Tilapia Summit 2014

This was the first international seminar in India on the tilapia. It was well attended by 324 participants comprising farmers, hatchery operators, exporters, entrepreneurs, aquaculture professionals, government officials and academia. At the event, Leena Nair, IAS, President RGCA and Chairman MPEDA (second left) said that if just 10% of the existing freshwater farming area in the state of Andhra Pradesh was used for tilapia farming, the state would be able to produce over 120,000 tonnes a year with an export value of USD 1.2 billion. This is subject to the resolution of issues pertaining to permission, registration and approval for tilapia breeding and farming.

Local and regional experts discussed various commercial technologies worldwide on tilapia farming; including breeding and genetics, seed production, grow-out farming systems, disease management, biosecurity requirements, saline resistant/tolerant strains, advanced intensive recirculation aquaculture production systems and market trends. Among the recommendations made by the expert panel was the need to hasten the process of granting permission for tilapia farming to encourage small scale farmers to take up tilapia farming. At the same time, farmers need to adopt responsible tilapia farming practices and this can be conveyed to them through training and awareness programs by centres such as RGCA. The panel also recommended market development and trade to further improve the demand for tilapia culture in the country (rgca.org.in).



Tilapia farming and trade in Bangladesh

By Fatima Ferdouse

The global production of farmed food fish including crustaceans reached 66.6 million tonnes in 2012 in which the share of inland or freshwater finfish was 66% at 38.6 million tonnes, reported Food and Agriculture Organisation (FAO) in its 2014 State of World Fisheries and Aquaculture (SOFIA). Bangladesh was mentioned as the smallest nation (147,570 sq km or 56,977 sq. miles) but is among the top 15 producers and ranked fifth in global aquaculture production of food fish in 2012.

On average, aquaculture production in Bangladesh increased by 5.5% annually over the last ten years reaching 1.7 million tonnes in 2012. Freshwater finfish had the lion's share in this production at 1.5 million tonnes which consisted mainly of carps, pangasius and tilapia. Almost all of these supplies entered the domestic fresh fish trade where demand for freshwater fish is traditionally high and has increased faster than production in parallel with the growth in population and urbanisation.

To meet this growing demand, Bangladesh imports fresh/chilled carps from as far as Andhra Pradesh in India and also from Myanmar. Per capita fish consumption in the country has increased to 18.4 kg, but remains below the global average of 20 kg, while the traditional daily food of the population has been rice and fish for centuries.

Traditionally, Indian carps namely rohu, catla and mrigal have been the popular freshwater fish widely farmed in Bangladesh. The tilapia is a newcomer in the aquaculture sector. Yet, farmed tilapia was the third largest contributor in the country's inland aquaculture (14%) after carps (75%) and pangasius catfish (19.3%) during 2012-2013 fiscal year.

In 2012, Bangladesh had a 5% share in the global production of farmed tilapia. Farmed tilapia production in the country was 228,450 tonnes in which 203,876 tonnes were harvested from pond aquaculture. In addition, 5,643 tonnes were harvested from the 'seasonal water bodies' and also from shrimp/prawn farms (18,631 tonnes). Being the world's largest delta area, where five large rivers merge, pond fish farming dominates current freshwater aquaculture in Bangladesh.

The tilapia

Tilapia is farmed using extensive, semi-extensive, intensive and highly intensive aquaculture methods. According to the 2012-2013 national data, 51% of the production was from intensive aquaculture, where the average production volume was 23.94 tonnes/ha and total harvest was 104,140 tonnes. The semi-intensive sector produced 67,600 tonnes which was 33% of the total farmed tilapia production at an average rate of 10 tonnes/ha.

The principal farming districts were Comilla (33,000 tonnes) in the Chittagong region, Mymensingh in the Dhaka region and Jessore (21,000 tonnes) in the Khulna region. Small scale cage culture of tilapia was introduced recently in the southern delta region (Barisal) under a government pilot project.

Trade

Similar to China and India, the lion's share of inland aquaculture production enters the domestic market in Bangladesh. Although the Indian carps are preferred by local consumers, nowadays they are considered as higher value fish and domestic supplies are not enough to meet the increasing demand. Rohu and catla are imported from India and Myanmar. Imports from India were nearly 23,000 tonnes in 2013 with a customs declared value of USD 22 million.

At the same time, the fast growing and easy-to-farm tilapia is gaining popularity among both urban and rural populations. Consumers from various income levels have access to this fish due to its 3-4 tier price levels in the retail trade. Fresh tilapia prices vary according to the fish size. Prices range from USD 1.25-3.50/kg in the city markets.

Government assistance in tilapia aquaculture has been a significant step in boosting production which has helped to increase the intake of fish protein in Bangladesh. It has also helped the country's national food security program. However, in seafood exports, the farmed finfish sector in the country is yet to make much progress, even though import demand for tilapia (and pangasius) is on the rise worldwide.

Aquaculture production of tilapia and other freshwater species (tonnes) in ponds (by region) during 2012-2013 (Fisheries Statistical Year Book, Department of Fisheries, Bangladesh)		
Region	Tilapia	All farmed species
Dhaka	43,900	473,647
Khulna	43,001	183,443
Barisal	14,709	85,813
Rangpur	8,133	100,500
Rajshahi	14,473	221,565
Chittagong	68,976	314,748
Sylhet	12,271	45,669
Total	205,463	1,446,594



Map credit: Department of Fisheries, Bangladesh



Culture of tilapia with carps, Daudkandi , Comilla



Feeding tilapia in a pond in Barisal

For the last three decades, the seafood export trade in Bangladesh is linked with farmed shrimp, mostly black tiger. With a 78% share from shrimp exports, the total export revenue in the fiscal year 2012-2013 from Bangladesh was USD 540 million. Exports are heavily dependent on two markets, European Union and USA. Currently, there has been little attention on the export potential of tilapia from Bangladesh.

However, consumer demand for the tilapia, particularly fillet has increased in these two markets with imports reaching almost USD 2 billion annually. Although tilapia imports are mainly from China, supplies from this source are declining due to increasing demand from their own domestic market. As a consequence, imports of tilapia fillets from Indonesia and Vietnam are increasing.

Expansion opportunities

Bangladesh has the world's largest river delta system (wikipedia.org/wiki/Bangladesh), which offers a vast potential to develop sustainable tilapia aquaculture for domestic consumption as well as the export trade. The present farming areas are mainly located in the central and eastern regions of the country. However, the delta areas in the southern region namely Khulna and Barisal offer the best potential to develop this industry.

The Barisal region, for example has more than 300,000 ha of open water bodies and 35,280 ha of closed water area (ponds) which are directly connected with large rivers through channels and tributaries. Current production of tilapia in the Barisal region is below 20,000 tonnes. With proper planning and management,

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this can be increased 10 times without causing damage to the environment (particularly the underground water level).

Recently, the Department of Fisheries in Bangladesh has initiated a pilot project with 996 floating cages and the harvest was 700 tonnes of tilapia, suitable for processing into fillet for local and export markets. However, in the absence of a marketing plan, the fish were sold in the nearby markets instead of markets in the larger cities where prices are better.



Fatima Ferdouse is a consultant on the international seafood trade with more than 30 years of experience in seafood trade and marketing in the Asia Pacific region. She was head of the Trade Promotion Division at INFOFISH, responsible for market information and technical advisory services to the regional seafood industry for 25 years. Fatima has strong links with the seafood marketing industry and producers and has presented at various conferences and symposiums. She is based in Kuala Lumpur. Email: fatimaferdouse@hotmail.com

Bangladesh

Most of the country is dominated by the fertile Ganges-Brahmaputra Delta. The northwest and central parts of the country consist of the Madhupur and the Barind plateaus. The northeast and southeast are home to evergreen hill ranges. The Ganges Delta is formed by the confluence of the Ganges (local name Padma or Pôdda), Brahmaputra (Jamuna or Jomuna), and Meghna Rivers and their respective tributaries. The Ganges unites with the Jamuna (main channel of the Brahmaputra) and later joins the Meghna, finally flowing into the Bay of Bengal. The alluvial soil deposited by the rivers when they overflow their banks has created some of the most fertile plains in the world. The country's haor wetlands are of significant importance to global environmental science.

