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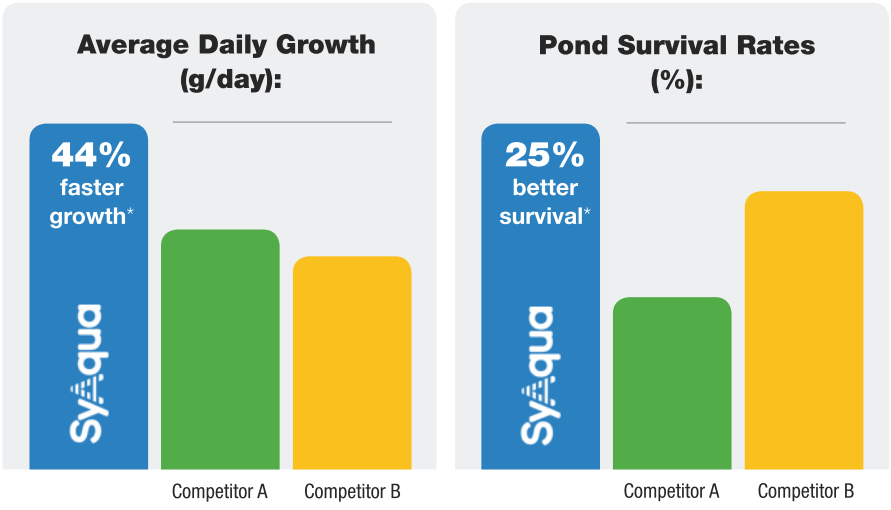


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Zuridah Merican

# Industry, Research and Nation building

The 1997-1998 recession has had more effect on the aquaculture industry and stakeholders than we would like to think. The governments in many countries in Asia have gone into austerity mode. This has affected academic institutions via reduced funding, and research has suffered. Industry has been propped-up, which was the intention in the first place, to ensure that the economy continued to grow and the trickle-down effect would maintain jobs and general prosperity. But one group has fallen through the cracks, namely the academic sector. The role of academia is not meant to only produce a supply of graduates but it is also an important place for research. Research drives industry and vice versa but today we see a disconnect, due in part to self-interest.

The private sector, in general, has flourished over the past decade and most of the research has moved in-house. Knowledge has remained in-house so that companies can maintain a competitive edge. Information gained is protected and not shared with other stakeholders in the industry. Academia, reeling from government underfunding has moved from the model of 'Publish or perish' to 'Patent or perish'. Many researchers today are trying to develop products and services so that they can patent it. The problem arises because researchers and academia are generally not good marketers; always holding out for the best bid. However, these patented products and services lose their value over time and solutions for the industry are eventually lost. Research has evolved such that the private sector and academia work in separate silos with no collaboration, believing that knowledge, which equates to cash, is king.

How does this affect Asian aquaculture? In 2018, Andy Shinn, FishVet Group, reported that calculated losses with Streptococcus outbreaks in Asia was probably around USD 713 million. For AHPND in Thailand alone, since 2010, it could have been more than USD 7 billion. This year-2019, we cross the point of 10 years since EMS/AHPND first devastated China's shrimp industry. (see revisiting EMS/AHPND on pages 18-23). There is a constant need for basic and applied research on the causative factors of current and emerging diseases in order to find solutions to the problem. Imagine, the potential revenue to the industry if research was coordinated and shared.

Improved genetics for the Asian seabass have been developed but the distribution is limited. One could argue for the broodstock to be sold at cost and more money be made in hatcheries and nurseries producing millions of fry and hundreds of thousands of juveniles, respectively which would yield a higher nett value. This is a simple multiplier effect which has been the catalyst of past industrial revolutions.

Dr Rohana Subasinghe reminds us that 70% of aquaculture production is cumulative from small farms. In marine cage farming, many farms are small family-based operations that need help with good genetics and disease diagnosis to improve current survival rates. Competent authorities and researchers should focus on solutions such as zoning of infected areas or biological control measures. This is part of the government service to improve farming efficiency and contribute to nation building.

Aquaculture can only be developed through an interdisciplinary approach to attain more sustainable farming practices and salmon farming in Norway is still the best role model. In the 1980s, a common challenge united research, competent authorities and the private sector to find solutions to support a growth industry. Norwegian aquaculture has since developed into a major GDP contributor through a close cooperation between industry and research institutions. According to the Norwegian Seafood Council, the export of salmon and trout from aquaculture was valued at NOK 67.2 billion in 2017. Now that is what we call nation building!

Asian aquaculture may seem light years away from the Norwegian model and the region is challenged by the fact that there are multiple countries with different agendas. However as stakeholders, we could start the ball rolling from a bottom-up approach and the best step forward is to renew industry-academia partnerships to ensure coordinated research within each country.

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# Past, present and future in marine aquaculture

As the guest speaker at INVE Aquaculture's celebration of 35 years in aquaculture, Professor Patrick Sorgeloos reviewed the early history of hatchery operations and gave his views on microbial management and other technologies for the future.

Professor Patrick Sorgeloos, Ghent University in Belgium was the guiding light in the history of INVE Aquaculture, initially established for the development of *Artemia* hatching techniques and the authentication of certified *Artemia*. Research continued with the development of larval feeds. As the guest speaker at INVE Aquaculture's celebration of 35 years in aquaculture (see page 44), Sorgeloos traced the developments since the 1970s to the present – on the early years working on the *Artemia*, a vital live feed driving marine shrimp and fish hatchery production to the turning point with microbial management to overcome disease outbreaks. His visionary view for the future is microbial management and live feed replacement.

*Sorgeloos looked back at the developments in backyard Macrobrachium and shrimp hatcheries to today's systems with closed hatcheries and nurseries. The take home message is to work on sustainable intensification of aquaculture and use new tools for precision farming.*

> "There is constant pressure on hatcheries to continuously lower fry production costs. They do not focus on the raising of quality fry or post larvae."

## Early stage with live feeds

The work on *Artemia* started in the late 1970s with a focus to limit variations in *Artemia* strains and as the crustacean could be a source of *Vibrio* in hatcheries, Sorgeloos' goal was to provide safe and biosecure supplies of *Artemia*. Most of the work was conducted at the Artemia Reference Centre, Ghent University, Belgium. It was also a resource centre for training researchers and users of *Artemia*.

The key to successful production of shrimp and marine fish is to ensure the availability of high quality post larvae and fry. The multi-million-dollar hatchery industry still requires a lot of improvements. "The focus has been the consistent supply of high quality fry and cost effectiveness of fry production. However, there is constant pressure on hatcheries to continuously lower fry production costs. They do not focus on the raising of quality fry or post larvae; this maybe because they do not have the tools."

In 1983, as Artemia Systems NV, a spin-off from Ghent University was being established, the concept of business aquaculture took off. There was a demand for live feeds. Artemia Systems focused on the selection of quality *Artemia* and strived to set standards and marketed certified *Artemia* cysts. In later years, INVE Aquaculture focussed on the improvement of products for meeting the nutritional demands in the first life stages of fish and shrimp aquaculture.

"In hatchery operations, we do not understand the science behind why one system works while another does not," said Sorgeloos. "In the 1980s, in Chinese hatcheries, probiotics were used to combat *Vibrio* outbreaks. In other countries, bioluminescence started

*Patrick Sorgeloos with guests at the anniversary celebration; Ramon Alegre, Dobe Hatchery, Philippines (third left) and Mary Ann Solis, Biosolutions International Corp, Philippines (second right). Photo by Mary Ann Solis.*


*Brendan Yeo, Blue Pearl Aquatic Sdn Bhd, INVE Aquaculture's authorised distributor in Malaysia (right) and Michael Janssens, area manager South-East Asia*

in post larvae tanks and antibiotics were common in backyard hatcheries. The late 1980s focused on preventive measures with manuals on good management practices." At the first Larviculture Conference in 1991, industry realised the need to learn more on the role of microbial conditions and zootechniques. It then focused on the need to improve water quality and *Artemia* hatching and cleaning.

Sorgeloos was reminded of two critical issues. A complete separation of cyst and nauplii is critical as contamination with shells can lead to obstruction in the digestive tract, in particular for the fish and bringing vibrios to tanks. Cold storage techniques, common in Europe but still rare in Asia, allows for frequent feeding during the day.

"We need to revert to the FAO protocols on using *Artemia* nauplii. Few hatchery operators focus on the difference between non-feeding instar 1 and instar 2 with functional digestive system. Harvesting instar 1 is recommended as most likely instar 2 is loaded with vibrios that they have ingested."

With regards to marine fish in Asia, there has been an explosion in production from the 1980s to 2013. "There are lots of opportunities, but the approach is still extensive, and largely hit and miss. The industry is large; in Europe, the production of 1.2 billion fry is valued at €150 million. It should be similar in Asia, but here we have invested on many species and find it difficult to solve the problems and continue to make the same mistakes."

## Microbial management and quorum sensing

"In the years to come, the focus will be on microbial management in hatcheries, nurseries and farms. At Larviculture 2017, it became clear that we are at a turning point in microbial management. Today, we no longer rely on plating. We have at our disposal molecular biology and full sequencing of all microbes present in the system," said Sorgeloos.

"Another crucial discovery is that a lot of bacteria communicate and when there is a certain number, the quorum is reached. People asked me whether it is $10^5$ or $10^6$, my answer is that science is in full progress as there remain many unanswered questions. We are always interested in vibrios which we do not wish in our systems. It is well documented that when quorum is reached, they switch on the virulence genes and reach the pathogenic status."

In aquaculture, there is a vast population of bacteria and identification can be simply the good bacteria versus the bad bacteria including the potentially harmful ones, like the Vibrios. "We can still continue to use traditional methods to disinfect ponds and tanks for biosecurity reasons, but note that seconds later, we get new colonisation; we can have populations of the fast-growing r-strategists or bad (*Vibrio*) bacteria and the slow growing k-strategists or good (nitrifying) bacteria which have roles such as enhancing the immune and digestive systems."

During EMS outbreaks where farmers practise more frequent disinfections, the risk is increased. Other techniques include stocking tilapias in hapas placed in ponds and then removing them before stocking shrimp, to provide a more stable environment.

"Today we understand why the number of small-scale recirculation systems are not only more predictable but the shrimp quality appears to be better than from a batch system. We should look at the intensification of hatcheries with control of microflora and higher production. It is clear that recirculation systems give a more stable microflora. The conclusion is, "We need to apply today's understanding into the traditional ways of hatchery operations," said Sorgeloos.

"However, as recirculation hatchery and nursery systems in modular units develop at a commercial level, we need microbial quality control (QC). Sometimes bioflocs systems work and sometimes they do not , and I attribute this to the lack of good QC."

> "We need to further replace and eventually completely substitute the live food but there are factors such as digestive enzymes etc..."

## Replacement of live food

Something which should have been realised long ago is that live food is often a problem. Sorgeloos added, "Microalgae, rotifers and *Artemia*, if not used the proper way, may also be bringing in the Vibrios and might be the origin of some of the problems we are facing today. We need to further replace and eventually completely substitute the live food but there are factors such as digestive enzymes etc which we do not have complete knowledge of, that might interfere. There may be critical roles for bioflocs, pre-and pro-biotics bacteria as we replace live food."

## Future is precision farming

The future will be challenging. Another 100 million tonnes of seafood must be added to the global supply. "We need to work on sustainable intensification of aquaculture and use new tools for precision farming. I believe that what is done in salmon farming can be done with Asian fish species. Technology and AI can be used in Asian farming. We can integrate fed and extractive aquaculture and the integrated monoculture with microbial management. In the next decade we can see this increasing. We can also see ocean industries integrating with aquaculture."

# Bangladesh to start vannamei shrimp farming

For several years, industry have been debating with authorities on farming of *Penaeus vannamei*. Bangladesh remains the only country in Asia not farming this shrimp. In the Jan/April 2018 issue of Shrimp and Fish News, M. Kabir Ahmed, Department of Fisheries (DoF), said that, "for an unknown reason, farming of this shrimp is not permitted and the country only exports 40,000 tonnes of *Penaeus monodon* and *Macrobrachium* sp. He added that Bangladesh should consider farming this shrimp to bring a revolutionary increase in total exports earnings. In January, it was reported in the Daily Star that the government is expected to allow experimental cultivation of non-native vannamei species of shrimp in the face of demand from exporters.

The initial plan is to farm vannamei shrimp in isolated facilities in Khulna and Cox's Bazar. The DoF formed an expert panel in August 2018 to assess the feasibility of farming. The committee, among others, suggested formulation of a comprehensive protocol on quarantine, disease surveillance, biosecurity, hatchery management and broodstock imports. It also suggested that 2 local hatcheries import pathogen-free broodstock. The Bangladesh Frozen Foods Exporters Association (BFFEA) has long been demanding vannamei shrimp farming. It said that, productivity with the monodon shrimp is only 300-400kg/ha and more can be achieved with the vannamei shrimp which will provide raw materials in higher quantity, utilise their unused processing capacity and compete in the world market.

In contrast, other industry stakeholders noted the dearth of infrastructure focusing on shrimp farming biosecurity. Syed Mahmudul Huq, chairman of the Bangladesh Shrimp and Fish Foundation (BSFF), said vannamei farming was capital-intensive and required scientific management. Proper infrastructure and trained workforce are prerequisites for vannamei farming. Huq suggested intensification of monodon shrimp farming and branding it in the international market as a premium product. But BFFEA's Kazi Belayet Hossain countered that production cost of the monodon shrimp was higher than of vannamei shrimp even when intensive farming was applied.

# Encouraging fish meal suppliers to meet IFFO RS standards

Thailand's Charoen Pokphand Foods (CP Foods) plans to take further steps to encourage its fish meal suppliers to stick with International Fishmeal and Fish-Oil Organisation Responsible Supply (IFFO RS) standards to ensure non-IUU fishing through its supply chain.

The European Commission's recent decision to remove Thailand from the "yellow card" status has made all relevant sectors to strictly adhere to traceability. CP Foods is also gearing up to encourage its fishmeal suppliers to take up IFFO RS standards to ensure sustainable business. It is important to note that all the fish meal used in CP's Thailand operations is certified by IFFO RS and comes from the by-product of fish-processing plants.

Dr Sujint Thammasart, chief operating officer of CP's aquaculture business, said the company will double the number of certified suppliers this year. This plan will not only help improve its manufacturing line, but also ensure that raw materials come from legal sources. Sujint added that the IFFO RS standard requires that all raw material, particularly fish, comes from legal sources with responsible fishing practices that are in line with the Fishery Improvement Project (FIP), certified Good Manufacturing Practices and traceability through the supply chain. Good practices in Thailand will also be expanded to CP's operations in other countries such as Vietnam, the Philippines and India.

## Auction of Australian Farm

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The property has been owned by a local family for the last 10 years and is on the market with Jon Kingston of Ray White Rural Chinchilla Miles with an auction date set on April 5 at 10:30am in Ray White's Corporate auction room in Brisbane.

"This endeavour has been building for nearly 10 years and the hard work is paying off. All the fish are sent to the Sydney and Melbourne Fish Markets plus some independent wholesalers. This is a very cash flow positive and the processes are in place," Kingston said. "The foundations have been laid! Take hold of an opportunity to acquire an operation with the potential to export worldwide."

The business comes with its six secure staff, including farm manager Scott Voller, plus a knowledgeable marine biologist consultant. "This aquaculture operation is one opportunity that should not be missed. Additional income streams are being generated from cattle, gravel and coal seam gas wells, which all assist in a diversified cash flow. The farm also has a 130kw solar plant to assist with cost controls and efficiencies," added Kingston.

The aquaculture operation has been in continuous growth and development since state and council approvals were provided in 2010. The farm is on both the Condamine River and Weimbilla Creek, so Condabilla, is excellently watered and comes with water licences that Kingston says, "are enviable throughout the Condamine catchment". See page 25 for more details.

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AN OPINION ARTICLE

# The good, the bad and the ugly side of shrimp farming

Manoj M Sharma says that settling the blame game on why disease happens is by managing or balancing the art and science of shrimp production.

If 25 years of experience with shrimp production has taught me anything, it is that rapid, unchecked expansion usually leads to rapid, devastating decline. At Mayank Aquaculture Private Limited, I have been farming shrimp for more than two decades in Gujarat, India's second largest shrimp producing state. Over this period, I have watched the growth of shrimp ponds, from 1 pond to 4,600 only in Surat district and 10,000 ponds overall in Gujarat state. Then I have seen the decline due to rampant diseases affecting shrimp production.

In this article, I will discuss the causes leading to the decline and the way the problems were handled. I have identified several major concerns faced over the years. Among them were lower post larvae survival rates, slower growth leading to higher feed conversion ratios (FCR), abrupt algal bloom with changes in water colour and body deformities. The diseases are white gut and white faeces disease (WFD), as well as *Enterocytozoon hepatopenaei* (EHP). Of course, white spot syndrome virus (WSSV) is still the biggest problem.

> "We have entered into almost 30 years of shrimp farming, but there is still no reliable method or methodology to calculate the exact figures for carrying capacity."

These setbacks have often been pointed out as problems related to water quality and carrying capacity. We have entered into almost 30 years of shrimp farming, but there is still no reliable method or methodology to calculate the exact figures for carrying capacity.

## Were farmers ever ready for the vannamei shrimp?

Shrimp farming started in Gujarat with the monodon shrimp as the primary species in 1995 until 2009. When the vannamei shrimp was introduced to India in 2009, we already had sufficient technology and knowledge to farm the monodon shrimp. Our entire set up – heart, body, and soul, everything was geared towards this monodon shrimp. This also includes our processing facilities.

When the vannamei shrimp was introduced to existing monodon shrimp farms, initially all went well. In 2010 with only 2.2 billion post larvae, farms did well with an 80% survival rates. However, in subsequent years, survival dropped. By 2017, although India produced 650,000 tonnes using 65 billion post larvae, survival rates only reached a paltry 40%. I believe that the mistake countries like Vietnam, India, China and many others made was leaping too fast without the proper tools and know-how.

Initially, everybody minted money in the production of vannamei shrimp during 2011 to 2015 in India from feed mills to supplier companies, technicians and farmers. In the late 2015 and 2016, we started facing problems. Farmers were caught in a state of confusion. They began playing the blame game for failed crops on all fronts – from post larvae quality to problems with feed and nutrition, knowledge of technicians and a lack of biosecurity in farm management (Figure 1).

*A new farm at Mayank Aquaculture,well designed with 40% of area for water treatment. Pond sizes are 0.5ha and water depth1.8m. All ponds have a 4-step filtration system and a sludge removal system. There are separate ponds for sludge treatment and storage. All ponds have autofeeders to increase feed efficiency.*

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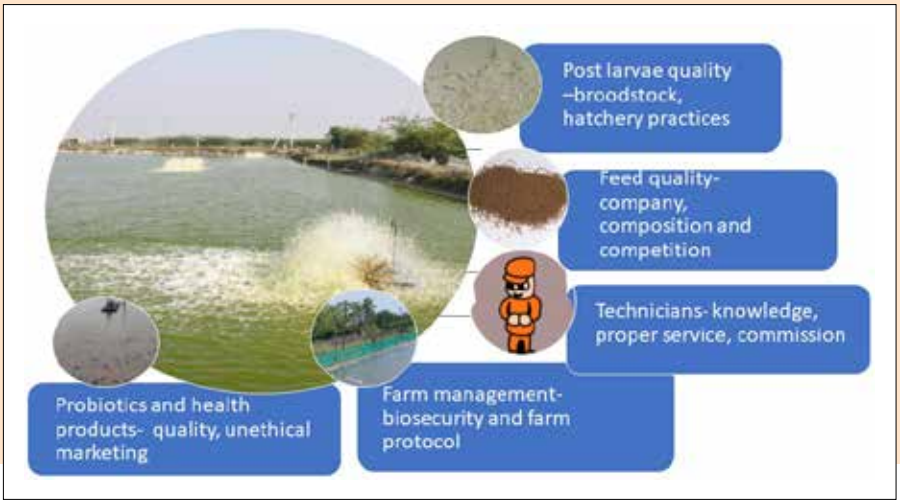


***Figure 1*** *The blame game*

In Gujarat, farmers easily shifted from large scale monodon shrimp production to the vannamei shrimp at an equally sizeable scale. We were the first to talk about farming the vannamei shrimp, "the monodon way" because all our farms are equipped for 10 to 15 post larvae (PL)/m$^2$) stocking density and I was the first to practise vannamei farming on the scale of monodon shrimp. We even reached stocking up to 19PL/m$^2$ of the vannamei shrimp in 2015 and 2016. Gujarat's shrimp usually grew to a size range of between 30g to 45g but growth began to slow down in 2017, as the vannamei shrimp could not reach the 20g to 25g range. By the first half of 2018, 85% of ponds were affected by WFD, EHP and running mortality syndrome (RMS). It led to emergency harvests of shrimp in the 15g to 20g range.

## How and why did the downward spiral occur?

I found two major factors responsible for the downward spiral in my area – pond production vs pond carrying capacity, as well as the number and distance between these ponds that affected the water source. I attributed these to unplanned development of ponds. I then made comparisons of several areas including Dumas, Olpad and Mandroi.

An aerial view of Dumas in 2009 showed hardly 40 to 45 ponds (Figure 2). However, by 2018, the face of the land had drastically altered with hundreds of ponds centred along the Mindhola Creek. The same issue appeared in Olpad and Mandroi. The density of farms in Mandroi has also pushed the creek to change its course (Figure 3).

In addition to the high stocking density, fluctuating weather patterns aggravated pond conditions as they affected water salinity, water temperature and organic loads. Issues with water temperature stressed the vannamei shrimp, which are naturally active swimmers. In high water temperatures above 33°C, we discovered shrimp with bent and cramped bodies. We then postulated that the shrimp physiology cannot support swimming in such high temperatures.

***Figure 2*** *Comparison of shrimp farming activity in Dumas in Gujarat state, in 2009, with 40- 45 ponds (left) and in 2018, with hundreds of ponds centred along the Mindhola Creek (right).*


***Figure 3*** *Changes in the density of farms in Mandroi which has also pushed the creek to change its course (right).*

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*From top: Shrimp with opaque flesh is common in ponds with high salinity water; At high water temperatures above 33°C, shrimp showed bent and cramped bodies; Shrimp affected by white spot syndrome virus; Sludge with dead shrimp. Accumulation of unconsumed feed and shrimp faeces attracted pathogens that resulted in disease outbreaks.*

Furthermore, feeding the vannamei shrimp in summer became a big challenge. Following the monodon shrimp culture technique, there was a lot of feed wasted because we provided daily, three to four times of feed in ponds without calculating how many pellets shrimp eat at any one time. Unconsumed feed and shrimp faeces accumulated as organic load, attracting pathogens that resulted in disease outbreaks.

