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A Nursery Business in India

Resistance to White Spot in Black Tiger Shrimp

Challenges in Marine Fish Culture in Asia

A Philippine Mariculture Park Experience

Improving Health Management

MCI (P) 011/10/2017 PPS1699/08/2013(022974)

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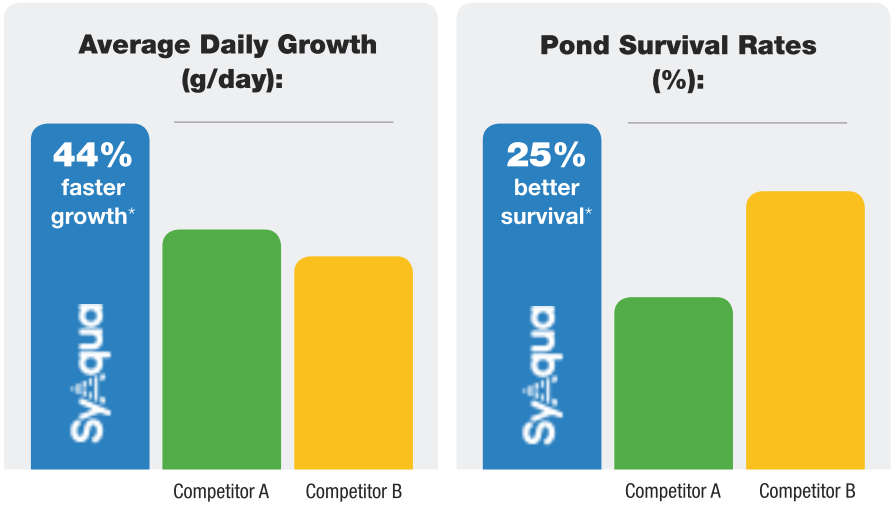

* Based on actual data from 2016 from 606 ponds in Southeast Asia.

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Photo credit: Kemily Huang. p21

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Zuridah Merican

Making aquaculture sexy for the next generation

The first wave of commercial shrimp aquaculture began with Dr IC Liao in Taiwan, *the father of monodon* and now, more than 40 years later, we need to discuss succession planning. How can we make aquaculture relevant for the next generation to take over? In the 1970s and 1980s, it was a difficult start-up for the first wave of aqua entrepreneurs with their trials and tribulations, and without the internet. They depended solely on hard work and on expert advice. However, as the industry was young and new, the process was a learning curve for both experts and farmers. The knowledge environment was totally different then; experts while imparting knowledge used the 80:20 rule; 80% advice and 20% secrets. Unfortunately, until today, we have maintained aquaculture as more of an 'art than science' which limits information exchange and solutions.

Some 7 years ago I visited a farm in Bali and met a young girl taking over her father's farm. That was admirable. Lois, thrown into the deep end of the pond (pun intended) was brave and lucky. The internet was available and it helped her to seek solutions to her farming problems and communicate the same to her staff. At that time, farmers in Indonesia were very active with their Blackberries. They created chat groups and shared information. Today, we do the same with WhatsApp. Unfortunately, running a shrimp farm still meant on-site operations and with all the disease challenges, the task requires 24/7 attention.

Fast forward 2018. Aquaculture and aquafeed production continue to see the fastest growth in the animal production sector. In fish farming, we are witnessing the second phase of growth with industrial farms, and in shrimp farming, the third phase from monodon to vannamei shrimp and for some, back to monodon as we face disease challenges with vannamei shrimp farming. However, the old ways of empirical solutions no longer can be applied lock, stock and barrel for these sectors as the farming and business environment change. Unlike aquafeed production, where there is a control room to operate the different activities, at the farm, we have to manage each unit of pond or cage individually.

Who, from the next generation do we want to attract into this industry? I recently met a young man working on a fish farm because he has a passion for fish farming and loves the outdoor life. He scoots to work; takes a boat across to the farm, and scoots home again. There is work-life balance, and this is what the young are seeking.

Today, a general concern is how do we encourage the young to join the aquaculture industry. The concern is not only to get young farmers but also technologists to research and support the industry. How do the young see this industry; a risky business with no future? Thus, our role is to change this perception. This new generation is a technology savvy group who rely heavily on their mobile phones for knowledge, monitoring and information exchange, as well as a communication channel through the various social media platforms and Internet of things (IoT) devices. As much as we encourage innovations on the farm, we also need the industry to create a market for digital innovations. They need access to knowledge that is readily available.

There seems to be a shift in the younger generation, in terms of opting for a less stressful lifestyle. Some are leaving the financial sector and moving into wine and food production which are considered 'sexier' according to features in the mainstream media, like the BBC and New York Times. However, these sectors are just as challenging as aquaculture.

The message is clear. We need to capture the attention of this generation. We need more young people to be passionate and involved in the aquaculture supply chain, from genetics to disease diagnostics, to seafood marketing. Last December, the National Cheng Kung University, Taiwan conducted a novel event, with biotechnologists and industry participation to show the young how 'exciting and interesting' aquaculture could be. After all, the blue revolution is the potential supply of food for future generations and we need young scientists to tell us how we can extract and exploit its potential. We need to 'make aquaculture sexy.'

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Indian farmed shrimp soars to new heights

The coming of age for the Indian shrimp farming industry, now recognised as a leading producer among global players.

AquaIndia 2018, the biennial 2-day conference organised by the Society of Aquaculture Professionals or SAP ended on a high note on February 3. Just like the farmed shrimp industry in India, for SAP, this 9th in the series, was a coming of age with an international repertoire of invited speakers focusing on "Taking Indian Aquaculture to Greater Heights." Besides Aqua India, SAP regularly organises seminars to bring industry up to date on developments and address challenges. This edition, held in Chennai was very well supported with 540 participants, 180 of them from outside India. Several local and global industry players sponsored the event.

In 2017, farmed shrimp production reached 601,000 tonnes which is a new milestone for the industry in India. It is now poised to increase production to 669,000 tonnes in 2018. While there was elation that India is on its way to be the largest producer of farmed shrimp, there were also cautionary statements. In his welcome address, SAP President, **S. Chandrasekar** said, "We have maintained consistent and stable growth of the hatchery, farming and processing sectors. The International Monetary Fund (IMF) said that by 2019, India will have the world's fastest growing economy at 7.8%. Our farmed shrimp production can parallel this. We need to retain the title as the top farmed shrimp producer but at the same time must not compromise on quality.

"We have reach this stage because we put in systems for strict use of specific pathogen free (SPF) vannamei shrimp broodstock. Adoption of improved farming and hatchery technologies helped the industry sustain its success over the years.

"Food safety and traceability are important issues. It is imperative that we revisit responsible farming practices to make our industry more sustainable and successful. For this, we need the commitment of stakeholders at all levels. SAP has also conducted a workshop to build the road map for making Indian shrimp aquaculture zero tolerant to antibiotics."

The industry today

The latest figures showed that production in 2017 comprised 563,000 tonnes of vannamei shrimp and only 38,000 tonnes of monodon shrimp. Almost 70% of vannamei shrimp production

"We need to retain the title as the top farmed shrimp producer but at the same time must not compromise on quality."

came from Andhra Pradesh while 55% of monodon shrimp production came from West Bengal. Slowly, farms in West Bengal are moving into semi-intensive farming of vannamei shrimp. Enterprising Andhra Pradesh farmers are expanding north into the newer Odisha coastal belt. In his review on the industry, **Balasubramaniam V**, General Secretary of Prawn Farmers Federation of India, said that the production is growing because of the expansion in farming areas but productivity is reducing. "We have 153,000 ha under scientific farming, using aeration, probiotics etc. and 40-50,000 ha of traditional farms. Odisha's production has overtaken that of Tamil Nadu. We have a potential area of 11,900 ha for shrimp farming. The average stocking density is 30 post larvae (PL)/m^2, producing 18g shrimp at a final survival of 55-60%. The average cost of production is USD4.42/kg for shrimp size 55-50/kg.

"Overall, we are doing well and profitable because of the current high prices. Prices were good in 2017 but in January, this year, prices have dropped. This is a serious concern. Also, in the last 2 years, it takes a longer time to produce 18-22g shrimp, from 110 to 150 days, because of diseases," said Balasubramaniam, who has been farming shrimp since 1994 in 20 ha of ponds in Tamil Nadu. "Our need of the hour is to focus on productivity for better margins, profitability and sustainability. This is mainly on disease control to improve survival rates and growth. We need to push for a comprehensive quality control program to proactively address food safety issues and traceability of farmed shrimp."

Concerns and disparity in industry

At the panel discussions and sidelines of the conference, industry stakeholders raised some concerns. **Kumaresan**, Sheng Long Bio Tech India said that the success rate in 2017 was 70% for the first crop, and down to 50% for the second, which affects profitability. Then in June to July, shrimp prices dropped by INR 20-30/kg. On

On the left, B Suryakumar, Hitide Seafarms, Tamil Nadu with SAP committee members, S. Muthukaruppan (second left) and R.Srinivasan (right) with Allada Narayaswamy, Synergy Biotechnologies (second right).

Balasubramaniam V (right) and Surendran V

Ravikumar Yellanki, Vaisakhi Bio-Marine (P) Ltd (centre) with Sathi Subbha Reddy, Sapthagiri Hatcheries, Kakinada (right) and his team. On second right is Ravinder Reddy, Inve Aquaculture, India.

Ramraj (left) with Grace Chu-Fang Lo and Jeff Jie-Cheng Chuang, Sheng Long Bio-Tech International, Vietnam (right).

feed conversion ratios (FCRs), although some were impressed by good FCRs at an average of 1.6 and best values at 1.2-1.3, others felt that the calculated FCR of 2.5 from feed usage of 1.3 million tonnes was too high. Overall, harvested shrimp were smaller than the sizes India is well known for producing (size 30/kg).

In his introduction to the session on diseases, **Ramraj D**, Padmanabha Labs/HiBreeds Shrimp Hatchery commented, "We have had an impressive growth in terms of production, at 10-15% per year but looking at our average productivity of 2.4 tonnes/ha/crop, we have a long way to go. We derived this figure from 70% of our production areas of 150,000 ha which produce two crops/year. This is not good but of course we have high performers too with a productivity of 10 tonnes/ha/crop."

PL efficiency

In 2017, PL efficiency (tonnes/million post larvae), was 10.4 tonnes/million PL based on data presented by Ravikumar Yellanki, Vaisakhi Bio-Marine (P) Ltd. Relative to countries faced with disease outbreaks, this is a good figure. However, **Surendran V**, Vaisakhi Bio-Marine (P) Ltd, said,"Historical data showed that in 2013, the PL efficiency was 21.4 tonnes/million PL with a production of 47,000 tonnes using only 2.2 billion post larvae. This means that our productivity was halved."

Thailand had a PL efficiency of 11 tonnes/million PL which **Robins McIntosh**, Charoen Pokphand, Thailand attributed to its focus on production efficiency since 2013. It moved from a PL efficiency of 4 tonnes/million PL in 2013. McIntosh reminded, "Hatcheries must maintain discipline and there should be only one policy, a zero tolerance for poor quality post larvae. If we use shrimp with pathogens, we are not just introducing pathogens but are actually spreading them."

Market led production

As India emerges as the leading supplier of shrimp to world markets, the industry needs to know what to do and what it should focus on. **S. Santhana Krishnan**, Maritech and SAP founder president said, "Our business model must change; we need to look at the markets and the expectations of buyers . This involves all players in the supply chain right from hatchery to farm to feed mill to input suppliers, processors etc.

"We have experienced a good year with stable prices. However, with good prices in 2017 and availability of post larvae, some farmers continue to restock ponds without any pond preparation. Unlike in other countries where farms program harvest sizes, here in India, we actually allow diseases to determine our harvest sizes."

The data presented showed the sizes harvested and marketed for the three crop seasons; March-May (less than 14g); June-September (more than 20g) and October-December (10g and 25g). "Buyers want consistency in the supply of a certain size. In terms of markets, the US prefers medium size, 17-20g. Europe needs small shrimp but due to antibiotic issues, market is a bit silent. Based on the harvest patterns in 2016 and 2017 and availability of mid-and small size shrimp, the market thinks that India has now become a producer of small shrimp."

The panel discussing emerging trends and requirements in shrimp genetics, from left: Eduardo Figueras, SeaProducts Development, USA; Surendran V; Dr Morten Rye, Akvaforsk Genetics Centre, Norway; Dr Robbert Blonk, Hendricks Genetics Aquaculture, the Netherlands; and Dr Harris Wright, SIS, Hawaii.

Digital software for shrimp farms

Cargill's launched iQShrimp, a predictive software which uses machine learning and sensors to give shrimp farmers real-time visibility into their farm operations. It captures data from shrimp ponds through mobile devices, sensors and automated feeders to record data on shrimp size, water quality, feeding patterns, and health and weather conditions. The system then combines production and environmental information into a "live operations dashboard" to provide insights and recommendations, such as feeding management strategies and optimal harvest dates.

iQShrimp is a first-generation offering from iQuatic™, Cargill's digital platform for aquaculture. Neil Wendover, Cargill's digital insights product line director for aquaculture said, "By working directly with shrimp farmers, we can deliver insights to inform decisions that directly impact the growth and economics of their operations." Today, the software is available for producers in Mexico, Central America, Ecuador, New Caledonia, Southeast Asia and India. It will expand to other countries in the coming months.

An aquaculture startup accelerator

Hatch, an aquaculture startup accelerator launched by Carsten Krome of Alimentos Ventures in Norway will help fill some of the gaps in the aquaculture startup ecosystem. Krome, founder of early-stage investor and consultancy Alimentos, noted that unlike industries such as IT, where entrepreneurs go to business schools and know how to talk to investors, in aquaculture a lot of good ideas were badly presented. There is a need for aquaculture companies to become investment ready. Hatch, together with Netherlands based dedicated aquaculture VC, Aqua-Spark and an investor in Hatch, will have a symbiotic partnership. Aqua-Spark can direct smart, early-phase companies to Hatch. "As Hatch actively finds and grows early-stage startups, Aqua-Spark can absorb those that have progressed beyond accelerator. It is a holistic win for the aquaculture industry as a whole," said Krome. Hatch will launch its first cohort of eight startups this spring (www. agfundernews.com/ www.hatch.blue)

Black tiger shrimp hatchery approved

Australia's Seafarms Group Ltd has planning approval for its shrimp hatchery at Gunn Point in the Northern Territory, according to www.proactiveinvestors.com.au. This hatchery will supply selectively bred, specific pathogen-free, juvenile shrimp for Project Sea Dragon, Seafarms' grow out facility at Legune Station. This is envisaged to be a large-scale, integrated, land-based shrimp project. Seafarms is already Australia's largest producer of farmed shrimp under the Crystal Bay brand (producing banana and monodon shrimp). At full-scale, the project has the potential to create around 1,500 jobs in northern Australia, with annual estimated revenues of more than USD 2.3 billion.

In 2018, based on the industry index, Santhana expects a price decrease until March as there will not be any improvements in the export market. Steady prices are expected until June and then a drop during June-September, as Indian shrimp floods the market. With supplies down, there could be a price increase in September to December.

Broodstock for the hatchery sector

India imported more than 200,000 pieces of SPF broodstock in 2017, valued at USD 17.5 million. In 2018, imports will increase by at least 10% to produce 69 billion post larvae. There is room to grow as the installed capacity for post larvae production is more than 100 billion. "There are pitfalls for a hatchery industry relying entirely on imported broodstocks," said Surendran. Broodstock prices are rising. Post larvae prices depend on the source, supply and demand, ranging from 22 paise (USD3,400/million PL) to 55 paise (USD8,000/million PL). "We never had a plan B. When we were farming the monodon shrimp and failed, we moved to vannamei shrimp. The moment the broodstock leaves the breeding centre, it loses its SPF status. This dependence on the external source is a TINA or 'there is no alternative' situation. With this comes business and biological risks, supply and logistics issues etc."

Alternatives for industry

"Do we need selective breeding of indigenous shrimp species in India?" asked Surendran. "The gestation period may take years, before SPF and better-growing stock, possibly with disease tolerance, is available. But it will help to improve productivity of farms in the traditional shrimp culture belts of West Bengal,

From left, Kumaresan, G Ramesh, Wenger; Professor A. Uma and Dr Jemila, Tamil Nadu University; and Gnanamani Thangairulappan, Nutriad India.

Odisha, Kerala and Karnataka. It will also eliminate a total dependence on the imports of broodstock. Some recent trials at the CIBA (Central Institute for Brackishwater Aquaculture) showed that running mortality syndrome (RMS) is not common in *P. indicus*. The latter is less susceptible to white faeces disease (WFD) while *P. monodon* is less susceptible to AHPND. In the early 1990s, we farmed *P.indicus* in India to produce 6-12 tonnes/ ha/ crop. The domestication program on *P. indicus* in Saudi Arabia reached the sixth generation in the mid 2000s. Post larvae from domesticated stock had lower average daily growth (ADG) in the farm compared to the performance of the wild stocks within India but productivity ranged from 6-12 tonnes/ha and FCR was 1.6:1."

(Related article: Route to the future, p18)

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A recirculation aquaculture system nursery business in Andhra Pradesh

View of four units of the nursery with walls made of shading material .Photo credit. Anil Ghanekar

Zero water exchange, biofloc and innovations in aeration are the essentials for this nursery business in India.

There are two ways to nurse post larvae into strong juveniles: an extension of the hatchery with a biosecure nursery or an open nursery within the farm as a prelude to grow-out. The latter according to Robins McIntosh, Chareon Pokphand, Thailand at the recent AquaIndia 2018, could be a hot bed for diseases with post larvae, especially when stocked at extremely high density.

In Andhra Pradesh, Anil Ghanekar, Systems Designer at Ecosecure Systems, India has set up a stand-alone closed system nursery away from both the hatchery and grow-out farms. Anil is very familiar with setting up such nursery systems, as a means to circumvent increasing biosecurity risks, adverse weather conditions and also to maximise farm output.

"I believe that nurseries within the pond environment is a biosecurity hazard. Disease will spread from the nursery to the ponds and vice versa. Today, shrimp farming is all about managing diseases. I learnt this 4 years ago, when I constructed a nursery in Nellore surrounded by shrimp ponds. Disease spread into our nursery. Some large farmers have also constructed full water exchange nursery systems. With low survival rates they have been very disappointed with operating a nursery phase.

"Thus, to avoid the spread of diseases, this should be the way. A zero-exchange nursery away from either the hatchery or ponds means that there will not be any introduction of disease to the larger pond environment. If there is an outbreak of disease in the nursery, we can easily destroy a batch in the tank. But if this happens in the nursery within a farm, the outbreak can quickly spread to the grow-out ponds. Imagine the economic loss and the subsequent massive clean out of the total pond system."

Anil (centre right) with his team at a N2 nursery room.

Anil also advocates the use of biofloc technology in shrimp nurseries to monopolise on heterotrophic bacteria for efficiency and reduce operational costs (AAP, May/June 2009; May/June 2016). Below is a description of a nursery business developed by Anil for Vijaya Durga Industries, Krishna District, Andhra Pradesh. Started in 2017, the nursery has already produced 15 million juveniles in the pilot cycle and has a monthly capacity of about 12 to 15 million juveniles. This nursery system comprises four units on a 800 m^2 land near Kaikaluru.

Biosecurity and pathogen monitoring

A walk-through the nursery shows the following features to ensure biosecurity. When buyers enter the nursery, they are guided through an area where they are shown the facilities and juveniles through a small window. They do not enter any culture area. When delivery of post larvae is made, it is through an opening in the fence on the opposite side of each nursery unit. Neither the truck nor the delivery personnel are in contact with the nursery nor the workers. "Extreme biosecurity is essential, as we can have 12 different batches at the same time and can expect all kinds of diseases," said Anil.

Each nursery unit has three tanks: a small 35-tonne tank and on either side, two large 150-tonne tanks. For biosecurity reasons, tanks are housed in separate rooms. Tanks are lined with 1.0mm thick high density polyethylene (HDPE) liners with a central drain. Post larvae (PL 8-9) are stocked into the smaller tank and cultured for 7 days during phase N1. Transfer for phase N2 rearing is done by pumping 80% of the water from N1 to N2 and then harvesting and counting the PL 15-18 and stocking them into a N2 tank. This shifting is done alternatively to one of the two tanks on a weekly basis. PL 15-18 are reared for a further 14 days and are ready for sale at 100–250mg, depending on the season.

"There is the testing for pathogens at the end of the N1 phase, before transfer to the larger N2 tanks. In this way, we can detect if this is a bad batch. We get post larvae from hatcheries which comply to the standard post larvae quality tests set by industry.

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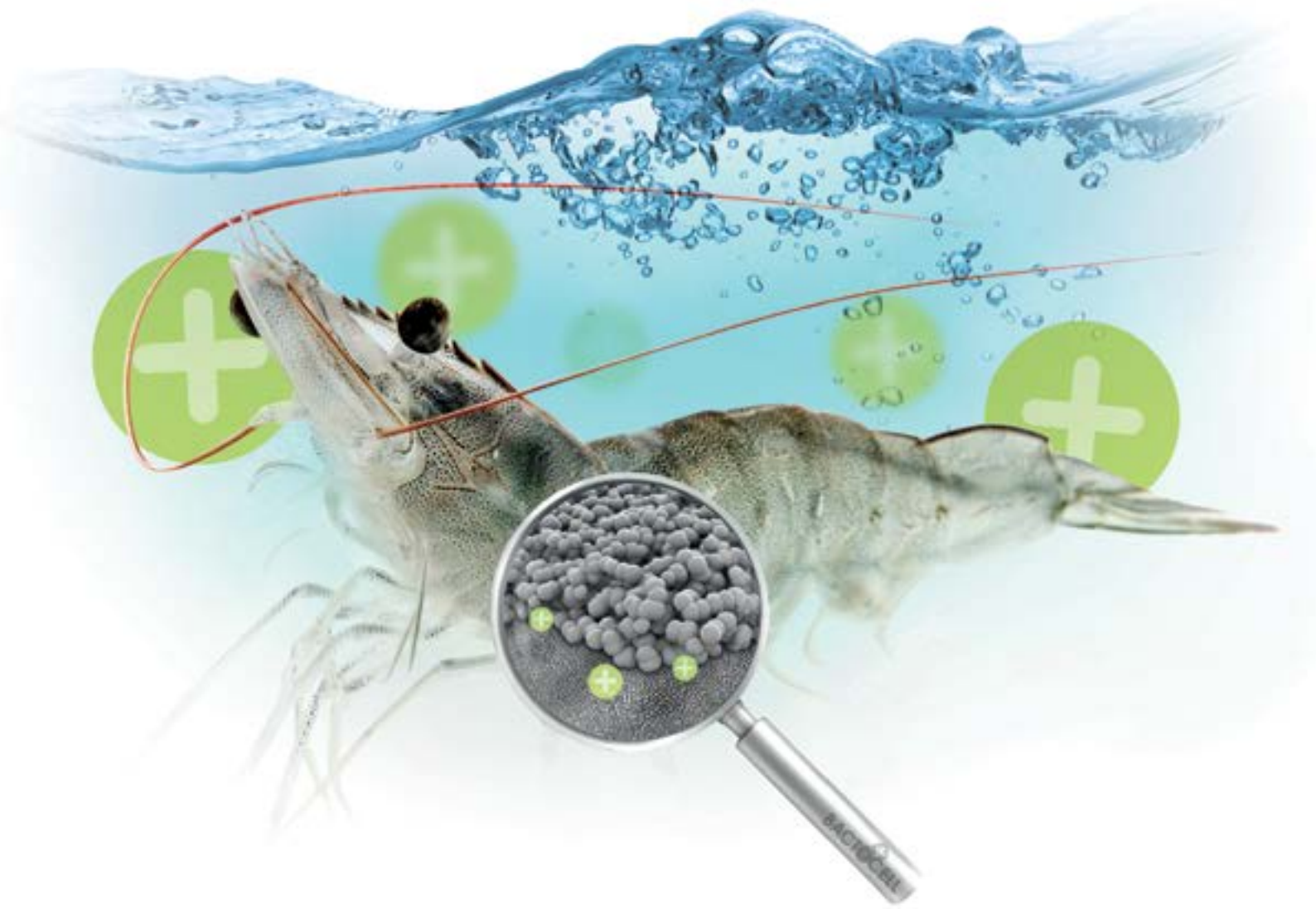

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Anil explaining his latest venturi aeration innovation. Used in the larger N2 phase tanks, three sets of these four-tube venturi system pushes water at high speeds creating fine bubbles (right). This is an improvement over an earlier model used in the smaller N1 phase tanks (left, in blue). Next to this is the square device positioned over the discharge drain with the aero tubes to provide aeration from the bottom of the tank. Both these aeration devices are weighed down at the bottom of tanks.

We counter check by sending the post larvae to 2-3 independent laboratories. The juveniles are tested by the farmer before transferring to the farm, so there is a 3-stage testing to protect the farm from diseases through the animals. We are in the middle of setting up our own laboratory.

"We are in Andhra Pradesh, which actually has a mild winter, compared to other parts of India. The winter weather can be a low of 17°C and a high of 28°C. In summer, temperatures are extremely high and can reach 40°C. The challenge is to actually keep the tank water temperatures steady at 29 to 31°C. There is a higher risk of vibriosis with water temperatures above 34°C.

"The walls of the facility are made from shading materials used in gardens to shade plants; they allow for some ventilation which is essential for the summer months. Conditions are fine during the day in the summer months but the N1 tanks require heating during the short winter months," said Anil, during the visit in early February.