Map credit: Department of Fisheries, Bangladesh



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Streptococcosis in cultured red tilapia in Malaysia

By Mohamad Noor Amal Azmai

The epidemiology of the disease will help in its future control and prevention

In 2013, the production of tilapia, *Oreochromis* sp. was 33,437 tonnes in Malaysia. The value was MYR 259 million, equivalent to USD 72 million at current exchange rates. The production was 25% of the total production of farmed freshwater fish making it the second highest farmed fish after the *Clarias* catfish. Although small in terms of volume compared to the production in Thailand and Vietnam, nevertheless, the farming of both the black and red tilapia is very important and totalled 42,774 tonnes in 2013. Generally, tilapia is farmed in intensive systems by small and medium scale entrepreneurs in ponds and cages located in rivers and lakes.

It is the high density culture which has led to disease outbreaks, especially due to gram positive *Streptococcus*, at the hatchery and grow-out stages. The situation in Malaysia is similar to other tilapia producing countries where production has declined because of *Streptococcus* infections. In 2008, losses at the global level were estimated at USD 250 million. Currently we have identified that in tilapia farms in Malaysia, *Streptococcus agalactiae* (in particular group B *S. agalactiae*) is the main pathogen that causes streptococcosis.



Red tilapia infected by *S. agalactiae* showing erratic swimming

History of outbreaks

In this collaborative study among research teams from the National Fish Health Research Centre and Freshwater Fisheries Research Centre of the Department of Fisheries, and the Faculty of Science, University Putra Malaysia, we tracked the epidemiology of *Streptococcus* outbreaks in Malaysia using old and newly collected data.



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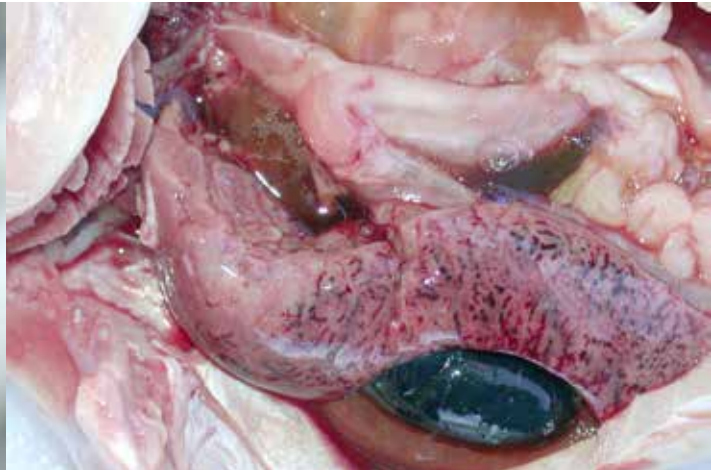
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Infection by *S. agalactiae*, on the left, corneal opacity and exophthalmia and on the right, marked congestion of the viscera

The first outbreak of *S. agalactiae* in red hybrid tilapia was observed in 1997 in the Pahang River system on the east coast of the peninsula. The disease affected tilapia weighing between 300-400 g, causing 60% mortality. In 2000, outbreaks of *S. agalactiae* infection were reported in Kenyir Lake, Terengganu and Pergau Lake, Kelantan, killing approximately 50% of the cultured tilapia population. The outbreaks were observed between March and June of the year. Lately, reported cases of *S. agalactiae*, infecting the wild, farmed black, red or GIFT tilapia strains have been more widespread, covering almost all states in Peninsular Malaysia.

The most significant external signs of red tilapia infected by *S. agalactiae* are erratic swimming behaviour and inflammation around the operculum area. Other signs are corneal opacity. Pathological signs are damage to the internal organs, including necrosis of blood vessels and swollen endothelium in the liver. Red hybrid tilapia infected by *S. agalactiae* show extensive infarction of tissue adjacent to an affected blood vessel.

Prevalence and transmission

The records in 2007 and 2008 showed the history of prevalence. Infections increased during the second and third quarters of the year in fish cultured in the irrigation canals, ponds and mining pools. In rivers, infections increased inversely with current flow, towards the downstream parts of the river. In reservoirs such as in the Kenyir Lake, infection rate increases towards the second to third quarter of the year. However, in 2014, we did not observe this pattern. In most cases, 10 to 30 cm fish have been infected and the median weight was around 200 g. Temperature is also a risk factor as studies with the thermocline showed that prevalence was high in May at 30.5 °C such as in Kenyir Lake and Pedu Lake.

Studies on transmission patterns showed that a batch of fry of 75 days in the hatchery had two isolates of *S. agalactiae* and at 180 days at the grow out farm only one isolate was identified and at 270 days in the farm, two isolates were detected. From REP-PCR genotyping and genetic sequencing, we observed that isolates were of the same strain which confirmed that the source was from the hatchery. In addition, our assessment of the 181 strains of *S. agalactiae* isolated from red hybrid tilapia (*Oreochromis sp.*) and golden pompano (*Trachinotus blochii*) showed that the genetic profiles of the strains corresponded with their geographical location of origin and host. These isolates also showed low resistance to antibiotics and our conclusion was that the intrinsic resistance to antibiotics rather than to their utilisation.

Aside from *S. agalactiae*, tilapia and pompano fish in Malaysia are infected with *Streptococcus iniae*. Although there are some commercial vaccines being marketed, local farmers are not using these, possibly due to the cost factor. At the WorldFish Centre, there is work to develop a GIFT tilapia strain with higher resistance to *Streptococcus*.

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In the picture, the author on the left with Dr Siti Zahrah Abdullah, National Fish Health Research Centre (middle) and Professor Mohd Zamri Saad, University Putra Malaysia.

This article was based on the paper by Amal MNA, Zamri-Saad M, Siti-Zahrah A and Zulkafli AR presented at the seminar Advances in Fish Health, organised by the Institute of Biosciences, Universiti Putra Malaysia, Malaysia, 4-5 February 2015.

Ways to sustainable aquaculture

By Zuridah Merican



This pond at this farm cum hatchery holds black tiger shrimp as well as the Malabar grouper although the main crop is the grouper. The demand for grouper is highest from March to October and China is the main market.

A workshop in Taiwan discussed steps towards sustainable aquaculture practices in ASEAN Part 2: Institutional and R&D support for sustainable aquaculture in Asia

In November 2014, under the collaborative platform for sustainable aquaculture, the Department of Aquaculture (DOA), National Taiwan Ocean University (NTOU) invited 30 ASEAN delegates to a workshop on sustainable aquaculture activities. This also facilitated information exchange on sustainability issues along the supply chain. Part 1 of this article in issue January/February 2015 was on ways to sustainable aquaculture through research in genetics and intensification of culture systems. Here in part two of the article, we report on institutional and R&D support

Institutional support

In Taiwan and in the Asian region, DOA is recognised as a leading player in tertiary education and advanced research in aquaculture. It has been providing competent specialists in aquaculture. It is the only institution in Taiwan to offer an aquaculture BSc back in 1974. Master's and doctorate (PhD) programs were established in 1987 and 1992, respectively. Since 2003, DOA has cooperated with the Taiwan International Cooperation and Development Fund-Taiwan to establish the international master's and PhD programs in aquaculture.

As an example of the dissemination of aquaculture training, during the workshop, a 2009 PhD graduate from NTOU, Roberto A. Santacruz-Reyes, consultant and lecturer at the Technical University of Machala, Ecuador, showed how he combined the training and knowledge he gathered from Taiwan to make changes to the industry in Ecuador. His presentation was on lessons learned from taura syndrome virus (TSV) and white spot syndrome virus (WSSV) disasters and measures against early mortality syndrome (EMS) from Southeast Asia. "Arising from the information on severity of EMS, the sector is on alert and has to be aware of brood stock and post larvae movements in Latin America. The response from the government was a total ban on

frozen aquatic products and aquaculture supplies from Asian countries affected by EMS (broodstock, post larvae, probiotics, artemia, etc)," said Santacruz-Reyes.