Nonetheless, quick fixes came with new knowledge on organic load imbalance, but long-term solutions require deeper research. An example is the short term solution of sludge removal, seen as a possible answer with the development of shrimp toilets. But I believe this knowledge is incomplete. It is not advisable to dump the same sludge into the same water source because it comes back to my farm or that of my neighbour in the same creek. The recommendation is a separate area for sludge disposal or recycling through treatment.

## A case study

To better understand the issues of disease, I conducted an experiment in four different sites

- an old pond with an old creek (OPOC);
- new pond, old creek (NPOC);
- new pond, new creek with high salinity (NPNC-HS); and
- a new pond, new creek with low salinity (NPNC-LS).

All aspects from feed, stocking density, seed and protocols or farm management were constant, with the water source and location as the only variables.

Results from the OPOC showed slow growth with 140 days of culture (DOC) producing size 36 to 40/kg with a 62.5% survival rate. The feed conversion ratio (FCR) was very high, ending up at 1.8 because we started losing biomass after every successful moult. The NPOC site showed an average growth producing size 33 to 37 kg shrimp with a 75% survival rate at DOC 133. While the NPNC-HS displayed slow growth at DOC 155, but also yielded good production of size 40 to 45/kg and a 90% survival rate.

> "For successful shrimp farming, it is very clear to us that pond carrying capacity versus the number of ponds over the creek is a critical factor."

Vannamei shrimp is not highly tolerant to high salinity or temperatures above 32°C but shrimp survived well even at temperatures as high as 35°C because the water source was very clean. However, the NPNC-LS site exhibited high growth yielding shrimp size 38 to 40/kg at only DOC 105 with a FCR of 1.15 and a 95% survival rate.

**Table 1** Results from the case study

| Trial No | Sites | DOC | Size/kg | Survival | Remarks |
|---|---|---|---|---|---|
| 1 | OPOC | 140 | 36-40 | 62.50% | Slow growth high FCR 1.8 |
| 2 | NPOC | 133 | 33-37 | 75% | Avg. growth & survival rate |
| 3 | NPNC-HS | 155 | 40-45 | 90% | Slow growth good production |
| 4 | NPNC-LS | 105 | 38-40 | 95% | Super growth FCR 1.15 |

The outcome of the case study is an eye opener. It very clearly showed that what matters is the organic matter load. The moment there is high organic load in the new incoming water source, then problems will occur. Shrimp health is directly related to water source. For successful shrimp farming, it is very clear to us that pond carrying capacity versus the number of ponds over the creek is a critical factor.

## Shared success

It is through these experiences for a quarter of a century that I have grasped the significance of developing a mutual understanding and cooperation among shrimp farmers. We are lucky because we have a strong association of vannamei shrimp farmers in Gujarat.

> "We decided to go with 50% capacity and rotate the crops, with the remaining 50% used for the second crop."

It is very important for everybody to understand how many ponds can be operated in a given creek. The problems faced have been because farmers have exceeded the carrying capacity of the creek. It is the collective decision of shrimp farmers making the right decision on operating ponds to overcome the load on the creek. We decided to go with 50% capacity and rotate the crops, with the remaining 50% used for the second crop. I strongly believe that when you interlink with farmers clubs or groups, you have a greater chance of success because you share your knowledge and successes with one another.

If you ask any farmer before 2015 in Gujarat, they will say creating good results (in shrimp production) is an art. We do not learn when making money. However, when farmers suffer losses, the learning process begins . This is an irony in shrimp farming. I wish to reiterate here the importance of replacing the blame game with managing or balancing the art and science of shrimp production.

*This article is adapted from the presentation titled "When Carrying Capacity is Exceeded in Shrimp Farming" at the Post-TARS 2018 session on Shrimp Disease Management, Chiangmai, Thailand, 15-16 August 2018.*

**Dr Manoj M Sharma** is managing director of Mayank Aquaculture Private Limited. He has been working relentlessly to educate farmers in Gujarat on good shrimp farming practices. The latest achievement is that farms have agreed on rotation of ponds to manage disease. Gujarat state contributes 10% to the annual production in India and her farmers are recognised for more sustainable farming practices than in other parts of India.
Email: mapl.shrimp@gmail.com

# IgY boosting Immunity in shrimp

## IgY antibodies act as immune modulator to protect shrimp from microbial infections

By Fazle Elahi, Hyuck-Se Kwon and Nam-Hyung Lee

Unlike mammals, poultry, such as the chicken can transfer their antibodies to their egg yolk. This process results in the development of IgY, immunoglobulin in yolk. The South Korean company, ADbiotech Co. Ltd has incorporated IgY antibodies in its product for the prevention of certain diseases as an immune modulator in shrimp as well as for livestock.

To acquire a specific antibody, specific antigen of pathogens such as *Vibrio parahaemolyticus*, *Vibrio anguillarum*, or *Vibrio harveyi* was injected into the breast muscle of chicken. When the chicken makes the antibody for that antigen, the antibody passes into the egg yolk, to produce the IgY.

Since the late 1800s, applications of this IgY antibody in diagnostics and therapeutics have been well received in human and veterinary medicine. IgY antibodies have been used for the prevention and treatment of fish diseases such as vibriosis, Edwardsiellosis and enteric redmouth disease, as well as white spot syndrome (WSSV) in shrimp.

ADbiotech commercialises this IgY technology and launched the product, "Ig Guard A" for shrimp health, which has been proven for its efficacy on growth, and prevention of shrimp diseases (early mortality syndrome/acute hepatopancreatic disease or EMS/AHPND and WSSV) in China, Vietnam and Thailand. These are the three major shrimp farming countries in Asia. Results from some *in vivo* trials are described below.

## Activating shrimp immunity

The reaction of shrimp against a pathogen is dependent on its immune capacity. It cannot produce immunoglobulin, and therefore has to depend on its innate immunity (Roch,1999). The immune process starts from the recognition of the attacking microorganisms. This process is executed by haemocytes through molecules that can distinguish structures in the cell walls of a pathogen (Lin et al., 2006). Once the invading pathogen is detected, haemocytes are initiated. A whole series of mechanisms are then induced to control or remove the intruders or microorganisms. Ig Guard A aids in this process by increasing the amount of haemocyte cells (Figure 1), lysozymes and phenoloxidase.

Our studies showed that in comparison to the control group, IgY antibodies influence the prophenoloxidase (proPO), serum lysozyme (LSZ) and pancreatic endocrine neoplasms (PEN-3) gene up-regulation to adaptive immunity, even at the molecular level. Compared to the negative control, the IgY antibodies augment the hyaline cells (HCs) (Figure 2) which are involved in phagocytosis, an important process for eradicating microorganisms from the body (Lin et al., 2013).

Phagocytosis is one of the main cellular defense mechanisms in shrimp against bacteria, virus, and fungus. It consists of recognition, attachment, ingestion, killing pathogens and removal from the body (Figure 3). Ig Guard A increased more than 50% of the phagocytosis activity compared to negative control after challenge. Lysozyme kills bacteria mainly by hydrolysis of the ß-1, 4-glycosidic linkages between N-acetylglucosamine in peptidoglycan and N-acetylmuramic acid leading to bacterial lysis of gram-positive and gram-negative bacteria including *Vibrio* spp.

For example, in 2010, the injection recombinant lysozyme protein prevented shrimp from a WSSV infection in Japan. Ig Guard A increased more than 200% of lysozyme level (Figure 4) in the haemolymph of shrimp before and after *V. parahaemolyticus* challenge. This indicates, IgY antibodies can be an antibacterial feed additive and an alternative to antibiotics, helping farmers reduce antibiotic use in feed for disease prevention. In addition, IgY antibodies was shown to improve phenoloxidase (PO) to around 16.0% as compared to the negative control (Figure 5). PO is an enzyme and a major component of the shrimp immune system which accelerates the pathway of melanin synthesis. Thus, the product acts as a tool to prevent microbial infections in shrimp.

Superoxide dismutase (SOD), enter the cell cytoplasm where the antioxidant catalase (CAT), halt hydrogen peroxide production and detoxify reactive oxygen species or ROS (Aguirre-Guzmán et al., 2009). This is one of the defense mechanisms against oxidative stress caused by pollution, infections, hypoxia, hyperoxia, temperature and other environmental stress. In Figure 6, we show that Ig Guard A increases the SOD level in the haemolymph.

## Serum antibacterial function

After an Ig Guard A dietary treatment for 30 days, the serum was collected from each shrimp and diluted using 2.6% NaCl at a ratio of 1:2, 1:4, 1:8, 1:16 and 1:32. Each serum (0.5mL) dilution were co-cultured with *V. harveyi* for 3h at room temperature. The control was 0.5mL NaCl. Before the challenge, the antibacterial capacity of the IgY treated group increased 4 times and remained 2 times higher after the challenge, indicating that the product augmented the antibacterial capacity in the serum of the shrimp. This effect might be due to the increase of the antimicrobial peptide in the serum of shrimp by this product.

| Treatment | Intestine (x10 CFU/mL) | | | Hepatopancreas (x$10^3$ CFU/mL) | | |
|---|---|---|---|---|---|---|
| | Days of culture | | | Days of culture | | |
| | 30 | 60 | 90 | 30 | 60 | 90 |
| Control | - | 2.90 | 3.80 | - | 4.07 | 6.20 |
| Ig Guard A | - | - | - | - | - | - |

**Table 1** The average number (CFU/mL) of *V. parahaemolyticus* in the intestine and hepatopancreas of *L. vannamei*

## Disease challenge

In one trial, 0.5% of Ig Guard A was added to 1 tonne of feed and was fed to *Litopenaeus vannamei* under challenge conditions with Vibrios documented to be implicated in causing EMS. The results showed an improvement in disease prevention against pathogenic bacteria. (unpublished data). A similar trend was also observed in the case of the WSSV challenge.

## Benefit to farmers

In *in vivo* studies in Vietnam, China and Thailand, weight gain improved from 35%-62% in shrimp fed the treatment diet as compared to the control. The supplementation of the product to shrimp feed showed an improvement in survival rates. In a field trial study in Thailand, *V. parahaemolyticus* was found in the intestine and hepatopancreas of the control group at 30-90 days of culture whereas the IgY treated group did not show any bacteria (Table 1). A similar trend was also found in a farm trial in Vietnam.

Therefore, Ig Guard A acts as an immune modulator or enhancer by increasing the haemocyte cell, phenoloxidase and lysozyme, to protect the shrimp from microbial infections especially EMS/AHPND and WSSV. In addition, it will also reduce stress in shrimp by increasing the antioxidant activity such as SOD. It has a dual function; as an immune modulator like passive immunisation and as an alternative to antibiotics to prevent microbial infections in shrimp.

ADBIOTECH

## Farmers' solution for EMS & WSSV

# Ig-Guard A

## Immune booster, Natural antibody

Summerized results on top 3 shrimp producing countries in the world

### Thailand

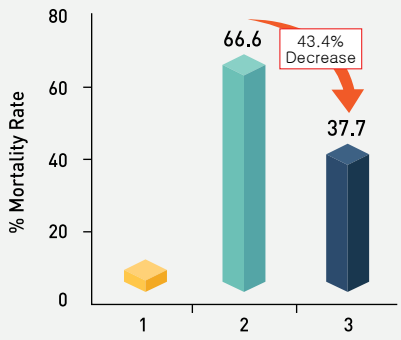


Fig1 : Cumulative mortality rate after EMS challenge

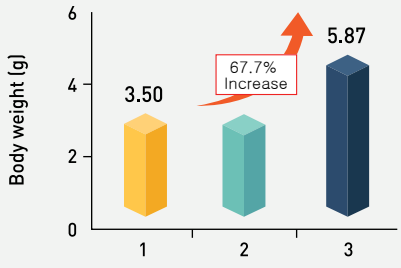


Fig4: Body weight after 42 days

### Vietnam

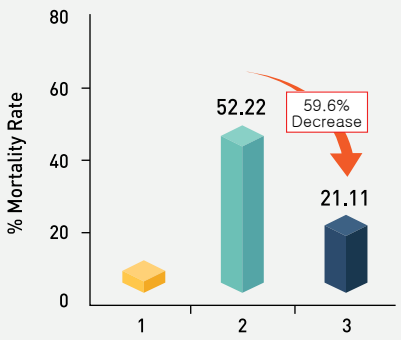


Fig2: Cumulative mortality rate after EMS challenge

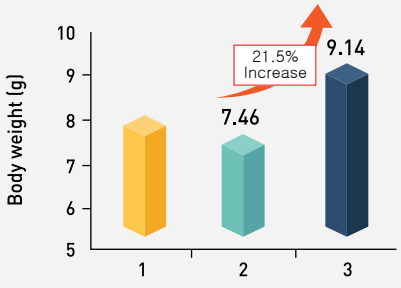


Fig5: Body weight after 42 days

### China

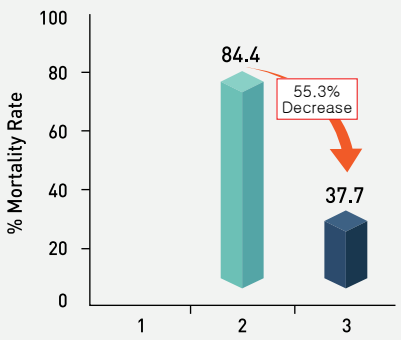


Fig3: Cumulative mortality rate after EMS challenge

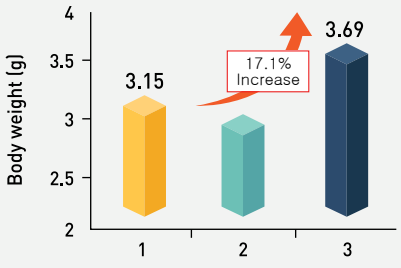


Fig6: Body weight after 42 days

1. Positive control 2. Negative control (challenge) 3. Ig Guard A

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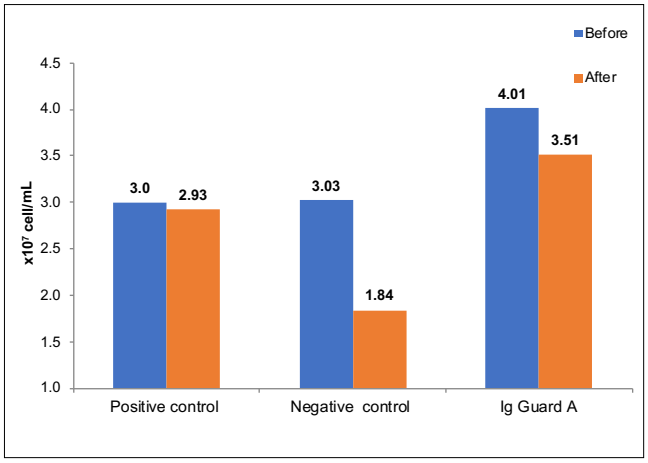



**Figure 1** The increase in total haemocytes in shrimp after an EMS challenge

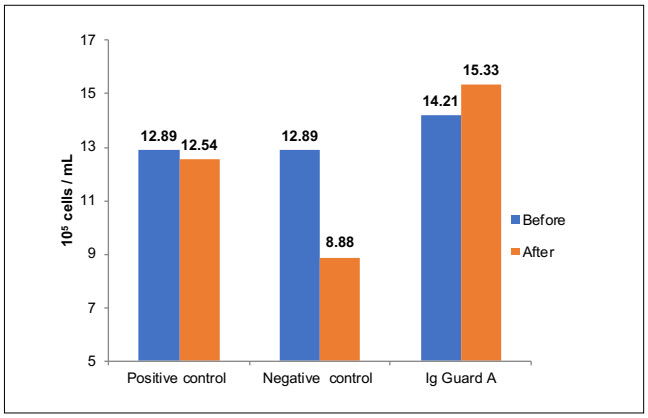



**Figure 2** The increase in hyaline cells in shrimp after an EMS challenge

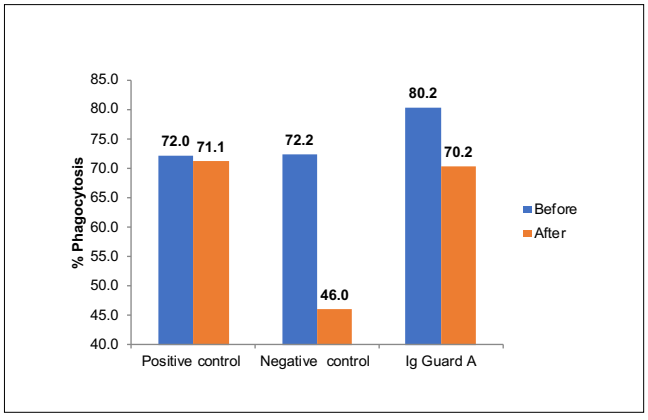



**Figure 3** Increase in phagocytosis in shrimp after an EMS challenge

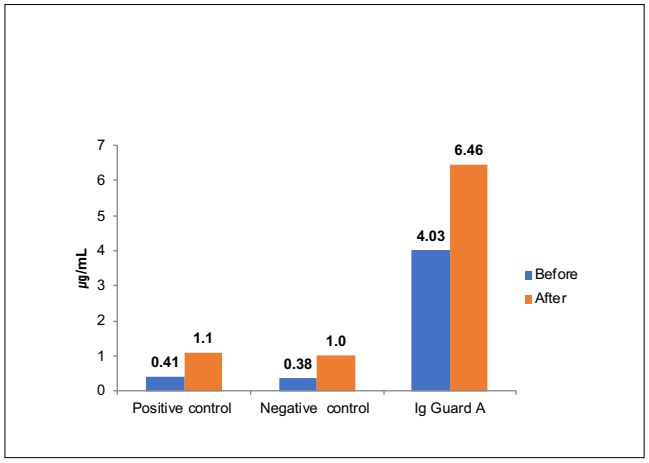



**Figure 4** The increase in lysozyme levels in shrimp after an EMS challenge

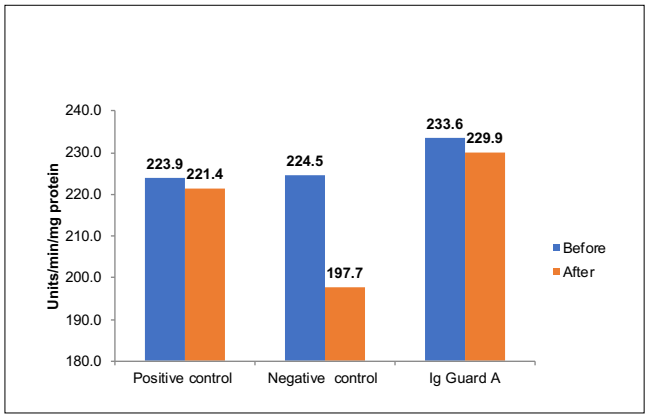



**Figure 5** The increase in phenoloxidase levels in shrimp after an EMS challenge

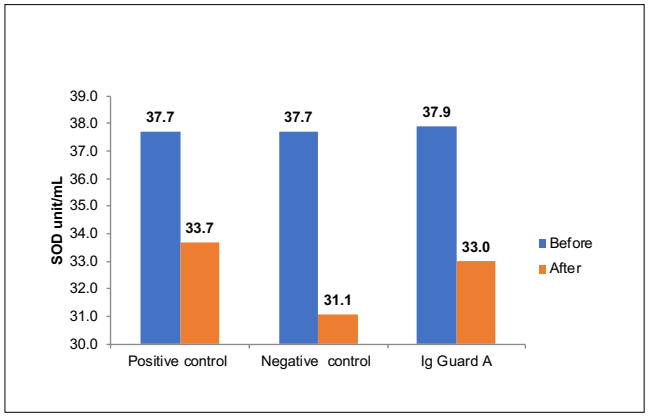
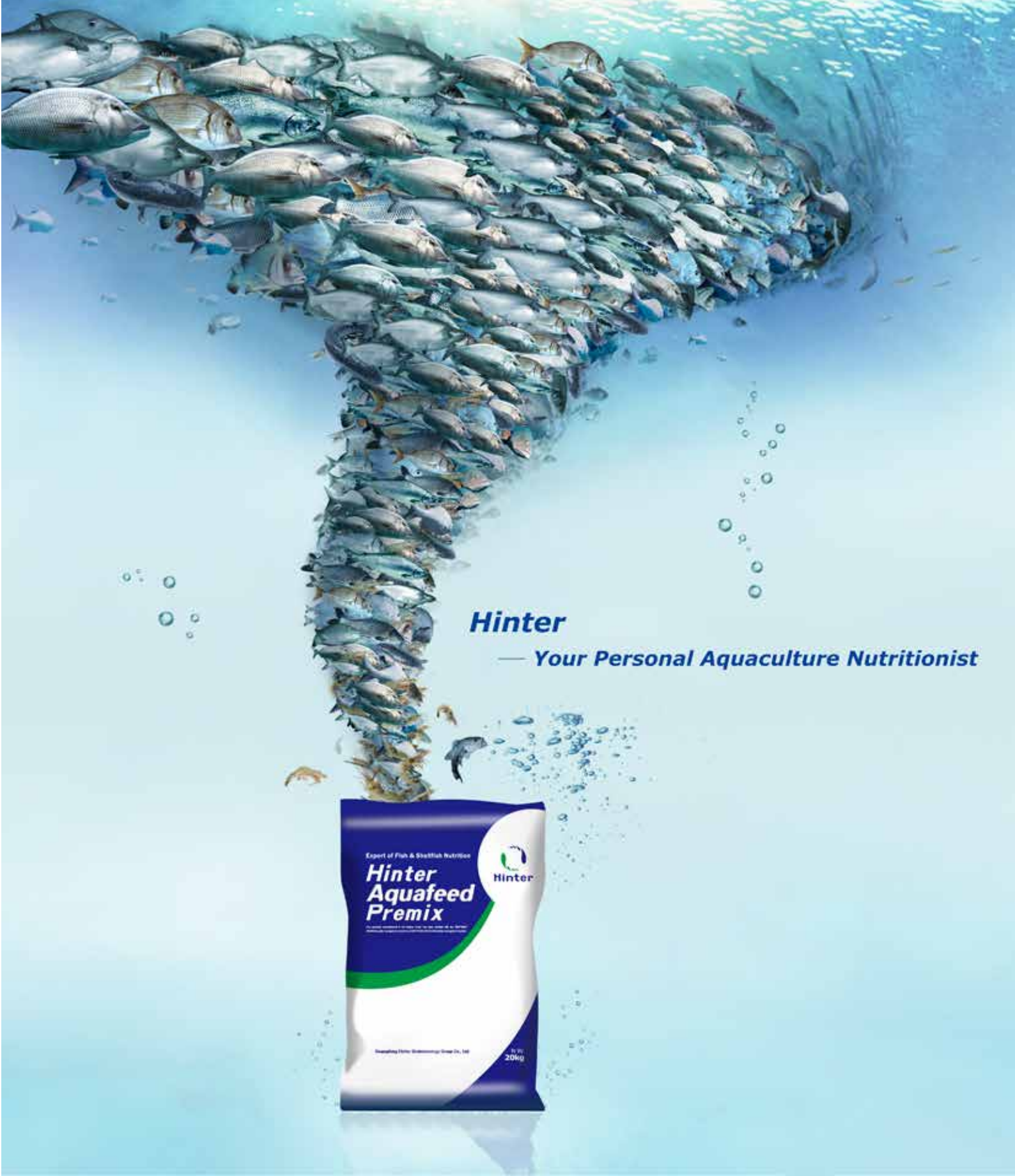



**Figure 6** Increase in superoxide dismutase (SOD) in shrimp after an EMS challenge

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# Revisiting EMS/AHPND

In its tenth year, four stakeholders share their understanding of this disease.