Keeping juveniles small

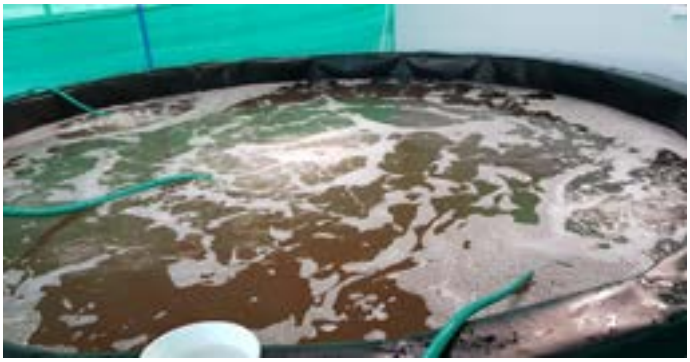
Post larvae sizes relative to weight vary; in winter PL 8-9 range from 1.6 to 2.0mg but in summer, it is 3.0 to 5.0mg. "Post larvae weight increases by about four times during N1 and can easily achieve growth from 5.0mg to 20-30 mg in phase N1. After 21-25 days, we have 100mg juveniles in winter and 250mg juveniles in summer. Actually, what we are doing is stunting the post larvae by stocking high at 1.25 million post larvae in the 35-tonne tank (>35,000/m^3). When shrimp are transferred to the large 150-tonne tanks, the density is reduced to about 6,000 to 8,000/m^3."

There are two reasons for this. "Stunted juveniles are easier to transport due to lower biomass. The other reason is to avoid the injury from a sharp rostrum. A hard and sharp rostrum of 500mg or larger shrimp damages other shrimp during harvest. Affected shrimp will die within 10 days in the ponds. Thus, I restrict the harvest size to 250mg by stunting the post larvae," added Anil.

The juveniles from this pilot scale project have been transported to farms as far away as in Nellore, a journey of 6 hours. Anil uses 1-tonne HDPE tanks to hold the juveniles. Each lorry can hold 10 tanks. The water is continuously aerated with oxygen throughout the journey and water temperature is lowered to reduce shrimp activity. The formula is 15kg/tank of biomass for a 6-hour journey and for longer journeys, such as to Bhimavaram, the biomass is 7kg/tank.

Once in the ponds, the stunted juveniles show compensatory growth and grow to the same size as directly stocked post larvae of the same age. Anil added that farmers have learnt to accept the nursery-reared juveniles. The juveniles are sold at double the cost of post larvae, which ranges from a low of 75 paise/PL to as high as 120 paise/PL, (USD11,000 to 18,000/million PL) depending on the season, demand and supply. "I explained the actual cost savings to farmers and gradually they are leaning towards this insurance of almost 100% survival in the first month of stocking. They will save on the cost of blind feeding if they were to stock small post larvae, usually PL 8-9. They save on the cost of staff required to feed shrimp. The win-win situation is also the 200% increase in productivity, larger size and higher survival rate."

Farmers stocking large juveniles harvest size 50/kg shrimp after 60 days in the ponds. "Farms around Vijayawada can get four crops per year instead of three, if we calculate a 60-day pond culture and 30 days for pond preparation after each cycle. Of course, if they continuously stock and harvest, they can get more crops, but this is not advisable."



Biofloc, appears as a brown substance in the tank water and is a bloom of heterotrophic bacteria floc.

Juveniles in a N2 phase tank.

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A nursery staff demonstrates how the sludge is removed from the large 150-tonne tank. Sludge removal is carried out every 12 hours

A biosecurity feature, staff receives post larvae deliveries through this opening in the fence.

Biofloc and innovations in aeration

Anil discussed the evolution of biofloc principles in shrimp farming. He has successfully used biofloc technology in recirculation aquaculture systems since 2004; biofloc is also the backbone of this nursery. "Biofloc, appears as a brown substance in the tank water and is a bloom of heterotrophic bacteria floc that grows in the water with a carbon source. This is a source of food for the shrimp. Biofloc can be tough to set up but once one learns to manage the technicalities and learn to monitor the floc, it is a workable technology."

There are benefits to using this technology. "In 2016 CIBA, India's Central Institute of Brackishwater Aquaculture did a study where they compared the efficacy of biofloc against early vibriosis mortality in shrimp. With biofloc, shrimp survived 75% versus 35% survival in non biofloc waters, when challenged with the EMS strain of *Vibrio parahaemolyticus*," said Anil.

This RAS uses saline ground water (5ppt) and brine is added to increase the salinity to 10ppt for the rearing process. "Water treatment is biological followed by ozonation. The preference is to use oxygen for the ozonation process rather than an oxygen generating equipment. The latter is expensive and has to be continuously maintained. After all, oxygen tanks are already required for rearing and packing processes. Cost is also manageable."

After treatment with ozone, inoculum is added into the 35-tonne tank to start the biofloc, 2 days prior to stocking of post larvae. The biofloc concentration is maintained at a range of 0.5-2mL/L. Carbon sources include fermented rice bran, sugar, grain powder and molasses. During culture, feed (starter pellets, Growel Feeds) is introduced every 3 hours. Ammonia is monitored twice a day. The average body weight is measured daily. Sludge is removed every 12 hours. The nursery has a team of 10 to carry out all these activities, comprising mainly a technician with 3 assistants and 2-3 feed boys. The nursery works with 10ppt salinity in the N1 phase. Depending on demand, during the N2 phase, the production salinity can be lowered to 6-7ppt.

In the culture process, all of the water and shrimp from phase N1 is transferred into the two tanks in the phase N2. Additional water is added. When the effluent treatment system (ETS) is completed, at the end of phase N2, water will be discharged into two treatment ponds, first into a pond containing pangasius and then into a pond containing tilapia. The overflow from this second pond will be filtered (physical and biological) and then passed through ozone treatment and then returned back to the phase N1 tanks for reuse, thus making this a zero discharge nursery system, with both biofloc and RAS.

Aeration is critical for any biofloc systems and progressively, Anil has innovated the aeration devices in this pilot scale nursery. His expertise is with venturi systems and he has continued to focus, move and aerate water using this principle. At this nursery, Anil has a new innovation for a venturi aeration system. This has four chambers and pushes water with very fine bubbles across the larger tanks. "These systems work on very small power such as half HP and hence we can have multiple points to move water in the tank at a much lesser overall power consumption," said Anil.

Additionally, a device holding aerotubes located near the central drain blows fine bubbles upwards lifting up settled floc particles back into circulation in the water. "Aeration is all based on horsepower. Each venturi system is 0.5HP and in the large tanks, the total horsepower is 1.5HP. Aerotubes blow water up from the bottom and fine stainless steel mesh cover will prevent shrimp from entering the drainage system. In all, these systems keep the dissolved oxygen system at more than 6ppm."

Raceways are common features for some nurseries. Anil commented, "In using bioflocs in nurseries, I found that the circular motion of these tanks help to push sludge to the central drain. We can then easily remove the sludge."

Vinay Dulam, Director, Vijaya Durga Industries (centre), is the owner of the nursery and has been testing the juveniles at his group's >100 ha shrimp farms in Krishna District. On the left is Sandip Ahirrao, Head of Marketing, for the nearby Growel Feeds

Call to industry

The RAS system developed here requires expert attention and close monitoring. "I do not think that a small farmer should try to run such systems on his own. It will divert attention from his farming business. Furthermore, farms should be aware of the need for exigent biosecurity and on possible spread of diseases. Farmers should focus on their expertise which is farming. My next venture will be to develop mobile compact nursery systems where we go close to a farming area, but not into any farms."

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How we alleviated EMS in our farm

By Poh Yong Thong and Mohd Fauzi Salamaun

The collective measures at this R&D farm in Malaysia included a central sump, no pre-fertilisation of the pond water and a strict feed management program.

The early mortality syndrome or more commonly known as EMS is a serious plague of the shrimp farming industry. With the determination of the causative pathogen, EMS is now referred to as AHPND or acute hepatopancreatic necrosis disease. The salient effect of EMS is a damaged hepatopancreas, thus compromising digestion and absorption of nutrients.

In Malaysia, the annual shrimp production was more than 80,000 tonnes in 2010. Since 2011, with frequent outbreaks of EMS, there was a reduction in annual production to only 35,000 tonnes as estimated by industry (AAP, 2018).

A pond at Bagan Tiang just prior to stocking

Southern China, Vietnam, Thailand and Mexico were also similarly severely affected. Andy Shinn of Fish Vet Group reported during the TARS 2016 Conference on Shrimp Aquaculture, that the Asian shrimp industry has lost an estimated USD20 billion in the last decade because of EMS. Laurence Williams echoed in November 2017 in The Fish Site that the Asian shrimp industry had incurred a loss of USD22 billion from EMS during 2009 to 2016. The economic loss and job annihilation due to EMS is thus enormous.

In the November/December 2014 issue of Aqua Culture Asia Pacific, this author, reported that EMS was absent in Indonesia (up until today) because of the strict cross-border control of shrimp to prevent importation of the disease and clean pond bottom management to eliminate environment conducive for the disease, made possible by regular sludge removal.

Improving production

Our R&D ponds in Malaysia are earthen ponds lined with 90% shading material. The farm is located in Bagan Tiang in the northern state of Perak. Adjoining the farm to the north and south are other shrimp farms. Both inlets and outlets are publicly shared and prone to cross-contamination of diseases. In 2017, we constructed central sumps fitted with sludge removal submersible pumps to ensure the routine and efficient removal of sludge and shrimp wastes from our ponds.

We also implemented Patrick Sorgeloos' principle of microbial management by deliberately preventing the harmful fast growing bacteria from propagating and dominating the ecosystem (see below). We carefully managed feeding, bearing in mind that high organic loads encourage the proliferation of pathogenic bacteria. Basic biosecurity was observed. As a result, we managed to alleviate EMS in our farm which was prone to diseases in the past due to rampant cross contaminations from adjoining neighbouring farms.

The ecological characteristics of

	r-strategist bacteria	K-strategist bacteria
Growth rate	HIGH	LOW
Effect of enrichment	RAPID GROWTH	SLOW GROWTH
Competitive ability: High substrate/indiv Low substrate/indiv	 HIGH LOW	 LOW HIGH
Importance for fish/ shrimp larvae	Dangerous (opportunistic pathogens)	Generally harmless

Opportunistic pathogens grow fast in high organic load environments (Graphic provided by Patrick Sorgeloos from his presentation at APA 2017)

Central sludge discharge sumps

We do not want our shrimp pond to accumulate shrimp wastes. Flushing regularly with an effective central sump can ensure a healthy pond environment. We built a central sump of 3m x 3m sloping towards the centre with a depth of 50cm.

For the central sump sludge remover to work efficiently, the paddlewheels must be arranged properly so that there was no counter-current and all the sludge was swept to the centre. A 4-HP submersible pump was fitted with a backflow check valve and then connected to a timer and sludge was pumped once every 2 hours for a duration of 3 to 5 minutes, 12 times a day to a disused pond. Upon harvest, we verified that sludge was removed very effectively.

Principle of microbial management

In the Asian-Pacific Aquaculture Conference (APA) in July, 2017, Professor Patrick Sorgeloos, Ghent University, Belgium clearly explained how microbes are the main culprit of low survival in both grow-out ponds and hatchery tanks. He further highlighted that microbial management plays a key role in sustainable aquaculture production. He illustrated that during the disinfection of pond and tank water, bacteria, both beneficial as well as harmful, are all eliminated. But thereafter, the opportunistic harmful bacteria are the first to re-establish themselves in the ponds or tanks.

Unfortunately, a common conventional practice during pond preparation is the pre-stocking fertilisation of water. This practice inadvertently encourages the opportunistic and usually harmful bacteria to grow and dominate the system, resulting in the pond or tank water being densely populated with lots of harmful bacteria even before we stock the post larvae.

This is all too true and we speculated that perhaps early fertilisation is the main cause of EMS! The harmful bacteria, predominantly the *Vibrios* are encouraged to dominate the pond before we even stock our post larvae and so EMS strikes as early as 15 days after stocking. For this particular cycle in our R&D farm, we threw away all the conventional wisdom of adding fertilizer and fermented organic matter. Two days after disinfection of the pond water, we just added a blue colorant (for shading the pond in lieu of phytoplanktons) and probiotics to encourage beneficial bacteria growth. Seven days after disinfection, we stocked the post larvae. Our shrimp grew to 3g in 30 days without the conventional fertilisation.

Feed management program

Realising the importance of low organic load in the intensive shrimp pond ecosystem, we began a stringent feed management program. We also made sure that there was no overtly strong water current to sweep away the feed in the feed tray by minimizing paddlewheels in front of the feed trays. This enabled us to observe the feed tray for remnant feed. We installed a current breaker upstream of the trays. This was necessary so that feed tray monitoring was not biased.

Basic biosecurity

Biosecurity is the prevention of entry of pathogens into the culture ponds. When the post larvae were about 8 days old in the hatchery, we sent samples taken from the hatchery for PCR (polymerase chain reaction) screening for EMS, white spot syndrome virus (WSSV) and infectious myonecrosis virus (IMNV) diseases. All post larvae to be accepted must be free of all the above diseases.

Visitors to the ponds were strongly discouraged. We practised alcohol based hand wash and foot bath at each feeding bridge. Vehicles were not allowed to enter the pond compound to prevent disease vectors that might adhere to tyres from spreading to the ponds. To prevent wild crabs from the outlet canal from crawling into the pond at night, we surrounded each pond with a 30cm high plastic fencing, buried 3cm into the ground.

Finally, free of AHPND pathogens

In early November, after repeated rainy days, there was mortality in some ponds. Samples were sent to a private laboratory (Lab Ind Resources) for PCR screening of the AHPND pathogens. It was found that WSSV was detected but not the strain of *Vibrio parahaemolyticus*, responsible for AHPND.

Harvest results

As the area is disease prone, we stocked only at about 70 PL/m^2. The harvest results (Table 1) showed that we were able to overcome EMS for this crop. Overall, we obtained a survival rate of 58.7% and feed conversion ratio (FCR) of 1.83. The shrimp were harvested at the sizes of 10.6 to 14.1g over 99 to 109 days of culture. In this crop, the diseases affecting the ponds were WSSV and white faeces, and there was no EMS infection.

In summary, we are convinced that together, these three measures helped us to alleviate EMS in shrimp farming: a central sump to regularly pump out the sludge, no fertilisation of the pond water and a strict feed management program.

Table 1. Harvest results of shrimp culture in ponds with a central sump and strict feed management program, and without the pre-fertilisation of pond water.

Block	No. of ponds	Area (m^2)	Harvest (kg)	Feed (kg)	Stocking (no. of post larvae)	Harvest (no. of shrimp)	FCR	Survival (%)	DOC 1st harvest	DOC Final harvest	Average harvest size/ shrimp	Reasons for harvest
A	4	24,900	17,414	20,649	1,700,000	1,236,928	1.19	72.8	55	99	14.1	White faeces
B	4	23,600	13,922	29,736	1,800,000	1,077,856	2.14	59.9	75	109	12.9	Ready for harvest/WSSV
C	5	28,200	9,713	24,548	2,000,000	916,017	2.53	45.8	67	82	10.6	WSSV
All	13	48,500	41,049	74,933	5,500,000	3,230,801	1.83	58.7			12.7	

Current breaker upstream of the feed trays

Clean central sump just after harvest

PCR test showed diseased ponds are EMS negative

Farm Manager, Mohd Fauzi Salamaun checks the feed trays daily

Note: Following a corporate re-organisation, this R&D Farm at Bagan Tiang was sold to Lean Huat Aquaculture Sdn Bhd at the end of December 2017. The farm is still operating.

Poh Yong Thong

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Mohd Fauzi Salamaun is a graduate from Ehime University, Shikoku, Japan in Electric & Electronics Engineering. He has been in aquaculture since 2008. From 2010, he farmed vannamei shrimp at the 121ha farm in Selinsing, Taiping, Perak for Hannan Corporation until 2014 and later with a Japanese group, farming vannamei shrimp in Pantai Remis until March 2015. He joined Gold Coin as Farm Manager until December 2017. He is currently operating a shrimp farm in Perak.

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Route to the future

Experts guide and prepare industry in India for continued growth and market-led production.

SAP Vice President, **Ravikumar Yellanki**, Vaisakhi Bio-Marine (P) Ltd had this to say as he skilfully introduced the various sessions and presentations at the recent AquaIndia 2018. "We became the number 1 shrimp exporter to the US in 2016 and we expect to do the same in 2017 and 2018. We have estimated that China had a production of 675,000 tonnes in 2017 and if we exceed this volume, India becomes the leading farmed shrimp producer. But to dominate the global shrimp market, we need to overcome current and anticipate future challenges. Support from industry players with technologies is crucial."

> "Understanding microbial ecology will create a stable and beneficial environment for the shrimp."
> -Philippe Leger

Dr Philippe Leger, CEO Inve Aquaculture, Belgium in his keynote presentation introduced current and upcoming technologies along the supply chain for sustainable shrimp farming. Disease is the single economic factor in shrimp farming and it is here to stay; it is hard to cure and should be avoided and averted through biosecurity and early diagnosis. Leger added that managing risks require the application of technologies. Adequate detection of disease serves as early warning on risks. Microbial management and quorum quenching are important in disease management. Understanding microbial ecology will create a stable and beneficial environment for the shrimp. Although RNAi technology for anti-viral treatment of diseases has been around for some time, an oral delivery mechanism through bacteria is still cost prohibitive. Still in progress are novel treatments, robust breeds and using antibacterial and antivirulence technologies on the animal's defence mechanism.

Farm technologies

"To increase tonnage, industry may look at increasing density, farming area or crop cycles. In Ecuador, farms with nurseries have a 50% gain over direct stocking," said **Aedrian Ortiz-Johnson**, Skretting Americas. He described nursery practices from sizing of the nursery, feeding management to harvesting. "In nurseries, we are going back to basics, not forgetting biosecurity using healthy post larvae and strong aeration to avoid dead zones. Harvesting of juveniles is not the same as harvesting large shrimp and if pipes are used, we need to inject oxygen into the pipes every 500m. "In India, stand-alone nurseries are being developed and SAP General Secretary Anil Ghanekar has been working on a nursery using recirculated aquaculture system (RAS) and biofloc technology in Andhra Pradesh (see page 8).

"Are synbiotics, the combination of probiotics and fermentation, being used again in the future?" asked **Dr David Kawahigashi**, Vannamei 101. The concept is gaining attention to stabilize the essential parameters in a shrimp pond. "Synbiotics is a 'management tool' for quickly stabilising the water quality and pond bottoms and help control pathogenic disease outbreaks from Vibriosis, early mortality syndrome (EMS), white faeces disease (WFD), white spot syndrome (WSSV) etc." said Kawahigashi. "In India, farms have been practising synbiotics for more than 15 years. It is a favourable low cost tool with readily available DORB (deoiled rice bran). In Korea, 30% of indoor farms are applying synbiotics and farmers are switching from bioflocs to synbiotics." His presentation included several examples on production and cost reductions at farms using synbiotics in India, Thailand, Mexico, Indonesia and Brazil.

Emerging trends in selective breeding

Aside from SPF broodstocks which industry in India is already importing from several breeding companies, **Chandrasekar S**, SAP President suggested in his welcome address that stakeholders in India may also look beyond to specific pathogen resistant (SPR) and specific pathogen tolerant (SPT) broodstocks. **Robins McIntosh**, CPF Thailand reiterated that industry must recognise that SPR is a genetic trait and SPF is a health status. They are not exclusive. "There is a need to change technology for better profit but industry needs to think how to do this. Any genetics which goes into the pond through bad post larvae does not mean much. Robustness is critical as survival is first as dead shrimp do not grow. We need to work with clean shrimp." In monodon shrimp farming, **Dr Grace Chu- Fang Lo**, National Cheng Kung University, Taiwan has WSSV resistant families bred by mating siblings. The WSSV resistance test on the second generation confirmed the virus resistant trait is heritable. (see pages 21-23)

Dr Morten Rye, Akvaforsk Genetics Centre, said that genetically improved disease resistant stocks offer the opportunity to stabilise production systems. Disease resistant stocks are not sufficient on their own and should be certified as disease free. The company's breeding centre in Colombia has robust vannamei shrimp populations with resistance to major diseases

From left; IPR Mohan Raju, Prawn Farmers Federation of India; Rahul Kulkani, West Coast Seafoods; Sagi Chacko; Balasubramaniam; Robbert Blonk; Steve Arce, Kona Bay, Hawaii and William van der Riet, Tomalgae, Belgium

Discussing shrimp diseases: status, challenges and way forward. From left, Dr Marcela Salazar, Benchmark Breeding and Genetics; Ravikumar, Alpha Biologicals, Nellore; Arun Dhar, Kallaya Sritunyalucksana, Olivier Decamp and Grace Chu-Fang Lo.

(taura syndrome virus-TSV and WSSV). However, growth is also important. He discussed how these stocks can be selected and adapted to Indian farming conditions. "The shrimp sector will continue to be repeatedly exposed to new epidemics while depending on broodstocks poorly adapted to local conditions," said Rye.

Some issues with the current broodstocks were raised by **Surendran V**, Vaisakhi Bio-Marine (P) Ltd. He said that the vannamei shrimp is not adapted well to high temperatures; in India, water temperatures can go up to 32-33°C and sometimes more than 37°C. It is easily infected with running mortality syndrome (RMS) and FCRs are low. "We are excited by the possible ADG of 0.33g with the new strains as compared to previous ADG of 0.13g." Rye said that in developing shrimp fit for the environment, "We cannot expect one animal to fit all environments. Furthermore, most commercially available broodstocks are not selected for all environments."

In discussing the changing roles in shrimp genetics, **Dr Harris Wright**, Shrimp Improvement Systems (SIS, USA) said that new technologies such as CRISPR will enhance shrimp farm productivity but genetics alone cannot solve all the production issues because intensive monoculture practices and changing environmental conditions also play important roles in shrimp farming. "To achieve desired performance objectives, we need to work together as an industry and support not only improved genetics but improved hatchery, farming technology and biosecurity." CRISPR is a very precise gene manipulation method. It allows genetic material to be added, removed, or altered at particular locations in the genome. "The EU may have determined it as non-GMO technology but to be a success, we must do a better job of educating the consumer."

Dr Robbert Blonk, Hendrix Genetics Aquaculture, the Netherlands, said that in India, there are extensive, moderate and intensive systems and average survival rates and harvest volumes differ by systems and region. Antibiotic resistance poses a big threat to industry progress. The company has selected shrimp which grew faster on 24% soybean meal diets.

Gulrez Alam, IB group (centre left) and team with Dr Manoj Sharma, Mayank Aquaculture, Gujarat (centre right)

Ravikumar Yellanki (right) and S Chandrasekar

Panel on shrimp production and status, from left: Rajagopal Choudary, Devi Seafoods, India; Balasubramaniam; Lorenzo M Juarez, American Penaeid, USA; Angel Rubio, Urner Barry, USA and Philippe Leger. Juarez gave an overview and sustainability of the global shrimp farming industry and Rubio presented on shrimp markets in the US: past, present, and trends.

Addressing diseases

"WSSV is the main threat which we learnt to live with but now we also have WFD, *Enterocytozoon hepatopenaei* (EHP) and running mortality syndrome (RMS)," said Surendran. "Biosecurity is poor in inland areas where inlets and outlets are often shared. In the 50,000 ha of traditional farms in West Bengal, Odisha, Kerala and Karnataka, which contribute 90% of monodon shrimp production in 2017, farm productivity is very low. Survival rate can be less than 25% and hatchery standards for post larvae are unpredictable."

Acute hepatopancreatic necrosis disease (AHPND) has not been reported in India, but it is a potential threat. **Dr Arun K Dhar**, University of Arizona's Aquaculture Pathology Laboratory said that considering the ubiquitous nature of the Vibrio causing AHPND, control of AHPND through avoidance of the pathogen alone is unlikely to work. His laboratory has sequenced the EHP genome and that since EHP can cause low levels of chronic infection, screening of broodstocks and post larvae could be even more important for managing this disease.

According to **Dr Olivier Decamp**, INVE Aquaculture Thailand, the potential causative pathogens for an EHP outbreak include mycotoxins, gregarines, cyanobacteria, Vibrio as well as microsporidians. On the co-occurrence of EHP and WFD in India, there was a study which showed higher prevalence of EHP in shrimp from ponds affected with WFD but there were no conclusive associations. "One major challenge with EHP is that the disease is not immediately recognised because growth inhibition occurs only 2-3 months after stocking," said **Dr Kallaya Sritunyalucksana**, National Centre for Genetics Engineering and Biotechnology, Thailand. Thus, today their research focused on characterisation of EHP and its detection in broodstocks, post larvae, suspected carriers and in the environment.

Raw material prices and costs of production

"In 2017, we did not see the big fluctuations in prices as we did in 2016. Consequently, the farmer did not need to ponder over whether to keep the shrimp in the ponds or to harvest. However, I wish to emphasise that it is actually important to calculate costs of production all the time and determine profitability. Thus in 2018, we should all work on how to soften the cost of production and to improve profitability which is usually impacted by disease." To cope with markets, **S. Santhana Krishnan**, Maritech, gave a list of do's and don'ts. These include: higher density stocking, only when infrastructure is adequate but up to a maximum of 60 post larvae/m^2, target size 14 ~ 17g (size 58-70/kg), plan for a minimum of two crops a year and aim for size 70/kg within 70 days/crop.