DOA also wants to play a larger role in the promotion of sustainable aquaculture in the region through memorandums of understanding (MOU) of its university, NTOU, with several universities and research institutions. In November, NTOU signed a MOU with Cagayan State University (CSU) Philippines. According to Dr Romeo R. Quilang, professor and president, some of the challenges in aquaculture in the Cagayan Valley is sustaining productivity and competitiveness. CSU's College of Fisheries and Marine Science is a key player in the industry along with other government agencies. More collaboration is needed among institutions to increase local capacity to restore productivity and degraded habitats, and conserve resources.

In Taiwan, the Freshwater Aquaculture Research Centre in Lukang has a germplasm bank for freshwater fish species. The aim is to prevent the decrease in genetic variation. The germplasm bank allows for the continuation of selective breeding of species such as pure strains of tilapia (*Oreochromis niloticus*, *O. mossambicus*, *O. aurea* and *O. hornorum*), snakehead (*Channa arga* and *C. asiatica*) and the crucian carp (*Carassius auratus*). It also conserves germplasm of river fish populations. Some achievements according to Dr Shuenn Der Yang, director at the centre are the selective breeding of tilapia hybrid (*O. niloticus* X *O. mossambicus*) for fast growth and resistance to cold temperatures. A recent challenge is artificial propagation and larval rearing of the Japanese eel.

Two major threats to sustainable production of the grouper are the nervous necrosis virus (NNV) and the Taiwan grouper iridovirus (TGIV) which cause heavy mortality of grouper during larviculture. The huge economic loss from these two diseases threatens the sustainability of the grouper industry which is a major one with a production of 25,942 tonnes in 2013. The production of healthy grouper brood stock and larvae has been a focus at the Marine Research Centre in Tainan. According to the centre, the transmission of these viruses is both horizontal and vertical which implies that the egg and larvae are the carriers.



These hatching tanks at the Freshwater Aquaculture Research Centre are part of the automated system for finfish seed production and transfer



Jennifer Kuo (left) with Dr Y-H Chien (right) and Dr Tob Chan Aun, Inland Fisheries Research and Development Institute, Cambodia

Their work, which is in progress, is to produce virus-free fertilised eggs through the development of specific pathogen free brood stock.

In Sabah, Malaysia, the R&D support for industry provided by the Borneo Marine Research Institute, University Malaysia Sabah is in brood stock management, larviculture, nutrition, and disease and health management. The work is on replacement of fish meal with plant based proteins in feeds for the grouper *Epinephelus* sp and marble goby *Oxyeleotris marmorata*. Based on growth performance and feed efficiency, 14 g grouper fed up to 30% of defatted soybean meal showed no significant differences in growth rate in comparison with grouper fed the control diet. "Another on-going study with the hybrid giant x tiger grouper (TGGG) or *E. lanceolatus* x *E. fuscoguttatus*) showed that fish fed another type of soybean protein in feed gave good growth and could accept a higher level of soybean meal in the diet. Both of these results showed that a reduction in the use of marine protein and the acceptance of plant proteins can contribute to a sustainable grouper farming industry," said Dr Annita Yong Seok Kian in her presentation on aquaculture research and community projects by the institute.

Biotechnology to support industry

At the Grobest group, Jennifer Kuo, general manager, Animal Health, explained to delegates how the research group at Research Institute of Grobest has been working closely with researchers at NTOU and National Cheng Kung University (NCKU) in biotechnology for sustainable aquaculture of the grouper and shrimp. Their focus is product development such as bioactive feed additives for growth and flesh quality.

Myostatin and muscle growth

In the development of functional feeds, Grobest director of R&D said that the myostatin or the GDF-8-protein inhibits muscle differentiation and growth in a process called myogenesis in fish. One way to inhibit this myostatin process is with an antibody. They applied a patented active immunisation process developed at NCKU. The team at Grobest is now developing a grouper myostatin epitope (antigen peptides) which when given to young grouper through three booster injections or added to grouper feed will induce the antibody to inhibit myostatin and fish will grow bigger.

"Trials with the orange spotted grouper showed increased weight for small grouper (20 g), medium size fish (60 g) and large fish (120 g) with more muscle. In addition, FCR improved

with higher feed efficiency at 1.37 in comparison to 1.53 in the control fish. However, as the work is with recombinant proteins, there will be a need for food safety and toxicity studies.

Field trials were carried out at NCKU with funding from the Ministry of Agriculture. These showed 41% weight gain as compared to fish fed trash fish. The overall benefit to industry is the reduction in culture period by as much as 3 months and the use of less fish meal. However, because of the homology of the myostatin gene between species, it will be possible to apply this technology to other fish like the tilapia and seabass.

A solution for EMS

Grobest, as a major shrimp feed manufacturer in Asia has been following the effects of EMS. "Similar to the aspiration of most stakeholders in the shrimp industry, the research team would like to have a solution for EMS," said Kuo.

"For the past three years, Grobest has been testing a product called 'Super Shield' which is not only a functional feed but is a product which contributes to the sustainable management of shrimp farming. Tests have been carried out in Vietnam, China, Thailand and east Taiwan where results indicated that the bacterial count of the good pathogen improved by 50%. There was recovery of the damaged hepatopancreas as hepatopancreatic tubules were revived and oil droplets increased. Pond water remains clean and *Vibrio parahaemolyticus* counts reduced from more than 10^4 to less than 10^2 CFU/ml. More importantly, the use of the bioactive feed additive must go hand in hand with good management practices."

Bioactive by-products

Taiwan leads in the development of by-products such as collagen from tilapia for cosmetic and pharmaceutical use. The current focus of biotechnology is to develop more by-products from aquaculture and fisheries. "This is in line with the move for a long-term economic sustainability of aquaculture," said Dr Y-H Chien, DOA. "The outlook for the long term is just not only rational use of land resources and environment, streamline production and marketing systems, and health management but also post harvesting technology to develop high value products for the niche markets."

At the Fisheries Research Institute, some of the biotechnology outputs from aquatic resources are essence of marine algae, which contains polysaccharides, polyphenols, peptides, amino acids, vitamins and minerals to whiten and recuperate the human skin. The results from oyster culture are tonnes of oyster



Grouper farmers, Wu (left) and Daniel Lin (right) with Luis F. Valenzuela M from El Salvador who is doing his MS in Aquaculture Nutrition.



Roberto A. Santacruz-Reyes (right) and some of the international students at DOA. From left, Isagani Pablo Angeles Jr. from the Philippines is a PhD student on aquaculture nutrition and Wilbur F. Dubon from Belize and Randy Morton from St. Kitts and Nevis are MS Aquaculture Technology and Management students.

shells, which according to the centre scientists, can be used to extract pearl layer peptides. These are effective as antioxidants. The process is under patent. Another study showed the value of phospholipids extracted from the integument of squid. *In vitro* test showed that the DHA-PL (docosahexaenoic acid-phospholipids) successfully protected neuron cells against cytotoxicity, and markedly increase cell proliferation. This may be an approach in the prevention of Alzheimer's disease and other neurodegenerative diseases.

Risk assessments

As the aquaculture industry moves towards a more biotechnological approach with research into transgenic animals for food and ornamental fish industry, the Mariculture Research Centre in Tainan has appropriately established an isolated experimental facility to assess risks of such developments. This is the genetically modified organism (GMO) facility, which will look at the impact on the ecosystem caused by a specific GMO, and carry out risk assessment studies before the GMO can be distributed in the market.



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Aquaculture bioremediation from Lallemand Animal Nutrition



Lallemand Animal Nutrition announced the launch of LALSEA BIOREM, a new range of aquaculture bioremediation solutions at VIV Asia 2015 held in Bangkok, from 11-13 March. This is a range of synergistic combinations of specifically selected naturally occurring microorganism strains to maintain water quality during crop cycles, control naturally degrading organic wastes and phytoplankton blooms. Lalsea Biorem is 100% biodegradable and a drug-free solution to optimise sustainable shrimp and fish production.