Unfortunately, 2019 is an apt year to talk on early mortality syndrome or EMS as the industry enters its 10th anniversary of existence since its emergence in China in 2009. This is not a celebratory note but a reminder that we are living with the disease and that many have not yet found any clear closure to outbreaks. Another concern which prompted this review were emails from farmers perplexed on what constitutes early mortality syndrome, the consequences, detection methods and solutions.

To date, only four countries in Asia have admitted to the presence of acute hepatopancreatic necrosis disease or AHPND in their midst. China, Vietnam, Thailand and Malaysia's local industries are familiar with detection and prevention, but the other countries are not giving this disease much focus. Hiding behind the adage 'ignorance is bliss' may be the reason why some Asian countries are still not familiar with AHPND. It could be added that countries which avoid declaring AHPND presence are also compounding the problem.

Published literature such as the FAO document on EMS/AHPND did throw some light on the causes of EMS/AHPND and subsequent research on AHPND in scientific journals have given deeper understanding at the molecular level. In the field, some farms continue to suffer with high shrimp mortality while others have been successful with living with the disease. The message from the most recent update on EMS/AHPND published in the Journal of the World Aquaculture Society (JWAS) was clear. "The identification of the causative agent in 2013 (Tran et al., 2013), and the development of rapid molecular detection methods from 2014 to 2015 was approximately 6 years. This interval might have been shorter if a global cooperative emergency response had been in place prior to 2009." (Prachumwat et al, 2019).

In the preparation of this article, AAP approached shrimp stakeholders in Vietnam, Thailand and Malaysia and sought their opinions/field experiences on the current understanding. Some solutions are proposed but as is often stressed in the shrimp farming industry, conditions may vary from farm to farm and adaptations to the proposed solutions are always recommended.

*The classic picture on AHPND. The hepatopancreas of a healthy Penaeus vannamei on the left, versus an EMS/AHPND infected shrimp. Picture credit: ShrimpVet, Vietnam.*

## EMS & AHPND

This recent 'Update on early mortality syndrome/acute hepatopancreatic necrosis disease in April 2018' by Anuphap Prachumwat, Suparat Taengchaiyaphum, Natthinee Mungkongwongsiri, Diva J. Aldama-Cano, Timothy W. Flegel, Kallaya Sritunyalucksana, 2019. Journal of the World Aquaculture Society, 50 (1):5-7 https://doi.org/10.1111/jwas.12559) gave the latest development. The following are excerpts from this article to introduce the disease to some and to further enlighten others.

### *What is EMS?*

EMS was coined by Asian shrimp farmers since 2009 to describe the acute, unexplained mortality in shrimp ponds within the first 30–40 days of culture. By mid-2011, Lightner et al recognised a new histopathological profile in some EMS shrimp characterised by acute, massive sloughing of hepatopancreatic tubule epithelial cells in the absence of any recognisable pathogenic agent. This is what we now call acute hepatopancreatic necrosis disease (AHPND).

### *EMS is not always AHPND*

A recent disease prevalence study was carried out in Thailand from August 19, 2013 to April 23, 2014 covering ~200 shrimp ponds randomly selected before stocking in areas where EMS outbreaks had previously been reported (Sanguanrut et al., 2018). The overall prevalence of EMS in ponds in this study was 16.3% but only 56% of these EMS ponds were diagnosed as AHPND ponds, indicating that a large proportion of the early mortality resulted from some other causes. For this reason, it is important to diagnose the cause of mortality in EMS ponds and not to equate it with AHPND.

### *What causes AHPND?*

The causative agent was reported in 2013 as specific isolates of *Vibrio parahaemolyticus* (VP) that were later found to harbour a plasmid (pVA) encoding the Pir-like binary toxin genes Pir A and Pir B. VP isolates colonise the shrimp stomach and release the binary toxins that cause massive sloughing of tubule epithelial cells followed by shrimp mortality. The molecular mechanism by which AHPND toxins induce hepatopancreatic cell necrosis and massive sloughing is still undetermined.

This Thai study hypothesised that AHPND bacterial isolates colonise and grow in the shrimp stomach where Pir A/B toxins are produced and secreted (via unclear mechanisms), perhaps under the influence of environmental factors including the gut microbiome. Through the gastrointestinal system, the toxins find their way into the hepatopancreas (HP) where they (perhaps together with other secreted proteins) cause massive sloughing of HP tubule epithelial cells, also by unclear mechanisms, but perhaps in a manner related to those of the Pir toxins of insects and the *Bacillus* Cry endotoxin.

**Dr Loc H Tran** is most well known as the young PhD student working with Dr Donald Lightner on deciphering the pathogen causing EMS since 2010. In 2013, it was determined as *Vibrio parahaemolyticus*. Tran returned to Vietnam and founded the ShrimpVet Laboratory, where he leads a young team of over 80 working on diagnostics, aquaculture product testing, disease prevention, hatchery and farming technologies. He is also assistant professor at the Faculty of Fisheries, Nong Lam University in Ho Chi Minh.

## How/what causes EMS/AHPND to occur in a farm?

It is well studied that the *Vibrio* bacteria that carry toxin genes (Pir A/B) can kill shrimp. There are two conditions for EMS to happen in a farm: the pathogens and the right conditions. The pathogens can be found in shrimp post larvae, water sources and pond sediments. The right conditions for the disease to happen include pollution, overfeeding, organic matter, high salinity-high temperature, algal crash and imbalance of microflora in pond water.

*Dead shrimp at the edge of the sludge area in a pond. Picture credit: Pornlerd Chanratchakool*

## What to do to prevent EMS/AHPND in a farm?

There are two main approaches to be done simultaneously: minimise sources of pathogen, and proper cleaning of pond bottom between crops, as well as proper water treatment for both water supply and discharge. To minimise sources of pathogen, the recommendation is to check the post larvae using PCR. For pond preparation, the steps are:

- Proper water maturation using probiotics (bioremediation) before stocking and during culture;
- minimise organic waste by routine siphoning;
- proper feeding regiment and avoid over feeding;
- probiotics in feed;
- prophylactics/immunostimulants in feed: organic acids, monoglyceride, yeast, fermented ingredients, fermented feed, etc;
- proper water exchange to minimise organic waste in ponds and reduce *Vibrio* density, and
- proper checking of shrimp health for any abnormal signs: hepatopancreas colour change, off-feeding, mortality, empty gut, etc.

If any of these occur, a series of intervention measures must be taken: reduce feeding, clean up pond bottom, exchange water, add prophylatics to feed, use fermented feed etc.

**Dr Pornlerd Chanratchakool** is a Thai pathologist working as head of technical services at Novozymes Biologicals since 2005. His field experiences on balancing animal health and pond environment started in 1986 when he was with the Aquatic Health Research Institute, Department of Fisheries, Thailand.

## How/what causes EMS/AHPND to occur in a farm?

Contamination of EMS strains can easily come from post larvae which have not been properly screened. The other common routes are from remaining strains in the water and pond soil. These strains, even in small numbers will grow faster than beneficial microbes once conditions are favourable. Their source of food comes from uneaten feed as well as dead phytoplankton/weeds (or other organic matter) known as pond sludge.

This sludge is concentrated with many bacteria strains. There is clear evidence that black sludge contains more pathogenic bacteria than beneficial ones- three times more concentrated than bacteria in water. Shrimp easily ingest these strains during feeding and can colonise the alimentary tract.

*There is evidence that black sludge (left) contains more pathogenic bacteria than beneficial ones; three times more concentrated than bacteria in water. Picture credit: Pornlerd Chanratchakool.*

### How do shrimp get infected?

After each moult, the shrimp gets a new and clean stomach wall but soon after, as feed, water, sludge and bacteria flow into the stomach, the bacteria colonise the stomach and grow. During this process, bacterial enzymes and toxins can damage the stomach wall and then the hepatopancreas cells. This is a similar process for vibriosis and EMS. However, if the pond condition is good, shrimp is healthy and grows normally: it will moult again before bacteria can cause the problem.

### What to do to prevent EMS/AHPND?

The best way to prevent EMS is to first prevent the pathogens from entering the pond. Testing the post larvae before stocking or stock post larvae into nursery tanks/ponds where we can minimise the contamination will help to reduce the risk. In the tanks/ponds, maintaining a low pH, salinity less than 10 ppt and minimising densities of filter feeders and zooplankton vectors also help to reduce risks since these measures will help to control the growth of these organisms.

*Healthy juveniles. A nursery stage to grow shrimp to 1-2g is recommended to reduce culture duration. Picture credit. Anil Ghanekar, Ecosecure Systems.*

It is critical to optimise feeding since uneaten feed are 'food' for pathogens. In general, the increase in feeds should be 0.5kg/day per 100,000 shrimp from 3g size until harvest. Often farmers attempt to feed more to get higher growth. However, the extra feed given does not always translate to significantly faster growth. During TARS 2018, the participants recommended feeding 150-250g/m$^3$/day. However, based on the general feeding table, for 20g shrimp, feeding rate is 2% body weight which is only 60g/day at 3kg/m$^3$ biomass.

Uneaten feed will not cause any problem if it can be removed out of the pond, together with organic sludge. But in practice, effective sludge removal is not easy in many farms, especially for small scale farmers. One common practice is trying to let the shrimp live in the pond for less than 50 days at each stage. This is to ensure that the pond can be maintained as clean as possible, to avoid disease. Nursery stage to grow shrimp to 1-2g is recommended to cut culture duration. If stocking with higher density, the farm should carry out transfers or partial harvesting. Each farm should set up its own maximum pond capacity and manage the biomass around that number, and not to try to go over.

Increasing microbial biota in the tank/ponds is common to prevent EMS/pathogenic strains becoming dominant in the system. Applying water probiotics works but they should grow well in the system. An option is to apply probiotics with the feed, especially for the first meal of the day during the moulting period. This is to ensure that the beneficial bacteria colonise the alimentary tract before the pathogenic bacteria.

**Ronnie Tan** is the former vice president at Blue Archipelago, Malaysia's largest fully integrated farm with 500 ponds in two locations in Peninsula Malaysia. AHPND occurred in the older farm from 2013 and in the newer farm in 2016.

The effects of AHPND are real but we have learnt to live with it. We have seen survival rates drop from above 80% to an average of 55% and this does not include forced harvests and aborted cycles. This has increased direct production costs by at least 50% in Asia amounting to an average of USD4.40/kg today. Another major effect is risk mitigation by the reduction of cycle time forcing farmers to shorten days of culture resulting in smaller harvest weights.

### What causes EMS/AHPND to occur in a farm?

Asia started the culture of *Penaeus vannamei* since the early 2000s and pursued the model of high and ultra-high-density stocking (the lowest- 80 PL/m$^2$ to as high as 300 PL/m$^2$). A consequence of this model is high levels of uneaten feeds and faeces which accumulate as sludge in the pond bottom. This sludge is the perfect habitat and breeding ground for the *Vibrio* bacteria and when threshold numbers are exceeded, can result in early mortality at less than 30 days of culture (DOC 30). The first wave of mortality can occur within 30 days and the next could occur within DOC 50-60.

### How does the shrimp get infected?

Although the industry uses the terms EMS and AHPND interchangeably, I prefer to address this disease challenge as AHPND in order to be specific. The potentially infectious Vibrio species such as *Vibrio parahaemolyticus*, *Vibrio harveyi* and others are always present in the water environment but in normal numbers. In the sludge environment, they multiply and become weaponised by developing plasmids in the system. These plasmids produce toxins which cause AHPND. However, when threshold numbers (arbitrarily 10$^4$) are exceeded, the *Vibrio* can communicate with each other by quorum sensing to produce the toxins known as Pir A and Pir B. This toxicosis results in a pale and shrunken hepatopancreas. The shrimp stop feeding and a sudden surge in mortality occurs.

The interesting question is where did the first plasmid-toting, toxin producing *Vibrio* spp come from? The hypothesis is that it came from live polychaetes harvested from China and fed to broodstock in the hatcheries. These polychaetes live in a brackish water environment and are probably carriers of the *Vibrio* which are infectious to shrimp.

*Tan says that often there is full attention to cleaning of ponds but less on cleaning of discharge canals.*

Via vertical transmission, these *Vibrio* spp are transferred to the post larvae.

### What to do to prevent EMS/AHPND?

There really is no one single method but a holistic approach is required. The first is to reduce the stocking density to 60-80 PL/m$^2$. This reduces the stress environment of overcrowding, high feed input (consequential uneaten feed) and faeces output. I want to highlight that many post larvae suppliers provide 10-20% extra animals and sometimes more to placate the farmer when quality is sub-standard, but these have not been counted in the stocking density.

We should absolutely avoid the use of live polychaetes and live animals as broodstock feeds. The downside here could be lower fecundity rates from the broodstock. Hatcheries/farms should perform all quality control checks for AHPND before the post larvae are stocked into ponds. Nurseries under controlled environment and high oxygenation (as extension of hatcheries) have been able to improve early stage care with better nutrition to produce stronger animals before being stocked into ponds.

Removing the sludge from the pond bottom daily via the shrimp toilets and improving aeration during the growth cycle are important. The sludge removed from ponds go into the discharge canal and later into the riverine environment. This is purely moving sludge from one place to another and not true disposal. In fact, AHPND could be easily spread to other farms via this movement and constitutes a biosecurity hazard. In my experience, I have seen attention to cleaning of ponds diligently but less on cleaning of discharge canals.

While the industry searches for an effective solution, prevention is the only option today. For new farms that have not experienced AHPND, count yourselves lucky but do not be complacent or be overtaken by greed because once an outbreak occurs, it will take a long time before it can be overcome.

### Food for thought

In my farming experience, I have never seen *P. monodon* affected by AHPND although I have heard non-verified observations of this happening. Is this due to the lower stocking density when farming the monodon shrimp and thus lower sludge content in the pond bottom?

Based in Thailand, **Robins McIntosh** is executive vice president for technical development of shrimp culture within the Charoen Pokphand Group (CPF). He joined the Group in 2001 to assist with the restructuring of shrimp culture in Thailand increasing the efficiency of shrimp culture and finding solutions to eradicate EMS/AHPND and EHP diseases in shrimp.

Prior to the onset of EMS, Thailand averaged over 85% survival in ponds and a pond failure rate of less than 5%. Today pond survival rates average less than 75% with a failure rate exceeding 5%. The first four years of the EMS (2009-2013) was defined by massive mortality

of shrimp stocked in ponds from 2 to 5 weeks of age; and hence the name EMS.

This causative agent was identified as *Vibrio parahaemolyticus* that carried two toxin genes (Pir A and Pir B) on a unique plasmid carried by this *Vibrio*. The toxin genes are very similar to the natural insecticide produced by *Bacillus thuringiensis*. Although the plasmid was carried by a *Vibrio*, the disease was best described as a toxicosis and not a vibriosis (the systemic vibrio diseases caused by *vibrios* such as *V. harveyi*).

Up to the time of EMS, shrimp disease had always been dominated by virus pathogens, and the biosecurity strategies of exclusion had been successful in controlling these diseases such as white spot syndrome virus (WSSV). But vibrios are free living and such biosecurity was not effective.

### How/when does the shrimp get infected?

Research by CPF laboratories discovered that the toxin from the bacteria was concentrated in the bacteria themselves that would concentrate in organic rich sediments, dead shrimp, on newly moulted shells, on dying phytoplankton blooms, and on old feed that was not rapidly consumed. It was also shown that sugars such as molasses were very good media for growing this bacteria. Quorum sensing controls whether the bacteria produce toxins i.e. the bacteria must reach a certain density in the pond for toxins to be produced.

*The shrimp toilet is a depression in the deepest part of the pond where sludge, uneaten and old feed, dead shrimp and moults accumulate. Frequent draining or flushing out is required. Picture credit. Robins McIntosh.*

### What to do to prevent EMS/AHPND?

The idea was developed that if the level of AHPND bacteria in the pond was limited through the reduction in available nutrients, toxin production would be turned off. Exclusion of the bacteria pathogen is not necessary but limitation of the bacteria numbers is required and so the concept of "shrimp toilet" was developed. This necessitated more water exchange to flush the toilets. As part of the strategy to efficiently remove organics from the pond, pond sizes were reduced. The adoption of auto-feeders became another tool to manage the disease, as it was learnt if you apply smaller amounts of feed more frequently you did not have the accumulation of old feed that would become toxic in the pond.

The dose of a toxin to kill an organism is often correlated with the body weight of that organism. With the AHPND toxin, small post larvae require much lower doses of toxin to kill the shrimp than a larger shrimp. Instead of directly stocking the post larvae (e.g. PL6-10), a nursery strategy often resulted in superior results. Stocking a larger juvenile meant a shorter DOC and harvest size would be reached sooner, thus reducing the risk of death by AHPND.

The early attempts to deal with the disease focused on trying to disinfect ponds with stronger disinfectants. But *vibrios* are very fast growers and create biofilms in which to hide on pond surfaces. Although, chlorine and ozone were used in higher amounts, very little progress was made. In fact, by killing the more stable slower growing bacteria and pond microbes, the pond ecology changed for faster and more complete domination by the pathogenic vibrios.

Today, the amount of disinfectants – which disturb the pond ecology – has been drastically reduced and many systems now employ strategies such as adding fish to water that will be introduced to the pond as a method of stabilising the microbial ecology. A more complex pond ecology prevents the domination of the toxic *Vibrio* from dominating the pond.

*Part of the strategy to efficiently remove organics from the pond is smaller ponds and autofeeders. Picture credit: Robins McIntosh.*

In the early days of AHPND, hatcheries did not realise that post larvae could carry the bacteria. EMS was reduced when hatcheries learnt to clean up.

As we learn more on AHPND and its management, breeders also began to develop shrimp that were more tolerant of the toxin, or shrimp that would require to ingest larger amounts of toxin before death sets in. The combination of new pond management, clean post larvae, and more robust genetics has resulted in fewer ponds suffering massive mortalities from the original "EMS".

### Co-infections

Today AHPND is still in our environment, but the early mortality that defined EMS at the start rarely happens. The combination of diseases and syndromes like *Enterocytozoon hepatopenaei* (EHP) and WSSV are significant challenges for the farmer, especially since many

*Pond with high oxygen levels, >5.8mg/L, are affected less by EHP than ponds at lower oxygen levels*

are incompletely understood and often made confusing by many different opinions.

Disease challenge research at the CPF laboratories have shown that when even a small level of AHPND is present, WSSV becomes much more virulent than when the pathogen is absent. Therefore, even though not enough toxin is produced to kill the shrimp, the shrimp has an immune system that is less robust. And it is this less robust immune system which results in the shrimp being affected by several other pathogenic agents.

There are examples where ponds that are kept at higher oxygen levels of greater than 5.8mg/L, or where the temperature ranges are regulated by covers to a very narrow range, are impacted less by EHP than ponds at lower oxygen levels and higher fluctuations of temperature.

Disease is a result of an overload of pathogens overwhelming the ability of a shrimp to tolerate the disease. We need to exclude those pathogens and limit those that we cannot exclude..

Our aquatic environments are more degraded than in the past; a degraded environment will also add "stress" to the shrimp. So specifically, here is the list of recommendations today (Table 1).

| Post larvae and stocking density | Ponds & water | Feeds etc |
|---|---|---|
| Use only healthy pathogen free post larvae | Start with a clean pond-free of EHP spores, and low organic content if using an earthen pond | Do not use molasses or any simple sugars |
| Use of nursery post larvae: larger stocking size results in less early mortality and faster cycle time | Viral carriers should be removed from any water that enters the pond, either by filtration or by selective use of safe chemicals | Only high-quality digestible shrimp feeds |
| The stocking density should be reflective of the pond aeration capacity, and ability to flush the wastes from the bottom of the pond to maintain high water and bottom quality environments | Farm design that removes sludge, excess nitrogen, and phosphorous wastes before returning water back to the aquatic environment | Use of auto feeders |
| Consider reducing stocking density: lower densities will result in lower organic inputs, less shrimp stress and larger sizes at harvest | Consider alternating aquatic crops: alternating vannamei shrimp with monodon shrimp, marine tilapia, or barramundi. | |
| Take a farming break of two months per year to completely dry out the farming system | Minimum DO at 5.8mg/L | |

# Why animal welfare is gaining prominence in aquaculture

By Douglas Waley and Stephanie Ghislain

Animal welfare guarantees are very meaningful to consumers in some markets as these may ensure them that the products are of high quality, safe and natural. Higher welfare standards are seen as assets in export markets, and can help to increase market share.