At the panel discussing farming technologies: New paradigms. From left, Dr Sagi Chacko, Onaway Industries, Gujarat, Aedrian Ortiz-Johnson, Robins McIntosh, David Kawahigashi and S. Santhana Krishnan

Working towards 'No more threats' from WSD in black tiger shrimp farming

By Zuridah Merican

A mission to help farmers, the Shrimp Genetics Centre in Taiwan is on track to produce SPF/SPR (WSD) shrimp.

During the last 4 years, Professor Grace Chu-Fang Lo and her team at Taiwan's National Cheng Kung University (NCKU), have been researching at the molecular level two major shrimp diseases: white spot disease (WSD) in penaeid shrimp and in *Penaeus vannamei*, the virulence and toxicity of *Vibrio parahaemolyticus* which causes acute hepatopancreatic necrosis disease (AHPND). At the Asian Pacific Aquaculture 2017 in Kuala Lumpur, Malaysia and the recent Aqua India 2018 in Chennai, Lo showed some results of her work. In this report, Lo described the progress with the work on WSD in the black tiger shrimp *Penaeus monodon*.

The white spot virus in this shrimp has now become a passion with Lo as she seeks to know more. Her work on the resistance gene has now led her to set up a Centre for Shrimp Disease Control and Genetic Improvement aka a nucleus breeding centre at the Annan campus of NCKU. During a visit to the Centre in December 2017, Lo said, "We do not want to do just research and publish. We want to see how we can help the industry. I know that farmers need help. My first development was a diagnostic kit. Often I hear sad stories of crop failures in the industry. Four years ago, NCKU's President Hwung-Hweng Hwung and Vice President Huey-Jen Su supported me with this plan, with land and funds for this centre. Although, now I am at NCKU, my tenure at the National Taiwan University (NTU) provided me with the background to carry on with this project."

This centre has the following: a shrimp genome biology laboratory, a shrimp disease laboratory, an OIE reference laboratory for WSD and two nucleus breeding buildings. The latter have their own hatchery and nursery facilities, as well as separate facilities for maturation and multiplication of shrimp families of interest, all with high biosecurity. All shrimp in these buildings are at least specific pathogen free (SPF).

At the Centre for Shrimp Disease Control and Genetic Improvement, Grace Chu-Fang Lo (centre, right) with speakers at the Mini Symposium on Frontier Aquaculture Science, held on 9 December 2017 at the Annan campus (see page 52). From left, Anchalee Tassanakajon and Kunlaya Somboonwiwat, Chulalongkorn University, Thailand; Celia R Lavilla-Pitogo, Philippines; Zuridah Merican and Han-Ching Wang.

"I have a great passion for the monodon shrimp. In the 1980s, the shrimp industry flourished in Taiwan and in Asia because of this shrimp. If I can produce a strain of monodon shrimp resistant to WSD, we can gain back the confidence of Taiwan's farmers in shrimp farming. The limitations in farming this shrimp depend not only on disease free and resistant stocks but also adapting culture systems with a new level of technology," said Lo.

Washing and checking nauplii, as seen through the observation window

Molecular mechanism of WSD infections

"In the past decade, our research on the *P. monodon* genome by our team member Dr Alex Yu gave us enough information to develop a linkage map. We are now developing DNA markers. We will also sequence the genome of a WSD resistant shrimp. We are ensuring that the shrimp are specific pathogen free (SPF) first, and the final target is WSD-resistant stocks. As we go along, we are selecting for WSD resistance and at the same time we are studying the mechanism for disease resistance. The process is slow but that is the way we are going about it, as we need to be sure.

"This is a basic genetic approach, so that we are able to determine whether disease resistance can be passed on to the next generation. We are not doing any manipulation of the genes. We collaborate with Dr Anchalee Tassanakajon, Chulalongkorn University in Thailand, who will be looking at the innate immunity to WSD for this species. Some preliminary challenge work showed that high doses of the virus did not replicate in the shrimp cell. Dr Han-Ching Wang, also at NCKU, is investigating the possible role of Dscam (Down syndrome cell adhesion molecules), in WSD infections," explained Lo.

Raceway for the rearing of post larvae to broodstock.

Checking broodstock for spawning

SPF/SPR monodon shrimp

Since 2014, while researching on WSD, publishing and announcing step by step research breakthroughs on the pathogenesis of the white spot virus at the molecular level at various conferences, Lo started working on setting up a nucleus breeding centre to develop SPF and specific pathogen resistant (SPR-WSD) monodon shrimp. Funding for the project came solely from the Taiwan government and NCKU.

In the development of the centre and the addition of various facilities, Lo uses the expertise within the university; The Architecture Department to develop programs to monitor and adapt the culture facilities to weather conditions, the Environmental Engineering Department to develop recirculation aquaculture systems (RAS) for water treatment. The Architecture Department also designed a green building, thus saving on energy costs.

The initial founder stocks were clean, wild and domesticated monodon shrimp from Madagascar. Lo collaborated with an organic monodon shrimp producer (OSO) which cultured a supply of post larvae as founder stock for the shrimp genetics centre. "First, we selected post larvae resistant to WSD. Susceptible shrimp were discarded. Resistant families were then reared in our facility. We looked at the hereditary information in the F2 shrimp. Our F3 shrimp, which will be ready in 2018, will undergo grow-out in real culture conditions in our new farm in Hualien for us to collect more information. Today, we are into our third generation where we are beginning to select shrimp for WSD resistance. So far, we have established that the second generation is SPF to the 9 OIE-listed shrimp diseases. While establishing this, we have been selecting for growth."

Biosecure conditions critical

Biosecurity is a critical aspect of any breeding facility. At this centre, running above the tanks on the second level, the designers have built a closed observation corridor for academic and industry visitors. While allowing complete openness of the facilities and activities below, biosecurity is not compromised.

At the biosecure centre, post larvae are fed commercial diets. As they reach broodstock sizes (>100g for females and >70g for males), the diet initially shifts to moist pellets with added astaxanthin and later to combinations of polychaetes, frozen squids and scallops. The grow-out from post larvae to brood stock takes 12 to 18 months. The fecundity varies, depending on the condition of the broodstock, ranging from a low of 300,000

In the broodstock maturation section, there is a 14-hour photoperiod followed by 10 hours of yellow light.

to 500,000 eggs. Broodstock can spawn continuously over a 1-2 months period.

In the centre's maturation tanks, conditions are kept very stable. Water quality monitoring (for pH, dissolved oxygen, temperature, ORP, and alkalinity) is automatically measured with regular autosampling of water from each of the 4 round 7.5 m^3 maturation tanks. Data is sent to the cloud and to mobile phone apps. Heaters maintain water temperature at 29.5°C. A 14-hour photoperiod is followed by 10 hours of yellow light, which is invisible to shrimp as recommended by Dr Chung-Hsiung Wang, a retired entomologist. After tagging, individual males and females are mated at a ratio of 1:1 and to date there are already 22 family lines.

Field trials

Preparations are already ongoing for ponds to carry out field trials in a 9 ha university leased land in Hualien, on the east coast. The plan is to have large and small ponds to run complete commercial trials as well as to carry out research projects. Lo is very excited at the prospect of these ponds showing the disease-free grow-out of the resistant strains but also some new farming protocols for the younger generation of farmers. This new generation of farmers constitutes the new entrants; they take over family businesses or are just young entrepreneurs in shrimp farming, and they are ready to adapt many of the digital water quality monitoring and feeding devices developed or currently in development by NCKU and elsewhere.

"At the new farm, we will be trying out controlled systems such as RAS in greenhouses and farming with deep and coastal seawater. I know that the deep seawater will be costly to extract but the higher salinity will produce a sweeter shrimp. We want to show farmers the choices available to redevelop our shrimp industry.

Initially we will be using most of our post larvae production to supply this farm and as we become ready, we will be supplying broodstock to hatcheries within Taiwan. These broodstock will come from our broodstock multiplication centre. Next we will move on to supply Asia," added Lo.

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Addressing challenges in farming marine fish

Production is increasing but not based on sustainable principles. There are challenges and opportunities according to stakeholders.

The uniqueness of the marine fish industry in Asia is the diversity of grow-out systems and the lack of economies of scale of farming. The industry is dominated by small backyard family-run coastal floating cages and brackishwater ponds to large operations with thousands of coastal floating cages, usually run by groups of farmers, followed by offshore cage farms with circular or square cages. In 2013, China had 50 million m^3 of offshore cage farms and 17 million m^3 of coastal farms (Lai, pers comm). There are combinations; on-shore tank systems with coastal cages or off-shore cages. There are also recirculated aquaculture systems with fully controlled production. Industrial farms are usually integrated, with hatchery-cum nursery and grow-out operations.

Asian producers, particularly those in China, farm many species. Total production from Asia increased 16.7% to 3.98 million tonnes in 2015 (FAO, 2017). China led the Asian production with 2.0 million tonnes in 2015. Indonesia and the Philippines followed with production of 0.67 million tonnes and 0.39 million tonnes respectively. The milkfish *Chanos chanos* dominated in Indonesia and the Philippines, comprising more than 95% of the marine fish production. In China, production of various groupers, eels, *Epinephelus* spp, yellow croaker *Larimichthys croceus* and pompano *Trachinotus blochii* reached more than 100,000 tonnes in 2015.

The major groups of mid and high value marine fish farmed in Southeast Asian countries include various groupers *Epinephelus* spp, snappers *Lutjanus* spp and Asian seabass *Lates calcarifer*. Groupers usually fulfil the demand for the live fish market while snappers and seabass, also the chilled and frozen fish market. In the last few years, the farming of hybrid groupers has gained interest fuelled by the demand and availability of fry and fingerlings from regional hatcheries. No marine fish species from Asia can match the market position of the freshwater tilapia in the whole/fillet white fish global market.

Most coastal farms are multispecies operations, such as KS Aquaculture in Malaysia. Industrial farms such as PT Philips

Feeding tuna broodstock in cages off the Gondol Research Institute for Mariculture in Bali.

Indonesia and PT Bali Barramundi in Indonesia, Barramundi Asia in Singapore and Australis Vietnam focus on the farming of the Asian seabass *Lates calcarifer* (or barramundi) in offshore round cages. Barramundi has a demand in the Australian and global markets. These farms have full control on production, processing and marketing. Taiwan and Thailand, each has a large cobia *Rachycentron canadum* offshore farm (Lai, pers comm). A leader in Singapore, Marine Life Aquaculture (MLA) supplies vaccinated Asian seabass fingerlings to farms in the region while it produces four finger threadfin for its own grow-out cages. In terms of cage structures, today, there is a certain level of sophistication with the use HDPE circular cages and LDPE square cages.

Producers of marine fish are frequently challenged along the supply chain, mainly in the supply of fry and fingerlings, diseases, feeds and marketing. Sustainability issues do crop up but less than for the freshwater tilapia and pangasius. In 2017, The Aquaculture Roundtable Series (TARS 2017) focused on the finfish farming industry in Asia. During the breakout roundtable sessions, Asia stakeholders analysed strengths, weaknesses and constraints in the finfish industry in Asia, both for freshwater and marine finfish. Groups also went on to develop some key performance indicators (KPIs) and strategies for growth. In this report, as we discuss some developments in Asia, we extract points relevant to the marine fish sector raised by stakeholders at TARS2017.

Asian-Pacific Aquaculture 2017 conference participants during a post conference visit to a KS Aquaculture farm in Malaysia.

Genetics, hatchery and nursery

Segmentation is strong in Asia, with small-scale backyard hatcheries cum nurseries supplying fry and fingerlings of various species. There is a large intraregional trade in fry and fingerlings. Most are small family run businesses and some have support from local governments. In Indonesia the government supports small-scale hatcheries in the production of fingerlings for the humpback grouper *Cromileptes altivelis*, brown-marbled grouper *Epinephelus fuscoguttatus*, leopard coral grouper *Plectropomus leopardus* from eggs to fry of 2.5cm and for the milkfish, eggs to a 14-16 day old fry (Endhay, 2016).

A major constraint is the lack of support on broodstock management and selective breeding, which is expected from governments. On the contrary, in Europe, there are several commercial companies involved in breeding programs for the salmon, seabass and seabream. The larger Asian seabass farms in Indonesia and Singapore are integrated, some with their own supply of broodstock and conduct their selective breeding work. A lack of interest in developing breeding programs for any Asian marine fish is presumed to be due to the number of species farmed and lack of demand.

Pathogen control in production

Disease management is challenging; poor biosecurity, poor water quality, inappropriate farm management and stress are predisposing for outbreak of diseases. Frequency of outbreaks has increased and this is associated with poor nutritional health, parasites, secondary bacterial infections and viruses carried by infected fry. In Malaysia, Khor (2017) listed the following parasites: *Benedenia* sp in red and golden snappers, *Dactylogyrus* in morbid red snapper and grouper, *Polyopisthocotylea (Microcotyle)* in red snapper, isopods in tiger and hybrid groupers, *Vibrio alginolyticus* and *V. parahaemolyticus* causing ulcers in orange-spotted grouper, tiger grouper and hybrid grouper, *Streptococcus* sp infections across all fish species, *Tenacibaculum maritimum* in the Asian seabass and *Nocardia* sp in red snapper. Leong (2017) reported on the outbreaks of the parasitic sealice *Caligus* in snappers in Malaysian farms.

In terms of disease mitigation, vaccines are only available for the main diseases, such as against iridovirus and streptococcus for the seabass. Looking to the future, multispecies farming has its constraints. To a certain extent, farmers do not really keep track of diseases and mortality; they tend to learn from disease outbreaks.

Small-scale farmers when given a choice, would always opt for the least cost protocol and need to be educated before they would decide to include vaccination into their farming practices. There is a need to understand biosecurity and how it helps in disease prevention. Absence of biosecurity systems means huge challenges with disease management.

With vaccines, three setbacks were identified: registration of the vaccines in each country, farmer acceptance on vaccination, and resistance to training the workforce to properly vaccinate fish. Usually registration of a vaccine is a long process and authorities, such as those in Vietnam, require field trials over a complete production cycle. Vaccinating the fingerlings in the hatchery at least 2-3 weeks before moving them to grow-out sites was highly recommended. On the need for antibiotics prior to vaccination, this can be replaced by heat shock treatment as applied at the MLA farm in Singapore.

Production efficiency

One of the biggest challenges in Asia's marine fish farming is moving small-scale producers from the low-cost production trap. Little is known on the production efficiency of these small farms. Farmers readily accept high mortality rates during the early part of the grow-out which is usually compensated by the addition of new stock. The use of lower cost trash fish is preferred despite the fact that poor water quality negatively affects growth and survival. In general, the knowledge on feed, productivity, systems and farm management is often limited and better farmer education is essential. Industry's goal should be to move from traditional farming to efficient and scientific production.

Regulators are liable for failing to recognise the effects of over-crowding of farms. There are consequences; consumers are not willing to pay more for fish farmed in crowded conditions. An example is the overcrowding of the extensive coastal marine fish farms from the Bohai Sea, Yellow Sea, East China Sea, and to the South China Sea in China. The situation in Asia is a far cry from the mature salmon industry in Norway, where there have been improvements in production efficiency such as the use of less labour/tonne of fish. Low feed conversion ratio of 1.1 to 1.2 has reduced feed use. Intensive systems are allowed but fish density is regulated by law and the government issues permits based on efforts to increase sustainability (Pedersen, 2017).

The strengths of large scale operations rely not only on technologies already in use in various phases of aquaculture, but also on those used in other industries. For small-scale operations, simplified systems such as automatic feeders can significantly improve farm operations. The emphasis is not on huge investments into sophisticated machinery but about bits and pieces, which if done step-by-step, can improve productivity. Automation can save time and manpower and reduce fish stress.

Feeds and feeding

Feed is a major cost component in marine fish farming, particularly as feeding is required for a long duration which is 8-9 months for a 600g Asian seabass and longer for the groupers. The strength in the industry is the adaptable farmers, keen to try new solutions and methods for a fast turnaround. The weakness is the dependence on low cost feeds. The range of feed conversion

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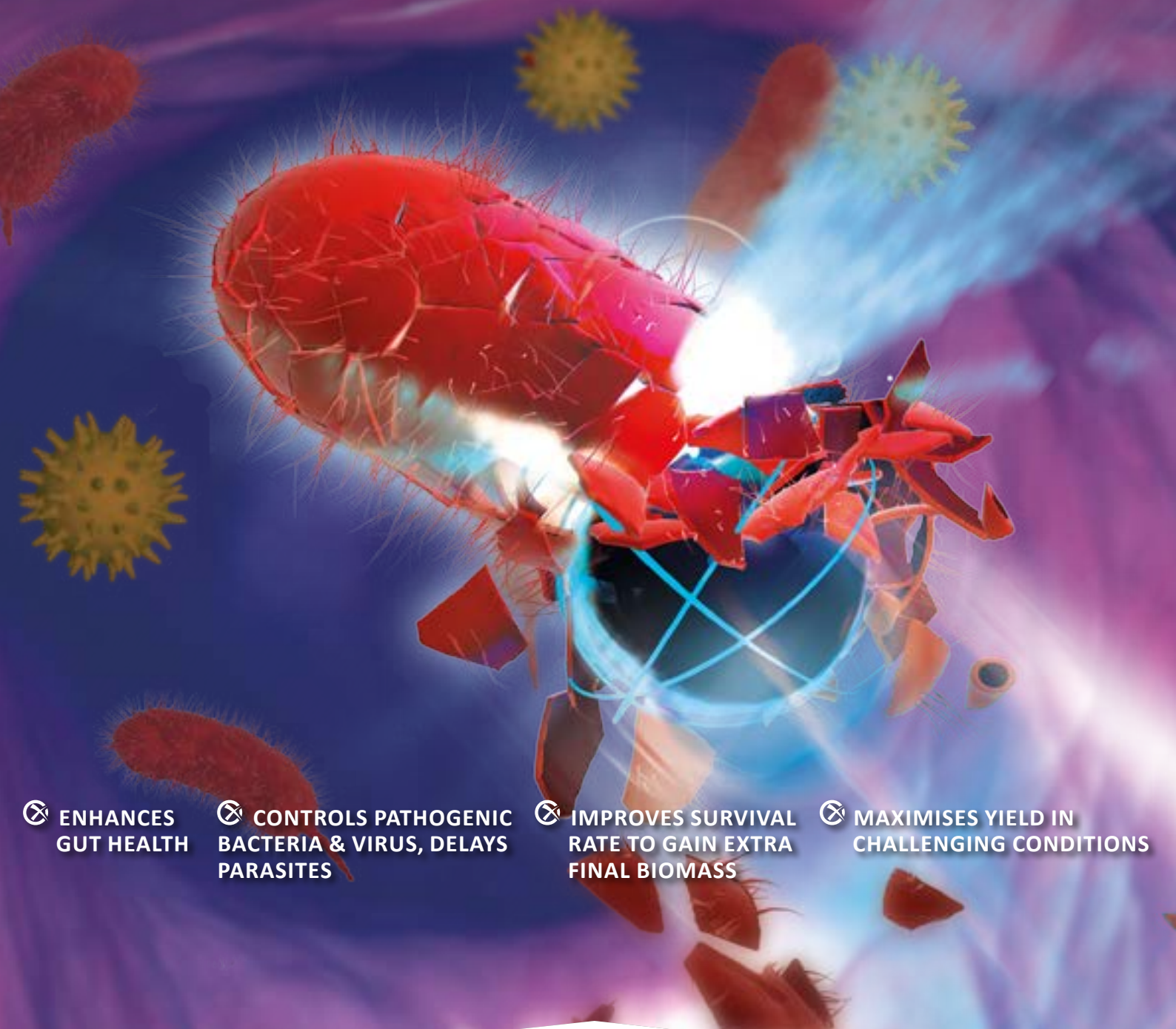

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ratio (FCR) for the Australian barramundi is 1.5 whereas for the green grouper in the Philippines, it ranges from 2-2.3 for a 600g fish.

The focus on feed cost/kg fish produced is one way in discouraging farmers from buying cheap feeds. A future direction for feedmills is to compete on feed performance, and not on the low feed cost. Eventually, this is about maximising profit. Performance feeds are usually relatively more expensive with better quality raw materials and better-balanced amino acids for faster growth and lower leaching of nutrients.

The difficulties faced by feed millers in multi-species farming include working out the feed requirements for the different species and for each of their life stages. Different technologies are required for different species. However, the feed industry will need robust data or have access to data that would allow them to make further progress on working out the feed requirements for the many species. Physical properties of pellets need to match the needs for specific species or farming conditions. There is certainly a lack of precision nutrition for most marine species in Asia, especially for least cost formulation, except for the barramundi where more information is available. With species specific feeds, storage of different feeds will be an issue. At one farm, pompano feeds were used to feed groupers and red snappers, inadvertently, resulting in the snappers having a pale red colour. The opportunity is with feed millers; if the demand is 30,000 -50,000 tonnes per year of feeds for a species, they should be able fine-tune formulations and produce specific feeds.

Feeds can address health issues but facilities are required to carry out disease challenge trials to test the ingredients and additives. There are a large number of feed additives in the market, often with unknown interactions and there is a need to benchmark these health additives and understand how they really work; otherwise there is unwillingness on the part of most producers to alter feed practices and to consider new additives and new ingredients.

A strategy is to focus on the importance of education; educating farmers and feedmillers on good farming practices, nutrition and disease management is of the utmost importance. Government and industry should play a larger role to collaborate in streamlining the industry, focus on a few species for culture, and use them as models for future species. Often, research is very basic and does not solve many of the problems facing the industry. There is incomplete knowledge on the local species and their feed requirements, as well as a lack of feeds for all of the species that are grown in the region and for different seasons.

More transparency between feed producers and farmers in Asia is required. There is more transparency in Europe, not because the mindset is different, but because of regulations which require the reporting on fish mortalities, escapes, contaminations etc. In Europe, farms force feedmillers to be more transparent and to state the ingredients in their feeds. There is transparency at the farm, feed and country level. These are important prerequisites for performance as well as functional diets.

Image building and a sustainable industry

In marine fish marketing, a main challenge is demonstrating sustainable practices. Marine fish has health benefits but negative reports such as overcrowding of cages may push consumers away. PT Bali Barramundi is marketing fish originating from Bali. The fish fetch premium prices and are promoted as being grown in the pristine waters off Bali. Millennials are the future consumers; they are technology savvy and favour the use of social media. They tend to quickly see negative news on the Internet. Online platforms are the new ways to market seafood and producers would need to keep up.

In marketing, there are lessons to learn from the salmon industry where the industry stakeholders and government have worked together in promoting the fish. Fish free feed challenge is also part of the image of aquaculture. A zero-fish meal diet may not be a long-term goal but what is important is that non-food grade marine ingredients should come from responsible fisheries.

Marketing the hybrid and giant grouper at the 2017 Taiwan International Fisheries and Seafood Show. Farms in Taiwan target markets in China but demand fell in 2017.

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Philippine mariculture parks: the Panabo City Mariculture Park experience

By Rafael D. Guerrero III

From the polyculture of milkfish and rabbitfish as well as the culture of high value fish, mariculture parks contribute to annual aquaculture production and fulfill a social objective.

The Philippines' archipelago comprises 7,100 islands and coastal marine waters of 26.6 million ha. In 2016, fisheries production was 4.5 million tonnes with aquaculture contributing to 50.54% of this production. More than 70% of the country's aquaculture production is from mariculture, which is the farming of aquatic organisms like seaweeds, fish and invertebrates.

The concept of a "mariculture park" was initiated by the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) in the coastal waters of Samal Island in Davao del Norte, Mindanao, in 2001 with three floating fish cages stocked with milkfish *Chanos chanos* for demonstration. A "mariculture park" is similar to an industrial park or estate on land where an appropriate area is designated for the commercial operation of business enterprises with government support.

Following its successful experience in Samal Island, the BFAR initiated the setting up of other marine parks in the country either singly or in collaboration with local government units (LGUs) of coastal cities and municipalities which are mandated by law to manage their marine waters up to 15km from the mainland. One such demonstration marine park was set up by the BFAR in Panabo City, a coastal city in Davao del Norte, in 2006.

Panabo City marine park

In 2009, the 330 fish cages in the park produced 1,999 tonnes of milkfish with a value of PHP160 million (USD3.2 million). As of 2015, there were 22 BFAR-LGU-managed and 20 LGU-managed mariculture parks with 4,888 fish cages in nine regions of the country that produced 31,032 tonnes of milkfish.

Fish were fed commercial slow sinking or floating pellets.

By 2012, the Panabo City government established the Panabo City Mariculture Park (PCMP) in its coastal marine waters with a demarcated area of 614ha of which 40ha were allocated for fish cages. With preferential rights given to marginalized fisherfolk who are among the "poorest of the poor" in the country, a City Ordinance governing the PCMP was passed to ensure "the sound ecological balance, protection and management of its coastal resources."

As the partner of the Panabo City government, the BFAR through its National Mariculture Center (NMC) based in the city has provided funds for the support facilities of the PCMP such as the moorings (anchorage) of cages, temporary fish landing and service boats. It has also extended technical/advisory services for environmental surveys and monitoring, training for its stakeholders on technology development and livelihood programs and mariculture tourism, among others.

According to Dr Andrew Ventura, Chief of the BFAR-NMC, in 2017 there were 348 fish cages operated by seven marginalized fisherfolk and 341 private investors in the PCMP that produced 2,505 tonnes of milkfish and rabbitfish *Siganus guttatus* with gross sales value of PHP239.3 million (USD4.8 million). The PCMP also provided 245 jobs to marginalized fisherfolk who were employed as cage caretakers, fish harvesters, sorters and processors.