Stéphane Ralite, aquaculture product manager, Lallemand Animal Nutrition said, “Lalsea Biorem is based on the combination of complementary microorganisms carefully selected for their activity, properties and synergies. Aquaculture bioremediation is complex because the conditions from one pond to another can be very diverse, in terms of salinity, pH, minerals, organic load, microorganism population, etc.

“Lalsea Biorem has been formulated to respond to a wide range of conditions. It has been proven to give the best results in farm and laboratory tests. The main targets are to prevent the development of anaerobic conditions, to help in maintaining a good equilibrium of the algal bloom and a low load of pathogenic bacteria. We have also paid special attention to develop a user-friendly formulation. Thanks to our development platform Lalsea Biorem can be directly used in pond water without any pre-fermentation phase”.

Dr Mathieu Castex, R&D director at Lallemand Animal Nutrition explained, “For the development and application of our bioremediation range we have the chance to rely on a very unique tool: one if not the largest collection of microorganisms of

marine origin - over 10,000 strains collected over the world- and a cutting-edge screening platform, notably based on our SeaRCH patent, at Lallemand Aquapharm. This allows us to screen, select and study a huge number of candidates based on several biological properties such as the ability to survive, grow and be efficient in a range of pond environments (various pH, oxygen level and salinity). In addition, they have beneficial features, such as specific enzymatic activities and the ability to digest organic compounds (wastes), ammonia, nitrite, the ability to help control water pH or the growth of certain pathogens.

“The link between the Aquapharm platform, Lallemand Animal Nutrition, aquaculture research laboratories and farms allows us to develop our solutions jointly from science and field results and makes our propositions based on technical facts.”

On bioremediation, the team explained that a pond is a complex and specific ecosystem where fish or shrimp, phytoplankton, zooplankton, invertebrates, bacteria etc are involved in waste treatment or production, nutrient delivery or consumption, chemical and physical parameter modifications. Bioremediation is using specifically selected bacteria to exert a positive control of pond microbial ecosystems. Bioremediation allows farmers to enhance the mineralisation of organic wastes, detoxify waste compounds, control water pH, control the development of pathogenic microorganisms and more — all in a natural way.

Lallemand, Inc. is a privately owned Canadian company specialised in yeast, bacteria and yeast derivatives, for animal nutrition, baking, winemaking and pharmaceutical industries. Lallemand is a primary producer and major supplier of yeast and bacteria. Lallemand Animal Nutrition is dedicated to the development, production, and marketing of profitable, natural and differentiated solutions for animal nutrition and health. The core products are live bacteria for probiotics and silage inoculants, specific yeast for probiotics, and high value yeast derivatives. Lallemand is a major supplier of probiotics and silage inoculants worldwide. More information: www.lallemandanimalnutrition.com

EHP and CMNV screening

The microsporidian *Enterocytozoon hepatopenaei* (EHP) and covert mortality nodavirus (CMNV) are two recent threats to the shrimp aquaculture industry in Malaysia and in the region. The screening for EHP and CMNV is available in Malaysia by Lab-Ind Resource Sdn Bhd, a Malaysian company providing detection solutions to industries, scientists, laboratories and universities.

EHP was first characterised in *Penaeus monodon* from Thailand in 2009 (Tourtip et al. 2009). It was discovered in slow growing shrimp and in shrimp hepatopancreas. Although EHP does not appear to cause mortality, it is however associated with severe growth retardation in *P. vannamei*. Thus, it is important to prevent infection of EHP. Recently, attention is on EHP in shrimp hepatopancreas and midgut accompanying early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND) in ponds. In a Thai epidemiology study, there was a high prevalence of shrimp infected with EHP as well as gregarine-like entities in the hepatopancreas (Flegel, 2014).

Detection of EHP is by microscopy, with a 100X objective and observation of stained hepatopancreas tissue sections. This is followed by a search of the characteristic spores that are

extremely small and sometimes produced only in small numbers. By PCR, detection is of the specific gene sequence of EHP, which is accurate and sensitive.

CMNV is a new nodavirus associated with shrimp mortality. It was first discovered in China and resulting in serious economic losses since 2009. The virus has been detected in other countries too. The signs of infection is that shrimp exhibits hepatopancreatic atrophy, empty stomach and gut, soft shell, slow growth and uneven slightly whitish muscle lesion in the abdominal segment. Mortality begins one month post-stocking and increases after 60-80 days post-stocking. CMNV virions can be detected using a nested RT-PCR assay with high sensitivity.

Besides these EHP and CMNV, Lab-Ind Resource also offer PCR detection for major aquatic diseases such as white spot syndrome virus (WSSV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), taura syndrome (TSV), yellow head virus (YHV), infectious myonecrosis virus (IMNV), acute hepatopancreatic necrosis disease (AHPND) and others. More information: Web: www.mylabind.com Email: info@mylabind.com

A strategic alliance on crustacean and fish nutrition and feeding



Jack Hung (First row, fifth from left) and Tie Teck Lok, GM of Lucky Star (standing, right) with the team from Marubeni Nisshin Feed and Lucky Star distributors from the Netherlands, India, Indonesia, and Vietnam at Lucky Star's 30th anniversary celebrations.

In January, Taiwan's Hung Kuo Industrial Co., Ltd., the manufacturer of Lucky Star Feed celebrated the company's 30th anniversary in Taipei, Taiwan, where it also signed a memorandum of strategic alliance agreement with Marubeni Nisshin Feed Co., Ltd. (also known as Marubeni Nisshin Feed), the manufacturer of Otohime feed.

Under the new strategic alliance, Lucky Star Feed and Marubeni Nisshin Feed aim to exchange their collective experience and expertise in crustacean and fish nutrition, aqua farming practices and aquafeed processing technology. The cooperation will give rise to a variety of new and exciting joint projects including new products and market development.

At the ceremony, Chihiro Shikama, president of Marubeni Nisshin Feed stated that the population and economic growth of Japan is comparatively slower than its neighbours and other South-East Asian countries. The company therefore actively seeks business partners to expand activities abroad.

The memorandum was signed by the president of Lucky Star Feed, Jack Hung and president of Marubeni Nisshin Feed, Chihiro Shikama. The signing ceremony was witnessed by Professor Liao I Chiu, Academician of Taiwan Academia Sinica as well as global distributors of Lucky Star, management of Marubeni Nisshin Feed and other guests from Taiwan. The collaboration between both companies is expected to leverage their joint expertise to yield new products and projects that will benefit the global aquaculture industry.

Founded in 1984, Lucky Star Feed originally exported raw materials for aquafeed manufacturing which also paved the way for close associations with Japanese producers. In 1985, Lucky Star Feed completed the construction of its first aquafeed mill and headquarters in Taiwan. Since 1989, the company has supplied *Penaeus japonicus* shrimp feed for grow-out to the largest shrimp producer in Japan. This represents over 25 years of continuous trade, which has laid a solid foundation for its feed business. In

1992, a second aquafeed mill was constructed in Xiamen, China to focus on the Chinese domestic market. Its production technology of extruder shrimp feed is highly regarded in this industry.

Lucky Star Feed began to manufacture and supply larval diets for newly hatched fish and shrimp in 2007. The aim is to replace or supplement the nutritional profile of various live feeds which are essential for newly hatched larvae. The company is committed and dedicated to the development of high-end larval diets, including nutrition and processing technologies. In addition to its existing coverage in Europe, North Asia, South-East Asia, the South Pacific and South America, Lucky Star Feed aims to continue to expand its sales networks globally.

Marubeni Nisshin Feed is a joint venture entity of Marubeni Corporation and the Nisshin Seifun (Flour Milling) Group. With a capital base of JPY 5.5 billion, Marubeni Nisshin Feed has 13 feed mills (including related mills) producing 2.8 million tonnes of formulated feed for aqua and livestock annually. It commands 11.7% market share in Japan, which places Marubeni Nisshin Feed as the largest aquafeed supplier in Japan with sales of approximately 100,000 tonnes of aquafeed annually. More information: www.luckystarfeed.net



Exchange of the memorandum of strategic alliance, Jack Hung, president of Lucky Star Feed (left) and president of Marubeni Nisshin Feed, Chihiro Shikama (right)

A sustainable future for krill

The Aker BioMarine's Antarctic krill fishery has been recertified against the world's most robust standard for environmentally sustainable fishing, according to a press release by Marine Stewardship Council (MSC).