There is a rapidly emerging focus on animal welfare in aquaculture, especially in Europe and in the USA. Statements have been given by European political institutions, third party certification bodies are running projects on fish welfare, and research funding programmes are increasingly addressing fish welfare issues. In recent weeks, major television shows and newspapers in the UK have been focusing on the conditions under which fish are farmed and killed. NGO campaigns are active across Europe including social media streams filled with secretly collected footages of practices on European fish farms.

## What is fish welfare?

The welfare of terrestrial animals is a familiar concept to consumers and producers around the world. Many consumers want to eat meat from animals that have lived happier lives – animals that were well treated, had been produced naturally, and would therefore taste better. Minimum standards for terrestrial animals have in many cases been legally established, for ethical reasons. This idea, however, is quite new in fish, but is quickly gaining attention in Europe and the USA in particular.

Research in the early 2000s, especially work by Lynne Sneddon and Victoria Braithwaite, showed that fish can feel pain and scientific consensus followed that they are complex and sentient animals. This scientific consensus has been reviewed and confirmed by political bodies including the European Food Safety Authority and the UK's Farm Animal Welfare Committee. It has been established that fish have conscious experiences, complex lives and social relationships, and that they can suffer pain.

The welfare of fish is a relatively new concept, but in many ways welfare is a familiar part of good husbandry practices which gives rise to good product quality. The central concept in welfare is to meet the needs of the fish, whether those needs are environmental, behavioural, nutritional, or others. The welfare objective is that the fish lives a life free of abuses. Many other objectives are also addressed through this approach, as welfare gives a holistic framework for monitoring and managing aquaculture operations. The link between health and welfare is particularly strong. Good health is essential to creating good welfare (a life worth living for the fish), while good welfare is essential to creating good health (low stress levels are essential for immune function and for good appetite). The link between product quality and stress during harvest and killing procedures is also very strong.

*Putting live fish directly on ice is being phased out in Europe. Photo credit: Essere Animali*

## Fish welfare standards

In UK aquaculture the welfare approach has become an industry standard. Twenty years ago the salmon industry approached the Royal Society for the Protection of Animals (RSPCA), an animal NGO. Together they have developed fish welfare standards that are used as a tool for farmers, and most farmed fish in the UK is now produced using these standards. In Norway, the FISHWELL project recently developed welfare indicators for salmon and trout that give farmers a comprehensive and practical toolkit of environmental, behavioural, and physiological observations for monitoring their farms.

Elements of fish welfare criteria can be found in large certification schemes today. For example, GlobalGAP requires that fish are stunned at slaughter when possible. The Global Aquaculture Alliance, Aquaculture Stewardship Council, and Friend of the Sea, each have projects aimed at developing new welfare criteria for their standards. Welfare criteria are also included in organic regulations and standards.

Some quotes:

"These are sentient animals; there is a responsibility of the farmer to practise good husbandry and to keep the welfare of the animals in mind.... We count animal welfare as critical to delivering responsibly produced, modern products."
*~ Dan Lee, Standards Coordinator Global Aquaculture Alliance*

"...upon slaughtering the fish, they should be inspected for instance, for bites (which are a sign of aggression), parasites, or other disease symptoms, and also for deformities or discolourations."
*~ Mark Nijhof, Vice-Chair Technical Committee Aquaculture GlobalGAP*

"Fish welfare is not something that is apart or unique; it is something that a good farmer takes care of anway because proper welfare for animals, including fish, means basically that they get less trouble in the farming process."
*~ Michiel Fransen, Head of Standards & Science Aquaculture Stewardship Council*

"73% agree that fish feel pain, and 65% agree that fish can feel negative emotions. Some 79% believe that fish welfare information should be given on the label."

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Several clauses of EU legislation that address the welfare of farmed animals have parts that apply to farmed fish. Regulation 1099/2009 governing the slaughter of animals requires that fish 'shall be spared any avoidable pain, distress or suffering during their killing and related operations'. There are similar requirements in Regulation 1/2005 governing the transport of live animals, and in Directive 98/58 governing conditions on farms.

## Market demands and access

Public opinion surveys have recently been carried out in the USA and in Europe. In both of these markets welfare guarantees are very meaningful to consumers. One message of 'welfare' tells the consumer that this product is high quality, safe, and natural.

Eurogroup for Animals and Compassion in World Farming commissioned a polling company to carry out a large-scale survey in nine of Europe's largest countries. Findings indicated that 73% agree that fish feel pain, and 65% agree that fish can feel negative emotions. Some 79% believe that the welfare of fish should be better protected than it is now, and that welfare information should be given on the label. When asked what 'sustainability' should be, and given the option to choose welfare as well as environmental and social criteria, the top answer was that fish were able to behave in a natural way at the farm.

The European Union is adamant about addressing animal welfare in its trade policy. In the past decade every trade agreement between the European Union and distant third partner countries has included provisions on animal welfare cooperation. The idea behind this is twofold. Firstly, it aims to meet the expectations of European consumers that care about animal welfare. Secondly, it will provide a level playing field to European producers (including aquaculture producers) that have to respect strict production rules. Higher welfare standards are seen as assets in export markets, and can help to increase market share for third partners.

## Welfare during slaughter

The welfare needs of fish are not well understood compared with terrestrial farmed animals, and these needs are specific for each species of fish. Welfare at the time of slaughter is the best understood area of fish welfare, and technologies and handling practices have been developed to address this production stage. The World Organisation for Animal Health (OIE) has specific standards for this in its Aquatic Animal Health Code. Automated stunning machines, and best practice stunning techniques, together with best handling practices have been universally adopted in major salmon value chains, as well as with trout, *Clarias* catfish, eel, and other species. Several European countries have laws with species specific detail on how fish must be slaughtered to ensure that they are immediately unconscious and do not suffer, and supermarkets are increasingly demanding this from their suppliers.

*© All photos Essere Animali. From top: European sea bass being mishandled during harvest; Gilthead sea bream being crushed and exposed to air during harvest; Gilthead sea bream in Italy processed alive for market; Keeping fish out of water is not longer seen as acceptable.*

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# Egypt's newest aquafeed producer goes beyond feeds to support farmers

## Grand Fish Feed assists tilapia farmers with overcoming summer mortality syndrome and introducing fast growth genetics.

In January, Egypt's newest aquafeed producer, Grand Fish Feed celebrated its first year in production with a 31-member technical visit to Malaysia. Egypt has a vibrant aquafeed industry with several feed multinationals entering the industry or expanding capacity in recent years. Grand Fish Feed is a local feed producer established only two years ago by its chairman Nabil Hamid.

At a dinner meeting in Kuala Lumpur, Nabil recounted his venture in setting up the feed mill. "After 35 years in the US, I came back to Egypt and looked for a new business venture. The fast-moving aquaculture business in Egypt was an attractive proposition. Helping me with this new venture is an old friend, Joseph Kearns, a feed processing consultant, who has recently retired from the US based feed equipment manufacturer, Wenger," said Nabil. "Together, we are now producing 'made in Egypt' fish feeds. Today it is feeds for freshwater fish but soon farms in Egypt and the Middle East and Africa can also look forward to our marine fish feeds."

The aquaculture industry in Egypt is booming. In 2018, Egypt's fish supply was 1.8 million tonnes and about 80% came from aquaculture. In 2016, fish production was 1.71 million tonnes and 1.4 million tonnes came from aquaculture (GAFRD, 2018). In the last 10 years aquaculture production increased 2.2 times – in 2007, aquaculture production was 636,000 tonnes (Sadek, 2018). Tilapia is the major species and Egypt is the third largest producer in the world. Nabil postulated, "We are expecting to increase production each year. Therefore, aquafeed production to supply the demand of farmers is a profitable business."

The feed mill located in an industrial area in New Damietta in the Nile delta, was set up with a total investment of USD30 million for land, construction and equipment. The delta is where almost all the aquaculture activities occur in Egypt and has seen the expansion of fish farming in recent times (Roderick, E, pers. comm). "We now have the state-of-the-art feed mill in Egypt, with an annual production capacity of 60,000 tonnes per year (tpy) from a Wenger extruder line. Next, we will invest in Wenger's high capacity Aquaflex XT which will add capacity by up to 15 tonnes per hour (tph). By 2020-2021, we expect to be the largest aquafeed producer in Egypt as well as in the Middle East with 150,000 tpy."

Currently, Grand Fish Feed produces a general freshwater fish feed for the farming of tilapia (*Oreochromis niloticus*), mullet (Mugil spp), common and Chinese carps (*Cyprinus carpio* and *Ctenopharyngodon idella*), other cyprinids and African walking catfish (*Clarias gariepinus*). The crude protein ranges from 25-36%. Currently, Grand Fish Feed sales are mostly for tilapia production. Feidi (2018) said that Egypt is the world's top producer of cultured mullets and Sadek (2018) postulated that in Egypt, the mullet could rise over tilapia production if issues on hatchery production can be resolved

"With this advanced equipment, we can then move up to produce feeds specific for all stages of the tilapia as well as starter diets for marine fish and shrimp. We can then increase feed exports to the Gulf states, Africa and perhaps export to Europe," added Nabil. "Most feed ingredients are imported, and I source fish meal from Mauritania." Grand Fish Feed has a feed partnership with US based Zeigler which provides formulation assistance, additives and guidance on related technical aspects.

## Increasing fish supply in Egypt

The projection in 2019 is 1.8 million tonnes of fish with 1.2-1.3 million tonnes of tilapia. Furthermore, the government wants to increase farmed fish production to 2.2 million tonnes by 2020. It has identified 71 sites covering an area of 63,400 ha around the country suitable for aquaculture and offered to interested investors. In the last 2-3 years, two mega aquaculture projects were initiated to increase farmed fish supply. The East Suez Canal Zone Project is for farming seabream and shrimp in 4,000 sedimentation basins as fish farms.

Fish fry will be supplied by local hatcheries. The Birkat Ghalioun is a fully integrated fish and shrimp farming project by the National Company for Fishery and Aquaculture (NCFA) and China's Guangdong Evergreen Group in the Egyptian Delta bordering the Mediterranean Sea. This was described as the largest in the Middle East with a final size of 21,000 feddans (8,820ha). The first phase of the project has 1,359 ponds, comprising 83 freshwater ponds (210ha) for tilapia and mullet farming. The target is also to produce 2,000 tonnes/year of shrimp in cages (Feidi, 2018).

*Nabil Hamid (left) with Mohamad Bahnasy (centre) who has been farming the tilapia for 20 years in Kafr-EL-Shiekh. Members of the team are farmers and feed distributors.*

*"Our mission is to follow up with all our feed customers; today they number more than 100 fish farms," said Mohamad Said (left).*

## Threats in tilapia farming

Most of the tilapia is sold to the domestic market, mainly as whole and live fish of 300-500g fish although there are also demands for larger fish of 500g-600g. Local demand for the tilapia is increasing, said Nabil. More production will also enable farms to export the fish to regional markets.

Tilapia used to be farmed in cages in the Nile river but because of concerns on the quality of household water, the government has prohibited any cage farming. Today, tilapia is farmed in earthen ponds, usually 1 to 2 acres in size (0.25-0.5ha). It is semi-intensive with a production of 1kg fish /$m^2$.

According to Mohamad Bahnasy, a leading farmer and trader at the meeting, "The demand is of small fish (250-300g) and we can produce these within 4-6 months. Ex-farm, tilapia is sold at US1.20/kg and with a feed conversion ratio from 1.1 to 1.3, it is a profitable business. Feeds cost USD492/tonne." Mohamad Bahnasy has been farming the tilapia for 20 years in his own farms in Damro Elhadad, Kafr-EL-Shiekh. He added that in recent years, production costs have been increasing while ex-farm prices have remained unchanged.

However, disease is a major threat in tilapia farming, added Mohamad Bahnasy. "We start our stocking in late February or early March and we enter into the hot summer months for adult fish. When we have bacterial infections, mortality can reach 50% or more in some cases. We call this the summer mortality syndrome."

Currently, farmers are trying to overcome these infections with functional feed additives such as beta glucans and feed probiotics, said Dr Mohamed Said, technical support manager at Grand Fish Feed. In Egypt, a common practice is for farmers to stock 3 to 4-week-old post hatching fry weighing 0.2 to 0.5g or to keep these for another 4-6 weeks and stock fingerlings of 1-5g (Nasr-allah, Ahmed et al, 2014).

*Mohamad Bahnasy (second left) and 12 members of the team discussed challenges in tilapia farming in Egypt, mainly that with summer mortality syndrome.*

## Overcoming 'summer mortality'

The discussion moved to how to speed up the culture period and avoid these summer months with high temperatures (>32°C). Options ranged from closed systems to control temperatures, vaccinations, reducing the time in earthen ponds by stocking 4-inch juveniles, oxygenating ponds with paddle wheel aerators, and to genetics for faster growth. Based on experiences in Indonesia, stocking larger fish with faster growth genetics will mean a culture period of only 3 months to reach 300-500g fish. This would be ideal for Egypt and avoid the hot summer months. "I want to overcome this disease problem and today, I am looking at a nursery phase to grow the young fish to 20-50 g before stocking into the open ponds," said Mohamad Bahnasy.

Mohamed Said who is also in charge of technical services for Grand Fish Feed added that some options are difficult for the industry to adopt. "We are very much aware of the various vaccines available for farms in Africa and Brazil, but we cannot import vaccines. If vaccines are important, we need to have vaccines developed in Egypt itself. Another hurdle that we have is that the government does not allow the imports of the GIFT tilapia strain, which we know has been developed for faster growth. The only genetically improved Nile tilapia available to fish farmers in Egypt is the Abbassa tilapia strain."

This faster-growing strain of the local Nile tilapia or Abbassa improved strain was developed by WorldFish in Egypt, simulating the genetic stock improvement program for the GIFT tilapia in Penang, Malaysia. Started in 2002, the Abbasa strain is in its 15th generation. WorldFish reported that fry from this Abbasa tilapia has been distributed all over Egypt, resulting in fish farmers increasing farm efficiency and yields by 5%. However, for several generations, the breeding cycle was in summer (July to October). Since both hatcheries and farmers follow a summer breeding or farming cycle, the Abbassa strain fry produced at the end of summer cannot be multiplied out by hatcheries or distributed to farmers until eight months later, i.e. it would only be available at the start of the following summer. Since 2016, with the 14th generation, the breeding cycle shifted to a winter breeding cycle in greenhouses (World fish, 2016).

"During this technical visit, we visited the headquarters of the WorldFish Centre in Penang. We discussed some collaboration to further develop the Egyptian Abbassa strain. We wish for fast growth, disease resistance and higher fillet yield," explained Mohamed Said, adding that the government is also pursuing YY tilapia technology to improve overall farm production. The YY super tilapia male technology is considered an effective breeding protocol, producing all-male progeny without the use of hormones and with larger fingerlings and using genetically improved strains, it may possible to harvest two crops per year (Roderick, E, pers. comm).

## Addressing farm challenges

Unique to Egypt, is the Grand Fish Feed technical service teams. "Our mission is to follow up with all our feed customers; today they number more than 100 fish farms. We visit farmers at least twice a month, even though the farmer can be 300km away." The technical team will service farms in all aspects of water quality in the ponds, inlets and outlets. They collect fish samples to analyse fish growth.

"We are the only feed miller to successfully develop a team to do this. Since we started, we have gathered a lot of data from about 500 visits within 2018. WorldFish in Penang admired the detail of this data and is interested in analysing this data for its development programs. Furthermore, the technical team has the support of four university professors," said Mohamed Said.

In any industry, there will be challenges but Grand Fish Feed has set out plans to help farmers overcome those challenges. The technical trip to Malaysia which included visits to a seabass cage farm and a closed system earthen ponds farm in Penang as well as to WorldFish in Penang, is a way to expose its major clients to practices outside of Egypt. At the same time, Nabil is ready to pursue other markets and expand his aquafeeds business.

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# The 8th Annual Global Feed Survey

The 2019 survey estimated that world feed production increased by 3% to 1.103 billion tonnes. Global tonnage of aquafeeds grew 4%, attributed to strong increases in the Asia-Pacific and European regions.

The Alltech Global Feed Survey assesses compound feed production and prices through information collected by its global sales team and in partnership with local feed associations in the last quarter of 2018. It is an estimate and is intended to serve as an information resource for policymakers, decision-makers and industry stakeholders.

"Alltech works together with feed mills, industry and government entities around the world to compile data and insights to provide an assessment of feed production each year," said Dr Mark Lyons, president and CEO of Alltech. "We are proud to present the eighth annual Alltech Global Feed Survey and share the results publicly to demonstrate the importance of the animal feed industry as we strive to provide for a planet of plenty."

Now in its eighth year, the annual Alltech Global Feed Survey has become the premier insight into the feed industry. The survey is cited in more than 80 articles or references each year, and it generates interest in all corners of the globe. Since the first iteration 8 years ago, the survey has grown in size, content and reliability to become the most complete source available for feed industry metrics. The eighth survey draws upon data from 144 countries and nearly 30,000 feed mills.

At Alltech's webinar on this survey, Lyons said that the data presented seemingly endless opportunities for comparison. "In 2018, world feed production increased by 3% to 1.103 billion tonnes. Production exceeded 1 billion tonnes for the third consecutive year. The feed industry has seen 14.6 % growth over the past five years, equating to an average of 2.76 %/year. As the population grows, so does the middle class, which is well reflected in an increase in overall protein consumption."

The top eight producing countries were China, US, Brazil, Russia, India, Mexico, Spain and Turkey. Together, they produced 55% of the world's feed production and contain 59% of the world's feed mills, and they can be viewed as an indicator of the trends in agriculture. Predominant growth came from the layer, broiler and dairy feed sectors.

## Asia Pacific feed production

Among the regions, the Asia Pacific region is home to several of the top 10 feed-producing countries, including China, India and Japan, and accounted for more than 36 % of the world's feed tonnage.

China maintained its status as the top feed-producing country in the world with 187.89 million tonnes, with 10 million tonnes more

than the US. Increased production for Asia-Pacific came from India with 13% due to growth in dairy, layer and broiler feeds. Other countries that demonstrated higher growth included Pakistan, Myanmar and Laos. Southeast Asia's feed production represented over 20% of the Asia-Pacific region's feed production, with Indonesia, Vietnam, the Philippines and Thailand contributing to 93% of Southeast Asia's feed production.

"Showing 7% growth in the 2018 feed survey, and 13% in this survey, India is clearly growing its feed production at a rapid clip, not just in one, but in all species! From aquafeed to goat grains, India's feed production increased across all 13 categories assessed." noted Lyons in presenting the report. China, the region's leader, also saw an increase of 1% over last year.

## Aquafeed production

Overall, aqua feed saw a healthy growth of 4% more than reported in the last global feed survey. This was primarily attributed to strong increases in the Asia-Pacific and European regions. Global aquafeed production rose to 40.14 million tonnes. China, the leading aquafeed producer saw a 1% increase over its production in 2017 to 15.740 million tonnes. China's aquafeed production was only 8.37% of its total animal feed production.

In Europe, both Norway and Turkey grew at 7%. Spain's aquafeed production grew at a substantial 31%. Other leaders in aquaculture showed strong growth or remained relatively flat. Norway is Europe's largest producer of aquafeed, with 1.89 million tonnes and 45% of the region's total aquafeed production.

The traditional Asia-Pacific leaders in aquaculture certainly showed growth this past year. Together, Vietnam, India and Indonesia contributed an additional 1.58 million tonnes of feed to the region. Vietnam saw an increase of nearly 1 million tonnes of aquaculture feed, bringing its production to 3.875 million tonnes. India's production was 2.104 million tonnes and Indonesia, 1.788 million tonnes (Figure 1). The report also gave production for the smaller and emerging producers in Asia Pacific such as Laos, Cambodia and Sri Lanka (Table 1). More data and insights from this 2019 Alltech Global Feed Survey, is available at alltechfeedsurvey.com

| Country | Tonnes per year |
|---|---|
| China | 15,740,000 |
| Vietnam | 3,875,000 |
| India | 2,100,000 |
| Indonesia | 1,788,000 |
| Philippines | 1,400,000 |
| Thailand | 1,000,000 |
| Taiwan | 425,000 |
| Japan | 350,000 |
| Myanmar | 350,000 |
| Australia | 160,000 |
| Malaysia | 143,000 |
| Sri Lanka | 18,000 |
| Cambodia | 10,000 |
| Laos | 6,000 |
| **Total** | **27,365,000** |

**Table 1** Aquafeed production in 2018 for the Asia Pacific region (source: 2019 Alltech Global Feed Survey)

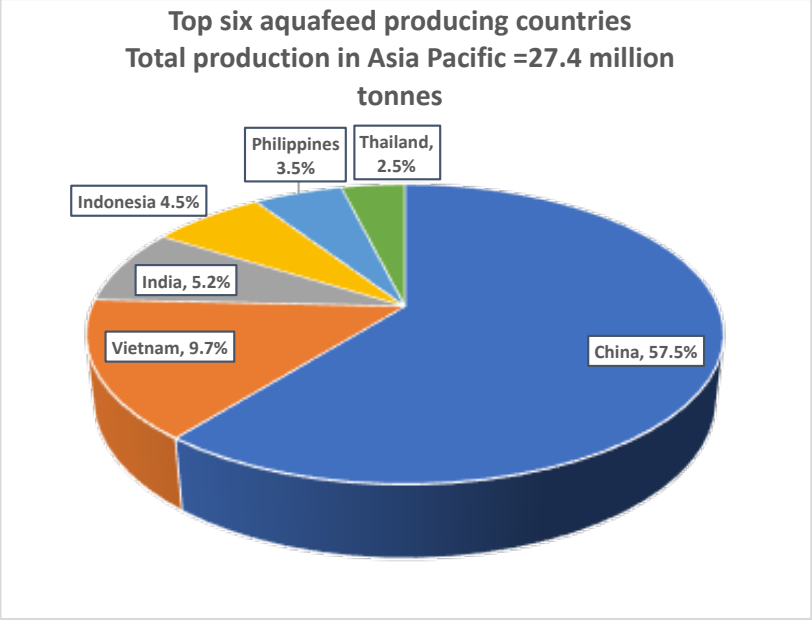


**Figure 1** Leading aquafeed producing countries in Asia Pacific and % of the total 2018 production of 27.4 million tonnes (source: 2019 Alltech Global Feed Survey)

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# Formulation of low phosphorus feeds for shrimp

By Sjo Zwart, Rafael Coelho and Daniel Lemos

The use of phosphates is under more scrutiny. Phosphate reserves worldwide are limited and a possible over-use of phosphates in feeds for fish and shrimp can lead to water quality deterioration and ultimately eutrophication.