The 10 x 10 x 4m floating fish cages in the PCMP are made of bamboo poles or high density polyethylene (HDPE) pipes for frames, plastic drums for floatation and polyethylene netting for the enclosures. Each cage has four concrete mooring blocks weighing 1.5 tonnes each. The cages are spaced 2-3m apart and 50m between cage clusters. Only four cages are allowed in each hectare of the culture area to maintain the "carrying capacity". Private investors pay a lease permit fee of PHP1,100 (USD22) per cage/year and a 0.3% gross sales tax to the City Government.

Polyculture of milkfish and rabbitfish

The polyculture of milkfish and rabbitfish in the PCMP cages is common. Milkfish fingerlings (12.5-15cm) are stocked at 10,000-15,000 fish/cage and rabbitfish fingerlings (2.5-5 cm) are stocked at 2,000-3,000/cage. The herbivorous rabbitfish help in reducing the growth of algae clogging the mesh of the net enclosures and lessen the need for changing/cleaning the enclosures from every month to every two months. Culture duration of the fish is for 120 days. Fish were fed commercial slow sinking or floating pellets. Two to three production cycles in a year are possible, if fingerlings are available. These fingerlings are produced in brackishwater pond nurseries with fry from either the wild, local hatcheries or imported from Indonesia.

The milkfish harvested at market sizes are categorized as small (250g or more), medium (350g or more) and large (500g or more). Production is 6.5 tonnes/cage. Ex-farm prices for the fish are PHP90-112/kg (USD1.8 - 2.2/kg), depending on the size. With a feed conversion ratio (FCR) of 2 and a survival rate of 80%, the total cost of production was PHP646,520 (USD12,930). The net income and return of investment (ROI) per cage/cycle

Fish harvested from floating cages

Milkfish harvested from a floating cage

was PHP85,500 (USD1,710) and 15%, respectively. On the other hand, the rabbitfish attain market sizes of 50-100g each with a survival rate of 70-80% and production of 100-200kg/cage. Ex-farm prices for the fish were PHP150-200/kg (USD3-4/kg)

High-value fish

To a limited extent, is the culture of the "kingfish" (saline red tilapia), green grouper *Epinephelus suillus*, and silver pompano *Trachinotus blochii*. Fingerlings of the "kingfish" are produced in a freshwater hatchery, grown to a post-fingerling size of 50g/fish and acclimatized to a salinity of 35ppt before being stocked at 10,000 fish/cage. Fed commercial pellets, the fish grow to market sizes of 250-300g each in four months with a survival rate of 70-80%. A total production of 1,700 tonnes and gross sales of PHP 306,250/cycle (USD 6,125) are reported. Ex-farm prices for the live fish market are PHP150-200/kg (USD3-4/kg).

Green grouper fingerlings from the wild or hatcheries, measuring 10-15cm in length, are stocked in the cages at 30-60 fish/m^3 and cultured for 6-8 months till they attain market sizes of 400-600g each with feeding of trash fish and/or commercial pellets. Silver pompano fingerlings from the hatchery, measuring 6.25-18.25cm, are stocked at 25-30 fish/m^3 and grown to market sizes of 250-300g/fish over 3-4 months with commercial feeds. The fish command prices of PHP600-800/kg (USD12-16/kg) for the grouper and PHP200-450/kg (USD4-9/kg) for the silver pompano in high end seafood restaurants.

The lack of fry/fingerlings for the culture of high-value fish is seen as a major constraint by BFAR-NMC which is presently helping 10 other coastal municipalities in Mindanao to put up their mariculture parks. To address this problem, more fish hatcheries are proposed. Nonetheless, there are bright prospects for the further development of mariculture parks in the country with the close collaboration of the government and industry, the application of good aquaculture practices in contributing to food security and livelihood generation for the marginalised fisherfolk.

The author at the PCMP cage farm

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Creating synergies towards better aqua farming

Apart from its latest acquisition of a probiotics company, Neovia continues to seek technologies to improve farm efficiency as a provider of global solutions for aquaculture.

At the end of 2017, industry was abuzz with the acquisition of American probiotics and larval feed manufacturer Epicore by the French feed and animal health group Neovia. The acquisition brings to Neovia not only Epicore's probiotics line but also a foothold in the shrimp industry in Ecuador, the largest in South America. After all, in aquaculture, Neovia already is in the leading market position in Brazil and is number 3 in Mexico. In Asia, it is strong in Vietnam, Philippines and Indonesia.

In 2016, InVivo NSA became Neovia. The company has 7 activities; complete feed, aquaculture, petcare, premixes and services, additives and ingredients, animal health and analytical laboratories. Amidst this excitement with bringing Epicore into Neovia's fold, CEO Hubert de Roquefeuil and Aquaculture Business Development Manager, Patrick Waty, told *Aqua Culture Asia Pacific* about Neovia's approach in its acquisitions as it moves forward to provide global solutions for the fish and shrimp farmer. Over the past few years, Neovia has been acquiring companies as and when it sees the need for better farm management.

Neovia's CEO Hubert de Roquefeuil (second left) and Patrick Waty, Aquaculture Business Development Manager (right) with, from left, Eric de Seguins Pazzis, Chief Marketing and Business Development Officer, Neovia; William Long, CEO, Epicore and Kyle McHerron Fermentation Microbiologist, Epicore.

Acquisition over organic growth

"It is all about aquaculture; we have several activities around the production of fish and shrimp. Today, we see ourselves as providing solutions to make farming easy, such as with this new

acquisition of Epicore to provide probiotics and some previous ones such as with Acui-T, in water quality management. As long as we see a need, we will look for a preventive solution to add to our portfolio. We have an holistic approach and our different acquisitions settle issues in farm management," said de Roquefeuil.

Neovia's plans are to expand in South America and Asia, where aquaculture is important. "The strategy is partly to acquire because this is a fast way to get something to the farmer. We acquire to grow quicker but we are also in favour of organic growth. We need to remember that the aquaculture market is expected to grow fast at 450% within the next 25 years. Therefore, we cannot only rely on organic growth. We actually need to develop positions in aquaculture in Asia and Latin America, two leading aquaculture producers."

Keeping up to be relevant

As Neovia grows in the aquaculture market, de Roquefeuil also sees several challenges for the industry. "The biggest challenge is water management. Fish and shrimp farming require lots of clean water and it also contributes to water pollution. Therefore, treating incoming and outgoing water is necessary and important to meet and go beyond sanitary standards. To avoid problems, we need preventive solutions and probiotics is part of this overall solution."

De Roquefeuil also discussed another challenge for the company's position in aquaculture. "In such a fast-growing market, in order to be relevant, we need to keep pace. Our aim is to work at the different stages in farm management. To meet demand for fish and shrimp, the farming model will move towards intensification and farms will be larger. Running a small farm is entirely different from large farms. We want to be there with solutions for farm management and data collection for farms to be more efficient."

Synergy with Epicore

The acquisition of Epicore gives Neovia access to both the former's probiotics product range and liquid larval feed for shrimp farming. The focus is on the probiotics portfolio of Epicore as Neovia itself is already strong in the larval feed business through Bernaqua, which was acquired entirely in 2013. "In all the products that Neovia is offering, we did not have probiotics which, today, is very important in shrimp farming, in our fight against EMS (early mortality syndrome) and white faeces disease. Epicore has been very successful with its probiotics product range which has been its focus over the last 25 years. It was a perfect fit for Neovia," said de Roquefeuil.

Waty added, "Epicore is also a door opener for us to be in the market in Ecuador. In the last 25 years, Epicore's teams have developed close relationships with farms and hatcheries. Our benefit is that we can now introduce our Myfarm app to identify the exact needs of farmers and hatchery operators and introduce our in-house solutions to help them achieve a higher level of success. Today, we have the capability of upstream integration with analyses at our mobile labs; identifying water quality needs and checking animal health."

"Our idea is to reduce the impact of disease on each crop. Probiotics can be in the feed, which is the core business for Neovia. It can also be included in premix which we are developing to supply feed manufacturers or as a farm pack. Probiotics can be for soil and water treatment and will actually complement Acui-T's water quality hardware solutions such as ozonation, water filtration and management."

De Roquefeuil commented, "In terms of synergy, interestingly, it is the knowledge on probiotics. Today, it may be only for shrimp farming but in the coming years, for fish farming. The first objective is the aqua business but later, after completing the integration of the R&D teams, we may see probiotic lines for swine, poultry or pet food which will benefit Neovia's other subsidiaries."

Epicore is well known in industry for its liquid larval feed while within the Neovia group, Bernaqua produces microencapsulated larval diets. Waty explained the integration of these products. "The feeds use totally different technologies, but both are close to reaching total replacement of *Artemia*. Perhaps, we can in the future, think of using microencapsulation of the liquid feeds."

Backing with core expertise

One might say that genetics is the missing link in Neovia's group mission to provide total solutions in aquaculture. Waty said that while it provides global solutions at the farm levels, backstage, Neovia's R&D teams are working with a strategic partner to match feeds to new genetic lines. "We give them support to find the right feed, matching feed formulation with the right feed additives to achieve their target or potential of their growth or resistant lines. We are not here to sell live animals but to help with the genetics as they are not nutritionists."

In the core business, aquafeeds, Neovia is active in Asia; India, Bangladesh, the Philippines, Indonesia, Malaysia and Vietnam with the Ocialis brand. In the first five countries, it imports shrimp feeds from Vietnam. In Indonesia and the Philippines, there is already fish feed production and diversification into shrimp production will begin soon. "We are entering India with feed production as we want to play a larger role in industry there. We are also importing feeds into Bangladesh. China is an important market, but we need to find a right partner with the right fit. We recently did an acquisition of a Chinese pet food company and this is a stepping stone into the Chinese market."

"We have moved away from just being a feed producer. We are so strong here in Latin America and we want to apply the knowledge we have to Asia. After all, the vannamei shrimp came from there. We feel we need to use this advantage to benefit farmers in Asia."

De Roquefeuil gave an insight into his acquisition trail. "We will definitely look out for and target suitable solutions to further enrich the aquaculture portfolio of Neovia. This is Patrick's role. Our development will be always on two legs; one leg is acquisition and the other, organic growth. With Epicore, we need to first integrate knowledge on probiotics, with expertise of our R&D team in Neovia to bring in-house new product developments."

"Aquaculture is a key business for the Neovia group. The future is also in Asia and Africa where with the strong need to develop fish and shrimp farming, there will always be a need for solutions to increase farm efficiency."

Improving health management in aquaculture

By Viviane Verlhac Trichet and Bent Pedersen

Optimal nutrition is a key element as most prevention measures would be given via feed.

Health management in aquaculture is targeted at the prevention of fish and shrimp diseases, which are caused primarily by the intensification of production and the drive for increased return of investment. Intensification of farming helps to meet the seafood demand for local consumption as well as for export.

Since its beginning, aquaculture has experienced production challenges which have contributed to increased mortalities, with adverse effects on the quantity and quality of the products, and considerable economic losses.

Diseases are, in general, difficult to prevent and control. This is especially true for aquaculture for various reasons such as:

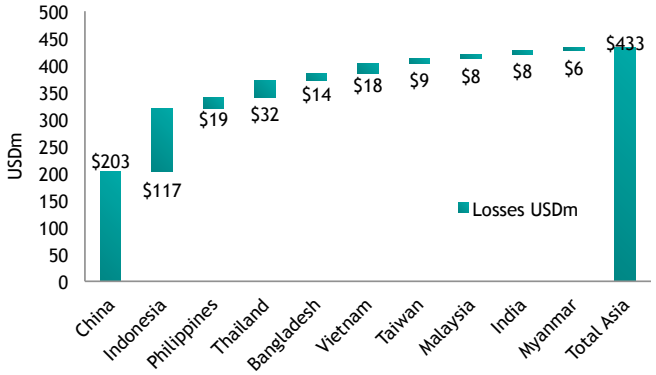
- the rapid spread of pathogens in the water,
- the weak immune defence system when targeting a specific pathogen which could also limit the potential success of vaccination,
- the difficulty to feed sick animals in the water environment, rendering therapeutic treatment quite difficult,
- the concern of using therapeutics such as antibiotics in the water environment.

What does it mean for the aquaculture industry today?

- To be successful with intensive farming, the aquaculture industry needs to be able to operate under increasingly stringent environmental constraints. Quick solutions, such as those involving the excessive use of antibiotics, have detrimental impacts, not only on the environment, but also on the profit and the market acceptance of farmed fish.
- To be successful with intensive farming, the aquaculture industry needs to minimize mortality and improve fish welfare by adopting a complete shift to prevention of stress and disease.
- To be successful with intensive farming, the aquaculture industry needs to increase farm efficiency and to achieve optimal farming condition.

Disease is a major issue in aquaculture today

The Food and Agriculture Organization of the United Nations (FAO) estimated that globally, losses in the aquaculture industry amounted to USD 6 billion/year. The impact of disease increases dramatically with the intensification of aquaculture production. Current massive increase in losses associated with disease outbreaks are partly due to inappropriate biosecurity systems and short-term business perspectives. As an example, streptococcal-based infections led to losses in excess of USD 400 million per year for the Asian tilapia industry, as estimated by Andy Shinn (DSM Aquaculture Conference, Bangkok 2015; Figure 1).



Assuming 7.5 % mortality rate for all countries, except Bangladesh and Philippines at 3.5 % due to lower harvest weights. Asian tilapia price of USD/kg 1.66. Aquaculture volumes for 2015 from GOAL survey 2015 (Global Aquaculture Alliance)

Figure 1. Estimated losses due to streptococcal infections in Asian tilapia industry (USD million). Source: Shinn et al. Aquaculture and Asia Pacific. Jan/Feb 2016. Ragnar Tveteras, GOAL survey 2015.

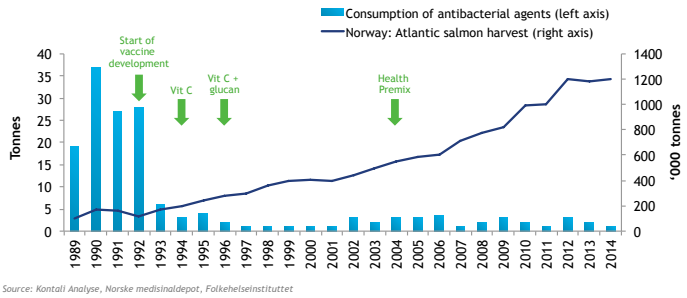
Indeed, the average mortality rate in the Asian tilapia industry has been estimated at around 7.5% which, volume wise, represents more than 250,000 tonnes of tilapia lost every year. Local disease situations vary considerably because of the difference in disease pressure due to different environmental conditions, husbandry techniques and biosecurity systems.

We have gone a bit further in the understanding of what this means in terms of financial losses. When considering an average mortality/loss of 7.5% in the Asian tilapia industry with a given feed conversion ratio of 1.6 as average, we can easily estimate the average loss per tonne of feed. The average exceeds USD 50 per tonne of feed which gives us the motivation to consider investing in disease prevention. This demonstrates the enormous opportunity for the warm water aquaculture industry to embrace an approach of disease control through prevention. DSM Nutritional Products spent many years of R&D to develop a health premix solution to alleviate stress and disease in aquaculture. This has primarily addressed the disease problems in the salmon industry.

Example from the salmonid aquaculture industry

In the salmonid aquaculture industry, since many years, the focus is fully on the prevention of stress and diseases, via health support through optimal feeding of functional micro nutrients. Nowadays, this is well established and has become common practice with measurable benefits. The first measure which has been targeted for more than 20 years, is to minimise the use of antibiotics because of environmental concerns and the rather low feed intake by sick fish.

The objective of the salmon industry was, at that time, to minimise the impact of stress and diseases with a minimal use of antibiotics. Presently, micronutrient combinations supporting immune functionalities have been successfully developed into very efficient and widely implemented practices (Figure 2). Today, all salmon feed producers have developed a functional- or health feed and health promoting diets are used as a standard part of farm management towards disease and stress control.



Source: Kontali Analyse, Norske medisinaldepot, Folkehelseinstituttet

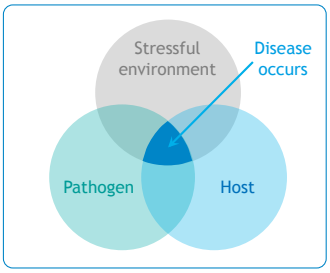
Figure 2. The reduction in the use of antibiotics is concomitant with the development of vaccines and functional feeds to prevent disease occurrence by reinforcing fish defences.

A rationale for field application of health solutions in warm water aquaculture

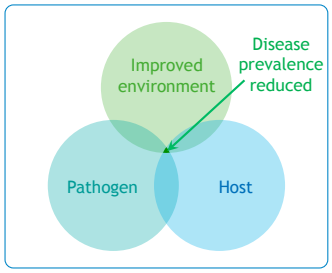
There is a need to reduce the impact of stress and diseases, primarily by supporting the fish immune defences to lower mortality rates and to reduce loss of performance so as to achieve an overall efficient and cost-effective way of managing health and optimal growth. This will significantly reduce the use of antibiotics, and improve the perception of fish farming and enhance consumer acceptance. Together with improved animal welfare, the overall sustainability profile of the industry will be raised.

How to reduce disease occurrence by minimising stress

Figure 3 illustrates the relationship between stress (the environment), the host (fish and shrimp) and the disease (pathogen). A stressful environment caused by various factors described in Figure 4 (water quality, transport, handling etc) induces the proliferation of existing pathogens due to a weaker defence system of the aquatic animal. Such situation leads to the development of disease. The prevalence of such diseases could be reduced by improving the environment of the animal, especially by reinforcing its natural defences. The host might be capable of controlling the proliferation of pathogens by activating its defence mechanisms. Such mechanisms could be even more powerful if the environment of the host is improved for example via better sanitary conditions and water quality.



A stressful environment induces pathogen proliferation due to a weaker defence system of the fish, leading to the occurrence of disease.



In an improved environment created by reinforcing the defence of the fish, the host is able to control pathogen proliferation and the risk of occurrence of disease is minimized.

Figure 3. Link between stress and occurrence of disease.

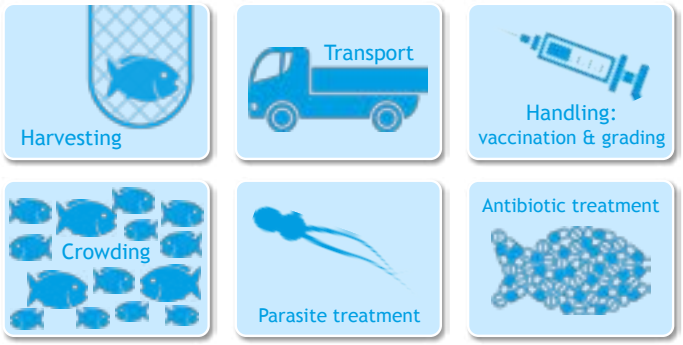


Figure 4. Examples of stress situations.

General concept of immune modulation

The development of health solutions within DSM has been based on the prerequisite that good performance could only be achieved by maintaining a good health status of the animals. There is therefore a need to to develop better defence mechanisms (innate and specific immunity) to alleviate the immune-depression consecutive to stress, to increase the capacity of the animal to fight disease and to improve the efficiency of vaccines which contribute to the prevention of some diseases.

The key success factor in the development of this concept of immune modulation is to achieve a synergism between substances which modulates different immune functions. These

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include phagocytosis, immune cell proliferation and natural cytotoxicity which are key elements of an optimal health status (Figure 5).

The general principle of this development is to target preferentially innate immune functions as they constitute the first line of defence. They are prompt to react against the premises of an infection - like the functions of phagocytic cells, the natural cytotoxicity and the protection of immune cells against auto-oxidation. This is achieved by combining antioxidant vitamins acting at different levels of the cell compartments, and beta glucans. To also guarantee a good turnover of cells acting at the different sites of inflammation and infection, the proliferation of cells is also enhanced via nutritional solutions using nucleotides. This could also contribute to better vaccine efficiency by targeting the proliferation of lymphocytes. The multi-component approach is illustrated in Figure 5.

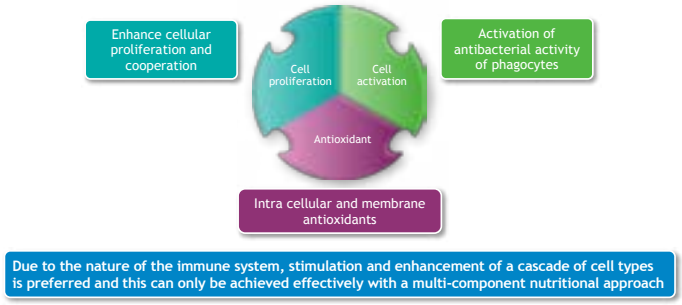

Figure 5. Synergism between substances which can modulate different immune functions.

Conclusions and recommendations

There is no doubt that the aquaculture sector needs to give higher priority to disease prevention to guarantee its sustainable development. In particular, since it is foreseen to be a major protein source to feed 9 billion people in 2050.

Optimal nutrition is a key element as most prevention measures would be given via feed. Optimal disease prevention should start with best management practices including good water quality and good sanitary conditions accompanied by good nutrition through dietary supplementation to support the defense system. This will minimise the consequences of stress and enhance the functionality and nutritional value of aquafeeds for intensive production.

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How phytobiotics reduce Vibrio counts and alleviate AHPND in white shrimp

By Niti Chuchird, Arunothai Keetanon, Cristina García-Diez, Álvaro Rodríguez Sánchez-Arévalo and Antonio Martínez

Reducing Vibrios in the gut improves survival rates during AHPND outbreaks

Early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND) has been causing severe economic losses since it was first reported in 2009 in China. The disease has spread quickly in Southeast Asia and was first reported in Central America in 2013. EMS/AHPND is caused by a singular type of *Vibrio parahaemolyticus* that contains an extrachromosomic plasmid encoding two toxins (pirA and pirB) which are responsible for causing high mortalities, at approximately 80% as early as 1 month after pond stocking. Usually the farmer is obliged to abandon the crop or harvest immediately.

The disease has two distinct phases: an acute phase and a terminal one which ends with the destruction of the hepatopancreas by opportunistic *Vibrio* spp. It can be detected through significant atrophy of the hepatopancreas which appears pale, yellowish or white and does not squash easily between the thumb and first finger. Furthermore the affected shrimp become lethargic and susceptible to secondary infections.

For several years, large efforts are ongoing with considerable resources worldwide to tackle the negative impact of the disease which is not yet fully understood, making it very difficult to manage and find a solution. Therefore, many approaches and suggestions have been made, the most important being a holistic management: water treatment, biosecurity, density, feed, salinity, etc.

Phytobiotics, produced from herbs and organic acids are known to be effective immunoboosters. They help the animals grow better because of the functional properties of the compounds in the gut. The synergistic effect of organic acids with essential oils are able to disrupt the cell membrane of pathogens. The herbs are substrates of saprophytic flora and help to increase population and avoid colonisation of pathogens by competitive exclusion.

Growth and survival

Between October and December 2017, an experiment was conducted to investigate the effect of using a phytobiotic made with organic acids, plants and essential oils on growth and survival of specific pathogen free Pacific white shrimp *Penaeus vannamei*. The phytobiotic used in this trial is commercially known as Liptofry shrimp (Liptoaqua-Liptosa, Spain). The duration of the experiment at Kasetsart University, Thailand was 30 days.

The study started with post larvae (PL10) transported from the hatchery and acclimated for 2 days in fibreglass tanks at the Aquaculture Business Research Centre (ABRC) laboratory, Kasetsart University, Thailand. Six fibreglass tanks (500 L) were used in this experiment and shrimp were stocked at a density of 50 shrimp/tank (100 PL/m^2). Salinity during the acclimation period and experiment was maintained at 25 ppt.

The phytobiotic in fish oil was top dressed on a commercial feed (Charoen Pokphand, Thailand, CP) containing 36% crude protein, 5% lipid and 4% ash. Feed pellets were dried for 15 minutes. There were two experimental groups with three replicates each. The treatment group had phytobiotic supplemented at 2 g/kg for the first 2 weeks and then 5g/kg until the end of trial.

Shrimp were fed four times daily to satiation according to a standard feeding rate. Water quality parameters, pH, dissolved oxygen (DO), ammonia and nitrite were measured weekly throughout the experimental period. Measurements were: DO at 6.6 mg/L, pH at 8.07, alkalinity 152 mg/L, NH_3 at 1.3 mg/L and NO_2 at 0.16 mg/L

After 30 days, shrimp were weighed. Growth (Figure 1) and survival rates (Figure 2) of the shrimp were statistically compared. (Data is presented as mean ± standard deviation, means in the same column with different superscript are significantly different from each other, P>0.05). Shrimp fed with phytobiotic showed significant differences (P>0.05) in survival rate, average body weight and feed conversion ratio (FCR, Figures 1, 2 and 3).

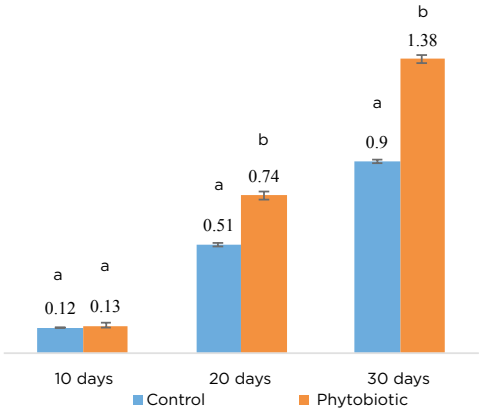

Figure 1. The average body weight (g) of Pacific white shrimp at 10, 20 and 30 days of feeding.