It said that a rigorous, third party assessment has shown that the Antarctic based fishery continues to meet MSC's demanding standards. As a result, Aker BioMarine's krill products, including krill oil, may continue carrying the MSC ecolabel, identifying their origin from a sustainable source.

The fishery first achieved MSC certification in June 2010. All MSC certified fisheries must be completely reassessed within five years of certification. This reassessment showed that Aker BioMarine not only continues to operate to the highest standards of environmental sustainability, it has also improved its practices and knowledge in order to better manage the fishery.

At current levels, Antarctic krill is one of the world's most underexploited marine stocks. Since 1994, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has set total allowable catch limits for the entire Antarctic. Recognising the need to protect krill populations, CCAMLR has set trigger catch limits at 1% of the total estimated biomass (620,000 tonnes). Current krill catch in the fishery area (CCAMLR Area 48) represents around 0.4% (212,000 tonnes) of the total krill biomass (60.3 million tonnes). At these rates fishing has a minimal impact on predators and other species in the food chain.

Aker BioMarine has taken significant steps to protect other species living in the Antarctic Southern Ocean. This includes

using a bespoke "Eco-Harvesting" method which has a fine mesh, monitored by underwater cameras, to prevent anything larger than krill being caught. Recent research shows that bycatch of juvenile species is around 0.2% of the total catch.

During the reassessment process, auditors, Food Certification International (FCI), ran a comprehensive consultation process, which included input from eNGOs, the Norwegian Ministry of Foreign Affairs, the Norwegian Directorate of Fisheries and the Institute of Marine Research.

Nina Jensen, CEO of WWF Norway said, "To be MSC certified, a robust management system must be in place, the impacts on the ecosystem must be minimal and the target species has to be in a good condition.

"As part of its environmental commitment Aker BioMarine has made a significant effort to reach out to the rest of the industry to communicate the importance of sustainability. Aker BioMarine also partners with various scientific entities to carry out important Antarctic ecosystem research. When buying krill oil, we encourage retailers and consumers to ensure that they products they buy and sell are certified by a credible independent third party, such as the MSC."

Sigve Nordrum, Sustainability director at Aker BioMarine said, "We are reassured that the scientific panel, after an in-depth review of the fishery, have concluded that Aker BioMarine's krill fishery does not negatively impact the krill population, does not negatively affect the ecosystem and that the fishery is well managed."

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Next generation pumps and products for RAS



XLHP

Pentair Aquatic Eco-Systems, USA has three new products for water management. These are the RIU3 (Point Four's next generation Remote User Interface), high performance heat/cool pumps and RFS-45 and RFS-60 line of radial flow settlers.

The RIU3 offers a host of features suited to customers' requirements for continuous monitoring and control of water parameters. It functions as either a stand-alone field mounted transmitter/controller, or can be daisy chained to create a multi-linked network

connection, supporting up to 99 units. An unlimited amount of multi-linked network connections can be made allowing for a scalable system from small hatchery operations to large RAS systems.

Pentair Aquatic Eco-Systems' XLHP™ high performance heat/cool pump is vital in today's world of high energy costs. The company said that compared to gas, oil or electric heaters, high performance heat/cool pumps use just a fraction of the energy to generate the same amount of heat. In fact, just USD 0.20 worth of electricity produces USD1.00 worth of heat generated by other methods. The pump has more standard features than any other pumps in the market. The pump is EPA-recognised as environmentally safe with non-ozone depleting R-410A refrigerant. Its 100% titanium heat exchanger assures corrosion-free performance for extra long life and value.

The third product is the RFS-45 and RFS-60 line of radial flow settlers. These products were formerly sold under the HE Group brand name; and they are used to remove particulates from effluent water. Some features are that it greatly reduces solids loading in a system, is a passive piece of equipment and requires no additional energy to operate and requires routine cleaning only with no additional maintenance or servicing required. The radial flow settlers are available in many sizes for various flow requirements. More information: www.PentairAES.com



Diagram of radial flow settlers. Effluent water enters the RFS Liquid Inlet, flows upward through the adjustable Standpipe Assembly, and back down through the Stilling Well. Solid particulates settle to the cone bottom for removal through a Solids Outlet. The filtered water flows upwards over a V-Notch Weir into the launder, exiting through the Liquid Outlet.



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New aquaculture research centre in Vietnam

In early 2015, BIOMIN will open its new aquaculture research centre to drive research and development of innovative and effective solutions to pressing challenges in the industry. The facility, located at Nong Lam University in Ho Chi Minh City, Vietnam, further solidifies the dedication of Biomin to the aquaculture industry.

In line with its expansion plans in the aquaculture industry, Biomin will take over and expand the facilities of the aqua research center at Nong Lam University to a 600m² aquaculture research center. This investment demonstrates efforts of Biomin in conducting innovative research to provide effective solutions to the industry with the focus on several key areas: nutrition and feed formulation; gut health; immune modulation; waste management and feed safety. Research and development will be centered on several of the most important species for the aquaculture industry in the region including marine and fresh water species such as catfish, tilapia, sea bass and shrimp.

Activities at the new research center will be jointly coordinated by the Biomin Research Center in Tulln, Austria, and the technical staff at the facility. The research facilities will be equipped with five different recirculating systems and two challenge rooms. A feed formulation lab for preparation of test diets, including a laboratory scale feed extruder that will allow testing of different ingredients and solutions under conditions similar to those found in the aquaculture industry, is also in place.

In partnership with Sanphar, a veterinary products and services company under the Erber Group umbrella, a state-of-the-art microbiological lab will be established to screen and investigate the status of infectious diseases in both livestock and aquaculture. Biomin will also collaborate closely with Nong Lam University to build the academic and research pipeline in Vietnam by creating undergraduate research opportunities and mentorship for local students.

GMP certification for premix facility in Vietnam

The 4.7 ha Biomin premix plant in Binh Duong, Vietnam is the first and only premix facility in Vietnam to obtain the Good Manufacturing Practice (GMP) according to the requirements of the GMP+ Feed Certification scheme. This is the Good Manufacturing Practice (GMP+ B1) certification. The certification reaffirms the confidence that Biomin has in the facility to meet the highest standards of the industry.

The certification audit, performed by SGS Vietnam Ltd., confirmed that Biomin Vietnam has attained an overall acceptable level of compliance with the GMP+ B1 Feed Certification scheme in the Feed Safety Assurance module. This encompasses all the recommendations of the Food and Agriculture Organization of the United Nations (FAO) in relation to GMP.

The GMP+ B1 Feed Certification scheme requires that the company is compliant with the standards required for the following: quality management, personnel, premises and equipment, documentation, production, quality control, contract manufacturing and analysis, complaints and product recall, and self-inspection.

Dr Jan Vanbrabant, managing director, Biomin Asia Pacific said, "We are very proud to be the first premix-producing company in Vietnam to be certified according to the international quality standards of GMP+ B1, which reflects the robustness of our feed safety system. This certificate further confirms the quality and safety of our products, and highlights our commitment to deliver quality products to our customers."

The premix facility opened its doors in 2013 with a fully-automated production system that has a capacity of 6.5 tonnes per hour in Binh Duong, Vietnam.

Commercial manager Asia



Multinational feed additive producer Nutriad has appointed **Ab Greven** as commercial manager for its Palatability Business Unit in Asia Pacific. Nutriad is currently investing in new production and lab facilities in the USA which, together with other dedicated palatability manufacturing capability in UK and China, will enhance its

leadership role in providing service and support to customers in all key feed markets.

Erik Visser, CEO Nutriad said, "Asia Pacific is a focus region in Nutriad's strategic growth plans for our unique palatability product offering and the appointment of Ab Greven as commercial manager will enable increased support to our customers and partners."

Ab Greven joins Nutriad from his previous position as business manager EMEA with Balchem. With over 15 years' business development experience gained in key account management, commercial and technical support he has an excellent understanding of the animal feed additive sector relating to both mono-gastric and ruminant production and feeding. More information: <http://www.nutriad.com>

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Quorum Sensing as a tool for selecting feed additive ingredients

Nutriad has demonstrated the use of quorum sensing (QS) as a tool in the development of new feed additives for livestock and aquaculture applications.