Shrimp, like all aquatic animals, have a nutritional requirement for phosphorus which, contrary to some other minerals, has to be supplied via the feed. It is becoming more common, because of the lower use of fish meal, to supplement shrimp feeds with inorganic feed phosphates to reach adequate levels of phosphorus in feeds. However, not all feed phosphates are equal; feed phosphates differ in composition, in phosphorus content, and so forth. But more importantly, they also differ largely in the ability to supply digestible or retainable phosphorus.

Windmill® Aquaphos (Aliphos, Belgium), especially developed for use in aquafeeds, has proven in trials with several fish species to deliver a superior quantity of both digestible and retainable phosphorus (P) when measured against monocalcium phosphate (MCP). To prove the same value of Windmill® Aquaphos phosphorus in shrimp, a trial was performed in which this inorganic feed phosphate product was measured against MCP and dicalcium phosphate (DCP).

## Trial and test diets

This trial was performed at the facilities of the USP Laboratory in Ubatuba (Brazil), between March 29 and May 21, 2018 to determine which inorganic feed phosphate is most suited to be used in shrimp nutrition. Taking into consideration estimated dietary phosphorus requirement for shrimp, a control diet was formulated to be supposedly deficient in phosphorus and with no addition of inorganic phosphorus (Table 1).

The test diets were based on the same control diet but with the addition of the different phosphorus sources: Aliphos® DCP (DCP), Aliphos® Monocal (MCP) and Windmill® Aquaphos (Aquaphos = monoammonium phosphate) to increase the P level from 4.4g/kg to around 6.9g/kg. Chromium oxide ($Cr_2O_3$) was added to enable the calculation of ingredient digestibility.

The trial was performed in a recirculation system with 16 tanks of 500L each to enable four replicates per trial group. Tanks were stocked with 33 shrimp/replicate and fitted with settling columns for the collection of faeces. Salinity of the water was 34ppt, with an average temperature of 30°C. Feeds were supplied continuously using belt feeders, starting from 5% biomass and adjusted daily according to the presence or absence of pellet leftovers. Shrimp were weighed at the start and end of the trial. Shrimp at the start and end of the trial were also sampled for whole body analysis to enable the calculation of ingredient retention. Faeces, for digestibility analysis, were collected six times daily from the settling columns.

## Growth and FCR

Shrimp performance was very good; growth and feed conversion ratio (FCR) achieved values according to practical farming conditions. Survival rates were lower for shrimp fed the control and MCP diets, whereas shrimp fed the control and DCP diets showed significantly lower growth and higher FCR (Table 2). Shrimp showed a significant difference in pellet intake according to diet: control< DCP < MCP < Aquaphos.

In addition, the researchers observed a persistent exuviae consumption for shrimp fed the control and DCP, decreasing for MCP and not apparent in the case of Aquaphos. This might indicate

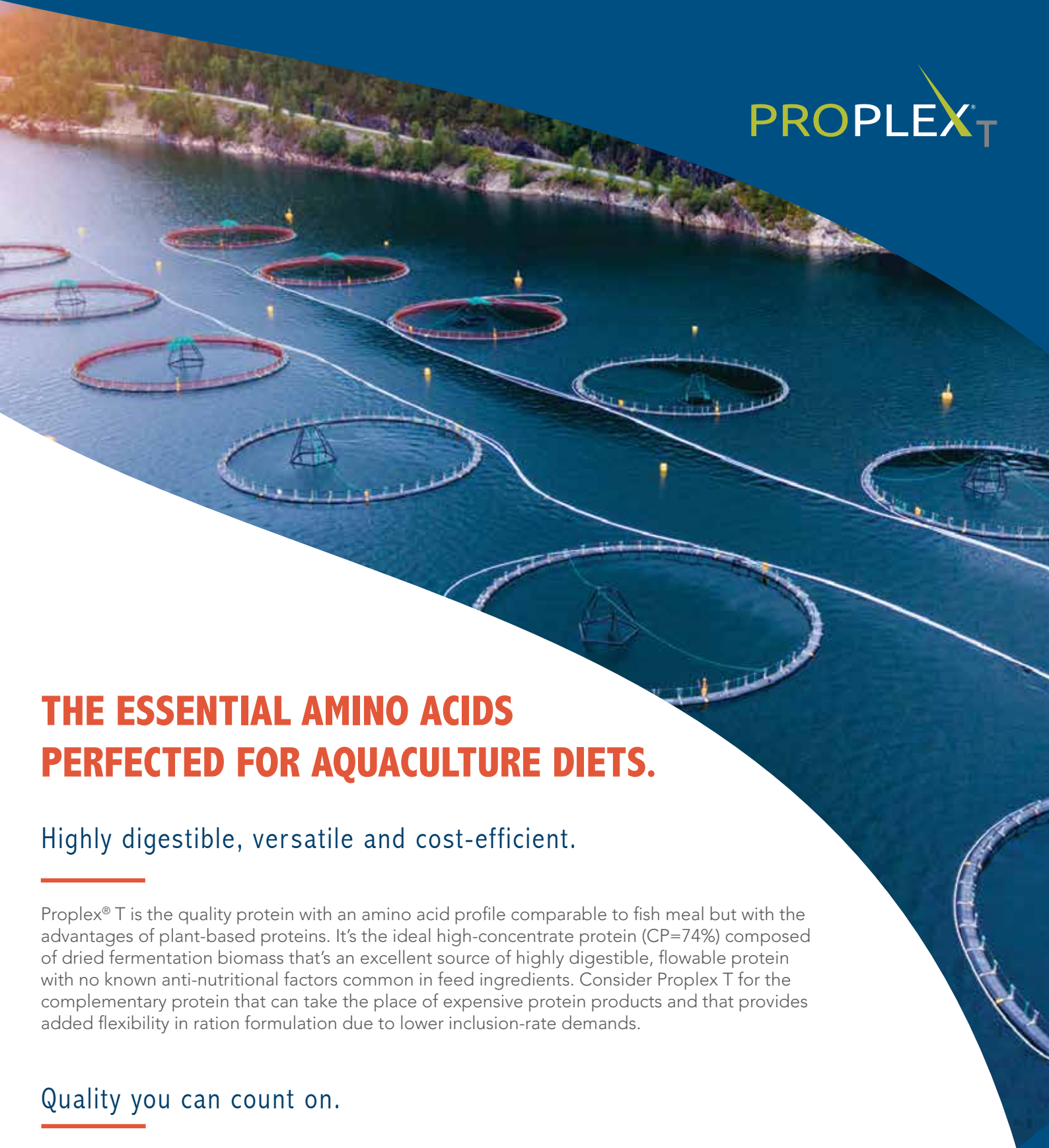
| Diet formulation | | | | |
|---|---|---|---|---|
| Ingredient (%) | control | DCP | MCP | Aquaphos |
| Wheat | 37.15 | 35.8 | 36.08 | 36.23 |
| Soybean meal | 18.0 | 18.0 | 18.0 | 18.0 |
| Wheat gluten | 10.0 | 10.0 | 10.0 | 10.0 |
| Squid meal | 7.5 | 7.5 | 7.5 | 7.5 |
| Fish hydrolysate | 5.0 | 5.0 | 5.0 | 5.0 |
| Blood meal | 3.5 | 3.5 | 3.5 | 3.5 |
| Soy protein | 4.0 | 4.0 | 4.0 | 4.0 |
| concentrate | 4.0 | 4.0 | 4.0 | 4.0 |
| Feather meal | 3.0 | 3.0 | 3.0 | 3.0 |
| Dried yeast | 4.1 | 4.1 | 4.1 | 4.1 |
| Vit. Min. premix | 1.0 | 1.0 | 1.0 | 1.0 |
| $Cr_2O_3$ | 0.5 | 0.5 | 0.5 | 0.5 |
| Rest | 2.8 | 2.8 | 2.8 | 2.8 |
| DCP | | 1.35 | | |
| MCP | | | 1.07 | |
| Aquaphos | | | | 0.925 |
| **Diet composition** | | | | |
| As is | control | DCP | MCP | Aquaphos |
| Moisture, % | 5.36 | 4.70 | 4.50 | 5.28 |
| Crude protein, % | 39.6 | 39.8 | 39.8 | 40.1 |
| Lipid, % | 7.25 | 6.63 | 7.08 | 7.37 |
| Ash, % | 4.03 | 5.02 | 4.66 | 4.13 |
| $Cr_2O_3$ % | 0.47 | 0.49 | 0.40 | 0.39 |
| P, g/kg | 4.39 | 6.70 | 7.20 | 7.64 |
| Mg, g/kg | 1.05 | 1.16 | 1.15 | 1.19 |
| Ca, g/kg | 2.43 | 6.36 | 4.36 | 2.68 |

**Table 1** Diet formulation and diet composition

| Ingredient (%) | Survival (%) | Initial weight (g) | Final weight (g) | Feed consumption (g) | FCR |
|---|---|---|---|---|---|
| Control | 87.9 | 5.49 | 16.3a | 659.8a | 2.28a |
| DCP | 93.2 | 5.44 | 16.0a | 697.8b | 2.24a |
| MCP | 90.9 | 5.49 | 20.7b | 729.2c | 1.66b |
| Aquaphos | 95.5 | 5.42 | 21.3b | 782.1d | 1.59b |

(ANOVA; P,0.05)

**Table 2** Shrimp performance; 82 ind/$m^3$, 30°C, 34 ppt salinity, 52 days



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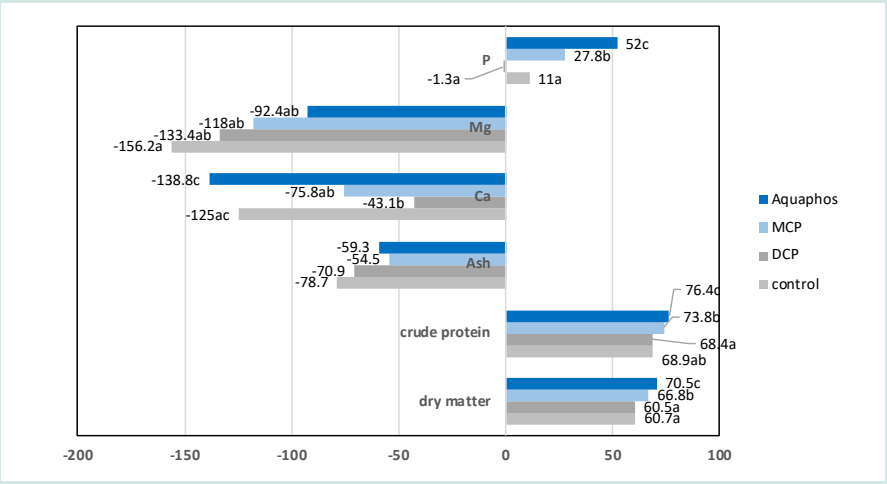


**Figure 1** Apparent nutrient digestibility in the test diets (%)

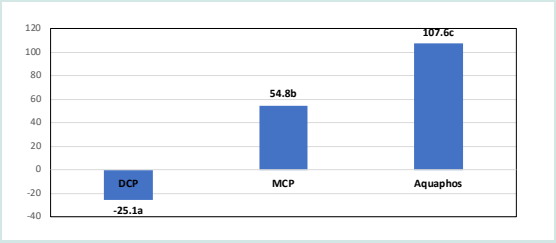


**Figure 2** Digestibility (%) of phosphorus in different sources

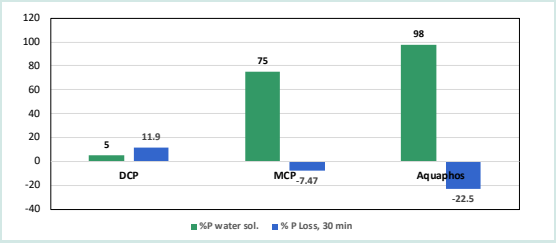


**Figure 3** Leaching of phosphorus from pellets

a lack of sufficient level of minerals, more especially P, from the feed, and which at least, partially, was compensated by the exuviae consumption.

Ingredient digestibility showed also significant differences amongst dietary treatments. Digestibility of dry matter, crude protein but certainly phosphorus was highly correlated with growth and subsequent feed efficiency (FCR). Digestibility of ash and the other minerals (Ca, Mg,) were apparently dependent on nutrient uptake from the water, showing negative digestibility values.

From these negative digestibility values for Ca and Mg it is quite apparent that for these minerals supplementation under trial water characteristics was not needed. Shrimp showed the capacity to absorb sufficient amounts from the surrounding water, thus saving space in feed formulations, thereby offering space for alternative feed materials.

Calculating the phosphorus digestibility of the phosphates tested based on the P-digestibility of the control diet and the P-digestibility of other test diets revealed quite large differences (Figure 2). It was slightly negative for DCP increasing to 55% for MCP and 107% in the case of Aquaphos.

The higher than 100% value found for Aquaphos can be explained by a few error sources, such as: sampling errors, analytical errors, and also leaching of P from the pellet and faeces resulting in an overestimated thus higher than 100% P-digestibility.

Since shrimp are slow feeders and nibble at the pellets it can be hypothesised that the higher the content of water-soluble P, the higher the possible pre-intake losses of P from the pellets because of leaching. In theory, the leaching out of the pellet of P from Aquaphos, being more water-soluble, will be higher than in the case of MCP and certainly of DCP. This has been tested simultaneously in this trial. The results indeed showed a higher P-loss in the case of Aquaphos than in the case of MCP and certainly of DCP. With the latter the P level increases in the DCP diets showing some possible retention of P from the surrounding water (Figure 3). On the other hand, the water quality parameters were monitored daily and parameters were kept at optimal levels for shrimp performance, both for phosphorus and ammonia.

To exclude this possible source of error or overestimation of the P-digestibility the determination of the retention of the phosphorus (and other nutrients) is a recommended and widely used method. For this ingredient retention determination, shrimp were sampled at the start and end of the trial. Whole body of sampled shrimp were analyzed to enable the calculation of nutrient retention efficacy, based on the apparent nutrient intake via the feed (content and quantity) and the nutrient increase in the shrimp.

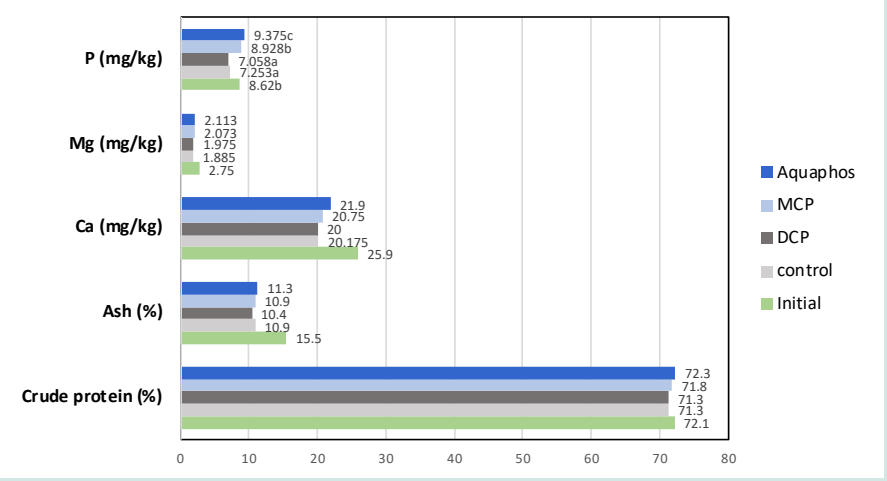


**Figure 4** Shrimp whole body composition

There were no significant differences between the trial groups in shrimp whole body nutrient content (protein, ash, Ca and Mg). In contrast, the content of P was significantly affected by the source of P, low for both the control and DCP group (in fact lower than in the initial shrimp), slightly higher for MCP and with Aquaphos reaching the highest value (Figure 4). It became apparent that small shrimp contain a higher ash and subsequent higher mineral level than in large shrimp with higher meat percentage.

Protein retention was significantly higher for MCP and Aquaphos against the control and DCP. Ash retention was significantly higher in the case of Aquaphos. This is also reflected in the retention of the other minerals. Aquaphos is a Ca-free P source, therefore, the diet containing Aquaphos has lower Ca, resulting in a more than 100% Ca-retention, indicating Ca absorption and retention from the water. Phosphorus retention efficacy was highly correlated with the P-digestibility of the different feed phosphates. It was highest for

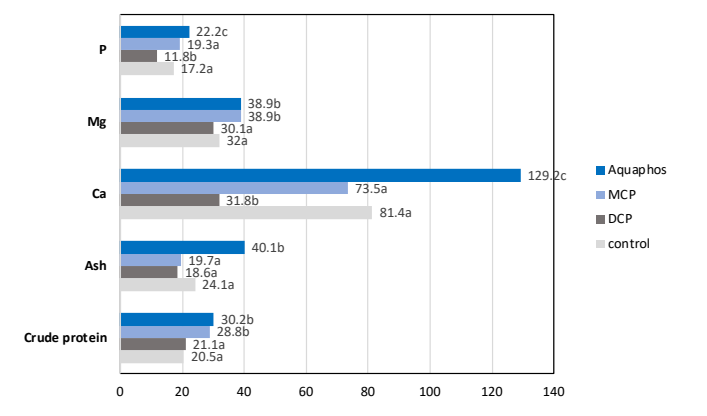


**Figure 5** Whole body nutrient retention efficacy (%)

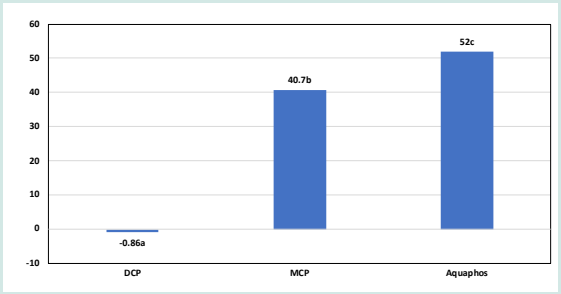


**Figure 6** Retention of phosphorus (%) according to phosphorus sources (%)

Aquaphos, followed by MCP, but DCP proved to be inefficient for supplying retainable phosphorus for shrimp, having a P-retention value lower than in the case of the control.

Based on the P-retention of the trial diets and that of the control, P-retention of the inorganic feed phosphates can be calculated. Aquaphos showed a significantly higher P-retention (52%) than in the case of MCP (40.7%) and certainly of DCP which had a negative P-retention (-0.9%).

## Conclusion

This trial carried out at the USP, Brazil confirmed earlier findings in trials with both fish and shrimp. Windmill® Aquaphos has a superior level of both digestible and retainable phosphorus for shrimp in relation to MCP but certainly to DCP. Next to its high P-content, the use of Windmill® Aquaphos enables the lowering of the P-content of shrimp feeds without jeopardizing P-digestibility or productivity of shrimp. It even contributes to a better environment by decreasing the P-excretion into the culture water, demonstrating a lower impact on the environment.



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**Rafael Coelho** (centre) is a Ph.D. candidate at University of Sao Paulo (USP), Brazil.

**Dr Daniel Lemos** is Professor at the Aquaculture Laboratory (LAM), University of Sao Paulo (USP), Brazil.

## Digestible-$-concept and the environment

The lifespan of rock phosphates is limited but at the same time an overuse of phosphorus can be detrimental to the environment. Therefore, knowledge of the P-digestibility of feed materials, including inorganic feed phosphates such as Aquaphos is critical for the formulation of modern shrimp feeds.

This knowledge enables one to calculate feeds closer to the P-requirements of shrimp and making it possible to select more digestible feed materials for the composition of these feeds. By enhancing the dietary P content of feeds but at the same time lowering the total P-content of feeds, there is a saving in the consumption of rock phosphates. Lower losses of P into the surrounding waters, protects the environment. At the same time calculation on digestible phosphorus saves on feed costs resulting in higher margins and higher earnings – not only for the feed producers but certainly also for the producers of shrimp, enjoying a lower feed cost but also a higher productivity of their shrimp. We at Aliphos call this the "digestible-$-concept", shown below.

# Full integration along the value chain ensures traceability

By Zuridah Merican

For Malaysia's GST group, the transition into a fully integrated aquaculture business is now complete with feed milling added in 2018.

It all started in 1985 when a young Dato Goh Cheng Liang started a fish processing plant in Simpang Ampat, Penang. He named the company after his father, Goh Siong Tee (GST). In the early 1990s, the younger Goh was an early pioneer in marine fish cage farming in Pulau Aman (Aman Island). A restaurant business was added 23 years ago, drawing tourists and foodies to the fishing town of Bukit Tambun in Penang, which was suffering from a dwindling capture fisheries industry.

In Malaysia, the GST group has secured its position as the only fully integrated marine fish aquaculture company, complete with broodstock and genetics selection programs, hatcheries and nurseries, marine cage and land-based farms and a thriving marketing business. In 2018, aquafeed production was added with the collaboration of China's Guangdong Evergreen Feed Industry.

## Millennials take over

This family business is divided into different sectors in the value chain. Since 2006, Goh took a step back for the next generation to take over running the group business; eldest son Allen Goh is now managing director; brother, Goh Soon Chin is responsible for trade and marketing for the Klang Valley, which is the largest market for the company, and youngest brother Roy is responsible for hatchery and land-based farms.

Fish farming and seafood processing are concentrated in Penang in northern Peninsular Malaysia, where the group began, although there is future interest to expand land-based Asian seabass farming through a joint venture in the southern region. "With our new feed business, we want to be in the fish and shrimp feed markets in West and East Malaysia. We are very excited with this latest challenge. I must say that, we are recognised for our sustainable seafood and farming operations," explained Allen Goh.

## RSA in production

In Malaysia, GST stands tall with responsible and sustainable aquaculture (RSA) practices. With the Friend of the Sea (FOS) certification in 2010, farmed marine fish from Malaysia is displayed at global seafood expositions. The supply of FOS-certified fish also gave market access to supermarket chains such as the Japanese AEON chain when it adopted selling sustainable seafood at its local stores (Star, 2015).