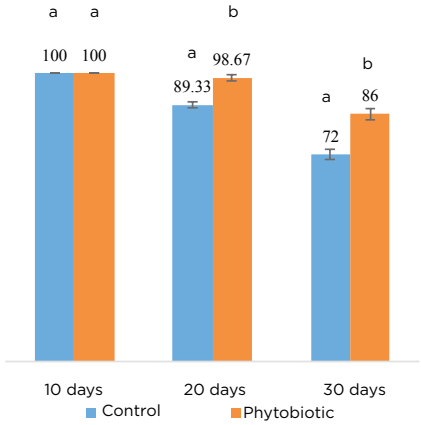

Figure 2. The average survival rate (%) of Pacific white shrimp at 10, 20 and 30 days of feeding.

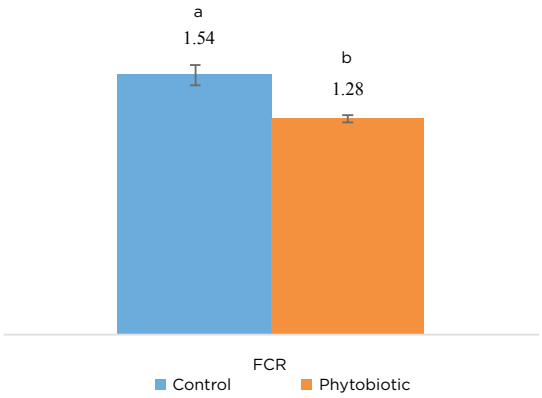

Figure 3. The average feed conversion ratio of Pacific white shrimp.

Bacteria counts

Results showed a direct relationship with the total number of *Vibrio* spp count. The total number of Vibrio spp. in the gut of shrimp at day 0 and 30 is shown in Figure 4 with colonies differentiated between yellow and green. At day 30, shrimp fed with phytobiotic had lower green and yellow colonies than the control group. There was a significant difference (P>0.05) among both groups.

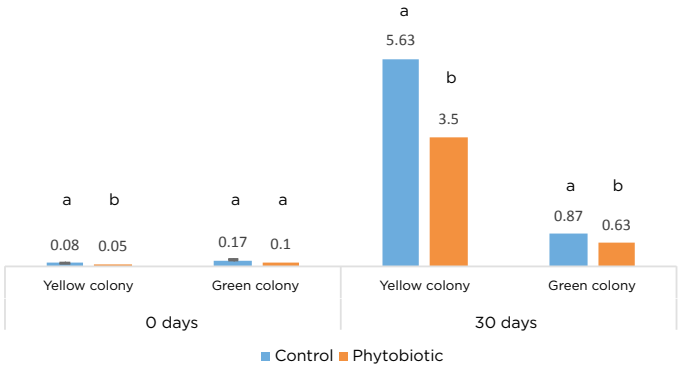

Figure 4. The average total number of green and yellow colony (x10^2 CFU/mL) of Pacific white shrimp at 0 and 30 days of feeding.

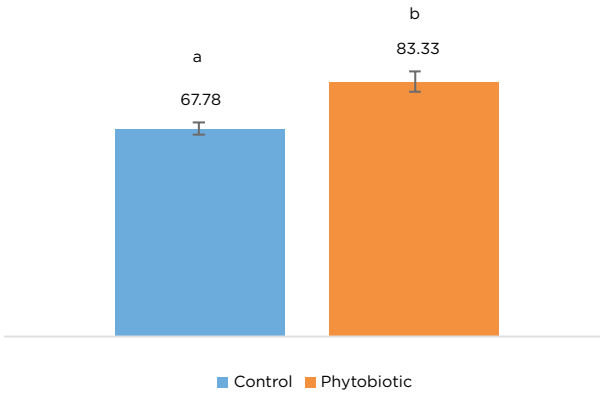

Figure 5. The average survival rate (%)

Challenge with *V. parahaemolyticus*

After the 30-day feeding trial, *V. parahaemolyticus* causing EMS which had been cultured in tryptic soy agar (TSA) with 1.5% NaCl was added into each tank at a dose of 10^4 CFU/mL. After 7 days in the challenged trial, shrimp fed with phytobiotic had a higher average survival rate (Figure 5) than the control showing significant differences between groups (P>0.05). The data are shown in Table 5 After the *V. parahaemolyticus* challenge test, the total number of *Vibrio* spp, vibrio green and yellow coloniesalso showed significant differences in the control and phytobiotic group (P>0.05).

Table 1. The total *Vibrio* spp. count green and yellow colony (x10^5 CFU/mL) of Pacific white shrimp of feeding after challenging with *V. parahaemolyticus* at 7 days

Treatment	Total number of *Vibrio* spp (x10^5 CFU/g)		
	Yellow colony	Green colony	*Vibrio* spp.
Control	0.11±0.00^d	1.5±0.01^e	1.61±0.15^e
Phytobiotic	0.02±0.00^b	0.15±0.00^c	0.17±0.00^c
Data are presented as mean ± standard deviation, Means in the same column with different superscript are significantly different from each other, P>0.05).			

Conclusions

A holistic approach should be adopted at the very first moment the farmer receives post larvae and stocks them in the pond, especially in an intensive culture system with high densities. One aspect that has to be taken into consideration is prevention of diseases through gut health. When using phytobiotics at the early stage (PL10) of grow-out the farmer starts combating and preventing Vibrio outbreaks, such as AHPND/EMS. Shrimp fed with phytobiotic showed significantly different results (P>0.05) in the three parameters studied: survival rate improved 19%, total average body weight was 53% higher than the control group and FCR was 20%.

The inclusion of phytobiotic in the diet has a clear effect on the total *Vibrio* spp (green and yellow colonies) counts in shrimp, reducing the counts progressively along the days of culture. This has a direct relation with survival rate during the culture period.

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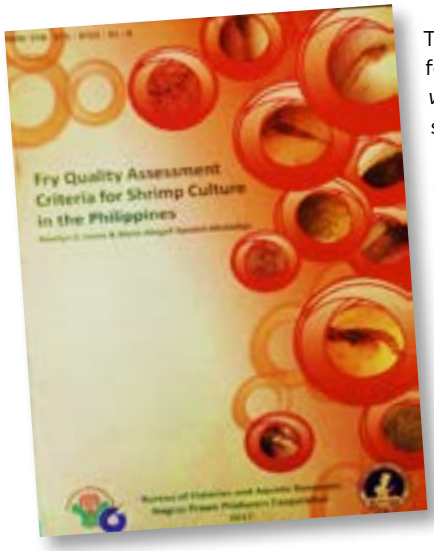
Manual on Fry Quality Assessment Criteria for Shrimp Culture in the Philippines

By Roselyn D. Usero and Abegail Apostol-Albaladejo



The aim of this manual is to provide guidelines and the system for best quality post larvae (PL) for stocking in ponds. Two separate parts cover post larvae quality assessment for *Penaeus vannamei* and *Penaeus monodon*. The authors worked with hatchery operators and farmers who shared data and criteria. The work is part of the HIPON program initiated by BFAR and Negros Prawn Producers Cooperative (NPPC). Criteria for P. vannamei were documented over 2014-2017 covering 120 ponds from 6 farms with harvest results: days of culture 91-100; average body eight (ABW) 21g and stocked at 80-100PL/m^2. The crop performance data backed up the fry quality criteria developed.

The book details sampling for microscopic, bacterial and PCR analysis. The first level of screening includes molecular (PCR for detection of pathogens-white spot syndrome virus (WSSV), *Enterocytozoon hepatopenaei* (EHP) and early mortality syndrome (EMS) followed by microscopic (total body length, lipid vacuoles in hepatopancreas, presence of filamentous bacteria and other protozoans in gills, necrosis, gut and muscle ratio and rostral appendages. Attention was given to rostral spines and appendages as unhealthy post larvae may have morphological age less than hatchery age. *Vibrio parahaemolyticus* is included in the bacterial analyses. In the case of *P. monodon*, Monodon Baculovirus (MBV) is included in the pathogen analyses. Photomicrographs of each stage of the post larvae are provided.

The first screening starts at <PL8 and second at PL10 for the vannamei post larvae. For monodon post larvae, the first screening is at PL 9-10 and the second at PL13-PL14. There is also a section on mechanics in fry sourcing and delivery. In all, there are three layers of screening; the first is the responsibility of the hatchery operator, the second and third by the farmer. NPPC staff will collect the sample at the hatchery. This manual serves as a guideline for hatchery operators and farmers before committing to a purchase. More information: mariaabegail11@yahoo.com/ r.usero@yahoo.com

How to improve the detrimental effects of low fish meal and fish oil diets in sea bream

By Cinta Sol and Mónica Puyalto

The potential of dietary sodium butyrate to reverse such effects was investigated in gilthead sea bream.

Aquaculture is probably the fastest growing food production sector in many countries around the world. The high demand for fish oil and fish meal along with their limited availability affects the supply and demand balance and leads to higher prices (Tacon et al., 2011). As a result, terrestrial plant-based products (vegetable oil and vegetable meal) are alternative ingredients to replace fish oil and fish meal because of their high availability and lower cost (Tacon et al., 2008).

As a carnivorous fish, gilthead sea bream *Sparus aurata* requires a high level of fish meal in its diets to provide an ideal amino acid profile and reach high digestibility and growth. Fish meal substitution with plant protein sources in sea bream diets is necessary to maintain the profitability of the farms. However, plant protein sources contain certain undigestible components such as non-starch polysaccharides (Morris et al., 2005) and antinutritional factors such as protease inhibitors, lectins, phytic acid, saponins, phytoestrogens, antivitamins and allergens (Francis et al., 2001). These compounds can affect nutrient digestibility and absorption (Santigosa et al., 2011), as well as gut integrity (Sitjà-Bobadilla et al., 2005; Dimitroglou et al., 2010), changing the gut microbiota in terms of microbial abundance and species richness.

Despite of the above mentioned, several studies have demonstrated a successful replacement of marine feedstuffs at relatively high levels in many fish species, including salmonid and non-salmonid fish (Regost et al., 2003; Benedito-Palos et al., 2007; Karalazos et al., 2007; Torstensen et al., 2008). The positive impact of the early feeding of a plant-based diet on its future acceptance and utilisation was reported by Geurden et al. (2009). However, low fish meal inclusion levels remain associated with poor growth and survival in different fish species (Gómez-Requeni et al., 2004; Welch et al., 2010; Medale et al., 2013; Baeza-Ariño et al., 2016). Likewise, when there is a low fish oil inclusion level, the nutritional value of farmed fish is compromised by a low content of ω-3 long-chain polyunsaturated fatty acids (Benedito-Palos et al., 2009; Ballester-Lozano et al., 2014). Thus, a better understanding of the long term physiological consequences of plant-based diets or other alternative feed ingredients is imperative if aquaculture sustainability is to be improved. At the same time, there is an increasing interest for fish feed additives to prevent or repair adverse effects of extreme diet formulations, which might result in impaired growth, enteritis or immune-suppression (Krogdahl et al., 2003; Gatlin et al., 2007; Knudsen et al., 2008).

Butyrate

One promising feed additive is butyrate, a salt of short chain-fatty acid (SCFA) produced by bacterial fermentation of undigested carbohydrates. The additive has received special attention for its positive effects on gut health in humans and livestock animals (Guilloteau et al., 2010). The potential to influence a wide array of cellular functions such as the inhibition of inflammation and carcinogenesis, reinforcement of various components of the colonic defense barrier, amelioration of mucosal inflammation and oxidative status have been reported in humans and animals (Roy et al., 2009; Hamer et al., 2010; Ortiz et al., 2015). Likewise, dietary butyrate also shows positive influence on performance and composition of intestinal microbiota, as well as epithelium integrity in growing pigs (Galfi and Bokori 1990; Kotunia et al., 2004) and chickens (Puyalto et al., 2015 and 2016; Sol et al., 2016).

The use of SCFA as an alternative to antibiotics is a subject of increasing research interest in aquaculture (Luckstadt, 2006). Presently published studies on the effect of butyrate on fish, however, are still very scarce.

Effects of dietary supplementation

Accordingly, Estensoro and co-workers (2016) have been studying whether butyrate supplementation has the potential to exert benefits upon the intestine of gilthead sea bream fed extremely low fish meal and fish oil diets.

One trial (T1) was performed to define the best-effective butyrate dose, mostly based on the effects on growth performance and hepatic and intestinal histopathology. Juvenile gilthead sea bream were fed diets containing 20% fish meal, 10% fish oil and graded levels of a commercial sodium butyrate preparation (0%, T1-diet D1; 0.2%, T1-diet D2; 0.4%, T1-diet D3; 0.8%, T1-diet D4), over a 9-week duration. The additive is a partially protected sodium butyrate, with 70% of sodium butyrate and 30% of fat (NOREL, SA). This amount of fat allows the active principle to be active along the entire gastrointestinal tract.

The results are presented in Table 1. Fish grew efficiently from 26–27g to 74–79g regardless of the butyrate supplementation level. The gut index was significantly higher in fish fed the diet with the highest butyrate dose (D4) than in the remaining fish groups. Blood haemoglobin concentration was not significantly altered. However, plasma glucose increased with butyrate supplementation with a maximum in fish fed the intermediate level (0.4%, diet D3), which was significantly different from values found in the control group. A similar pattern was found for plasma cortisol, although the trend was not statistically significant.

Table 1. Dose dependent effects of sodium butyrate on growth performance and blood parameters in trial T1.

Treatment diets	D 1 (0%)	D 2 (0.2%)	D 3 (0.4%)	D 4 (0.8%)	P-value
Parameter					
Performance					
Initial body weight	26.6	26.6	26.6	26.8	0.932
Final body weight	74.6	73.8	78.0	78.7	0.513
FI (g DM/fish)	54.7	51.7	55.1	58.5	0.167
FCR (%)	1.09	1.07	1.12	1.19	0.320
Viscera Weight (g)	4.99 ^{a}	4.96 ^{a}	5.14 ^{a}	5.64 ^{b}	0.027
GI	8.16 ^{a}	9.17 ^{a}	9.47 ^{a}	13.2 ^{b}	0.050
SGR	1.74	1.71	1.73	1.72	0.918
Plasma parameters					
Haemoglobin (g/dL)	9.23	9.17	9.36	9.27	0.997
Glucose (mg/dL)	46.4 ^{a}	49.9 ^{ab}	53.7 ^{b}	51.3 ^{ab}	0.024
Cortisol (ng/dL)	5.70	5.70	6.43	6.68	0.364

FI, Feed Intake; FCR, Feed Conversion Ratio = 100 x (dry feed intake/wet weight gain); GI, Gut Index = 100 x (fish weight/ intestine length^{3}); SGR, Specific Growth Rate = 100 x (ln final body weight - ln initial body weight)/days (Source: Estensoro et al., 2016)

Long term effects

Considering those results, T1-D3 dose (0.4%) was selected to include in a second trial (T2) with an extremely low fish meal/ fish oil diet to test the long-term effectiveness in preventing an inflammatory condition or other metabolic dysfunctions. Juvenile fish of 15–16g initial body weight were fed for 8 months with four experimental diets. Fish meal (FM) was added at 25% in the control diet (T2-D1) and at 5% in the other three diets (T2-D2, T2-D3, T2-D4). Added oil was either fish oil (FO, T2-D1) or a blend of plant oils (VO) replacing 58% (T2-D2) and 84% (T2-D3, T2-D4) of the fish oil (FO). Protected sodium butyrate was added to T2-D4 diet at 0.4%.

The results showed that the extreme diet (T2-D3; 5% FM + 84% VO) modified significantly the transcriptomic profile, especially at the anterior intestine, up-regulating the expression of inflammatory markers. This was in coincidence with a higher presence of granulocytes and lymphocytes in the submucosa, and changing genes involved in antioxidant defenses, epithelial permeability and mucus production.

Previous experiments in gilthead sea bream (Benedito-Palos et al., 2016), with similar diets, showed that low inclusion levels of fish meal reduced plasma haemoglobin levels, but these effects were reversed by butyrate supplementation (0.4%). Moreover, butyrate supplementation reversed the up-regulated expression of inflammatory cytokines and muscle markers of cellular morphogenesis and protein breakdown in the muscle of fish fed the extreme diets.

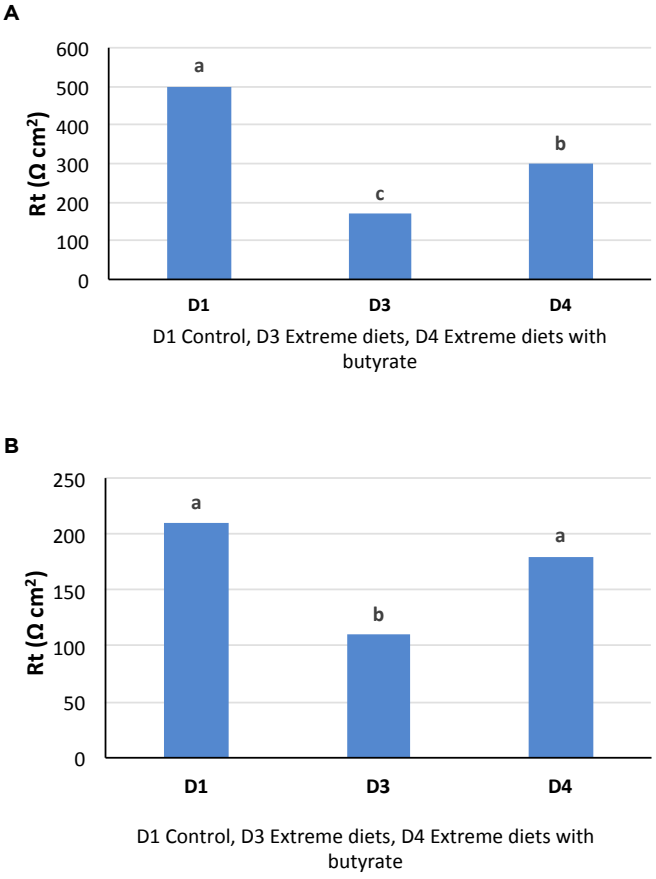


Figure 1. Trans-epithelial electrical resistance (Rt) of the anterior intestine of gilthead sea bream from T3. A: fish from T3-A (mean weight 1,420g): B: fish from T3-B (mean weight 249g). Data are given as the mean ± SEM of the tissue resistance along the 120 min of *in vitro* experiments with Ussing chamber. Groups displaying different letters are significantly different ($P < 0.05$) (Source: Estensoro et al., 2016).

In the third trial (T3), two groups of fish were fed for 12 (B) and 38 (A) months with T3-D1, T3-D3 and T3-D4 diets of T2. The effects of dietary changes were studied using electrophysiological tools.

The results of trans-epithelial electrical resistance (Rt) showed that large fish (T3-A) showed higher Rt values than small ones (T3-B), regardless of the diet group. Dietary treatment induced modifications of the Rt in both T3 groups, as D3 fish (extreme diets) had significantly lower tissue Rt than fish fed the control diet (D1). The decrease was higher in large fish fed D3 for 38 months than in small fish fed D3 for 12 months (~3.5-fold decrease vs ~1.9 fold decrease). Butyrate supplementation (D4) improved tissue integrity, resulting in intermediate trans-epithelial electrical resistance (Rt) values in both size groups, though only reaching D1 values in T3-B.

Conclusions

The transition from fish meal/fish oil diets towards plant-based diets is highly challenging and the effects of plant ingredients have been extensively studied (Turchini et al., 2009; Collins et al., 2013). Previous studies using dietary butyrate to avoid the negative effects of low fish meal/fish oil diets, in different fish species, have achieved improvements in growth and feed utilisation (Rimoldi et al., 2015); but in others did not produce any change in growth performance. There were changes in the expression of genes related to mucosal protection and inflammatory response (Terova et al., 2016).

In the present study, the result of trans-epithelial electrical resistance was decreased in T3-D3 (5% FM + 84% VO); however, these modifications returned to control values with the addition of protected sodium butyrate T3-D4 (5% FM + 84% VO + 0.4% sodium butyrate).

These results further confirm the potential of this additive to improve or reverse the detrimental effects of extreme fish diet formulations with reduced levels of fish meal and fish oil.

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A natural mix of free amino acids enhances shrimp feed intake and growth

By Guillaume Le Reste, Pierrick Kersanté and Luxsanawadee Soonngam

Pond and laboratory trials showed that this unique mix of L-amino acids has a clear potential to improve feed palatability for the white shrimp.

The lower inclusion of marine products in shrimp feed can lead to a lower feed intake in shrimp. White shrimp *Penaeus vannamei* is known for its appetence for marine products such as cephalopods, molluscs, fish and crustaceans. Due to the costs and the scarcity of such raw materials, feed formulators have to reduce their inclusion rates and to find alternative ingredients.

Functional ingredients can be interesting for their chemical composition (protein, fat, ash, etc.) as well as for their non-chemical characteristics. This is the case with hydrolysates containing active peptides or other raw materials with binding capacities. Palatability enhancers are part of this category.

In this context, Kera-Stim 50® (BCF Life Sciences, France) appears as an interesting candidate for shrimp feed formulas (Table 1). It comprises 50% amino acids (92% of which are free amino acids) and is an innovative and sustainable mix of amino acids obtained through a unique and extensive keratin hydrolysis process. It contains 100% of L form amino acids. In this article, we described results from three trials conducted to test the efficiency of this amino acid mix when included in shrimp feed.

Trials

Three successive trials were carried out at the Neovia Nha Be Research Centre in South Vietnam (Table 2). Shrimp used were healthy white shrimp juveniles weighing 4 to 6g (see Table 2 for details). The objective of trials A and B was to test two doses of Kera-Stim 50® (5kg/tonne of feed and 10kg/tonne of feed) in different systems. Trial A was conducted in cages placed in a brackish water pond in order to mimic farm conditions. In such an environment, pond natural productivity can have a big impact on the final outcome. In order to compare product efficiency and eliminate the influence of natural productivity in trial A, it was decided to launch a second set of tests in 160-L glass tanks where natural production was close to zero. In these trials, the amino acid mix was sprayed on the control feed (Table 3). To do so, a fixed quantity of the product was mixed with a fixed quantity of water (ratios 3:5 and 2:5 respectively). This solution was sprayed with a hand-held sprayer onto the feed in a mixer. Mixing lasted 6 minutes.

A third study (trial C) was carried out to measure the effect of the product when mixed with other raw materials prior to pelleting. For this application, only one dosage was tested. We decided to use this dosage based on the results of trials A and B. As growth improvement was not significantly different between K0.5% and K1%, we only tested the 5kg/tonne of feed dose.

In each trial, shrimp were fed twice a day to apparent satiation. Feed left on feed trays in each cage or glass tank was collected and weighed in order to calculate daily feed intake (DFI) and feed conversion ratio (FCR). The proximate composition of feeds used is described in Table 3. Water quality parameters were checked regularly throughout the experimental period. There were eight replicates for each treatment in each trial.

Table 1. Composition of Kera-Stim 50®

Composition	%
Dry matter	98.4%
Total amino acids (CE 152/2009)	50.4%
Free amino acids (CE 152/2009)	47.3%
Crude ash	43.8%
Sodium	18.6%
Chlorides	26.8%

Effect of top dressing of pellets

Results of trial A and trial B where the amino acid mix was coated onto pellets are presented in Table 4. During the test, water quality parameters (temperature, dissolved oxygen, turbidity, ammonia, pH, nitrite, nitrate, alkalinity) and survival rates between 78.9% and 93.8%, conformed with results previously obtained in such systems. FCR in trial B (glass tank) was roughly 50% higher than in trial A. This difference was probably linked to the absence of natural production in glass tanks. Interestingly, specific growth rate in trial B was significantly enhanced by the use of Kera-Stim 50®. This improvement was higher in the K0.5% group.

Table 2. Summary of experimental design used in trials A, B and C

Trial	Kera-Stim 50® Application	System	Treatments	Initial body weight (g)	Shrimp/ group	Replicates (n)	Duration (days)
A	Coating	2.5 m³ cages in a pond	Control	4.06	1,600	8	49
			K0.5%				
			K1%				
B	Coating	Glass tank 160 L	Control	5.11	144	8	42
			K0.5%				
			K1%				
C	Inclusion before pelletizing	2.5 m³ cages in a pond	Control	5.83	1,280	8	38
			K0.5%				

Table 3. Proximate composition of feed used for trials A, B and C

Ingredients (% as fed basis)	Trial A	Trial B	Trial C
Marine products	15.7	14.2	14.3
Protein	41.0	41.9	43,2
Fat	7.1	7.3	7.6
Ash	12.4	11,0	12.7
Phosphorus	1.8	1.5	1.8

Table 4. Performance of shrimp in trials A & B. Data are means ± SE. Different letters in the superscript indicate significant differences between treatments (Duncan's test, P<0.05)

Trial	Treatment	Weight gain (% over initial body weight)	SGR	Survival (%)	FCR
A (in cages)	Control	259.7 ± 12.0	2.61 ± 0.07	78.87 ± 6.2	1.52 ± 0.09
	K0.5%	263.8 ± 12.1	2.63 ± 0.07	80.62 ± 5.0	1.54 ± 0.10
	K1%	259.1 ± 12.4	2.61 ± 0.07	82.19 ± 4.7	1.60 ± 0.09
B (in tanks)	Control	101.8 ± 8.5	2.00 ± 0.12 ^{a}	88.1 ± 6.8	2.38 ± 0.15
	K0.5%	119.3 ± 12.2	2.24 ± 0.16 ^{bc}	93.8 ± 4.6	2.27 ± 0.10
	K1%	111.1 ± 9.2	2.13 ± 0.13 ^{ab}	83.3 ± 15.1	2.43 ± 0.25

Daily feed intakes by shrimp in treatment groups K0.5% and K1% were higher in both trials A and B independent of the dosage of Kera-Stim 50® used (Figure 1). A dose effect was apparent in trial A in which shrimp fed the feed containing 10kg/tonne of the amino acid mix consumed 5.2% more feed than those fed with the control diet.