QS is a form of bacterial communication that is critical to bacterial virulence. By starting up a dedicated research program in 2011 and investigating the ability of several highly bioactive compounds to inhibit QS, Nutriad was able to select a combination of components that, in *in vivo* models, had a positive effect on the viability of microbially-challenged simple model organisms at sub-MIC concentrations. Furthermore, these prototype additives were shown to be efficacious in improving zootechnical performance of production animals under field conditions.

Nutriad CEO Erik Visser said, "Gut health is one of several factors important to obtaining optimum efficiency and profitability in livestock and aquaculture production. We see increasing evidence of the central role played by gut microbiota in animal health and disease. Our technical staff therefore works closely together with leading universities around the world to further improve our feed additives portfolio aimed at supporting gut health."

Dr Tim Goossens, Nutriad added, "When selecting ingredients that affect gut bacteria, such as botanical components, many feed additive producers often rely on *in vitro* experiments that demonstrate their bacteriostatic effect. However, the active ingredients of these botanicals will end up in the digestive tract of animals at concentrations far below the minimal concentration needed to inhibit growth of (pathogenic) bacteria. A more reliable approach might be to select feed additive ingredients based on the effects botanical (and other) components can have at much lower concentrations that are more likely to be relevant to gut health improvement. An example of a test with which sub-MIC effects of bioactive components can be explored is quorum sensing."

QS is a bacterial signaling process that is critical for several biochemical responses, including the production of several virulence factors. Molecules that inhibit QS have the potential to be used to fight pathogens by decreasing their virulence rather than killing them directly. Reducing QS in the gastro-intestinal tract is an interesting approach to control gut microbial activity and composition.



Erik Visser


The probability that bacteria will build up resistance against these products is low due to the fact that phytochemicals can disrupt distinct QS signal transduction steps, such as production, secretion and uptake of signaling molecules, binding to the specific receptors, modification of signal transducing proteins and activation of DNA by transcription factors. This

reduces the chance of a single mutation rendering the bacteria resistant. The selective pressure for molecules that only suppress bacterial functions (rather than kill the organism) is much lower as it does not affect bacterial growth and viability.

Using QS, Nutriad has been able to select (from a list of botanicals with known beneficial effects on animal performance) a combination of components that almost completely abolished QS signaling *in vitro* at very low concentrations. These mixtures also had a positive effect at sub-MIC concentrations on the viability of microbially challenged organisms in two *in vivo* models, *Vibrio* and *C. elegans*.

In subsequent field trials, these botanical mixtures improved health and performance in poultry and aquaculture species, showing the potential of QS as a tool to select for botanical ingredients. Currently, the importance of QS in animal production is not fully understood. The many pitfalls and possible advantages or disadvantages of inhibiting QS remain to be investigated. However, Nutriad believes that, in order to increase the chance of selecting the highest performing bioactive components *in vivo*, it is vital that the effect these substances exert at low concentrations are explored and QS is a potential promising tool to be considered for such investigations.

Nutriad International delivers products and serviced to over 80 countries through a network of own sales offices and distributors supported by four application laboratories and five manufacturing facilities in 3 continents. More information: www.nutriad.com



NEXT ISSUE

May/June 2015

Issue focus: R&D Genetic Selection

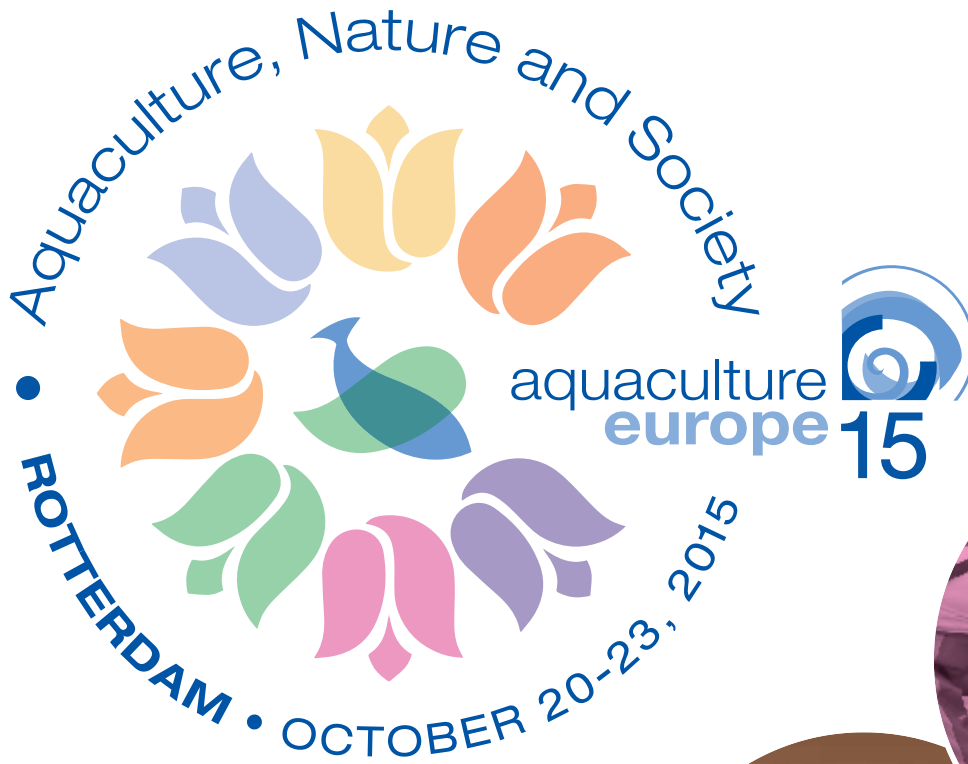
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World Aquaculture 2015

26-30 May, Jeju, Korea

Aquaculture for Healthy People, Planet and Profit

This is the annual international conference & exposition of World Aquaculture Society (WAS), Asian-Pacific Chapter and Korean Chapter, WAS. It will be held at the Jeju Exhibition and Convention Centre, Jeju Island, Korea, one of the leading flatfish production centres in the world. WA 2015 will begin on 26 May with the newly introduced aquaforum, conference on 27 May and the trade show will be from 28 to 30 May. An industrial tour will be held on 31 May 2015.

The theme for World Aquaculture 2015 in Jeju is 'Aquaculture for Healthy People, Planet and Profit' and is very relevant for an area which has a strong aquaculture industry, a population which has a high seafood consumption and is home to a natural UNESCO World Heritage Site. The plenary speakers for the event have been chosen specifically to cover the theme in their presentations.

Dr Kang-sen Mai is professor of aquaculture nutrition, Ocean University of China, Qingdao, China. As a member of the Chinese Academy of Engineering, Mai has a major role in shaping the country's aquaculture policy. Additionally he is vice chairman of the China Society of Fisheries and committee member of International Fish Nutrition and Feeding.

Mai's current research topics are mainly on the nutritional physiology and nutrient quantitative requirements of the representative mariculture species in China, such as turbot, yellow croaker, sea-bass, and groupers. He is particularly interested in the comparative studies on the protein metabolism among carnivorous, omnivorous and herbivorous fish, and the replacement of fishmeal by alternative protein sources in their feeds. Mai has produced more than 200 publications and 30 authorised national invention patents in aquaculture nutrition and feeds. He will also chair the 'Aquaculture in China' session at WA2015.

Shakuntala Haraksingh Thilsted is Senior Nutrition adviser at WorldFish Center in Bangladesh and has a background with the Department of Human Nutrition, University of Copenhagen, Denmark. Her broad area of research and expertise is food-based strategies for improved food and nutrition security in low-income countries. She has carried out work in Bangladesh, Cambodia, West Bengal and Nepal, together with government institutions, universities and NGOs, focusing on the potential of nutrient-dense small fish in combating and preventing vitamin

and mineral deficiencies, in particular, vitamin A, iron, zinc and calcium, especially in women and children. At the WorldFish Center, she has been developing and implementing the CGIAR Mega Program 4: Agriculture for Improved Nutrition and Health.