More recently, it led efforts to push for more sustainable marine fish cage farming practices under the Aquaculture Improvement Programme (AIP) in Malaysia. Since 2018, its seafood from the Oceanic farm qualify them to supply seafood marketed under the Improvement Programme. GST already has a 3-Star Best Aquaculture Practices (BAP) for its multispecies hatchery and farms. Besides the mandatory MYGAP (Malaysian Good Aquaculture Practices), there are various certifications essential to export and to gain market access.

"Our trading arm, GST Fine Foods is the only seafood company permitted to export to the EU. We realise that annual costs of these certifications are high, but they permit us to sell into premium markets and to be rewarded for our traceability efforts," said Allen Goh.

## Seafood from Malaysia

Raw materials for the processing plant and for direct sales to domestic markets are mainly from its farms. The group is the largest producer and exporter of farmed Asian seabass in Malaysia.

At the marine cage farms, daily harvests supply the processing plant. Live, chilled and frozen whole, and chilled and frozen fillet are for the local Horeca (hotels, restaurants and cafes), cruise liners and hypermarkets. Harvest sizes

*Allen Goh is looking forward to expansion with the production of fish and shrimp feeds.*

"Most of the feeds are used in-house by our marine cage and land-based farms but we look forward to expanding sales in the open market."

*At the Oceanic cage farm, 3kg Asian seabass (top) and 3.5kg hybrid grouper.*

*Top right: Leang Wei Chi. The cage farm uses slow sinking diets, produced in house at Green Island Feeds. Above, partial harvesting a red snapper cage.*

are planned for specific fillet sizes for various markets. Skin-on fillet yield range from 41%-46% depending on fish size. More than 900g fish for 100g-200g fillet are required and 1.7kg fish for more than 400g fillet. The processing plant has an annual capacity of 3,000 tonnes with 120 workers. Export products include whole live, fresh chilled and frozen fish, and fresh and frozen fillet. Exports are to Australia, US and Midde East. Groupers are usually sold as live fish for local and Hong Kong markets.

## Multispecies marine cage fish farms

GST has three multispecies marine fish cage farms. Two farms are located in the channel separating Penang with the mainland. This first farm off Pulau Aman has 416 cages. Its largest cage farm with 1,400 cages is located in Pulau Pangkor, Perak and was set up in 2010. This is complete with a hatchery and cages to hold broodstock. Eggs from this hatchery are then hatched in its two land-based hatchery and nursery in Penang.

*Left: Leang Wei Chi (second right), Rohaya Ahmad Ramli (third right) and the team at the Oceanic Cage Farm, Zaaim Zahari, Farm QC (right) and Yeow Ah Lek (fourth from right).*

The Oceanic Farm off Pulau Jerejak, Penang was set up in 2013. There are 320 cages for the farming of various marine fish – pompano *Trachinotus blotchii*, Asian seabass *Lates calcarifer*, hybrid grouper *Epinephelus lanceolatus* (giant grouper) x Epinephelus fuscoguttatus (tiger grouper), red mangrove and golden snapper (*Lutjanus argentimaculatus* and *Lutjanus johnii*), emperor snapper (*Lutjanus sebae*) and the four-finger threadfin *Eleutheronema tetradactylum*. The top four species in terms of volumes are the two snappers, seabass and hybrid grouper. The farm is managed by Leang Wei Chi, farm supervisor who oversees all marine cage farm operations for the group, including broodstock development. At this Oceanic farm, he has a staff of 11 for an annual production of 160 tonnes (14 tonnes/person). The most labour intensive activity is net cleaning which has to be carried out every 10 days for each net.

In general, 5-inch (<13 cm) seabass and groupers fingerlings, and for the snapper, fingerlings ranging from 2-4 inches (5-10 cm) are stocked into the 18X18 feet cages (~5x5m). Cage nets are 10-15 feet (3-4.5m) deep. In general, fingerlings come from the nearby Omega hatchery and only the hybrid grouper fingerlings are sourced from an outside hatchery or from Indonesia. As fish grow, the cages and nets are expanded to the larger 1,296 $ft^2$ or 120$m^2$ space.

Partial harvesting starts with sizes such as 700g for the seabass, 900g for the grouper and 500-700g for the snappers. The final size differs such as 3kg for the seabass, 4-5kg for hybrid groupers and more than 1.5kg for the snappers.

The culture cycle differs with species; the hybrid grouper will reach 1kg in 8 months, pompano, 400-500g in 4 months and golden snapper, 500-700g in 12 months. In the case of the seabass, it takes 23 months to reach 5kg but here at the Oceanic farm, the largest size is only 3kg. All is well, except that survival rates have gone down.

"Before, we used to achieve 70-80% survival but now the average is around 45-50% only. The reason is that over the years, water quality has deteriorated. Oxygen levels are much lower. The Department of Fisheries collects water samples once a year while the Department of Environment also does its annual checks. We are seeing new cage farms coming up, especially in 2018," said Leang.

"In addition, we see that growth is slower for the red snapper. But as the farm in Pulau Pangkor, where broodstock are kept, has started to do some genetic selection with focus on the growth trait, we can expect some changes with future stocks."

"Disease is the major threat as mortality is highest during the first 3 months," said Rohaya Ahmad Ramli, quality assurance manager for the group. "We monitor pH, dissolved oxygen and temperatures weekly. This is part of our standard procedures as well as for our certifications. We noted that with fluctuations in these parameters, fish are stressed and chances of attachment by the lice *Caligus* are highest. Stocking is usually from March to July."

Leang added, "In fish farming, we have developed the right technology and standard operating procedures but our weakness is with handling disease pathogens and morbid fish. During disease outbreaks we really need a lot of help. We usually send morbid fish samples to disease experts at the National Fish Health Research Division (NaFisH), Fisheries Research Institute to help us identify the pathogen. With the help of the Yellow Sea Fisheries Research Institute (YSFI), China and a Malaysian disease consultant, Dr Leong Tak Seng, we have identified via scanning microscopy, *Caligus* in one outbreak. I have undergone training at YSFI for 10 days."

"Compliance with certification requires us to record all farm activities, from stocking to harvest. This is the role of my team, to implement the standards in all farms, "said Rohaya who started working in this company in 2007. In addition, WWF demands environmental reporting as part of the participation in AIP."

## Hatchery and nursery

GST has two land-based hatchery and nursery. Both are on the mainland side of Penang in Juru and Batu Kawan. Broodstocks are kept in cages off Pulau Pangkor where the water quality is the best among the three farms.

The 20ha Omega Hatchery and Nursery has reservoirs and water treatment ponds, and 20 culture ponds. Annual production is 5 million juveniles. Salinity varies and is usually 25-26ppt in mid-February. In December, when water conditions are not ideal for fingerling production, the farm shifts to farming the marine shrimp or seabass.

"Over at Pulau Pangkor, the breeding ratio of male: female is usually 8:2. This hatchery receives the eggs, hatch and grow them in earthen ponds. For example, it takes 60 days for golden snapper fingerlings to grow to a size of 5 inch (12.5cm). We sell different size fingerlings, based on demand in the open market. Farmers usually demand 2-inch (5cm) red snapper fingerlings and 3-inch (7.5cm) golden snapper fingerlings. Our farms only stock 5-inch fingerlings. In general, we only use half of our fingerling production ourselves," said Roy Goh.

*Roy Goh (centre) and his technical team at the Omega Hatchery and Nursery, established in 2015.*

*Left, 5-inch golden snapper fingerlings. Right, 3-inch seabass fingerlings.*

*Khoo Chai Hee said that autofeeding has helped him to lower manpower needs but for the seabass there is room for more improvements in autofeeding technology.*

*Autofeeder at a seabass pond.*

Fingerling production starts with pond preparation followed by fertilisation for live feed production. In the case of the golden snapper, fry are weaned onto dry feeds at 1-inch size. The larval and starter diets up to 1.2mm sizes are produced by the company's Green Island Feeds. Feed additives are photosynthetic bacteria (PSP) and *Lactobacillus*. With regards to diseases, Roy said that the main problem is with the parasite *Trichodina*, affecting mainly seabass and red snapper fry.

"This area is well located close to farms. We usually deliver within 1.5-2.5 hours in open trucks. Only when we need to make deliveries to Johor in the south, do we make preparations the evening before for an overnight trip."

There are no requirements for disease quality control either by its own farms or by outside farmers. However, this hatchery has its own quality control protocol where prior to delivery, fingerlings are transferred into concreate tanks for "training". Sampling is then carried out to determine uniformity and health status of the fish.

## Land based seabass farming

Most of the seabass comes from its eight land-based farms, with brackishwater ponds. The 29-pond, Juru Aquaculture Farm, is managed by Khoo Chai Hee. Three-inch (7.5cm) fingerlings are stocked into around 0.5ha ponds. Usually fish are harvested after 5-6 months at 400-600g or less than 1kg for processing for domestic markets or sold to brokers. Larger 15-month old or 2kg or more fish are processed at the group processing plant for export.

"The SOP is that we keep to the standard carrying capacity of 3kg/$m^3$. As the fish grow, we harvest to keep to this capacity," said Khoo. "Of course, this depends on the survival rate too. Stocking depends on the availability of fingerlings. Survival probably averages 50-60% and at best, 80%."

Khoo added, "Water salinity also varies greatly, from 10 to 25ppt. I usually wait for the high tide to pump in water to get the best salinity (25ppt) for stocking. The first month is usually the most difficult and the most important period. Rainy periods are bad for stocking but good for grow-out when the fish is more than 200g. We stock all year round."

For Khoo, the other challenge is feeding. The farm uses floating marine fish feeds produced by the Green Island Feed mill as well as imported floating feeds imported from Vietnam. Feeding is automatic using a blower type feeder with a tube extending into the pond. "Feeding the seabass is not easy as we cannot use the spindle autofeeder as the seabass tend to clump together in a corner. We get a large size variation and thus, there is room for improvement with autofeeding in seabass farming. But autofeeding has helped me to lower my manpower to only seven," said Khoo.

"Feeding is most difficult during the first month. We need to feed slowly so that all fish are fed to avoid cannibalism. Then once they start to feed, they eat too fast. The plus point is that once we start the blower, the fish hear the noise from the feeder and move towards the feeds."

On ex-farm prices, Khoo said that fortunately, prices have been relatively stable since the Chinese New Year (February 5-6, 2019). It is now MYR13.80/kg (USD3.4/kg) for 700-800g fish. Larger fish of 3kg can fetch MYR18/kg (USD4.4/kg).

"I am happy as my costs are around MYR 8-10/kg (USD 2-2.45/kg). This is so different from the days when many shrimp farms shifted to farming the seabass as they faced the early mortality syndrome (EMS). Imagine during that time, the oversupply of seabass dropped prices to MYR7/kg (USD1.72/kg)"

## Joint venture on aquafeed production

The progress of this joint venture with China's Guangdong Evergreen has been very fast with production starting in June 2018. Evergreen, a leading and dedicated aquafeed producer in China assisted with the total set-up, from the raw material sourcing, formulation to final production. Henceforth, Green Island Feedmill is tasked with marketing the feeds. The production capacity is 1,500 tonnes per month (tpm) of shrimp feeds from one pelleting line and 3,000 tpm of extruded fish feeds, from one extrusion line. There is space for expansion of additional lines, one each for fish and shrimp.

"We are new in the country's aquafeed market but we are lucky that we can ride on the Evergreen name. The brand names follow that of Evergreen too. Our strategy is to compete on quality, rather than on price. For us, an important factor is gaining the trust of the industry in Malaysia," said Allen Goh.

Moving back to its core business, Tho Ching Ching, assistant general manager who is also in charge of group marketing, added, "One way is contract farming, supplying feeds and post larvae and at the same time, we are assured of traceability of our seafood."

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# 35 years in aquaculture

*Artemia* is synonymous with INVE Aquaculture but more is expected with holistic solutions for aquaculture in Asia

*The INVE Aquaculture team in India, S.Chandrasekar, area manager, India and South Asia (second left) and Nagarajan, sales manager-India (second right) with Raveendrakumar, Rudira Aqua (left); Ravikumar, CEO, Golden Hatcheries group, Chennai (middle), and Rutvik Reddy (right), Rudira Aqua has been a distributor in India for more than 20 years.*

*Stelios Leontios (right), Rudi Bijnens (middle) and Michael Janssens, area manager South-East Asia.*

"Today, I am proud to announce that half of them are still with us and 30% of them have been with us for 20 years. We value these relationships and partnerships," - Philippe Léger.

INVE Aquaculture is now part of Benchmark Holdings and in January, the Asia Pacific team celebrated its 35 years in aquaculture with more than 100 distributors, clients and staff. The one-day celebration centered around Pichit in central Thailand where 20 years ago, it built its first production facility for Asia.

CEO Philippe Léger, Stelios Leontios, commercial director, Wim Martens, operations director and Rudi Bijnens, regional sales director for Asia led the celebration. Suranard Sreenara, plant manager organised a factory tour for guests. Guests of honour included Thailand's Director General of Fisheries, Dr Chumnan Pongri and deputy director general for aquaculture, Thawaon Jirasoponrak, Idesbald van der Gracht, first secretary of the Royal Belgian Embassy and Marc Devriendt, Flanders Government's investment and trade counsellor.

The day's event also included a seminar introducing various solutions available under the Benchmark platform for sustainable food production. Professor Patrick Sorgeloos, Ghent University played a visionary role in the development of INVE Aquaculture; initially as the developer of *Artemia* hatching techniques. Sorgeloos looked back at the early years working on the *Artemia*, a vital live feed driving marine shrimp and fish hatchery production and depicted a future of replacements of live feeds and using microbial management to overcome disease outbreaks (see pages 4-5).

Today, the company has achieved > 20% market penetration in the global shrimp and marine fish hatchery nutrition segment. It is present in 70 countries, has sales revenue of USD 97 million and EBITDA of USD 26 million in 2016. In Asia, INVE Aquaculture leads in the markets for *Artemia* and larval feeds, although its market share is constantly challenged by locally sourced and new products. Penetration into some markets have been constrained by registration protocols as well as changing regulations. Nevertheless, innovations keep the company ahead in many markets.

The company continues to focus on early stage nutrition (broodstock and larval stages) but has also added health and environment for the aquaculture lifecycle. In 2016, it launched its global campaign titled 'Care for Growth'. This is a renewed and intensified approach to the market, strongly focusing on knowledge transfer and information sharing as a catalyst for growth in the industry.

## In the beginning, all on *Artemia*

Remembering the journey of 35 years, Léger who became CEO in 2010 said, "In the early 1980s, as the growth curve in marine aquaculture started, we were working on standardisation of *Artemia*. Patrick was the initiator to bring science to the developing world of aquaculture. In 1983, Artemia Systems, a spin-off of Ghent University, was formed with 2 major investors from the oil and gas industry. *Artemia* was our only product and this explains why *Artemia* is close to our hearts and a big part of our business.

"Those days, *Artemia* sales was less than 5% of the current annual sales. This shows how aquaculture has progressed. We worked with pioneers in shrimp aquaculture in Latin America, to understand what they were doing and their problems in order to develop solutions for the emerging industry. In Europe we worked with start-ups in in turbot and seabass farming. With marine fish, at that time the problem was with larvae survival; it was less than 5%. Today, this is much higher but still needs improvement."

Working with *Artemia*, the company looked at differentiating the *Artemia* and developing specifications. Léger said, "Our milestone is that we defined standards for industry. This is the way to progress."

## Next to early stage nutrition and health

Artemia Systems was the first company to specialise in encapsulated larval feeds. The turning point came in 1991. With the oil crisis, its major investors moved back to their core business. INVE, which was already developing early stage feeds for livestock, acquired Artemia Systems.

"Since 1983, we were already pioneering live food enrichment through bioencapsulation as well as to replace algae. We wanted to enrich *Artemia* and rotifers. Selco, our first enrichment diet, is still in the market. The final and ultimate call is to replace *Artemia* and other live foods."

Under INVE, aside from nutrition, a health products portfolio under Dr Patrick Lavens, was added. "We developed a sales network with service centres and a distributors network, from Latin America to Europe and Asia. Today, I am proud to announce that half of them are still with us and 30% of them have been with us for 20 years. We value these relationships and partnerships."

During the 21 years from 1991 to 2012, INVE's revenue grew 10 times. In 2012, the shareholders divided INVE into two companies, each to define its own future; Nutriad for feed additives and livestock solutions and INVE aquaculture for aquaculture solutions.

## Innovation

"Innovation is how we started with and in this fast-growing industry, innovation is the way to keep ahead of competitors," said Léger. The research and product development have been taken out of the university. In Belgium, there is INVE Technologies and in Thailand, test centres in Pichit and Chonburi. The company also has R&D contracts with 50 research institutes as well as with distributors and customers.

Bijnens recounted the journey for the *Artemia*, from a commodity to value-added product. "Affecting nauplii quality and quantity output for the hatchery operator are among others harvest, storage, hatchability, biosecurity, light, temperature and hatch rate. "Over 25 years, we have worked on improving standards, hatching percentage and efficiency of *Artemia* cysts. A safe and biosecure product is essential to the market, otherwise *Artemia*, like any other live food could be a source of vibrios in a hatchery."

In terms of innovations, in 2008, Sep-Art was introduced into markets. This is life changing for hatchery operators, ensuring almost 100% separation of nauplii and cysts, ensuring a safe, nutritious and viable nauplii. Today, there is the SMART or Sensitivity Modifed Artemia concept, a new technology to reduce the effects of suboptimal environmental factors on the hatching performance. For the moment, the concept offsets the often-poor light conditions in hatcheries. Through innovation, the concept will address other limiting factors over time." By applying SMART concept on cysts, operators can have good hatching results in suboptimal conditions." Another innovation is D-Fense, to address bacterial growth during the hatching process.

Answering market need for strong post larvae during transport and stress during stocking, is Sanocare Fit in the health portfolio. Eva Werbrouck said, "This is unique as it makes use of the potential of phytochemicals and health booster to stimulate innate immunity in post larvae. The antimicrobial properties will suppress growth of vibrio during transport of post larvae from the hatchery to the nursery or farm. The improved robustness aligned with optimal environmental conditions is part of the holistic approach in the hatchery."

*Mary Ann Solis, Biosolutions International Corp, Philippines (centre) with from left, Suranard Sreenara and Vittaya Rungtivasuwan, quality division manager, INVE Thailand Ltd; Marc De Feyter, HR director, INVE Technologies, Belgium and Nguyen Van Trung, area manager, INVE Vietnam Company Limited.*

The product is a result of R&D at the centre in Belgium, then tested at the centres in Thailand and a final commercial trial at a customer farm. The mode of action is to trigger the production of heat shock proteins (HSP) inherent in the shrimp. "The response to an abiotic stress of high temperature (43°C for 1-2 hours) or low salinity (from 30ppt to 1 ppt over an hour) was higher survival of Sanocare Fit treated post larvae. The biotic challenge was exposure of Sanocare Fit treated crustacean to a pathogenic strain of Vibrio campbelli over 2 days. Pre-treated animals showed a higher survival. During a transport test, there was a strong suppression of the vibrios in post larvae and in the water in the bag. In the case of Vibrio parahaemolyticus, the reduction was by 100 times in the shrimp," said Werbrouck.

## Benchmark takes over to drive food sustainability

INVE Aquaculture grew 16 times from 1991 to 2015. But in 2016, its investors decided to divest the company to UK based Benchmark Holdings. "This worked well for us as we had planned to offer a total package in sustainable aquaculture, from breeding to health and genetics, and under Benchmark, there is already expertise in these areas. Benchmark is a good fit," said Léger.

Benchmark added an advanced nutrition division. "Benchmark's mission is to drive sustainability in food production by bringing biology and technology to development innovative products. This is not one single product but solutions and an understanding of how they work together to improve yield, quality and animal health and welfare," said Dr Doerte Laure, group marketing director. "Benchmark's aim is to be aquaculture's leading provider of genetics, advanced nutrition, animal health and knowledge services. It is well known in Norway and the new challenge is to raise its visibility in Asia."

In his description of the work ahead under Benchmark's one stop technology platform, Leontios said, "Eighty-six percent of Benchmark's business is in aquaculture where the norm today is intensive production systems which brings challenges with diseases and other problems. We have seen the results of reducing risks and making investors feel secure. We believe we can give the best solutions along the supply chain and handle the whole lifecycle through knowledge sharing.

*(Left) Amir Khalil said that if the focus is only on biomass but there is lack of biosecurity, it is risk taking.*

*(Right) Manuel Poulain described his work on controlled indoor farms to control contamination and assure 'consistency and predictability' in shrimp farming.*

"The point is to control costs of production to reach profitability and predictability in production. I can assure that what we have for the future is attracting attention. The dream is that someday Benchmark will be the 'Intel' inside aquaculture."

## Indoor nursery and controlled farming systems

This view on "profitability and predictability" in sustainable aquaculture production starts is matched by the focus on indoor nursery and controlled indoor farming system. Amir-Antoine Khalil, commercial project manager, said, "The indoor nursery phase, common in Latin America but still rare in Asia, is the path towards better biosecurity. It cuts the time in open grow-out ponds. It increases efficiency and profits with batch management. Ultimately, it is growing shrimp sustainably and to be able to predict production." Amir gave an example of PL9-15 reared in a nursery for 10-30 days instead of straight into grow-out ponds for 90-150 days and being exposed to EMS outbreaks during the first 30-35 days and later at the pre-harvesting stage with significant losses. "If the focus is only on biomass but there is lack of biosecurity, it is risk taking. High water exchange increases risks of pathogens. Therefore, it is biosecurity and cost management with limited or zero water exchange."

The starting point is the nursery structure with the full service. "Supported by a civil engineering team, we work in close collaboration with farmers; learning and understanding their needs. "It can be a 200-tonne nursery, with liners as an extension of the hatchery in Thailand, or a 1000-tonne indoor nursery in Vietnam. In all systems, it requires protection from the entry of pathogens. Water exchange should be limited and perhaps go down to zero. Any savings in pumping could be used for high quality feeds and probiotics."