We attributed this result to the ability of this amino acid mix to act as a palatability enhancer in vannamei shrimp diets. This characteristic is probably linked to its composition. L-amino acids are among the few compounds known to stimulate diet intake in aquatic animals (NRC, 2011).

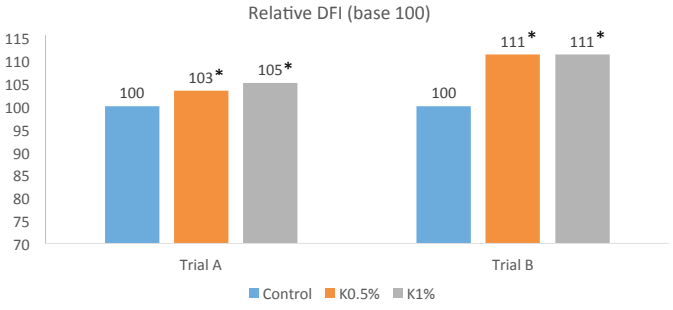

Figure 1. Relative daily feed intake (DFI base 100) of shrimp in trial A (cages in a pond) and trial B (glass tank). * indicates significant differences between treatments (Duncan's test, P<0.05)

Effect of inclusion into pellets

Shrimp fed with Kera-Stim 50® incorporated at 0.5% in the pellet had a significantly better growth (Figure 2). FCR also improved in the K0.5% treatment. Contrary to previous trials, feed intake did not increase with the inclusion of the product in the raw material mix before pelleting.

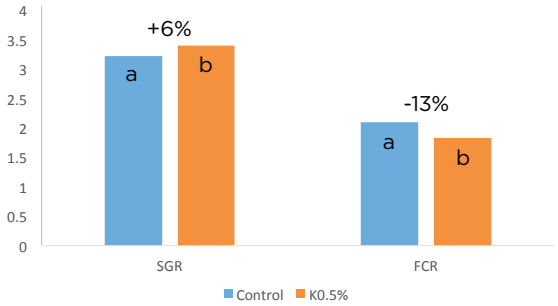

Figure 2. SGR and FCR in trial C (Kera-Stim 50® incorporated in the feed at 0.5%). Different letters in the superscript indicate significant differences between treatments (Duncan's test, P<0.05)

Trial C results are in line with previous observations. A palatability enhancer is generally more efficient when applied via coating compared to inclusion. When mixed and cooked with other raw materials, the attractability role was reduced. In this context, it is interesting to note that Kera-Stim 50® significantly influences shrimp performance. As a mix of almost completely free amino acids, this ingredient is highly digestible (96.8% digestibility based on cockerel *in vivo* methodology). Such compounds are also digested quite rapidly. The product can be an efficient provider of rapidly available amino acids for the animal.

Conclusions

These series of trials highlighted the interest in Kera-Stim 50® for inclusion into shrimp feed formulations. This unique mix of L-amino acids has a clear potential to improve shrimp feed palatability. In current feed formulations, such attributes can make a big difference by maintaining a satisfying feed intake. Its high content of free amino acids also constitutes an advantage when used as an ingredient in the pellet. Further research is needed to understand how the highly and rapid digestible mix of amino acids in Kera-Stim 50® can improve shrimp growth and FCR under commercial farming conditions.

Furthermore, the product is available in powder form which makes it easy to handle and store in a feed mill. Every batch of product is submitted to a complete range of analysis before it is allowed to leave the factory. This process ensures a very stable and standardised product, easy to formulate with (no need to upload formulation matrix with each delivery).

Its high content of protein and very high digestibility also makes Kera-Stim 50® an interesting ingredient for young animals with immature digestive tracts. This new application will be tested soon.

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New directions with the black tiger shrimp

Return to black tiger shrimp in Malaysia and in Bangladesh, a new push with the availability of SPF broodstock.

On display at Vietfish 2017, Minh Phu's organic black tiger shrimp, size 8-12/kg exported to Australia, Japan and Korea.

In 2017, the shrimp farming industry in many parts of Asia reported a continued decline in black tiger shrimp *Penaeus monodon* production. Estimates of the total production of this shrimp in Vietnam, Bangladesh, India, Indonesia, Philippines, Malaysia and Thailand ranged from 275,000 to 319,000 tonnes, accounting for up to 15% of white shrimp *Penaeus vannamei* and monodon shrimp production (Merican, 2018).

In Vietnam, less black tiger shrimp is being produced as farmers prefer *P. vannamei*. In 2017, the indication was only 30-40% (200,000 tonnes) of total farmed shrimp production. Vietnam has built a reputation in the production of eco-friendly black tiger shrimp. In general, it is farmed in the Mekong Delta at low density (20-30 post larvae (PL)/m^2) and harvested at size 30-40/kg after 120-150 days of culture (DOC). Survival rates are good at 70-80%. "There are a few farmers who stock post larvae from Moana Technologies with success. They harvested large shrimp at size 30/kg in 120-150 DOC. In my opinion, this shrimp has a promising future as post larvae from specific pathogen free (SPF) breeding programs have shown success. It will most likely make a return in farms in Southeast Asia," said Jeff Jie-Cheng Chuang, Sheng Long, Bio-Tech International, Vietnam.

In 2014, industry in India reported a production of 50,000 tonnes of the black tiger shrimp, which declined to 27,450 in 2015 and 21,000 tonnes in 2016. At AquaIndia 2018, industry reported a production of 38,000 tonnes in 2017 and predicted a rise to 40,000 tonnes in 2018 (Balasubramaniam, 2018). The shrimp is mostly farmed in traditional ponds in West Bengal, Odisha and Kerala. However, industry in India noted that there is no chance of a large revival in farming this shrimp, despite the availability of SPF broodstock from Moana Technologies, Rajiv Gandhi Centre for Aquaculture (RGCA), Aqualma in Madagascar, iAqua International and most recently from Charoen Pokphand Thailand. RGCA, the aquaculture arm of the Marine Products Export Development Authority (MPEDA) started marketing domesticated and SPF shrimp broodstock in 2015. It now has generation 4 of SPF broodstock.

In contrast, figures from the 2018 Global Seafood Market Conference (GSMC) Shrimp Panel conducted by the National Fisheries Institute, USA, gave a production volume of more than 50,000 tonnes for the 2016-2017 period. The report added that this shrimp is preferred when vannamei shrimp fails; apparently it is not affected by the early mortality syndrome (EMS) and will not make a comeback unless there is a massive failure in farming *P. vannamei*.

In India, hatchery production of black tiger shrimp post larvae has declined from 1.9 billion/year in 2015 to only 1 billion/year in 2017 (Balasubramaniam, 2018). "No hatchery is consistently producing monodon shrimp post larvae. However, we may see a small switchover to farming of the Indian white shrimp *Penaeus indicus* as it is being popularised by the research arm of the Central Institute for Brackishwater Aquaculture (CIBA). This shrimp is suitable for small and medium size markets." said S. Santhana Krishnan, Maritech, Tamil Nadu, India.

Gradually, the traditional farms all over Indonesia and the Philippines are switching to farm the vannamei shrimp. Farmers depend on post larvae from wild caught broodstock in the Philippines and Indonesia. In Thailand, there is little interest to revert to black tiger shrimp farming. In Taiwan, Dr Grace Chu-Fang Lo is aiming for a revival of its farming in Asia, beginning with Taiwan. She is developing SPF/specific disease resistant (SPR) against white spot disease broodstock and expects to undergo pond trials in 2018 (see pages 21-23).

Markets for black tiger shrimp products

In US markets, Urner Barry's black tiger shrimp index indicated that prices were high in January 2017 at USD8.80/lb but dropped to just below this level in December 2017. As a comparison, the highest price was in 2015 at USD9.50/lb but in the same year, prices dropped to USD6.80/lb (Rubio, 2018). Along with Japan, Europe is a traditional market for black tiger shrimp products. Recently, China has become a major importer, mainly sourcing from Vietnam and India.

For the Taiwan market, black tiger shrimp farmed in Malaysia using post larvae from Madagascan origin broodstock at the 2017 Taiwan International Fisheries and Seafood Show.

At SIAL 2017 in Shanghai, Selva Shrimp®, black tiger shrimp from mangrove ponds in Vietnam, was being marketed to high-end supermarkets chains in China.

Bangladesh is a major supplier to UK, the largest market in Europe at 23%. Other imports to Europe come from Vietnam, Indonesia and India. While suppliers from Bangladesh are increasing, supplies from Vietnam are decreasing, according to a report at cbi.eu. In 2017, it said that Europe expects to import from Myanmar when some administrative issues are completed. The report said that European importers focus on sustainable black tiger shrimp and added that eight Vietnamese companies and two farms in Indonesia have certified FOS (Friend of the Sea) operations. The first Aquaculture Stewardship Council (ASC)-certified black tiger shrimp was available in the Scandinavian market at the end of 2014 and since then countries in northern and western Europe have followed. There are five black tiger farms with ASC certification (four in Vietnam and one in Madagascar).

Return in Malaysia

Malaysia always has a small group of farmers farming the black tiger shrimp producing 6,000 tonnes annually. This then surged to 9,000-10,000 tonnes in 2017, which comprised 27% of the total production of marine shrimp in Malaysia. Prior to 2017, the main source of black tiger shrimp post larvae was from only two hatcheries, one using Moana Technologies broodstock and another using domesticated broodstock from Madagascar. This recent development in 2017 came with the production of post larvae using Thailand's Charoen Pokphand SFP broodstock and several other hatcheries producing post larvae with Moana's SPF broodstock. In the industry, the preference is for post larvae from the Madagascan broodstock which are active and swim in the water column. As this shrimp is usually sold live to markets in China, Singapore as well as local market, active shrimp are preferred.

Despite implementing some changes such as higher rates of water exchange, clearing of sludge and reducing stocking density to around 75 PL/m^2, most farms in Peninsular Malaysia farming the vannamei shrimp have hit a brick wall. The average survival rates dropped to less than 50%. Average harvest sizes have dropped to size 12-13g (size 70-8-/kg) and size 18g (size 50/kg) is now rare.

On the menu at a seafood restaurant in Malaysia, black tiger shrimp at USD 37/kg.

"The key to this recent development is that we have found that we could not manage vannamei shrimp farming well. That is the reason for reverting to the black tiger. With lower stocking, the cost of production is also lower at MYR22.70/kg (USD5.80/kg). Margins are better than with vannamei shrimp The selling price was MYR35/kg (USD8.9/kg) for size 30/kg," said Jeffrey Lee, Kembang Subur.

"Diseases with the black tiger shrimp include white spot syndrome virus (WSSV) and the occasional black gill as the shrimp is a bottom dweller. The stocking density ranged from 30-45 PL/m^2. Growth was to 30 g in 150 days. One farm reported production of 5.5 tonnes/0.4 ha. There were differences in growth between the different sources of post larvae, but overall survival ranged from 70-80%," said Karunanithi, Yogaa Bio Shrimp, who markets products for shrimp farming.

Mohamad Fariduddin Othman from the Fisheries Research Institute (FRI), Department of Fisheries Malaysia said during the Asian-Pacific Aquaculture 2017 Conference that black tiger shrimp are harvested at size 40-45/kg and farms have been gradually moving up to higher density stocking of 50-70 PL/m^2 with these post larvae produced from SPF broodstock. Survival was more than 80% and harvests closer to 10 tonnes/ha/crop were normal after DOC 120. He expects this current trend to pick up if sufficient post larvae supply is guaranteed.

Sample of black tiger, size 45/kg from a farm recently converted from farming the vannamei shrimp in Malaysia

In Bangladesh, harvest of shrimp in hand. Photo credit: Anisur Rahman

SPF broodstock as a pull factor in Bangladesh

Bangladesh had not moved away from this endemic species. Despite calls for the farming of *P. vannamei*, the government has not given permission to import vannamei shrimp broodstock. However, it has given permission to one hatchery to import SPF black tiger shrimp broodstock. In response to a request for an update in Bangladesh, David Currie, Aquaculture Production and Trade Specialist, Safe Aqua Farming for Economic & Trade Improvement (SAFETI) at Winrock International based in Dhaka has provided the following information.

Hatchery and broodstock

In Bangladesh, for the hatchery sector, wild shrimp remained the major source of spawners. Only one hatchery (MKA Hatchery, http://agtech.partneringforinnovation.org/docs/DOC-1564) in Cox's Bazar, is using SPF black tiger shrimp broodstock from Hawaii-based Moana Technologies. In 2017, it produced 180 million post larvae which is an insignificant amount when compared to a total output of 10 billion post larvae from 56 other hatcheries. In 2017, 13 hatcheries out of a total of 69 in the country did not operate.

David Currie teaching field staff. Photo credit: Masud Rana

"Post larvae produced using SPF broodstock were sold at USD8,000/million PL to traditional farmers. These were sold at higher prices (USD12,300/million PL) to intensive farms. This was because of the USAID funding to the company, which in turn has offered a price break to small scale traditional farmers," said Currie.

"In the case of other hatcheries, small quantities of post larvae (probably less than 300 million) were polymerase chain reaction (PCR) tested for WSSV and sold at USD9,900-12,300/million PL. At the other end, we also have sales of untested post larvae at USD3,700-4,950/million PL. Most of this production came from hatcheries in Cox's Bazar in the east. Post larvae are flown to Jessore in the south-west and then onwards by land transport to markets in the region. Post larvae prices in 2017 have remained unchanged from that in 2016."

A major perennial issue in the industry is the high WSSV infection levels in wild caught broodstock where the range is 20-80%. An estimated 50% of post larvae stocked in the farms were tested as WSSV positive.

Farming

The farming of both black tiger shrimp (locally known as 'bagda') and the giant prawn *Macrobrachium rosenbergii* (locally known as 'galda') are largely in Satkhira, Khulna, Cox's Bazar and Bagerhat districts. There are 1,000-1,200 ha used for the intensive (using paddlewheel aeration) black tiger shrimp farming. Productivity is 3-8 tonnes/ha/year. "The first crop is from February to June when salinities are higher (8-27 ppt). Production is around 2-5 tonnes/ha. During the second crop from June-November, when salinities are lower (0-16 ppt), production is 1-3 tonnes/ha. In 2016, the production from 1,000 ha was an estimated 5,000 to 6,000 tonnes. We expect a similar output for 2017," added Currie.

In terms of stocking density, the range is 8-15 PL9-10/m^2. Harvest size range from 30-60g from a culture period of 5 months if a 1-month nursery stage is used, and 6 months for direct stocking. Typical survival rates are more than 75%. Feed conversion ratios (FCR) for shrimp fed 38% protein feeds range from 1.2-1.5:1.

Crop rotation and polyculture

However, most of the production is from shallow fields converted to ponds called 'ghers'. There is an estimated 216,000 ha of ghers with at least one crop/year of black tiger shrimp. Average land

Woman farmer emptying a trap. Photo credit: David Currie

In Bangladesh, most of the production is from shallow fields called 'ghers'. Gher with hut, photo by David Currie

holding is less than 1 ha per household. Most gher owners rotate between shrimp, prawn and rice; polyculture shrimp, prawn and fish or rotate with salt production. These depend on the seasonal salinity patterns in their local area.

"In these 'ghers', stocking of black tiger shrimp post larvae is typically carried out every 2 weeks, and harvesting is either daily or weekly using traps after 3 months of culture. Survival is very poor with less than 20% from post larvae to harvest. Disease outbreaks are common and average production is around 300kg/ha/year. Harvest size is typically 30-35g and almost all the shrimp produced is for export.

"Our best estimate for production in 2017 would be around 50,000 tonnes of black tiger shrimp, plus 5,000-10,000 tonnes of other penaeids that mainly go to the domestic market is very ambiguous, and the official production data do not tally with export data. Often the data combine production of both crustaceans. An estimated production for *M. rosenbergii* for 2017 was around 35,000 tonnes. Both production figures are probably similar to that of 2016," said Currie.

In 2017, ex farm prices for black tiger shrimp were higher compared to 2016. Typically, these were at USD14.80/kg for whole shrimp (HOSO) for 50g size, USD10.50/kg for 33g and USD9.00/kg for 20g at local auction markets in early December 2017.

Industry concerns in 2017

Cost of inputs for farm operations have remained steady since 2016. "An estimated 50% of the black tiger shrimp post larvae stocked in extensive farms carry the white spot virus and this is likely to be one of the major causes of mortalities. Vibriosis and stress-related mortalities also account for losses in extensive farms, particularly as most ghers are less than 50cm deep. Acute hepatopancreatic necrosis disease (AHPND) has been reported by several researchers in extensive farms and for causing losses in some intensive farms, but it has not been officially acknowledged as present in Bangladesh."

The main industry concern is the continuing dependence on wild monodon shrimp as broodstock. Another, issue is the shallowness of most of the ghers and the reluctance of farmers to invest in improvements because of the poor survivals. "Year 2018 will continue as in 2017, though a USDA funded project being implemented from 2016-2021 by Winrock International, with local partners, aims to assist Bangladesh in overcoming the obstacles and to realize its potential as a major shrimp farming country. The first year of the project's work will start in 2018 with an initial group of 9,500 farmers and the success or otherwise of the initiative can be reported in the 2019 shrimp review."

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Mini symposium on shrimp biotechnology

Grace Chu-Fang Lo (sixth from left), KC Han-Ching Wang (third from right) and Professor Chung-I Lin (third left) with speakers and participants.

Passing the baton on shrimp biotechnology to Gen X and millennials in Taiwan

The first generation of commercial shrimp farmers is most likely the baby boomers and as they approach retirement age, universities and industry need to educate the generation X and millennials on shrimp farming technology. Taiwan bequeathed the legacy of shrimp farming to Asia with the establishment of the monodon breeding technology by Dr I-C Liao in the 1970s; it is apt if the younger generation continues to lead and be well trained to bring the industry to its next level.

The objective of the mini symposium on Frontier Aquaculture Science was to garner the interest of undergraduate students (third year) in frontier aquaculture at the National Cheng Kung University (NCKU), to get them to consider a career in the shrimp farming industry, as young entrepreneurs, biotechnologists or researchers. Together, Professor Grace Chu-Fang Lo, Professor KC Han-Ching Wang and Vice Principal Professor Chung-I Lin, wished to foster students' independent learning, encourage students to understand research work and develop organisational, presentation and communication skills. Basically, the students planned the program, developed the introduction speeches and polished up on their English language skills for this symposium. Speakers were asked to comment on the students' performance.

Dr Celia R Lavilla-Pitogo with students who also prepared and organized the tea breaks

"In the next 10 years, Taiwan's institutes of higher learning have to combine education and research. In the past, NCKU was a leading research university in Taiwan. We now need to combine and promote research together with education. This event provided an opportunity for these NCKU's students to improve their skills, while the invited scholars provided inspiration to the students and cultivate their interests in aquaculture. At this symposium, they get an an insight on the development of a productive and sustainable industry," said Professor Lin in his welcome address.

Industry challenges

This mini symposium was held at the Translational Centre for Marine Biotechnology, Annan Campus, NCKU in in Tainan. Student Chin-Hao Chen was chairman. Topics for the five presentations were very diverse. Dr Zuridah Merican, Aqua Culture Asia Pacific, Singapore started the symposium with her presentation on the future role of the young generation in aquaculture. Her take was that as shrimp farming moves towards more intensive and controlled systems, its future will be in the hands of a new generation of young farmers and entrepreneurs. Although they can learn from the older generation, they must use science and digital technology to control production parameters to achieve success.

In disease management, Dr Celia R Lavilla-Pitogo, Consultant, Philippines said that having a grasp on challenges in implementing biosecurity for effective and shrimp health is critical. "Experiences have taught us that diseases happen not just due to the mere presence of pathogens but its outbreak is an interplay of factors resulting in weaknesses and susceptibility of hosts, strength of pathogens and increase in the number of opportunists. Biosecurity is a challenge because culture systems are large and open to various intrusions. Where breaches in biosecurity happen, early recognition of diseases, abnormality in shrimp behaviour and quality of culture environments is important to

Anchalee Tassanakajon and student moderator in the background

avoid losses. This requires disease diagnosis, professionalism of health services and shrimp health care at each stage of culture."

Molecular control of diseases

Research in the molecular aspects of diseases and their applications in disease management were discussed by three presenters. At the Centre of Excellence for Molecular Biology and Genomics of Shrimp, Department of Biochemistry, Chulalongkorn University, Thailand, Professor Anchalee Tassanakajon and Assistant Professor Kunlaya Somboonwiwat have been working on basic and applied research on shrimp immunity and molecular pathways to immobilize disease pathogens. "Such basic research is important to gain knowledge on the host defence mechanisms for the implementation of effective measures to prevent disease outbreaks. Shrimp rely on the innate immune system to defend against a range of microbes by recognising and destroying them via cellular and humoral immune responses. Our work led us to focus on antimicrobial peptides (AMPs) and melanisation. Melanisation also plays a crucial role in the killing and deposition of invading pathogens. In her presentation "From immunity to disease resistance: bringing back basic research to shrimp farming", Anchalee said that aquaculture needs biotechnology to prevent disease outbreaks. Little knowledge on biotechnology has been applied in shrimp when compared to that in agriculture.

Kunlaya presented on "Shrimp antimicrobial peptide antilipopolysaccharide factor (Alf): basic and potential applications." A major isoform of *Penaeus monodon*'s antilipopolysaccharide factor (ALFPm3) is a potential candidate for use in shrimp disease control. "It exhibits a broad antimicrobial activity spectrum against filamentous fungi, gram-positive and gram-negative bacteria including *Vibrio harveyi* causing vibriosis and *Vibrio parahaemolyticus* (Vp) causing acute hepatopancreatic necrosis disease (AHPND). It acts against bacteria by binding to and permeabilising the bacterial membrane resulting in cell lysis. The anti-viral property of ALFPm3 against white spot virus (WSV) was investigated. ALFPm3 inhibited WSSV propagation in crayfish haematopoietic cell culture and in shrimp." She described the anti-WSSV activities of ALFPm3. The recombinant protein of ALFPm3 used as shrimp feed supplement showed its ability to control AHPND and also to prevent WSD.

Anchalee discussed a recent work on the exposure of *Litopenaeus vannamei* to non-lethal heat shock (NLHS). A direct injection of recombinant heat shock 70 could enhance resistance to specific strain of Vp causing acute hepatopancreatic necrosis disease (VpAHPND) inducing innate immunity. "Acute heat shock treatment at 28-38°C for 30 min once or chronic treatment daily over 7 days for 5 mins gave resistance to AHPND for 30 days. When challenged with VpAHPND during the recovery period, at day 3, 7 and 30, shrimp exposed to either acute or chronic NLH survived 50% compared to 20% at day 3 for untreated shrimp."

She added, "We also researched on direct muscle injection of recombinant heat shock protein (LvHSP 70) which for it to be effective, needed to get to the haemocytes. We tracked with antibodies. We saw mortality was 90% in untreated shrimp compared to high survival in treated shrimp in challenge tests. Now the challenge is to develop a stable HSP."

In the final presentation, Professor Han-Ching Wang discussed the dynamics of the shrimp stomach bacterial microbiomes in an AHPND affected pond. According to Wang, the AHPND *V. parahaemolyticus* with extra-chromosomal elements produced a virulent toxin which damages shrimp hepatopancreas. Whether all AHPND outbreaks are caused by this *Vibrio* alone or with the involvement of other elements is still unclear. "We propose that destabilisation of the microbiota in either the pond or seawater may cause an outbreak. We collected samples of post larvae from ponds from 21-36 days after stocking. Using culture independent metagenomics approach, we then characterised the AHPND related microbiome. By calibrating with AHPND-associated microbiomes in a Vietnamese pond which succumbed to an outbreak, we could cluster the stomach microbiome into two distinct groups and predicted the microbiome changes associated with a AHPND outbreak. Instead of just the abundance of this Vp being the critical factor, there were actually third-party microbiota which could be potential AHPND biomarkers. Altered bacterial metabolism of stomach biota might alter host environment and increase Vp virulence."

Kunlaya Somboonwiwat

Student Chin-Hao Chen was chairman for the symposium

Zhe-Song Tang

Chang-Shang Lai

Life Achievement Award

Dr Thomas Zeigler was presented with the US Aquaculture Society's Life Achievement Award at the opening ceremony of Aquaculture America 2018 in Las Vegas. With a vision for the future, Zeigler has been a leader in the development of nutritional technologies for aquaculture for over 50 years. Obtaining his PhD from Cornell University in Animal Nutrition and Veterinary Pathology in the 1960's, he has since led the family business from a local manufacturer of farm animal feeds to an internationally recognized producer of aquaculture feeds.