The final plenary speaker will be from Korea's National Fisheries Research and Development Institute (NFRDI). The NFRDI headquartered in Gijang-eup, Gijang-gun, northern Busan, is a scientific body operated by the South Korean government, Ministry for Food, Agriculture, Forestry and Fisheries. It was first established in 1921 and subsidiary institutes operate in each of the major Korean fisheries/aquaculture areas.

Exhibition

Accompanying the aquaforum and conference will be a 140-booth trade show. At press time, exhibitors comprised companies involve in hatchery feeds and hatchery supplies, feed manufacturing equipment, aqua health and disease diagnosis services, oxygenation, water quality and monitoring, complete feeds, feed ingredients and additives, metal fabrication and filter netting, tilapia broodstock and seed stock. Exhibitors are from Abu Dhabi, Australia, Brazil, Canada, Indonesia, France, Japan, Korea, Norway, Spain, Singapore, Thailand, UK, UAE and USA. Twenty Korean companies, cooperatives and universities will be exhibiting in 40 booths. The participating Korean companies include feeds and feed additive producer, CJ Feeds and Daebong LF, aquaculture suppliers, A-Mi Corporation, Aquaplanet and Aquanet, as well as the Korean Society of Fisheries and Aquatic Science and Jeju Fish Culture Fisheries Cooperatives.

Websites to get updates and information

Registration and information: www.was.org
AquaForum: info@marevent.com (English)
or le.hue2008@gmail.com (Chinese).

Industrial Tour on 31 May (www.was.org/meetings/pdf/WA2015FarmTours.pdf)

Getting To Jeju' blog for delegates travelling to Jeju for the first time some <https://www.was.org/meetings/pdf/WA2015GettingToJeju.pdf>



AquaForum 2015

For the first time, the World Aquaculture Society is organising this AquaForum. This will held on 26 May in the Industry room at the Jeju Exhibition and Convention Centre. It will start with a workshop on "Introduction to aquaponics", organised by Pentair Aquatic Eco-Systems and followed by industry sessions from 14.00hrs.

The aim of this aquaforum is to enhance industry participation and to benefit industry professionals during the WA2015

conference and exhibition. At this first aquaforum, each industry session will focus on a specific, timely and industrially important aquaculture topic in the region, targeted towards industry professionals, farmers, and suppliers. These are on biosecurity, nutrition and aquaculture production systems. Each session will begin with presentations from experts. Panel discussions will follow. There will be simultaneous translations.

This forum is free of charge. However, the participants have to register in advance to reserve seat and obtain an entrance badge. The badge allows entrance to the WA2015 exhibition only.

On May 27, there will be an Industry Day, organised by Global GAP. This session led by Isidor Yu will be from 14.30 to 16.30hrs and is specific for flounder farmers and regional producers. This will be in Korean, Chinese and English. Participation is free.

AquaForum Program	
Date: May 26 Industry Room	
Workshop- Introduction to Aquaponics (organised by Pentair Aquatic Eco-Systems)	
08.30-13.30	<ul style="list-style-type: none"> Aquaponics Overview, Types of systems and components Plant selection; propagation, substrates, and IPM (integrated pest management) Water Quality (aquaponics) Discharge Waste Use Decoupled Aquaponics Systems. Operation and components Urban Organics System UVI system
Welcome and Introduction to AquaForum 2015	
14.00-14.10	Welcome by Michael Schwarz, USA
14.10-14.30	Successes and challenges in aquaculture in Korea, a model for regional technology development-Isidor Yu, Korea

Biosecurity	
14:30-14:50	Assuring health and biosecurity in finfish & shrimp culture systems- Leo Galli, Fish Vet Group, UK
14:50-15:10	An update on the role of biosecurity in controlling disease in marine shrimp culture- Victoria Alday, Spain
15:10-15:40	Panel discussion on "Biosecurity: 'developing a regional aquatic disease initiative (Panel members will be from FishVet, Bayer, Merck, Pharmaq, Novartis and Phibro)
15:40-16:00	Break
Nutrition	
16:00-16:20	Aquaculture feeds and feeding: New technologies to sustainably double of aquaculture production by 2050- Craig Browdy, USA
16:20-16:40	Sustainability of China Aquaculture and Aquafeed Industry- Kang-sen Mai, China
16:40-17:10	Panel Discussion -"The Alternative Ingredients and Future Aquafeeds in 2020" (Panel members from Alltech, Biomar, Skretting, Hinter, NutriAd, Uni-President, INVE, Tyson, Grobest, Cargill, Lesaffre, EWOS, Biomin)
Aquaculture Production Systems	
17:10-17:30	Progress in marine fish and shrimp larviculture with focus on opportunities for Asia- Patrick Sorgeloos, Belgium
17:30-17:50	Current and future trends in regional aquaculture production systems in China- Shuanglin Dong
17:50-18:20	Panel on "Future Production Systems, in Korea and Asia - What to Choose?" (Panel members from Pentair, AKVA and Faivre)

What to look forward to in Aqua Culture Asia Pacific in 2015

Our editorial calendar reflects the new and existing issues in aquaculture in Asia Pacific which we see as most relevant to the industry. We will continue to present trends and update you with technologies to help the aquaculture industry in Asia Pacific move to the next level.

Volume 11 2015				
Number	3 - May/June	4 - July/August	5 - September/October	6 - November/December
Issue focus <i>Recent developments and challenges for the next step</i>	R&D & Genetic Selection	Industrialisation & Aquaculture Insurance	Health Monitoring & Disease Management	Biofloc Technology
Industry Review <i>Trends and outlook, demand & supply</i>	Aqua Feed Production	Catfish	Marine fish	Freshwater Fish/Prawn
Feeds & Processing Technology <i>Technical contributions from feed industry</i>	Extrusion & Processing Technology	Feed Enzymes, Additives & Probiotics	Feed Safety & Hygiene Processing & Environment	Nutrition & Formulation
Production Technology <i>Technical information and ideas</i>	Recirculation Aquaculture Systems	Sustainable & Responsible Aquaculture	Genetics in Fish/Shrimp	Aeration Technology & Waste Removal
Aqua business Feature articles	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc			
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)			
Company/Product news	News from industry including local and regional trade shows			
Deadlines for Technical articles	March 30	June 1	July 27	September 28
Deadlines Advert bookings	April 6	June 8	August 3	October 5
Show Issue & Distribution at these events as well as local and regional meetings	*World Aquaculture 2015 May 26-30 Jeju, Korea	The Aquaculture RoundTable Series (TARS 2015) Aqua Feeds 2.0; From Farm to Plate August 19-20 Hanoi, Vietnam Vietfish 2015 August 24-26 Ho Chi Minh City, Vietnam	20th China Seafood & Fisheries Exposition 2015 November 4-6 Qingdao, China 10th Philshrimp Congress General Santos (TBA)	
*Show preview				



6th AQUATECH

May 28-29 2015, Summit Ridge Hotel, Tagaytay City, Philippines

The 6th AQUATECH Aquaculture Expo & Convention Philippines will be held on May 28-29, 2015 at Summit Ridge Hotel, Tagaytay City, Philippines. It will be organised by Events Quality & Interactive Promotions (EQUIP), Inc. in partnership with B-MEG Aquatic Nutrition and in cooperation with Asian Fisheries Development Center-Aquaculture Department (SEAFDEC-AQD). Aquatech aims to educate and unite the Philippine aquaculture community towards a progressive and sustainable industry.

The 5th Aquatech held from May 29-31, 2014 at the Leisure Coast Resort, Dagupan City, Philippines was an overwhelming success. It was participated by leading aquaculture industry players, local and

international organisations, government agencies as well as fish farm communities. The keynote address was by Nestor Domenden, director of BFAR Region 1 who looked at the current status of the aquaculture industry in the Philippines and the region. Katherine Hawes, Aquarius Lawyers in Australia discussed current and future free trade agreements within the fisheries and aquaculture industry in the Philippines. There was also a presentation by Naderev Saño, Climate Change Commission whilst Phillip Ong, Santeh Feeds Corp presented on the need for higher production and new markets in aquaculture. Fish nutrition and feed ingredients was covered by several presentations.