Manuel Poulain, technical support manager, is also a farmer in Spain producing vannamei shrimp in a farm, 500km away for the coast (AAP, 2015). Poulain described his work on controlled indoor farms to control contamination and assure 'consistency and predictability' in shrimp farming. He discussed recirculation aquaculture systems (RAS) and bioflocs, both of which have limited water exchange and microbial management. The latter clearly showed an increase in performance. "Basically, with any business, success is about risk management," said Poulain. "We have introduced several greenhouse systems. Some examples for *Penaeus vannamei* are in China and a higher-level system with 1ha greenhouses in Vietnam. In Indonesia, some applications of indoor and outdoor systems to match the challenges of farmers." Poulain emphasised the future for such models, "We are linking sustainability to finance; stimulating investment into sustainable aquaculture systems. Without these, there will not be a blue revolution."

## Bringing Benchmark genetics to Asia

In charge of the operations at Benchmark Genetics in Benchmark's shrimp genetics division, Oscar Hennig introduced the various activities in the genetics division at Benchmark. "Expertise in aquaculture genetics, allows us to use the technology developed in salmon breeding to other species such as tilapia and shrimp. We also have genomics to move faster in the selection programmes."

Hennig described the work combining robust specific pathogen resistant (SPR) with specific pathogen free (SPF) stocks which Genetica Spring uses to develop lines for the global markets. "From the nucleus breeding centres in Colombia, we bring post larvae to the broodstock multiplication centre in Thailand, Florida and other global locations. All families are DNA-fingerprinted. This allows for local adaptation and for the farmer, post larvae which are already adapted to local conditions.

Hennig indicated some commercial lines under development and ready for markets. These included growth lines, low salinity (5ppt) lines, and resistant lines as such for white spot disease, acute hepatopancreatic necrosis disease (AHPND) and general pond survival. He expects to market robust animals from the family selected AHPND resistant lines soon. "We disseminate a robust animal which does not amplify prevalent diseases and is adapted to local conditions."

Matching INVE Aquaculture with the genetics platform, Hennig said, "Maturation diets can come with genetic selection and I can now look forward to 100% replacement of fresh feeds."

## Looking ahead to its 50th year

"By the end of 2019, we expect to be 21 times larger than we were in 1991. As aquaculture grew 7 times, we were growing 3 times faster. Over these 35 years, we have gone through a staggering adventure," said Léger, adding, "I am looking forward to our 50 years in aquaculture. Aquaculture has to grow, there is no other options for the global seafood supply. We can grow only if we give what our customers want; we need to take into consideration ecological impact and costs along the supply chain. Lastly, investing in research is our service to customers."

## 20 years in Pichit

"This is where we started here in Thailand," said Wim Martens, operations director as he introduced the processes at this factory, located in Pichit, 5 hours from Bangkok. The factory has a staff of 200 from the local community. "This whole facility was based on the earlier one in Belgium, with extra innovations. We produce all that are in our product range here, starting with *Artemia* and encapsulated feeds for hatchery and early life cycle nutrition, to broodstock diets and products for health care and environment. Biosecurity is top of our standard manufacturing practices and we totally separate out rooms for probiotic production.

"Today, what we can achieve is 3 times the volume and the quality products. We have the safest aquaculture products for markets and as the Department of Fisheries raises the quality criteria, we also raise that of our products."

# Return of the kancra fish

By Muhamad Husen

A revival of this endangered fish *Tor douronensis* known by several local names, will be apparent with its breeding following success in domestication.

Ikan kancra is the name in the local Indonesian language (ikan meaning fish) for the freshwater fish belonging to the genera *Tors or Labeobarbus*. It is often found in clear and rocky waters around Cigugur and Cibulan in Kuningan in West Java. Other names include "white fish" as well as "ikan dewa" or" sacred fish." It is not recommended or forbidden for some to catch because of some customary beliefs. However, the fish found around the sandy and clear water ponds in Sumedang including the Cimanuk River is often caught and commonly traded.

There are various other local names for the fish. In North Sumatra, the fish is known as "ikan batak" and just as in Kuningan, it is closely associated with local customs and culture. In southern and western Sumatra, it is known as "semah" or "gariang". In Kalimantan, it is known as "sapan" and in Malaysia, as "kelah" or mahseer. Recently, catching the fish has been the dream of freshwater fish enthusiasts as their population has declined and the fish is available only in some river systems.

*(Top) This kancra broodstock was taken from the Cipunagara river and weighs 4.5kg. (Left) The author with one of Indonesia's famous personalities, Solihin GP, looking at the kancra fish. Standing is the Dean of the Faculty of Fisheries and Marine Sciences-UNPAD, Yudi Nurul Ihsan.*

## A high value freshwater fish

The kancra is favoured for its firm flesh texture and taste. Furthermore, the small population has led the fish to be categorised as endangered. Not surprisingly, it is highly priced. In Sumedang and in parts of Sumatra, prices can be around IDR500,000/kg (USD35.33/kg). In Malaysia, prices have reached IDR1,500,000/kg (USD105/kg). It is said that fishermen in West Kalimantan capture the fish for markets in Malaysia. Its rarity is increasing its demand and popularity.

There is a high economic value for this torpedo-like fish with a longitudinal body. This fish is found in distinctive habitats where the rivers are fast flowing and where the waters are clear. It is a relatively large endemic fish and can reach 1m in length. It is an omnivorous fish with the main diet being fruits, molluscs and insects. Around 1910, on the Cimanuk River in West Java, Dutch biologists had studied its habits and named the fish, "java salmon", similar to the characteristic of the salmon, heading upstream to spawn. At that time, conditions in the Cimanuk River were optimal for the survival of the kancra.

## Potential for culture

The success in artificial fertilisation following domestication seems to pave the way for the re-population of this endangered fish. In short, various economic and environmental benefits as well as its conservation, are expected. Furthermore, in addition to promoting farming activities, the Ministry of Maritime Affairs and Fisheries (MMAF) decree No. 66/2011 mandates the release of the kancra into river systems to re-establish its population. The government is also immediately implementing the rules of CBF (culture-based fisheries) in some open waters. Guided by the MMAF decree No 15/MEN/2009 concerning "types of fish and area of re-distribution and cultivation of fish", the aim is also to rehabilitate the aquatic environment to more conducive levels for this endemic species.

**Muhamad Husen** is a board member of the Indonesian Fisheries Society.
Email: moes349@yahoo.com

# Using brine to deep freeze shrimp

By Hervé Lucien-Brun

A system to deep freeze shrimp for a product with excellent texture to meet the quality demands of high-end niche markets.

## Part 2: Brine freezing systems

Today there are two types of brine systems. In the older immersion technique, blocks of shrimp are immersed in a tank with chilled brine. In early 2000s, a new method was developed by a French company in its farm in Madagascar. This consists of spraying chilled brine on the shrimp. Today, this 'shower technique' has been further developed by other companies.

## Immersion

This system is more efficient than air blast or contact plate freezers (Figure 1). The production is not continuous because the blocks must be grouped together in batches to be immersed (Figure 2). The flow of brine cannot penetrate fully the pile of shrimp blocks and turn around. So, the penetration of the cold brine will need more time (Figure 3).

When shrimp are removed from the brine (T°≈ -12 to -14°C), they must be rinsed quickly to remove brine residues (T° ≈ -8 at -10°C) and then passed through an air blast tunnel to reach a core temperature of -18°C.

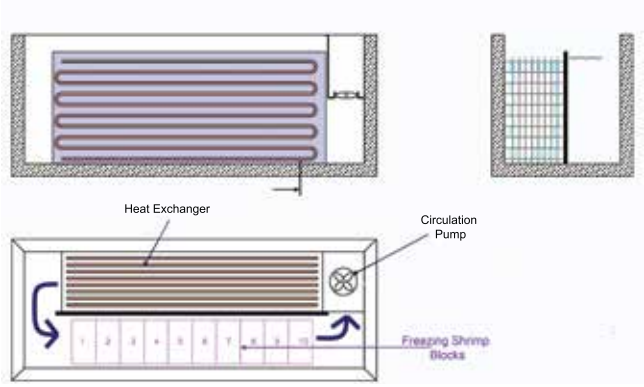



**Figure 1** Drawing of an immersion brine freeze

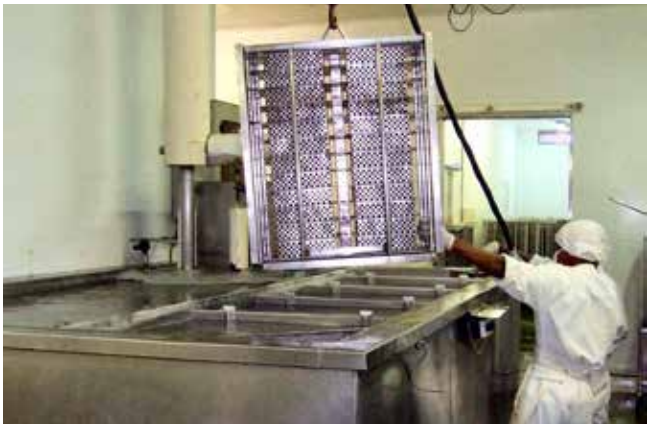


**Figure 2** Dipping piles of shrimp blocks in brine

## Shower

The chilled brine is showered over the blocks of shrimp transported on a conveyor belt. The conveyor belt will pass through the brine chamber and thereafter into the blast freezer. With this method, the cold penetration is much faster and is carried out under continuous freezing. There is no time loss between the entry of the fresh shrimp into the packing plant and to the time when the shrimp are frozen. This improves the quality of the final product (Figure 4).

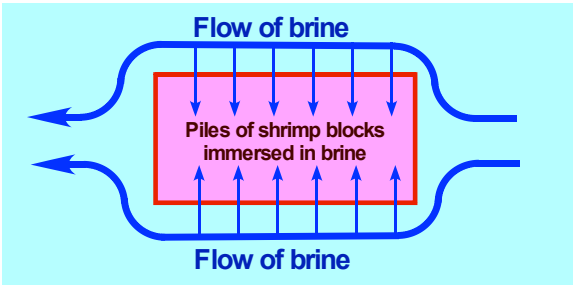



**Figure 3** Flow of brine and cold penetration in immersion brine systems

Today, there are two types of shower brine freezers: one using an external plate heat exchanger (Figure 5) and the other using plates for temperature exchange in the reservoir of the brine itself (Figure 6) just as in the case for the immersion technique.

The heat exchange capacity depends on the contact surface between the coolant and the brine. In the second case, it is necessary to have enough depth in the brine tank to be able to install the necessary exchange surface. This requires a large reservoir and thus, a large volume of brine. In contrast, if the plate exchanger is located outside of the reservoir, about half the volume of brine is required. This is very important because with less brine, it is easier and cheaper to manage and replace. Furthermore, we must also consider the removal of used brine which is always a problem.

## Managing the brine

To prepare new brine, the rule is to first dilute little by little all the salt by constantly checking the increase in density with each addition after at least 10 minutes of mixing. Sugar can be added gradually only when the density of 1.170kg/L (or kg/dm$^3$) is reached with the salt. When all the sugar is diluted, the density at ambient temperature must be 1,200kg/litre (or kg/dm$^3$) The density of brine varies considerably depending on its temperature (Figure 7) and thus it is critical to constantly conduct the density checks.


*Shrimp blocks entering the blast tunnel*

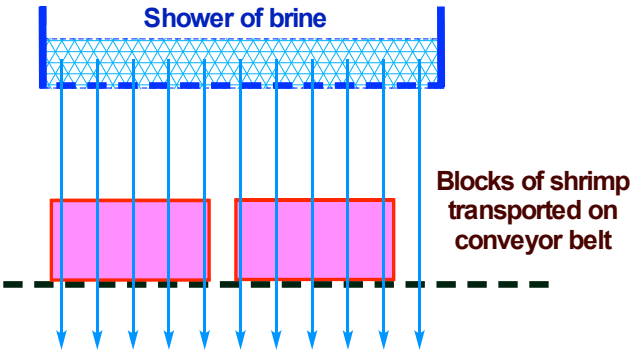



**Figure 4** Flow of brine and cold penetration under a brine shower

## Brine consumption

During the process, in terms of volume and solutes, the brine is reduced in two ways. The volume will reduce through misting; the dissipation of the brine in the tunnel. It is also reduced with the absorption by shrimp: one part is absorbed individually and another part rests in inter-shrimp spaces. Lastly, the volume goes down as the brine remains trapped in the moulds. However, this depends very much on the type and volume of the moulds. It also varies according to the type and the size of the moulds.

Solutes (salt and sugar) will deplete with the penetration of the molecules of salt (NaCl) and sugar into the carapace and then into the flesh of the shrimp. This penetration varies according to the size of the processed shrimp. It is more important with small shrimp.

This brine depletion must be compensated continuously in two ways during the process to avoid the icing of the system: compensating for the missing volume by adding brine with the initial characteristics. The solute depletion requires measuring the quantities of solutes (salt and sugar) lost so as to estimate the complementary amount to be made.

The concentration of the brine can be controlled only by checking the density (> 1,210kg/L) to avoid risk of icing. If the density decreases, salt and sugar must be added. Nevertheless, the density will not give any information on the relative consumption of salt and sugar. Thus, it is necessary to control the two values (volume and solute) at least once a day and readjust them properly.

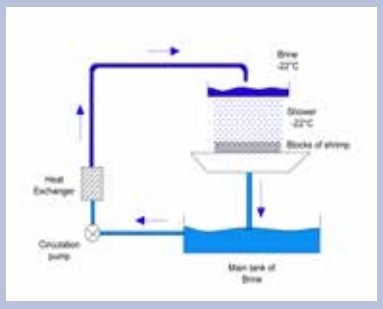
The evaluation of the respective intake of salt and sugar is determined by doing a titration of the chloride ion using the Mohr method and calculation of the concentration of salt. Sugar is estimated by measuring the Brix value (°Brix) of the solution with a specific refractometer.

It is important that the solute depletion be done only after compensating for the brine volume. Salt or sugar must never be added as crystals (powder) directly to the brine reservoir of the freezer. Brine must be returned to the specific preparation tanks to dissolve the necessary quantities of salt and sugar, just like it was done during the initial preparation.

As concentrations are near saturation, the dissolution is difficult. It is therefore necessary to track the brine frequently. This is to avoid the addition of too large a quantity of solutes at any one time. If the crystals of salt or sugar are added directly to the tank, there will be the risk that they do not dissolve and will fall to the bottom of the tank, thus forming a layer which becomes useless or even harmful.

## Duration of brine use

When the shrimp is frozen, the set point must be at least -18°C. Between production, the temperature of the brine can be allowed to rise to -8°C to prevent the propagation of microorganisms. The brine could be used over several months. The main reason for replacing the brine is bacterial contamination and it is important to monitor the evolution of brine contamination daily by carrying out bacteriological analyses. It is also important to define acceptable and critical levels. When the critical level is reached, the brine must be changed as soon as possible.



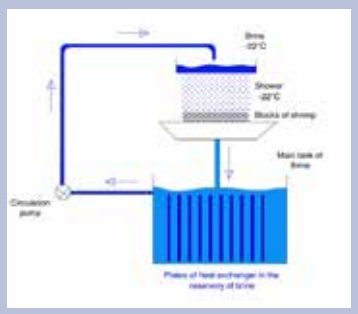


**Figure 5** Brine system with external heat exchanger

**Figure 6** Brine system with the plates for heat exchange in the brine reservoir

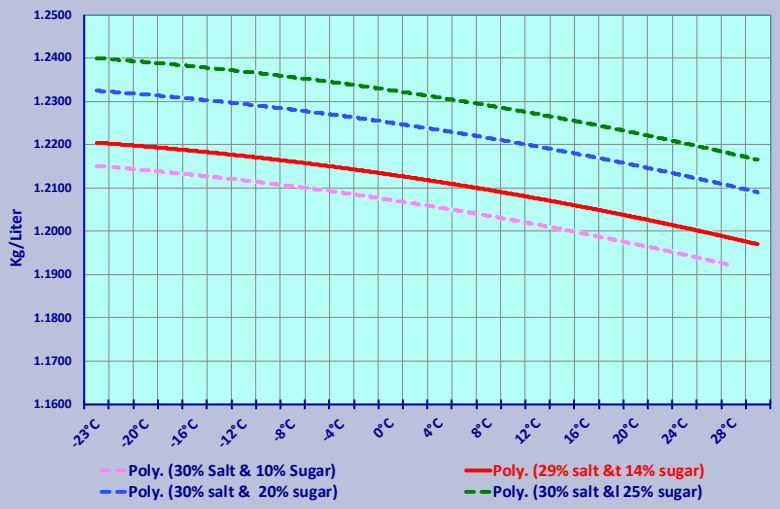



**Figure 7** The evolution of the density of four types of brine as a function of its temperature.

*Boxing: A stainless-steel mould of brine frozen shrimp. (left)*

*Shrimp brine frozen in carton boxes*

## Boxing

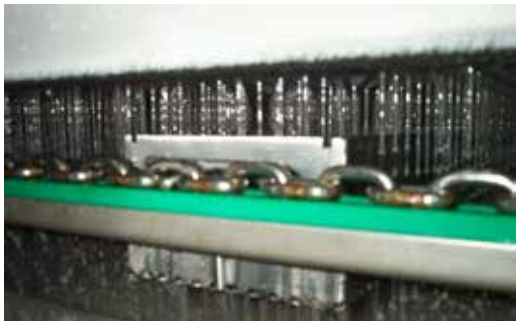
For many years, shrimp were set in plastic or stainless steel moulds to be frozen in the brine. After removal from the final blast tunnel, it was necessary to remove the block of shrimp from the mould to transfer them to carton boxes. This was a delicate operation, and tedious for the workers handling the frozen blocks. In recent years, manufacturers of cardboard boxes have made boxes resistant to the brine shower which simplifies the handling of products at the exit of the freezer and to position these in the master carton before storage in a cold room.

## Conclusion

The use of brine is an excellent method to deep freeze shrimp. It gives the final product an excellent texture due to the rapid freezing with a very high coefficient of heat transfer. Compared with other traditional methods (blast and plates), this also reduces the energy required to freeze products with significant savings and in cost of production. This system is not complicated but needs special care throughout the process.

Some tips are:

- Never add fresh water to chilled brine reservoir.
- Never empty solid salt and/or sugar directly into the brine reservoir.
- Adjust the volume of the brine prior to compensating depletion solutes.
- Compensate for the depletion solutes of the brine (volume and concentration) routinely during the process.
- Always keep brine at a temperature below -8 °C.



*Shower brine freezers in plants in Madagascar, France and Honduras.*

**Hervé Lucien-Brun** is an independent consultant based in France. He has more than 32 years of experience in tropical marine shrimp and finfish aquaculture and in quality control of shrimp, pangasius and seafood processing and auditing of facilities and procedures in Latin America, Asia Pacific and New Caledonia. He is an ADEME, France Carbone Footprint certified auditor and certifier for HACCP. Email: hervelb@gmail.com

# Book review

**Dr Nyan Taw** is a shrimp aquaculture consultant who has worked in marine shrimp farming since the late 1980s, initially with FAO and later in the field, with Charoen Pokphand Indonesia on biofloc technology. He then went on to work at several large integrated shrimp farms in Indonesia: PT Dipasena Citra Darmaja and PT Central Pertiwi Bahari in Lampung, South Sumatra and PT Sekar Abadi Jaya in West Sumbawa and in Malaysia: Blue Archipelago Bhd, Arca Biru in Kedah and the iSHARP in Terengganu.

In this book, Nyan Taw has compiled previously published works; R&D and field trials, magazine articles and experiences. These details strategies used in shrimp farming, biosecurity and biofloc technologies since the emergence of viral disease in Asia from late 1994s. He has included examples of different biofloc and recirculation aquaculture (RAS) shrimp farming systems used in Asia in the last two decades. In some of the projects covered, Nyan Taw was personally involved and provided technical expertise, as well as some perspectives on these technologies. Several of the articles have been published in the Advocate, Aqua Culture Asia Pacific and World Aquaculture magazines.

ISBN:978-620-2-30264-7


**Intensive shrimp farming systems in Asia by Nyan Taw**
*Publisher: Scholars' Press*

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# Industry 4.0 technology and profitable integrated aquaculture business in Indonesia

While Indonesia maintains its status as a leading aquaculture producer, there are calls for stakeholders to move into the digital era.

The Indonesian Aquaculture Society or IAS (Masyarakat Akuakultur Indonesia or MAI in the Indonesian language) continued to attract an international crowd at its 2018 edition of the International Conference Aquaculture Indonesia (ICAI) held in Jogjakarta from October 25 to 27 2018. Keynote and presentations covered a range of subjects essential for the future of aquaculture in Indonesia and the region. The focus is for sustainable and profitable aquaculture business using technology. MAI President called the latter, Industry 4.0 technology. MAI also organised a session to discuss a recent industry challenge - the call to ban or limit floating cage farming in lakes to maintain water quality for tourism.

A global overview in aquaculture and the role of biosecurity was given by **Dr Rohana Subasinghe**, Futurefish, Sri Lanka. He is also the president elect of the Asian Pacific Chapter of the World Aquaculture Society (APC-WAS). "Indonesia is the third largest supplier of fish, after China and India. As the Indonesian fish supply from capture fisheries dwindled to 57% in 2016, from 84% of the total volume in 2000, it was aquaculture which has been maintaining Indonesia in third position," said Subasinghe.

The global fish supply is currently 70 million tonnes and an additional 47 million tonnes are needed to feed the growing global population. A forecast by Cai and Leung (2017) indicated that if price and consumer preference remain the same, income growth may drive fish demand, raising consumption from 20kg/person/year in the mid-2010s to 25kg/person/year in the early 2020s. They added that the annual growth of global aquaculture has been at 4.5%/year since 2010. However, to bridge the demand-supply gap, world aquaculture should grow at 9.9%.

The spread of diseases is a major challenge for the sector. Reducing disease risks requires diagnostics, vaccines, high health fry/post larvae, resistant strains and vigilance on emerging diseases. Disease outbreaks have resulted in massive production and economic losses. Clearly, these are attributed to transboundary movements of pathogens. Subasinghe said, "Lately we have concerns over the tilapia lake virus (TiLV). It is time to rethink. We are not focusing on biosecurity for small scale farms even though 70% of global aquaculture production comes from these farms. We tend to focus on large commercial farms."

His message was, "From past experience it is clear that producers will always attempt to bridge the supply and demand gap, even forgetting the issues and concerns over sustainable production, thus leading to serious environmental and social impacts, including disease, which should be avoided at all costs."