Among his achievements, Zeigler has authored or co-authored 19 scientific publications, and has served as officer or director of 8 scientific and/or trade associations, including President of the US Aquaculture Suppliers Association. In the 1980's, he led the development of ascorbyl-2-tripolyphosphate (Stay-C), a new patented stable form of ascorbic acid (Vitamin C). The commercialisation of stable vitamin C technology had a highly significant impact on the industry, helping to significantly improve the performance and stability of aquafeeds.

In recent years, Zeigler has focused on the development of high performance feeds and precision feeding strategies that have helped to positively impact operational profitability. He was instrumental on ways to improve biosecurity through the development of feeds that replace or reduce the dependence on live or fresh frozen feeds for aquaculture. Through his continued vision, Zeigler Bros continues to support a rigorous R&D program to advance nutritional technologies and solutions.

Dr Thomas Zeigler (right) receiving his award from Dr David Cline, President of the United States Aquaculture Society

One of the most familiar faces of US aquaculture for many decades, Zeigler is regarded as a true friend among the network of current and former employees, collaborators, colleagues, and customers. He retains a sincere passion for aquaculture and continues his mission to build value to life through innovative nutrition. www.zeiglerfeed.com

Veramaris JV for the production of EPA and DHA from natural marine algae

DSM and **Evonik** have established a new company, Veramaris V.O.F., for the production of omega-3 fatty acids EPA and DHA from natural marine algae for animal nutrition. The 50:50 joint venture has its headquarters at the DSM Biotech Campus in Delft, The Netherlands. Veramaris's breakthrough innovation – an algal oil – will, for the first time, enable the production of the omega-3 fatty acids EPA and DHA for animal nutrition without using fish oil from wild-caught fish, a finite resource. DSM and Evonik announced their intention to start this joint venture in March 2017. Since then, all necessary approvals have been received.

Construction of the USD 200 million production facility at the Evonik site in Blair, Nebraska, USA has begun. Commercial quantities of the algal oil will be ready for sale in 2019. Pilot quantities for market development purposes are already available. The initial annual production capacity will meet roughly 15% of the total current annual demand for EPA and DHA by the salmon aquaculture industry.

Veramaris will be headed by CEO Karim Kurmaly and CFO Frank Beissmann. Marine biologist Kurmaly has been with DSM for more than 16 years, most recently as Vice President Animal Nutrition & Health in Asia Pacific. Beissmann, an engineer, has been with Evonik for more than 20 years and has held various positions in production, supply chain, marketing and controlling.

"Our algal oil, rich in both EPA and DHA, is our response to the industry's call for a sustainable and traceable source of the omega-3 fatty acids EPA and DHA. Veramaris will now enable our partners along the value chain to grow in a responsible way and meet the demand for healthy animal protein rich in both EPA and DHA for consumer health," said Kurmaly.

Veramaris engages in dialogue with all stakeholders across the value chain, including NGOs. Pioneering collaborations have allowed leading players in aquaculture to develop salmon diets free from marine ingredients, using the Veramaris algal oil as a complete replacement for fish oil. "Our goal is to establish the industry standard. We are committed to delivering consistent high-quality of the omega-3 fatty acids EPA and DHA. Drawing on our expertise in supply chain and logistics, we are able to transition customers to Veramaris as smoothly as possible," said Beissmann.

Until recently, the omega-3 fatty acids EPA and DHA added to animal feed have been almost exclusively from marine sources such as fish oil and fishmeal, which are finite resources. Currently, a total of 16 million tonnes of wild fish are caught for the production of fish oil and fishmeal. By using natural marine algae, Veramaris contributes to closing the omega-3 EPA and DHA supply-demand gap, while helping to conserve marine life and biodiversity in the oceans. www.veramaris.com

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New General Manager at Diana Aqua

Since January 2018, **Jérôme Le Friec** has been appointed as head of **Diana Aqua**, a global strategic growth segment for DIANA and the Symrise Group. Le Friec's mission will be to define and implement the Aqua business strategy by developing, coordinating and managing the Aqua activity in accordance with Diana's objectives. He will lead the growth and profitability increase of Diana Aqua, coordinating the different departments involved in the activity, through the development of functional solutions dedicated to the aquaculture market. He will explore and develop external strategic partnerships.

Diana Aqua develops and delivers advanced natural and sustainable solutions for the aquaculture feed industry, enhancing the nutrition and health of farmed fish and shrimp and, indirectely, the consumers' well being. Valorizing marine co-products, Diana Aqua acts as a responsible and trustworthy partner contributing to the sustainable growth of aquaculture industry, providing advanced functionalities to the aqua feed players while enhancing aqua farms performance.

Jérôme Le Friec has 24 years of international experience in the animal nutrition and feed additives industry. Le Friec began his career with Timab, Roullier group where he spent 17 years. He then joined Olmix where he was Managing Director for 6 years before taking this position of Deputy General Manager at Mixscience (Avril Group) in 2016

Diana Aqua is part of Diana, a division of Symrise AG and relies on a unique global network of scientific and technological experts, a team of 140 passionate employees and industrial sites all over the world. www.diana-aqua.com

At centre stage at ONE: The Alltech Ideas Conference

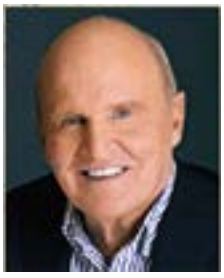
Jack Welch, one of the world's most respected CEOs, will share his groundbreaking management practices with the attendees of ONE: The Alltech Ideas Conference (ONE18). The celebrated former CEO of General Electric is highly regarded for his track record of success and his commitment to building leaders and teams. Named as one of the "100 Greatest Living Business Minds" by Forbes magazine in 2017, Welch has been called "The CEO of CEOs." He began his career with the General Electric Company in 1960 and in 1981 became the company's eighth chairman and CEO. During his 20-year tenure as CEO, the company's market capitalisation rose from USD13 billion to over USD 400 billion. In 2000, he was named "Manager of the Century" by Fortune magazine. Today he serves as executive chairman of the Jack Welch Management Institute.

Also featured on ONE18's mainstage will be **Professor Robert Wolcott** and **Dr Rodolphe Barrangou**. Wolcott is clinical professor of innovation and entrepreneurship at the Kellogg School of Management at Northwestern University. The author of "Grow from Within: Mastering Corporate Entrepreneurship and Innovation," Wolcott is a regular contributor to Forbes on the impact of technology on business, society and humanity. His work appears in MIT Sloan Management Review, strategy+business, the Harvard Business Review (online), the Wall Street Journal, Advertising Age, Businessweek, the Financial Times (European Edition), The New York Times and numerous overseas publications.

Barrangou is the T. R. Klaenhammer Distinguished Scholar in Probiotics Research in the Department of Food, Bioprocessing and Nutrition Sciences at North Carolina State University, where his work focuses on the evolution and function of CRISPR-cas systems and their applications in food manufacturing. Recently, he received the 2016 Warren Alpert Foundation Prize, the 2016 Canada Gairdner International Award, the 2017 NAS Award in Molecular Biology and the 2018 NAS Prize in Food and Agriculture Sciences. He is also the former chairman of the board of directors of Caribou Biosciences, a co-founder and member of the scientific advisory board of Intellia Therapeutics, and a co-founder and chairman of the scientific advisory board of Locus Biosciences.

"This is the most impressive lineup of mainstage speakers that we have ever had," said Aidan Connolly, vice president of corporate accounts and chief innovation officer at Alltech. "If you are ready for ideas that could fundamentally change your business, ONE18 in Kentucky is the only place to be this May."

The transformative power of ideas is the underlying focus of over 50 topics slated for discussion at ONE18. Twelve sessions, covering all major agriculture sectors, as well as brewing and distilling, business, and health and wellness, will set the stage for an epic exchange of ideas between thought leaders and knowledge seekers. More and register at one.alltech.com



Jack Welch

Professor Robert Wolcott

Dr Rodolphe Barrangou

Commitment to the Indian aquaculture industry

The Nutriad team at Aqua India 2018, from the left, Allen Wu, Alexander van Halteren, Gnanamani Thangairulappan and Peter Coutteau

NUTRIAD, a leader in species specific additive solutions for fish and shrimp, was present with a delegation at Aqua India 2018, a bi-annual event organised by the Society of Aquaculture Professionals (SAP). This year's event, held in Chennai, attracted industry professionals from all over India, following a strong growth year where the country closed in on the global leadership position in shrimp production. Nutriad has been present in the Indian market for many years, building relationships with local producers and industry experts.

Nutriad showed its commitment to the Indian aquaculture industry through a sponsorship for the event and was represented by Allen Wu, Regional Manager – Aquaculture, Asia Pacific, Business Unit Director Aquaculture Dr Peter Coutteau and Country Manager Gnanamani Thangairulappan.

Alexander van Halteren, Business Development Manager Aquaculture Nutrition, presented "Balancing nutrient levels in commercial shrimp feeds" based on a 2016 Feed Survey. The survey investigated the different nutritional strategies in commercial shrimp feeds during 2016, when the number of shrimp feed suppliers increased sharply. The study analysed representative feed samples of 8 major brands that were collected in the market. Analysis included proximate composition as well as a number of essential nutrients (amino acids, phospholipids, cholesterol, n-3 highly unsaturated fatty acids). Some of the nutrient levels detected during the survey, revealed the potential for functional feed additives to optimise nutrient utilisation in shrimp feeds in India.

"Nutriad is committed to the development of innovative feed additives for aqua customers, that target the specific nutrition and health challenges producers face. We bring practical solutions to the market that build on years of close interaction with fish and shrimp producers around the world," said Nutriad CEO Erik Visser. "APAC in general and India in particular are part of our strategic focus to further build on our leading position in the feed additives market for aquaculture," concluded Visser.

Hosting aquaculture seminar in Myanmar

In Yangon, Myanmar, the Nutriad team share its knowledge and experiences with a group of industry professionals at a seminar. The highly valued aquaculture event was organised by Tan Sao A Ltd., Nutriad's distributor for aquaculture products in Vietnam.

Allen Ming-Hsun Wu, presented "Global aqua and shrimp culture outlook and Nutriad's solution"; Dr Kanjanaworakul Poonmanee (Fai), Aqua Tech. Manager SE Asia, Nutriad presented on Thailand's shrimp farming practices. This was followed by a presentation entitled "Vietnam shrimp farming practices" presented by Truong Minh Duc, Vice Director, Tan Sao A Co., Ltd. Dr Kyaw Tun Myat, Chairman, Myanmar Shrimp Association presented on shrimp farming practices in Myanmar.

As delegates from Vietnam and Myanmar share common interests and face similar challenges, the interaction was met with great enthusiasm. "This is the most successful aquaculture seminar in Myanmar, as it offers very practical and useful insights. Our association is thankful for the support of an internationally recognised company such as Nutriad", commented Dr Kyaw Tun Myat.

Nutriad has recently obtained promising results against white faeces, luminous bacteria in shrimp via the application of its health range of specialty additives in farms and feedmill. In his closing speech Wu thanked Tan Sao A Ltd. for their efforts in the 13-years partnership and thanked Dr Aong, Multi Aquaculture Livestock Trading Ent., Ltd., Myanmar for his local support.

Shrimp farm customers in Vietnam have been using Nutriad's products for many years and are extremely satisfied with the results and performance. Nutriad is committed to continue to innovate its product portfolio, adapting new challenges and emerging diseases such as *Enterocytozoon hepatopenaei (EHP)*.

Nutriad provides feed additive solutions for animal nutrition and health to more than 1,200 customers in over 80 countries, through a network of sales offices and distributors. These are supported by 4 application laboratories and 5 manufacturing facilities on 3 continents. www.nutriad.com

Tree planting ceremony to mark integration

Multinational feed additives producer **Nutriad** received a delegation of **Adisseo** to mark the kick-off of the integration between both companies. In a symbolic act CEOs of both companies joined in a tree planting ceremony. Attended by a broad group of employees, the positive energy was palpable as the excitement on the opportunities following Adisseo's recent acquisition of Nutriad was shared by all present.

As the completion of the agreement was recently confirmed, a kick-off meeting was organised to enable teams of both companies to get to know each other and jointly develop an agenda for next steps. The two-day meeting at Nutriad's headquarters in Dendermonde (Belgium) was concluded with a ceremony, which saw Nutriad CEO Erik Visser and Adisseo CEO Jean-Marc Dublanc plant a tree together to mark the start of a growing relationship between the two companies.

"Upon the conclusion of this kick off meeting, I am happy to note the positive energy and enthusiasm across both teams on the opportunities that the combination of Nutriad and Adisseo will bring to our companies, teams and customers," said Visser. "As the kick-off meetings marked the start of the integration process, today's planting of a tree symbolises putting down roots and future growth."

Nutriad CEO Erik Visser (right) and Adisseo CEO Jean-Marc Dublanc, planting a tree

Expansion

Country Manager Indonesia

Nutriad announced the appointment of **Dr Chutaemil Marom** as Country Manager Indonesia. The company continues to invest in people in key markets around the world. Indonesian feed production is expected to continue to grow in 2018 across various species applications with strong opportunities in poultry and aquaculture.

Chutaemil who qualified with as doctor of veterinary medicine from Bogor Agricultural University, comes with more than 20 years of experience in the animal health and feed milling industry. Chutaemil said, "I am excited about joining Nutriad and look forward to help the Indonesian producers with the excellent product range and service level that Nutriad can deliver in this dynamic market. The strong technical file that comes with the portfolio as well as the practical experiences with customers around the world makes for a powerful combination."

Dr Glenn Alfred S. Ferriol, Area Manager for Indonesia, Malaysia and the Philippines mentioned "ChutaemII's wealth of experience and knowledge of the Indonesian livestock industry will support further growth of the company in the country. The appointment is also a sign of our strong commitment to the Indonesian market. I am confident that Chutaemil will be effective in providing and implementing effective solutions in the field of non-antibiotic digestive performance enhancers and mycotoxin risk management amongst others." www.nutriad.com

Aqua Innovation team

Lead Scientist, Aquaculture

Nutriad announced the appointment of **Dr Waldo Nuez-Ortin** as Lead Scientist Aquaculture. Nuez-Ortin has more than 10 years of academic and industry experience in aquaculture research and project management. Graduated a veterinarian at the University of Zaragoza, Spain, he obtained his MSc in Animal Nutrition from the University of Saskatchewan, Canada, and completed a PhD on fish nutrition at the University of Tasmania and CSIRO, Australia. After his PhD, he continued as lecturer/researcher at James Cook University, Australia, where he actively collaborated with industry and academic partners in the evaluation and development of novel feed ingredients and additives.

"Specialised feed additives are playing an increasingly important role in aquaculture feed formulations and profitability of fish and shrimp farmers. Our continued research programs on different specialty additives for different aquaculture species increases the need for innovation and specialised product development." said Dr Peter Coutteau, Business Unit Director Aquaculture.

CEO Erik Visser added, "Nutriad has consistently been investing in species specific solutions for the aqua market, which has helped us to create a leadership position in the industry that recognises us for how we convert science into practical solutions, that build on a deep understanding of the challenges producers around the world face. The recent acquisition of Nutriad by Adisseo will help us accelerate our solution offering to the market, as it will allow us to combine technical knowledge across various platforms, combine portfolios and tap into a rich R&D pipeline."

Skretting Tilapia Forum:

Helping the tilapia sector achieve its full global potential

Tilapia represents one of aquaculture's greatest success stories of recent times; transitioning from small-scale, rural farming into one of the world's most productive and internationally traded fish, thereby providing a nutritious and inexpensive protein to consumers in many markets. Indeed, it is estimated that the global tilapia harvest has now reached a level of around 6 million tonnes, which is considerably more than the annual production of salmonids and shrimp.

Today, more tilapia is produced in Asia than in the species' native Africa, and its production has grown at a significant rate in many regions around the world. However, it is widely recognised that the potential exists to increase production dramatically. To facilitate this growth, bring greater market credibility and improve margins, the tilapia sector has put strong emphasis on advancing its production systems, with great strides made on establishing best-practice.

In order to further stimulate this progress, **Skretting** organised its first-ever Tilapia Forum. Held on 26 February – 1 March 2018 in Egypt, this international business conference brought together many of the world's leading stakeholders from the tilapia industry to share invaluable information, insight and opinion. Skretting's top 50 tilapia farming customers from around the world were invited to join leading authorities from areas such as genetics, farming, health, raw materials, feed, nutrition, processing and retail.

Attendance at the conference, which began in Cairo before moving south to Aswan, was strictly by invitation only. "We brought these companies and experts together for the first time; partly to enable important networking opportunities, but also to share technical and informative presentations from across the value chain," said Arjen Roem, Marketing Director, Skretting Africa.

"As one of the world's leading tilapia producing countries, Egypt provided the ideal setting to show the aquaculture sector and the broader supply chain as well as that of salmon and shrimp, Skretting is also leading the way when it comes to collaboratively progressing tilapia farming on a global scale."

In addition to looking at the market developments in recent years, discussions at the forum focused on the challenges and opportunities facing the tilapia sector today and in the future. For example, with soya bean being a key ingredient in tilapia feeds, there were sessions on the situation and outlook for raw materials, as well as for the application of novel feed ingredients.

Sustainability and the direction that tilapia production needs to take to ensure it continues to deliver a responsible aquaculture product were another important focus area, while Carrefour shared valuable insight from a leading international retailer's perspective.

Anita Viga, Marketing Director of Skretting AS, presenting at the Skretting Tilapia Forum

The program also contained sessions on the value that Skretting is bringing to tilapia farming, in which company representatives delivered presentations on the four pillars of Skretting; namely R&D and innovative products, feed-to-food safety and quality (Nutrace), and models and services (AquaSim), as well as on the sustainability commitments delivered through the Nuterra program. Skretting also arranged two fact-finding excursions – a visit to the WorldFish Centre, and the Egypt fish feed plant.

As the global leader in tilapia feeds, Skretting has long held the ambition to support the advancement of the sector, and maintains that the best way to achieve this aim is by ensuring a consistent supply of high-quality fish feed products. As part of this commitment, Skretting has opened dedicated tilapia feed plants in key markets. Similar to all of its other plants around the world, these facilities share the philosophy to make best use of the company's world-class R&D; have local validation of its feeds; and to also invest heavily in providing technical support to the industry.

"We have been increasingly engaged in tilapia research in recent years, with the Skretting Aquaculture Research Centre (ARC) dedicating resources to progress tilapia feed, nutrition and technology R&D. This ongoing work has already led to a starter feed specifically for tilapia, with health, grower and other nutritional concepts also in the pipeline. These latest developments were also shared with our guests in Egypt," said Roem. www.tilapiaforum.org

Aquaculture in Occitanie, France

This report compiled by members of the AQUA 2018 Steering and Local Organising Committees introduces the aquaculture of marine and freshwater fish, shellfish as well as Spirulina and other microalgae and macroalgae.

The upcoming AQUA 2018 event ***#We R Aquaculture***, co-organised by EAS and WAS will be in Montpellier from August 25-29. Occitanie is a new super region of France, created in 2016 from the former regions of Languedoc-Roussillon and Midi-Pyrénées.

France is one of Europe's biggest aquaculture producers. In 2015, it produced 262,012 tonnes, comprising shellfish (216,917 tonnes) and fish (45,095 tonnes).

Shellfish Production comprised 125,151 tonnes of cupped oyster *Crassostrea gigas* and 87,894 tonnes of stake-grown mussels (bouchot). Some 55% of oyster production is consumed over the Christmas and New Year holiday periods. Production data fluctuates each year, due to mortality (juveniles and adults) that regularly affect the sector. Since 2008, massive mortality of cupped oysters have been reported in almost all farming areas in France (Miossec et al. 2009, European Food Safety Authority 2010, Martenot et al. 2011, Pernet et al. 2012, Pernet et al. 2016). These epidemiological events are associated with infection of oysters with a newly described genotype (QVar) of *Ostreid herpesvirus* 1 (Segarra et al. 2010) that has expanded along the European coastline.

Fish Production has increased in recent years. This is mainly in farming of the rainbow trout, with portion-size and large trout, and common carp. There are about 500 production sites managed by approximately 300 commercial enterprises (Agreste Census 2007). The French regions of New Aquitaine, Hauts de France and Brittany account for 70%of national production. France is the third largest producer of freshwater trout in Europe with nearly 38,714 tonnes produced in 2016. Rainbow trout production is 96% of the national salmonid production.

Caviar production from reared Siberian sturgeon *Acipenser baerii* is about 27 tonnes, which places France among the leading producing countries in the world with Italy (but behind China). The sturgeon sector is made up of ten companies spread over 18 production sites. Sturgeon meat represents 306 tonnes.

France is a European pioneer in the breeding of marine species (i.e. seabass, sea bream, turbot, sole) but produces only 4,821 tonnes of market-size marine fish. Six species dominated this sector, sea bass, sea bream, turbot, meagre, salmon and sole. Some 113 million fry are produced in French hatcheries, with 90% exported to other Mediterranean countries for on-growing.

Aquaculture Research Sector

In addition to 12 universities spread all around France, 4 main organisations lead national aquaculture research in fish and shellfish, all of which are present in the Occitanie Region.

INRA. The National Institute of Agricultural Research is the leading agricultural research institute in Europe and the second largest in agricultural sciences in the world. It contributes 90% of the national research effort on farmed fish, most on freshwater species. http://www.inra.fr/en/Scientists-Students

IFREMER. The French Research Institute for the Exploitation of the Sea contributes with its work and expertise to the knowledge of the oceans and its resources, to surveillance of marine and littoral environments and to the sustainable development of maritime activities. In aquaculture, it essentially works on marine species and brings together 90% of the research effort on shellfish. http://wwz.ifremer.fr/en

CIRAD. The Center for International Cooperation in Agricultural Research for Development is an organization for agricultural research and international cooperation for sustainable development of tropical and Mediterranean regions. http://www.cirad.fr/en/home-page

IRD. The Research Institute for Development brings an original approach of research, expertise, training and knowledge sharing for the benefit of territories and countries that make science and innovation one of the first levers of their development. https://en.ird.fr/ird.fr

Next issue: Focus on macro and microalgae for food, health, feed and cosmetics in Occitanie, France. More information and to read the full report, go to www.aquaeas.eu.org

Montpellier's Le Corum is the venue for Aqua 2018

Epibionts on oyster collectors

Rearing structures under breeding table

Sea bass at the Ifremer Palavas station

L'Aquatourisme –Discover French freshwater fish farms

The French Interprofessional Committee for Aquaculture Products has developed a new aquaculture tourism portal at www.aqua-tourisme.fr It is based on the idea that fish farmers are eager to share their knowhow and allow members of the general public to visit their farms. It gives people the chance to have a good day out and learn more about how fish are farmed. Visits are often combined with fishing possibilities and direct sales of aquaculture products. The interactive map on the portal allows people to select a region of town and see all the farms in that area, so as to be able to contact them and arrange a visit.

AQUA 2018

The joined meeting of the European Aquaculture Society and World Aquaculture Society

For more info on the TRADESHOW : mario@marevent.com
For more info on the CONFERENCE : www.was.org and www.aquaeas.eu.

The **Asian-Pacific Aquaculture (APA 2018)** conference and trade show, organized by the World Aquaculture Society –Asian Pacific Chapter will be held at the Taipei International Convention Centre, Taipei, Taiwan will be hosted by the National Taiwan Ocean University (NTOU). The event, from 23-26 April 2018 will start with the following plenary speakers:

Professor Ching Fong Chang is President of NTOU and co-chair of APA18. His presentation will introduce the conference theme "Aquaculture innovation, sustainability and food safety" to all APA18 participants. Under the leadership of the former presidents and through all the faculty and staff members' efforts, NTOU strives to be one of the most outstanding universities of Ocean Studies both in Taiwan and in the world. The University has transformed itself into a comprehensive university and is recognized in teaching, research and social services. It was awarded as one of the World Top 400 universities by The Times Higher Education (THE) in 2011.

Professor Patrick Sorgeloos will present "New insights in microbial management to make intensive aquaculture more sustainable" which is linked to the theme of APA18. Sorgeloos is Emeritus Professor of aquaculture at Ghent University in Belgium and has been involved in fish and shellfish larviculture R&D in Europe, Asia, Latin America and Africa ever since the mid-1970s. He has more than 40 years' experience of research in different aspects of the biology and culturing of the brine shrimp *Artemia*, and in larviculture / aquaculture of fish and shellfish at the Artemia Reference Center of Ghent University with a scientific, technical and administrative staff of 25 persons.

More information: Conference, contact John Cooksey (worldaqua@was.com); Booths and Sponsorship, contact: Mario Stael (mario@marevent.com); WAS-APC office: apcsec@was.org. Web: www.was.org / www.was-apc.org

AT THE TRADE SHOW

APA 2018 3-day tradeshow will start on ***Tuesday April 24*** (10.00 - 18.30; Happy hour 17:20 - 18:30 and will end on ***Thursday April 26 at 16:00***. There will be more than 100 booths. Below is a preview on activities at some booths.

BOOTH 68

Jade & Gold Agriculture Products Co., Ltd markets three probiotic strains, Bio Activator, Bio Ferm and Bio Great, of the company's products selected from petri dish tests against pathogenic *Vibrio parahaemolyticus* and inhibition zone are 1.7- 2.6 cm. They have been proven to be able to prevent and treat effectively white faeces syndrome, ATM (Aggregate Transformed Microvilli), black gill syndrome and highly polluted pond water. The company welcomes you to browse the products file in the facebook page of Jade & Gold Agriculture Products Co., Ltd. and email through jadengoldagri@gmail.com if there any questions.