The event also include a free seminar attended by local farmers of Dagupan City, Pangasinan. Some of the topics presented by BFAR region 1 officials at this session were on seaweed production and processing and on proper collection and management of seaweed. There were presentations on the culture and management of high value finfishes in mono and polyculture in ponds and cages. Daniel Cabrera, Santeh Feeds Corp. discussed ways to boost profits in bangus culture He also discussed "efficiency - last frontier of aquaculture management quest for profit" at the main session.

More information: mgv.equipinc@yahoo.com (Mary Ann Venturina)

2015

Details on the events below are available online at <http://www.aquaasiapac.com/news.php>

To have your event included in this section, email details to zuridah@aquaasiapac.com

March 11-13

VIV Asia 2014/Aquatic Asia Bangkok, Thailand
Web: www.vivasia.nl

March 16-18

Aqua Middle East-AquaME Dubai, UAE
Web: www.aqua-middleeast.com
Email: aquame@informa.com

March 17-19

International Conference on Marine Science & Aquaculture (ICOMSA 2015) Kota Kinabalu, Malaysia
Email: icomsa@ums.edu.my
Web: www.ums.edu.my/ipmb/icomsa

March 25-27

Aquafeed Extrusion Technology Short Course Arboretvn, Norway
Web: www.foodstream.com.au/events/event/aquafeed-extrusion-technology-norway/

April 2-4

Tilapia 2015 Kuala Lumpur, Malaysia
Email: info@infotfish.org
Web: www.infotfish.org

April 5-6

Middle East Aquaculture Forum Dubai, UAE
Email: info@meaf.ae
Web: www.meaf.ae

April 21-23

Seafood Expo Global Brussels, Belgium
Web: www.seafoodexpo.com/global

April 22-24

2nd International Symposium on Aquaculture and Fisheries Education (ISAFE2) Shanghai, China
Email: l_li@shou.edu.cn; ttzhou@shou.edu.cn
Web: <http://isafe2.shou.edu.cn>

May 20-24

World of Seafood Bangkok, Thailand
Web: www.worldofseafood.com

May 25-27

Asia-Pacific Aquaculture Expo 2015 (APAEXPO 2015) Xiamen City, China
Email: apaexpo@chgje.com (Ping Yang, Dr Lisa Pang)
Web: www.apaexpo.com.cn

May 26-30

World Aquaculture 2015 Jeju, Korea
Email: mario@marevent.com (Mario Stael for trade show)
Web: www.was.org

May 26

World Aquaculture Aquaforum 2015 Jeju, Korea
Email: mario@marevent.com
Web: www.was.org

May 28-29

6th Aquatech: Aquaculture Expo & Convention Philippines Tagaytay City
Email: mgv.equipinc@yahoo.com (Mary Ann Venturina)

May 28-31

AQUARAMA 2015 Singapore
Web: www.aquarama.com.sg

June 9

8th Aquafeed Horizons Cologne, Germany
Web: www.feedconferences.com

June 9 - 11

FIAAP VICTAM GRAPAS International 2015 Cologne, Germany
Email: patriciaheimgartner@victam.com
Web: www.victam.com

July 20-22

International Conference on Aquaculture & Fisheries Brisbane, Australia
Email: aquaculture@conferenceseries.net
Web: www.aquaculture-fisheries.conferenceseries.com

August 19-20

The Aquaculture RoundTable Series (TARS 2015) Hanoi, Vietnam
Email: conference@tarsaquaculture.com
Web: www.tarsaquaculture.com

August 24-26

Vietfish 2015 Ho Chi Minh City, Vietnam
Email: quocthanh@vasep.com.vn; tienloc@vasep.com.vn
Web: www.vietfish.com.vn



World Aquaculture 2015

Aquaculture for Healthy People, Planet and Profit



www.was.org

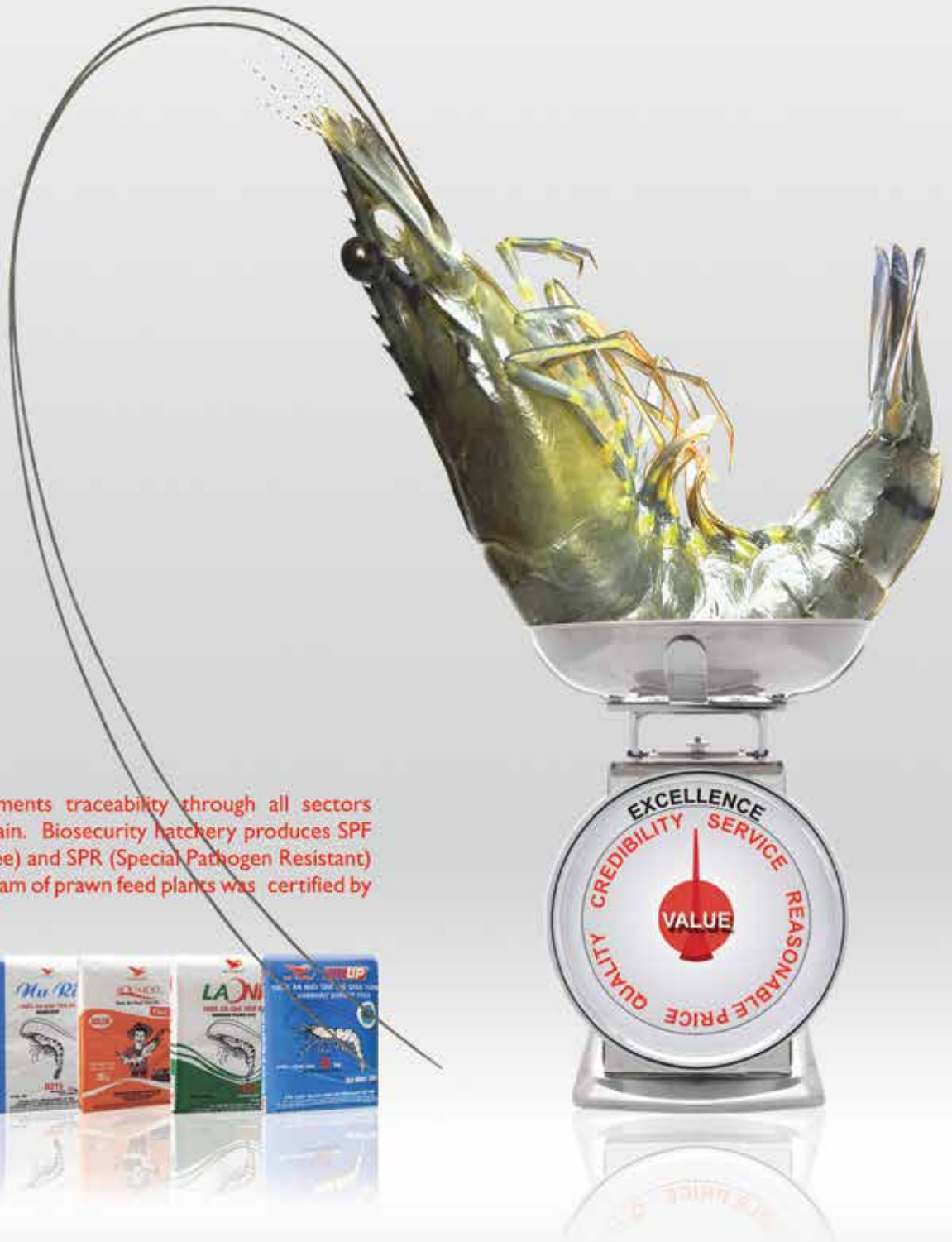
WORLD
AQUACULTURE
Society

WA2015 - Jeju Island
Korea

May 26-30, 2015



CREATES THE VALUE OF PRAWN



Uni-President implements traceability through all sectors along with supply chain. Biosecurity hatchery produces SPF (Special Pathogen Free) and SPR (Special Pathogen Resistant) larvae. Quality program of prawn feed plants was certified by ISO 22000 & HACCP.



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