Jade & Gold Agriculture Products Co., Ltd
Jimmy Wang (jadengoldagri@gmail.com/ ilovekoi2@gmail.com)

BOOTH 80-81

DaBomb Protein will sponsor the Functional Ingredients for Aqua Feed session to be held on the afternoon of 25 April. During the meeting, there will be a 15-minute presentation reviewing the company's previous research and the advantages for Bio-hydrolyzed soy protein "DaBomb-P" in aquafeed. Join this session and visit the booth for more business discussions. www.dabombprotein.com

DaBomb Protein Corp
Jeffery Jiang, regional manager, market@dabombprotein.com

BOOTH 99-100

Established in 1974, **GROBEST** is dedicated to the establishment of aquatic feed, pond water & soil treatment & seafood supply chain for vertical integration. Our research team continues to innovate nutrition technology for seafood and animals with leading techniques. The technical experience in aquatic animal feeds accumulated over several decades, by introducing additives made from leading fermentation techniques, we develop feed formulas that help animals' digestion and improve metabolism and immunity. At the conference, Grobest will sponsor part of the session on Sustainable Aquaculture Environment. It invites the speaker from academia to share their target for the coming year. http://www.grobest.com

Grobest
Shawn Yeh (shangpeng_yeh@grobest.com)

BOOTH 21

National Pingtung University of Science and Technology (NPUST) will introduce research performance, including functional aquafeed, selected breeding technique, aquafarm management and biotechnological application in aquaculture. It will also show student recruitment information. http://www.npust.edu.tw/

Presentations: Professor Yu-Hung Lin will present:

- Nutritional concept in plant-based aquafeed: a brief review for cholesterol and bile salt
- Effects of dietary *Lactobacillus* fermented soybean meal and lactic acid supplementation on growth, nutrient digestibility and intestinal morphology of grouper

National Pingtung University of Science and Technology
Professor Yu-Hung Lin (yuhunglin@mail.npust.edu.tw).

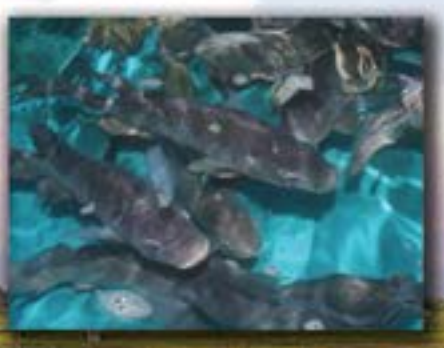
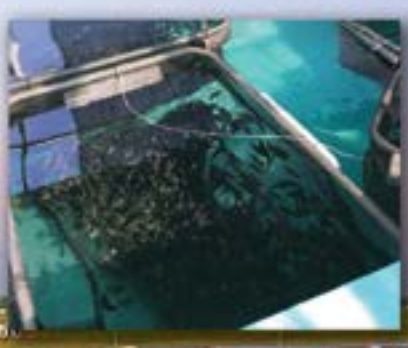
Asian Pacific Aquaculture 2018
Taipei - Taiwan -April 24-26

Innovation for Aquaculture, Sustainability and Food Safety

APA 18

WORLD AQUACULTURE Society

All info: www.was.org
Conference management: worldaqua@was.org
Trade show & Sponsorship: mario@marevent.com

BOOTH 28-29

LIPTOSA is a Spanish company specialised in manufacturing phytobiotics and nutraceuticals for animal feed. LIPTOAQUA is the aquaculture division with a tailor-made portfolio of prebiotics focused on gut health for preventive use controlling bacteria, parasites and fungi diseases on fish and shrimp. There will be oral presentations by Liptoaqua on results obtained *in vitro* with a prebiotic able to reduce vibrio load in intestine. Prebiotics improve zootechnical parameters along the culture helping the farmer to obtain more survival when AHPND/EMS or other diseases appears. Products as natural growth promoters or antiparasites against gill and skin fish parasites will be presented at the booth. www.liptoaqua.com

LIPTOAQUA-LIPTOSA
Cristina García Díez (cristina.garcia@liptosa.com)
Alvaro Rodríguez (ara@liptosa.com)

BOOTH 5 & 6

At the booth of **Lallemand Animal Nutrition**, discover the world of bioremediation and the specific microbial solutions developed by the company for fish and shrimp that target gut health, immune modulation and pond environment management.

Presentation: Eric Leclercq, PhD, Aquaculture Technical Support Manager at Lallemand Animal Nutrition will present during the conference, the latest scientific results on the effect of a multi-strains yeast based functional additive on EHP-challenged shrimp. He will also introduce some critical steps to the successful deployment of an integrated bioremediation strategy in pond aquaculture. http://lallemandanimalnutrition.com

Lallemand Animal Nutrition
Stéphane Ralite (sralite@lallemand.com)
Eric Leclercq (eleclercq@lallemand.com)

BOOTHS 35, 36, 43 & 44

Visit **BIOMIN** at APA 2018 to discuss the latest trends in the aquaculture industry, including insights from the latest 2017 annual global mycotoxin survey results and the impact of mycotoxins on aquatic species. Biomin experts from Asia and Europe will be presenting in a series of APA 2018 scientific conferences. Biomin will be showcasing solutions in the gut performance management line featuring probiotics – AquaStar®, acidifiers – Biotronic®, phytogenics – Digestarom® and our mycotoxin risk management line – Mycofix®. The Biomin team warmly invites all delegates to our booth for discussions over a cup of freshly brewed coffee by baristas. www.biomin.net

BIOMIN
Justin Tan (justin.tan@biomin.net)
Anwar Hasan (anwar.hasan@biomin.net

BOOTHS 49, 50, 57 & 58

For over 30 years **INVE Aquaculture** has been enabling growth in aquaculture. The healthy growth of fish and shrimp, the growth of our clients' local businesses and the growth of global aquaculture. As a recognised reference and innovator, Inve will show some innovating products at the booth. Since December 2015, Inve Aquaculture has become part of Benchmark, an aquaculture biotechnology business. Together the group offers a complete package of nutrition, health and genetic solution across all the major aquaculture markets. www.inveaquaculture.com

INVE AQUACULTURE
Nicolas Mace (n.mace@inveaquaculture.com)
Weechita Ittipatsakul (w.ittipatsakul@inveaquaculture.com)

Friends in Aquaculture lunch-seminar in 2017

In November, to celebrate Dr I Chiu Liao's 82nd birthday, Peter Chiang, Hanaqua Tech Inc. hosted Friends in Aquaculture luncheon-seminar in Kaohsiung on 4 November 2017. More than 60 close friends were invited and around 20 of them had previously submitted short stories on "How to Improve the Aquaculture in Taiwan" to facilitate the discussion during the seminar. The seminar started with Liao's sharing his professional experience, illustrated with old photos. He said as a graduate student in Tokyo University, his passion on research had endured him to record for 7 straight days without sleeping, the feeding behavior of the Kuruma shrimp. He ended his story by 3 mottos: 'Earth provides enough to satisfy every man's need but not every man's greed.'- *Mahatma Gandhi*; 'Aquaculture, not the Internet, represents the most promising investment opportunity of the 21st Century.' – *Peter F. Drucker*; and 'Boys, lofty ambitious!' – *William Smith Clark*.

82nd birthday wish. Left to right: Prof. Shi-Yen Shiau, Chin-Hui (Philip) Hsieh, Dr. I Chiu Liao, Peter Chiang and Prof. Yew-Hu Chien

Offshore MARICULTURE Asia2018 Conference

In association with: USSEC

Supported by:

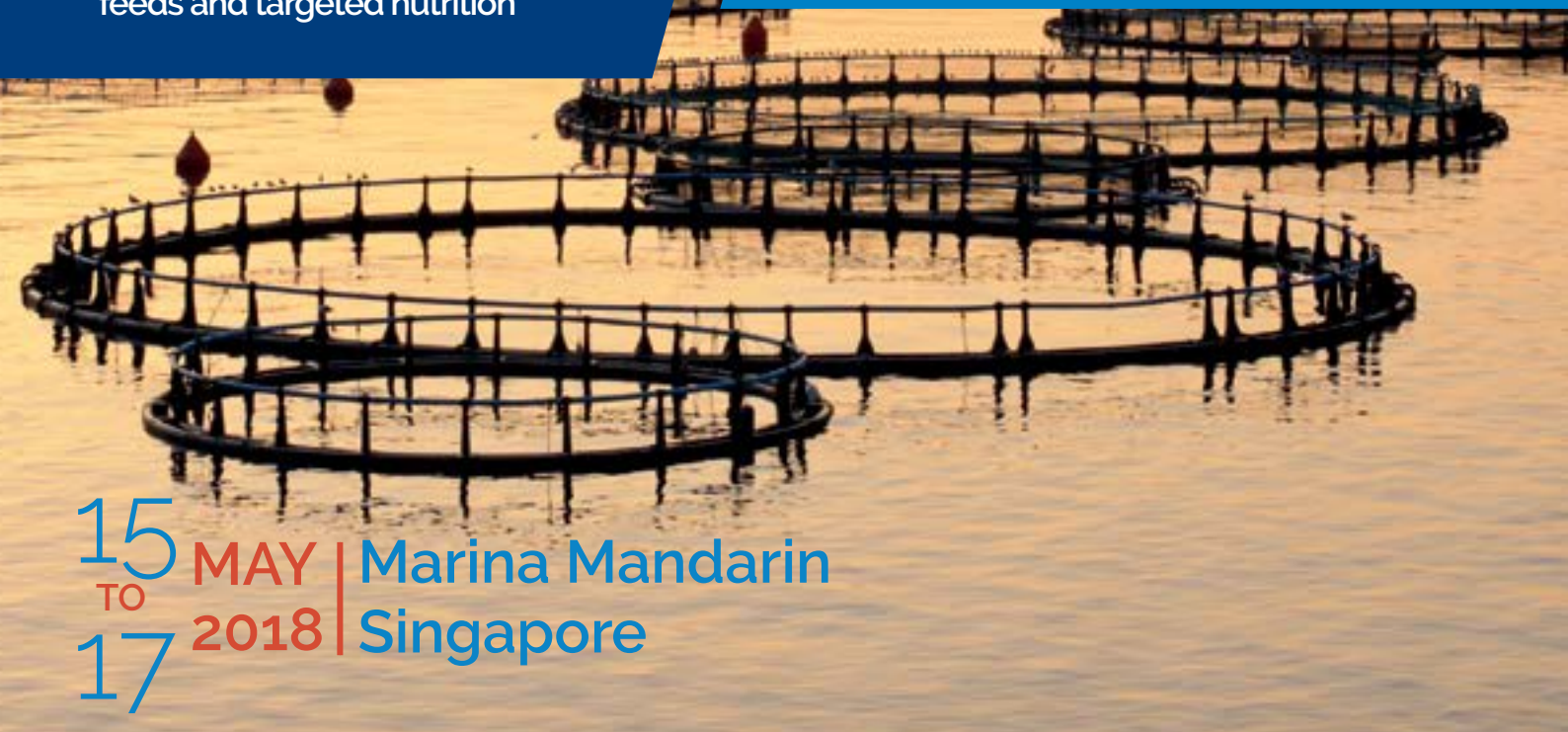
EXPLORING OFFSHORE MARICULTURE OPPORTUNITIES IN ASIA FOR THE FIRST TIME

OMC ASIA - Two-day conference chaired by the FAO with topics including:

- Zoning, licensing and security for offshore operations
- Investment case studies: securing financial support
- Netting the right offshore technology: cages, netting, monitoring systems
- Maximising the efficiency of your operation: the need for high quality feeds and targeted nutrition

Offshore Mariculture expands into Southeast Asia!

The perfect meeting place for learning about and investing in industrial marine fish farming operations.



15 TO 17 MAY 2018 | Marina Mandarin Singapore

To book contact the events team: **+44 1329 825335**

or email **conferences@offshoremariculture.com**

www.offshoremariculture.com/asia

Organiser: mercatormedia magazines|events|online

Media partner: WORLDFISHING & AQUACULTURE

INFORMING THE GLOBAL FISHING INDUSTRY SINCE 1952

BOOTH 38, 39, 40 & 41

Nutriad International NV delivers products and services to over 80 countries worldwide through a network of own offices and distributors, supported by four application laboratories and five manufacturing facilities located on three continents (Belgium, Spain, UK, USA, China). Nutriad is an industry leading specialist in the development, manufacture and marketing of animal and aqua feed additives worldwide. Nutriad's business unit Aquaculture offers species-specific R&D capabilities, innovative products and nutritional/technological expertise for the Aquaculture industry. Key specialty programs for aquaculture additives are Health (additives supporting the prevention of diseases and parasitic infections : Sanacore®, Aquastim®, Apex® Aqua, Apex®Branchia C, Bactinil® Aqua); Digestion (species specific digestive/metabolic enhancers to reduce feed cost and improve performance in fish and shrimp: Aquagest®, Aqualyso, Lipogest), and Palatability (palatability enhancers and attractants to replace fishmeal and stimulate appetite: Aquabite®, Aquaflavour).

NUTRIAD is a session sponsor for ***Functional Feed for Health Management*** at 9 am, April 25. Room 103, TICC Taipei. Session chairs: Dr Peter Coutteau and Prof. Wang Han-Ching. Presentations will include:

- Prof Lin, Yu-Hung (NPTSU, Taiwan): Nutritional concept in plant-based aquafeed: A brief review for cholesterol and bile salt.
- Dr Isern I Subich Maria Mercè (Nutriad, Spain): Effect of novel feed additive on performance and health indicators during natural thermal fluctuations in gilthead sea bream *Sparus aurata* in cage culture.
- Dr Prakan Chiarahkhongman (CPF, Thailand): The 3C Strategy: Antibiotic-free health management practices for shrimp farming in Thailand.
- Ho, Gim Chong (Nutriad Asia Ltd): Farm Application of a functional feed additive: An essential tool in the health management of white feces syndrome in Asian shrimp farming.

BOOTH 45 & 46

ZEIGLER FEEDS will present the following new products at its booth.

Redi - Mate - Zeigler's newest semi-moist shrimp broodstock diet sets a new standard for quality and performance in this product category.

Rescue – A new probiotic designed and proven to effectively manage Vibrio loading in a variety of production environments.

Remediate – The newest water management tool for production managers, Remediate raises the standard for organics digestion and water quality improvement in a probiotic.

Presentation: Dr Craig Browdy, Director R&D will present on biosecurity strategies & solutions for shrimp hatcheries. www.zeiglerfeed.com

Chris Stock (chris.stock@zeiglerfeed.com); Craig Browdy (craig.browdy@zeiglerfeed.com); Ramir Lee (ramir.lee@zeiglerfeed.com); Cao Khanh Ly (cao.khanhly@zeiglerfeed.com) and Ch.Satyanarayana Murthy (satya.murthy@zeiglerfeed.com)

BOOTH 30

Leiber GmbH manufactures brewers' yeast products - for example dried brewers' yeast, betaglucans, MOS, nucleotides - and yeast extracts since 1954 at a highest level of quality. There are many application areas in the field of aquaculture where Leiber brewers' yeast products bring further benefits. www.leibergmbh.de

Leiber GmbH

Dr. Holger Kühlwein, Key Account Manager Aquaculture (h.kuehlwein@leibergmbh.de); Dr Pradeep Padmaja Jayaprasad, Regional Sales Coordinator APAC (p.padmaja-jayaprasad@leibergmbh.de); Nikolaus Jungbluth, Business Unit Director Animal Nutrition, (n.jungbluth@leibergmbh.de)

Appointments

Marketing Manager

The genetics division of **Benchmark Holdings** plc has announced **Jorge Piazza** as marketing manager, Benchmark Genetics. In his new position, Jorge will be working on the marketing activities for the breeding programs of Atlantic salmon, tilapia and shrimp in Latin America.

For 11 years, Jorge ran his own full-scale advertising agency in the southeastern region of Spain. Since 2011, Jorge has worked in the seafood industry in Norway, last as Key Account Manager in SalmonView.

Birgitte Sørheim, Marketing Director of Benchmark Genetics said, "Tilapia and shrimp are exciting species that are early in industrial development compared to salmon. Benchmark has a strategy to use the expertise acquired through many years of breeding and genetics on salmon, for the development of these species. Marketing is an important part of the effort of sharing knowledge, and developing distribution and sales of breeding material." www.benchmarkplc.com

Global Category Manager Enzymes

EW Nutrition as leading provider of innovative feed solutions recently announced that **Dr Ajay Awati** has joined the company's product management team as Global Category Manager Enzymes.

Ajay finished his Bachelor´s program in Veterinary Science and Animal Husbandry at the KNP College of Veterinary Science, now part of Maharashtra Animal and Fishery Sciences University, India. He continued his masters education under International Master's program in Animal Science at the University of Wageningen with focus on nutritional immunology. In his professional career he worked several years in leading companies in animal nutrition and animal production industry and gathered profound scientific and practical experiences in the development and application of feed additives in animal nutrition. www.ew-nutrition.com

FAO to chair Offshore Mariculture Asia 2018

Alessandro Lovatelli, Regional Fisheries and Aquaculture Officer at the FAO, has been named as the chairman of Offshore Mariculture Asia Conference 2018, said the UK based Mercator Media Ltd, organiser of this event in January. The 2018 Offshore Mariculture Conference will be held on the 15-17 May at the Marina Mandarin, Singapore.

The FAO Fisheries and Aquaculture Department promotes 'policies and strategies aimed at sustainable and responsible development of fisheries and aquaculture in inland and marine waters'. According to the organisation, fisheries and aquaculture have the capacity, if supported and developed in a regulated and environmentally sensitive manner, to contribute significantly to improving the well-being of poor and disadvantaged communities in developing countries. Its mission is defined as 'strengthening global governance' and emphasises its desire to lead consensus-building towards improved conservation and utilisation of aquatic resources.

The need to increase the intensity and improve the approach of marine fish production per square meter in Southeast Asian waters was voiced by the FAO chairman at the 2016 Offshore Mariculture Conference Europe. In light of this, Singapore has been chosen to host the first Asian edition of Offshore Mariculture.

Held in association with the U.S. Soybean Export Council, USSEC, the conference will provide attendees with the chance to learn from and network with well-established and pioneering medium to high volume producers/ stakeholders, including expert equipment suppliers and investors. The conference will conclude with a technical visit to a local fish farm, where delegates will have the opportunity to view an established, functioning fish farm, followed by a question and answer session with the farm managers.

Marianne Rasmussen-Coulling, Events Director, Mercator Media added, "OMC Asia is the perfect meeting place for those interested in learning about and investing in industrial marine fish operations. We are pleased to welcome Alessandro Lovatelli as Chairman of the 2018 OMC conference and look forward to the wealth of knowledge he will bring"

The conference is aimed at professionals who are looking to gain valuable information on the progress and prospects for farming offshore such as the latest policies, products, research and case studies within the fin/shell fish and seaweed offshore farming industries. Companies include: • Farming companies • Investors • Hatcheries • Ministries of Fishing and Fisheries • Research organisations • Export associations. www.offshoremariculture.com/asia

Aqua Culture Asia Pacific in 2018

Volume 14 2018					
Number	**2 – March/April**	**3 – May/June**	**4 – July/August**	**5 – September/ October**	**6 – November/ December**
Issue focus *Trending issues and challenges for the next step*	Health Management	Sustainable & Responsible Aquaculture	Disease Management	Genetics & Genomics	Integration and supply chain
Industry Review *Trends and outlook, demand & supply*	Marine Fish	Aquafeed Production	Tilapia	Monodon shrimp	Catfish/General Freshwater
Feeds & Processing Technology *Technical contributions from feed industry*	Feed Additives Fish oil replacements/ omega 3 oils	Extrusion & Processing Functional Feeds	Lipids & Minerals Nutrition	Feed Safety and Hygiene	Functional Feeds
Production Technology *Technical information and ideas*	Finfish Industrialisation	Hatchery Technology	SPF/SPR/SPT shrimp	Post-Harvest Technology	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	EU	Tilapia	China	USA	Catfish
Aqua business *Feature articles*	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc				
Company/Product news	News from industry including local and regional trade shows				
Deadlines for Technical articles	**January 19**	**March 16**	**May 18**	**July 13**	**September 14**
Deadlines for Advert Booking	**January 26**	**March 23**	**May 25**	**July 20**	**September 21**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	****Asian Pacific Aquaculture 2018*** April 23-26, Taipei, Taiwan **Seafood Expo Global 2018** April 24-26 Brussels, Belgium	**Offshore Mariculture Conference Asia** May 15-17, Singapore **Asia-Pacific Aquaculture Expo & Global Aquaculture Summit** June 1-3, Fuzhou China	****TARS 2018 Shrimp Aquaculture*** August 15-16 Chiang Mai, Thailand **Vietfish 2018** August 22-24 Ho Chi Minh City, Vietnam **Aqua 2018** August 25-29 Montpellier, France		

VICTAM Asia 2018 will be held on March 27 - 29, 2018 in Bangkok, Thailand; exhibition and conferences will be held once again at the Bangkok International Trade & Exhibition Centre (BITEC) in Bangkok, Thailand. VICTAM Asia is an established event dedicated to the animal feed processing, grain processing, ingredients and additives, aqua feed and pet food industries within Asia. The last edition in 2016 was sold out.

VICTAM exhibitions display the latest technology, ingredients and additives available to manufacture and process feed for animals, pets and aquatics, together with a wide range of necessary ancillary equipments – silos, conveyors, bagging, elevators, etc. The exhibition also showcases the newest equipment for grain, rice and flour milling.

Co-located with VICTAM Asia are a series of high quality industry conferences, including Aquafeed Horizons Asia 2018, FIAAP Animal Nutrition Conference Asia 2018, and World Feed Perspectives Seminar. New features at VICTAM Asia 2018 include a business matchmaking program and the VICTAM newsroom. The former will help exhibitors and visitors get the most out of the program and will support in finding their match. The VICTAM newsroom will report semi-live from the show floor to allow those who cannot attend to still be part of the action. Furthermore, speakers, visitors and exhibitors will be interviewed on their expertise and the news crew will make running reports on the event through Victam's social media channels.

Victam 2018 is supported by several organisations: Feedstuff Users Promotion Association, Thai Feed Mill Association, Animal Husbandry Association of Thailand, Animal Health Products Association, Department of Fisheries, Ministry of Industry, Thai Chamber of Commerce, Department of Livestock Development and Thailand Convention and Exhibition Bureau

For detailed information: www.victam-asia.com. Registration is direct for the exhibition and conferences at https://victamasia.com/registration.

2018

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 14-16
Ildex Vietnam
Ho Chi Minh City, Vietnam
www.ildex.com.vn

March 27-29
Victam Asia 2018
Bangkok, Thailand
www.victam-asia.com

March 27
Aquafeed Horizons Asia 2018
Bangkok, Thailand
www.feedconferences.com

April 19-21
Aquaculture Asia 2018 Expo and Forum
Kuala Lumpur, Malaysia
www.livestockasia.com

April 23-26
Asia Pacific Aquaculture 2018
Taipei, Taiwan
www.was.org

April 24-26
Seafood Expo Global
Brussels, Belgium
www.seafoodexpo.com/global/

April 27-29
Vietshrimp 2018
Bac Lieu, Vietnam
www.vietshrimp.net

May 15 -17
Offshore Mariculture Conference Asia
Singapore
www.mercatormedia.com

June 1-3
Asia Pacific Aquaculture Expo & Global Aquaculture Summit
Fuzhou, China
www.apaexpo.com.cn/

June 3-7
18 th International Symposium on Fish Nutrition and Feeding (ISFNF)
Las Palmas de Gran Canaria
Canary Island, Spain
www.isfnf2018.com

July 16-20
Certificate in Aqua Nutrition
Bangkok, Thailand
www.progressus.asia

August 15-16
The Aquaculture Roundtable Series (TARS): Shrimp Aquaculture in Asia
Chiang Mai, Thailand
www.tarsaquaculture.com

August 22-24
Vietfish 2018
Ho Chi Minh City, Vietnam
www.vietfish.com.vn

August 25-29
Aqua 2018 Montpellier, France
www.was.org/www.aquaeas.eu

VICTAM Asia 2018

FIAAP grapas

27 – 29 MARCH 2018 · BITEC EXHIBITION HALLS, BANGKOK, THAILAND

Asia's largest feed and grain event

Your global marketplace – an international event in an international city being held in a country with large home markets

What's on show at VICTAM Asia 2018?
• Feed production technology • Packaging • Energy efficiency
• Auxiliary equipment

What's on show at FIAAP Asia 2018?
• Ingredients • Additives • Formulation • Laboratory equipment
• Quality control

What's on show at GRAPAS Asia 2018?
• Rice milling and sorting technology • Flour milling technology
• Flakers, extruders • Grain processing systems • Additives

Industry conferences
• The FIAAP Asia Animal Nutrition Conference 2018
• Petfood Forum Asia 2018 • Aquafeed Horizons Asia 2018
• Proagrica Feed Efficiency Conference Asia 2018
• GRAPAS & Global Milling Conference Asia 2018 • GMP+ Seminar

Supported by
• The Feedstuff Users Promotion Association • Thai Feed Mill Association • The Animal Husbandry Association of Thailand
• Animal Health Products Association • Department of Fisheries
• Ministry of Industry • The Thai Chamber of Commerce
• Thailand Convention and Exhibition Bureau

TCEB
THAILAND CONVENTION & EXHIBITION BUREAU

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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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