*Dr Agung Sudaryono (second right) with (from right), Dr Nyan Taw, Dr Rita Rostika and Thomas Dharmawan.*

**Professor Jeong-Dae Kim**, Kangwon National University, Korea gave an overview on aquaculture and feed development in Korea. He associated some targets with those for aquaculture in Indonesia where production of fish and shrimp was 6.4 million tonnes in 2017. Kim estimated that the aquafeed demand in Indonesia for fed fish was 4.1 million tonnes, but 62.4% came from home-made feeds. The use of commercial feeds was only 1.6 million tonnes. "Globally, the trend is to move towards, 'neither fish nor animal by products but single cell, insect meals and plant PUFAs etc.," said Kim. "This is our target in Korea too after focusing on fish-free and animal by products-free meals post-2010."

Kim discussed a current issue in Korean aquaculture. "In 2017, the production of the flounder and rockfish reached 63,551 tonnes. The major problem in Korea is the use of moist feeds to feed flounders and rockfish. In 2017, we used 500,000 tonnes of moist feeds as compared to only 87,000 tonnes of extruded pellets." The government is worried on the use of moist pellets, where FCR is 6.7. These add to nutrient loadings into the environment. There is also the use of trash fish, which results in the introduction of pathogenic bacteria into the environment and disease transmission. "The aim is to reduce the use of moist pellets by 2050 via legislation. It will be through the development of functional feeds with reduced fish meal. It will be diets based on requirements. We will also need selective breeding for fast growth."

There were several other keynote speakers. In seafood marketing, **Dr Ravi Fotedar**, Curtin University, Western Australia, discussed expectations in the global seafood business. Fotedar gave nine strategies or keys to success. Among them, information on markets and the customers, learning the science of products, opportunity costs, and focus on quality and innovation. **Dr Nyan Taw**, Consultant Myanmar, gave some updates on the use of biofloc technology for sustainable shrimp farming. Risk assessment and management in aquaculture using new biotech tools were discussed by **Dr Joergen Schlundt**, Nanyang Technology University, Singapore. Here the mission is integrating new scientific developments for more efficient, safer and sustainable food production in Singapore and South-east Asia (more details in issue January/February 2019, p36).

"Marine by-products are sources of invaluable compounds such as functional hydrolysates," said **Fabio Soller**, Diana Aqua, Thailand, who presented on the manufacture and use of functional hydrolysates in shrimp and fish diets. Using results from trials with tuna hydrolysates, conducted in Jeju, Korea, Foller demonstrated how marine functional hydrolysates are valuable sources of soluble protein and bioactive peptides that cannot be found in traditional raw materials (more details in an article in issue January/February 2019, p25).

*Dr Rohana Subasinghe (left) and Jerry Jianguo Shi, Kona Bay*

## Industry 4.0 technologies

President of Indonesian Aquaculture Society, **Professor Rokhmin Dahuri** presented on "The application of industry 4.0 – based technology and a circular economy for a productive, efficient, inclusive, and sustainable aquaculture." Some non-conventional roles of aquaculture are production of algae-based feed, and pharmaceuticals and cosmetics products from bioactive compounds of microalgae, macroalgae (seaweed), and other aquatic organisms.

Rokhmin call for industry to apply "Industry 4.0 technologies" for a productive, efficient, competitive, inclusive, and environmentally sustainable aquaculture. His vision included, "Site selection for aquaculture using drones, big data and IoT; as well as using DNA sequencing and recombinant, nanotechnology, big data, and IoT to produce fast growing and top-quality SPF (specific pathogen free), SPR (specific pathogen resistance), broodstocks and onwards post larvae and automatic feeders with acoustic feedbacks for feeding fish and shrimp.

Rokhmin listed several examples of start-ups in Indonesia which include the following:

- Minapoli- an information network hub and fisheries business;
- efishery-smart technology that integrates the continuous feeding of shrimp;
- Iwa-ke-marketing applications for various fish such as red tilapia, catfish and gourami;
- JALA-shrimp farming solutions that offer the latest management system, with input of actual farm data to make the right management decisions;
- InFisha-help to search for fisheries investment capital that can have a social impact;
- Growpal-investment opportunities with promising profits in the fisheries and marine sector;
- Venambak-the transition of cultivation from traditional farmers to smart farmers.

## Development of offshore submersible cages in Asia

This is a presentation from PT Gani Arta Dwitunggal, manufacturer of the Aquatec brand of cage structures in Indonesia. This company has sold 15,000 units of cages within Indonesia and have also ventured to Singapore, Malaysia, Philippines, China, Taiwan, Maldives and Ghana. Andi Jayaprawira Sunadim, director, Aquatec division, described the recent work to develop submersible cages. He said, "Considering the extreme typhoon and storms commonly occurring in Asia, we think that there is a need for submersible cages that are able to withstand up to 9m waves, easy to operate, economical and with a fast-operating time.

After several tests since November 2016, the company has perfected the submerging process. It takes 5 minutes to open the valves and 5 minutes to auto submerge the cages, with two operators. The cage submerges equally on all sides and the net retains its shape perfectly underwater. The refloating process takes 10 minutes to float to the surface and the net can be lifted easily for cleaning. The 5th test in Hainan China in August 2017 was the first

*From left, Dr Firmansjah S, PT Central Proteinaprima, Muhamad Husen, and Dr Bambang Widigdo, Bogor University.*

real test against a typhoon. The 25m diameter cages in Hainan, China was in operation since April 2018 for the farming of the pompano. Andi showed a video demonstrating the operation of the cages. www.aquatecindonesia.com

*From left, Andi Jayaprawira; Dr Ketut Sugama and Thomas Dharmawan and sons*

*The Olmix team, Alexandre Veille (right) and Maarten Jay van Schoonhoven.*

## KJA session

This was a special session held to discuss the government's plans to ban/restrict floating aquaculture net cages (keramba jaring apung or KJA in the Indonesian language) in freshwater lakes and reservoirs. KJA farmers dispute claims that they pollute Indonesia's fresh water bodies. Their claims were supported by recent evaluations and field analyses by academicians from several universities, research institutes and the Indonesian Institute for Science. Results showed that on average, floating cage aquaculture contributes only 10% to the total pollutants. The rest came from municipal wastes, natural run off, and factories along rivers to the water bodies such as Cirata and Jatiluhur reservoirs, West Java and Lake Toba, North Sumatra. In addition, water quality deterioration, such as in Lake Maninjau, West Sumatra, is caused by natural volcanic activity.

Around 59,000 cage farming families are involved in this aquaculture business, with an annual production valued at IDR 875 billion (USD62.5 million, jogja.tribunnews.com). "A large part of the national production of freshwater fish is from this culture system. The disruption of KJA would have an impact not only on the economic sector of the community, but also national food security. Production from this sector is essential in order to achieve the targeted national fish consumption of 40kg/capita/year in 2019," said MAI's secretary general, Dr Agung Sudaryono. The sector has a large role in food security, (farming carps and tilapia) and foreign exchange. Indonesia is the world's leading exporter of tilapia after China.

A five-point petition was submitted to the President of the Republic of Indonesia. The policy of the central government is unclear. Some local governments banned KJA operations, others reduced the number of cage farms. The central and regional the governments have been asked to review the rules for limiting or eliminating KJA and to hold dialogues with KJA farmers.

Agung said, "We want the government to understand that cage farming is an important economic activity which the government should support and facilitate," He added that the government support may not be in the form of funds but can be in the form of regulations to ensure that floating cage farms are being operated sustainably. (Source: jogja.tribunnews.com; news.detik.com; ussec.org).


# Sustainable shrimp farming in Mexico

This is the largest shrimp event in Mexico organised by local producers in collaboration with the feed association.

The annual congress for the shrimp aquaculture industry in Mexico has been growing and CONACUA'18 had an attendance of more than 800 producers, mainly owners and technicians. Conacua'18 was held in Los Mochis, Sinaloa state in the northwest part of Mexico from November 29-30. Organisers were aquaculturists of Ahome, a district in Sinaloa (Acuacultores de Ahome A.C) together with CONAFAB, the Feed Producers Association in Mexico.

According to C. Luis R Campos González, president of Acuacultores de Ahome A.C, as shrimp farming faces production, health and marketing challenges, this gathering fulfilled the need to be at the forefront in technology and innovation and to have direct dealings with suppliers of goods and services.

Organisers lined up a series of presentations to fulfil this need – on the status of shrimp production and challenges in Mexico's leading producing states, Sinaloa and Sonora; the situation with early mortality syndrome/acute hepatopancreatic necrosis (EMS/AHPND) in Mexico and on marketing shrimp. Other presentations included global trends in shrimp farming as well as in Asia and Ecuador, to learn from experiences of industry in other regions for a strong and sustainable development of the industry in Mexico.

## Challenges in 2018

The Comité Estatal de Sanidad Acuícola de Sinaloa, A.C. or CESASIN has 9 diagnostic laboratories and 2 molecular diagnostic laboratories. In its presentation on industry trends in Sinaloa 2018, it reported that production was 43,615 tonnes using 5.4 billion post larvae. Production was higher than in 2017 at 35,487 tonnes. Stocking density in intensive, semi-intensive, and extensive systems ranged from a high of 72 post larvae (PL)/$m^2$, 11 PL/$m^2$ and 6.4PL/$m^2$, respectively. Data on disease outbreaks according to the 3 cycles/year showed that a total of 388 (50%) farms reported disease outbreaks in 2018. Only 174.95 tonnes were produced by intensive farms which the committee said will be the future for shrimp farming in Sinaloa.

The Comité de Sanidad Acuícola del Estado de Sonora A.C. reported production at 62,100 tonnes in 2018 with average sizes of 20.4g. The pathogens affecting farms in 2018 were white spot syndrome virus (WSSV), AHPND, infectious hypodermal and hematopoietic necrosis virus (IHHNV), necrotising hepatopancreatitis (NHP) as well as bacteriosis and water quality problems. The cycle in Sonora, starts in February as compared to March in Sinaloa. The average size of stocked post larvae was 279mg. Stocking density has changed, increasing to 18.8PL/$m^2$ as compared to 18.5/$m^2$ in 2017 but overall lower than in 2016, which was 19.6PL/$m^2$. Out of the 2.6 billion post larvae used, 67% of post larvae came from hatcheries in Sonora.

*Marcelo Costero (second right) and Juan Miguel Sanchez (right), Vimifos, with Heinz Grunauer (second left) and Regis Bador, IQuatic. Vimifos displayed the various feed types for the shrimp market; extruded feeds for 1g to 5g shrimp, special raceway for 50mg to 1g post larvae and for 5g to 15g shrimp and three ranges of pelleted feeds from 8g to harvest*

*The organisers; farmer members of Acuacultores de Ahome A.C; C. Luis R Campos González (second right), Ramsés A. Chávez Zazueta (third left) and Genaro Bernal Cruz, CONAFAB (centre). Chávez Zazueta's farm is featured in issue January/February 2018, p8-13.*

**Dr Sonia Araceli Soto Rodriguez**, Centre for Research in Food and Development A.C. in Mazatlán described the current status with AHPND in Mexico. In 2013, production in Mexico dropped to around 40,000 tonnes from more than 90,000 tonnes in 2012. Eight states in the Pacific coast and 4 in the Gulf of Mexico reported outbreaks. The virulence of the Mexican strain of *Vibrio haemolyticus* was compared with $VP_{AHPND}$ strains from affected countries. In 2013 and 2014, Soto Rodriguez said that different strains of VP showed different virulence and is dose dependent. Post infection, the mortality was 100% for strain M0904 but for strain M0607 mortality was 50% in 17 hours.

*Dr Sonia Araceli Soto Rodriguez; Dr George Chamberlain; Ronnie Tan*

**Dr George Chamberlain**, Global Aquaculture Alliance, gave his vision on global shrimp production. He said that the good news is that globally farmed shrimp production is growing at 6%/year, but prices were at their historic low in 2018. The hope in managing disease with iRNA is in progress with delivery systems. Chamberlain described the convergence with specific pathogen free (SPF) and specific pathogen resistance (SPR) programs as well as the development of genetic strains adapted to lower dietary levels of fish meal. Among the recent progress in shrimp farming performance quoted was the low feed conversion ratios (FCR) averaging 1.3 and average daily growth (ADG) at 0.2 to 0.25g. Chamberlain believes that the future will be with autofeeders, covered ponds for intensive culture systems such as in Peru, covering ponds and reuse of pond water such as with Camanor farms in Brazil using the same water for 5-cycles.

In his description on recent developments in Asia, **Ronnie Tan**, Malaysia detailed the Asian shrimp farming model along the value chain from genetics to sales and branding. Tan said, "Asian vannamei culture focuses on high stocking density in order to provide sufficient returns on the capital investment. This brings the risk of diseases ranging from WSSV to EMS/AHPND, *Enterocytozoon hepatopenaei* (EHP) and white faeces disease (WFS). While farmers have learnt to live with AHPND and lower survival rates, EHP is considered more damaging in terms of profitability. With the lower margins experienced by farmers due to weaker prices with the vannamei shrimp, many are turning to farm the monodon shrimp due to the interest and demand in China."

However, he added that, the monodon shrimp has a lower stocking density and longer culture cycle to reach the larger sizes in demand. At 2018 prices, the margins/kg for vannamei and monodon shrimp were USD1.26/kg and USD3.42/kg respectively. Industry in Asia is now working on improving the SPF genetics to build in more robustness. It is also looking at improving efficiency by measuring the tonnage produced per billion post larvae. Another trending issue is the emergence of independent nurseries as a stand-alone business producing juveniles (PL35) from PL10.

**David Kawahigashi**, Vannamei 101, presented on the worldwide use of synbiotics in shrimp farming, defined as when prebiotics+probiotics+fermentation comes together to form synbiotics, a "management tool" to stabilise water quality and pond bottoms to help control pathogenic disease outbreaks. He reported that the worldwide adoption of this farming method was attributed to reported success in farms. The system can raise the survival rate in ponds from 40% at days of culture (DOC 150) to 75%. Production recovery was demonstrated in several farms, such as those in Belize, India and Indonesia.

**Dr Peter Coutteau,** Business Unit Aquaculture, Adisseo/Nutriad International NV, in his presentation on functional feeds stressed that prevention is key for good farming practices. Curative treatments are costlier. He discussed the range of functional feed additives and said that these are integral in disease prevention and have roles as antimicrobials and gut modulators and are anti-parasitic. Broad spectrum functional feed additives are most effective under practical pond conditions with few single pathogens. However, the dose is dependent on disease pressure, feed intake, biomass and other factors. Biomin's **Benedict Standen** looked at the importance of pond management to ensure a clean environment and referred to the use of the shrimp toilet in Asian farms as examples. There are lots of choices for bioremediation of pond soil bottom said Standen. (see article in issue November/December 2018, p33-35).

*At the Skretting booth, from left, Daniel Fonseca, Aedrian Ortiz-Johnson, Jorge Gomez, Ocean Garden, Martín Téllez Castañeda and Herve Lucien-Brun.*

## Fulfilling market needs

Companies providing a range of supplies and services for shrimp and fish farming in Mexico were active at the 52-booth tradeshow. Leading post larvae and broodstock producer Fitmar was there as well as almost all shrimp feed producers and importers. Local feed company, Vimifos is a leader in Mexico's shrimp feed industry, comprising 2-3 local feed millers and several multinational feed producers such as Cargill and Neovia. The newest entrants to the shrimp feed market in Mexico are Peru-based Nicovita and Skretting. Both came in 2017 and Skretting focusses on the micro-extruded feed segment. Zeigler has a franchisee feed mill in Mexico where it provides technical assistance with formulations and premix and protein mix.

Marcelo Costero, commercial director, Vimifos, said that together, Vimifos and Cargill have 70% of the open market for shrimp feeds. Integrators with feed milling may hold 25% of the market share. Vimifos has two aquaculture research centres, in Guadalajara which specialises fish nutrition and the other in Cd Obregón, exclusively for shrimp nutrition. Both provide the possibility of evaluating diets, ingredients, technologies and trends in nutrition. Vimifos has aquafeed plants in Sonora, Guadalajara and Queretaro, producing feeds for tilapia, trout and shrimp. It has three lines for pelleted shrimp feeds. "For the shrimp, we produce feeds for the various culture systems. Our newest range, started in 2018, are extruded shrimp feeds from sizes 0.8mm to 1.5mm for raceways and as well as for the whole cycle. By September 2019, we will have a plant in Tabasco to produce only fish feeds, such as for the tilapia and marine fish," said Costero.

*(Left) Professor Simon Davies, Harper Adams University, UK presented on strategies to produce a robust shrimp via nutrition and novel additives. (Middle) David Kawahigashi. (Right) Benedict Standen*

At the Skretting booth, Aedrian Ortiz Johnson, technical support manager for marine hatchery feeds, based in Mexico, was marketing diets for post larvae. It also has Vitalis, a maturation diet. Out of Vietnam, Skretting also produces post larvae diet to match the needs of the hatchery industry in Vietnam. Regis Bador was promoting Cargill's digital platform iQuatic for aquaculture. The predictive software uses machine learning and sensors to give farmers real-time visibility into their farm operations. He reported that the team has been making progress in introducing digitalisation to farms and next, he will be working on digitalisation in nurseries.

FIRA, a strong supporter of Conacua'18 is a government linked bank which has been providing financing to the shrimp farming industry since the early 2000s. It is the leader in financing, offering information and support in business decision-making to producers, companies, technicians and financial intermediaries in agricultural, fishing, forestry sectors in Mexico (fira.com). To approve farm credits, it starts by investigating the social sustainability of the farm. "It is important to assess the sustainability of the farm as for example, during the EMS crisis in 2013, we got the small farms to link with large integrators," said Martín Téllez Castañeda, a specialist in the sub-directorate of fisheries, forestry and the environment at FIRA.


*At Zeigler/Nutrimar's booth, from left, Ramon Gonzalez, Adriana Armijo and Israel Lopez, Nutrimar; Dr Craig Browdy, Zeigler Feeds, USA and Fernando Baez, Nutrimar.*


*Dr Peter Coutteau (right) at the Adisseo Nutriad booth.*

## Growth of the industry in Mexico

In a 2019 article on perspectives on the industry in Mexico in El Economista (eleconomista.com.mx), **Martín Téllez Castañeda** said that production of shrimp (farmed and capture) in Mexico presents an average annual growth rate of 1.59% between 2008 and 2018, increasing from 196,300 to 229,800 tonnes, respectively. The industry resumed its dynamism from 2015 to 2018, after battling diseases in 2010 to 2014, presenting an average annual growth rate of 8.36%, with a record production estimated at 164,000 tonnes in 2018, compared to the 150,000 tonnes in 2017. Despite this important recovery in aquaculture production, Mexico's production is still modest at 2.5% of global production and 17.6% of production in the Americas, as reported by FAO in 2016. It has however a great potential, combined with the preference and differentiation of Mexican shrimp in the US market and with a very important and growing domestic market of 187,000 tonnes.

By 2019, total shrimp production in Mexico is forecasted to be 245,000 tonnes and an annual growth of 6.6%, of which 73% would come from farming. Regarding wholesale prices, medium shrimp was sold at MXN 137.37/kg (USD7.1/kg) in December 2018. In 2018 prices for the domestic market began to rise due to the increase in demand for the Lent season and summer holidays. In 2019 it is possible that prices are slightly lower than those observed in 2018. https://www.eleconomista.com.mx/opinion/Perspectivas-en-la-industria-del-cultivo-de-camaron-en-Mexico-II-20190214-0116.html

# Celebrating Asian Aquaculture

## Asian Aquaculture 2018 was the first in the series looking at the holistic role of technology in today's aquaculture in Asia.

The first in the Asian Aquaculture conference series was held at the Asian Institute of Technology (AIT) campus in Pathum Thani, Thailand from December 3-6, 2018. It was attended by around 200 participants from 25 countries; many of the attendees were alumni of AIT and who now hold distinguished careers in aquaculture or its related fields.

"AIT has a holistic yet Asian view of aquaculture technology," said conference organiser, **Dr Krishna R. Salin**, "Aquaculture development must not only focus on the long-term impacts of technology on the aquaculture industry but also on the social aspects, as aquaculture is about communities whose lives revolve around fish and shrimp farming. Aquaculture research is more than just increasing production; it is also about reducing pollution and waste, and optimising nutrition and health of our farmed stock and consumers."

*Dr Krishna R. Salin (left) is associate professor and program chair, Aquaculture and Aquatic Resources Management (AARM) at AIT. On second right is Veerasun. Prayotamornkul. Photo credit. JB Bernardo, AIT.*

## Food security, nutrition and AI

The conference had three keynote presentations: aquaculture for food security, utilising resources, and application of artificial intelligence (AI) in modern aquaculture. **Dr Miao Weimin**, aquaculture officer, FAO Regional Office for Asia and the Pacific, stressed that aquaculture development must aim for sustainability, and must contribute to food security and livelihood. He called for the establishment of more effective public services and infrastructure, so that industry, especially small scale farmers will be empowered, and will not be made to bear the high risks of crop failures and low profit margins. "Stronger support should be given to farmers in times of crop failures, and new technology should be used to improve profit margins," he said.

**Dr Sadashivam Kaushik**, European Research Area chair, Ecoaqua, University of Las Palmas, Spain gave a presentation on "Improving resource utilisation efficiency: key for sustainable aquaculture development". To produce dense protein-rich high energy aquafeeds, industry cannot rely just on a few ingredients, whether of aquatic or terrestrial origin. "But producing fish with fish is not sustainable either. There are concerted efforts to reduce the use of fish meal and oil in aquafeeds," said Kaushik. Aquaculture now competes for crop resources with livestock, the energy industry and direct human consumption, raising concerns on the impact of aquatic farming on global food resiliency.

On using finishing feeds to tailor the fatty acid profile of the cultured aquatic animal, he said that the practice still needs to be fine-tuned. Farmed fish are efficient converters of dietary protein and energy, but not all aquatic systems perform equally well. In terms of measuring environmental performance (for example land and water, eutrophication potential, greenhouse gas emissions) aquaculture performs better than livestock production on land. He stressed, however, that there is still room for improvement in terms of resource use and efficiency.

**Dr Farshad Shishehchian**, CEO and president, Blue Aqua International Co. Ltd., Singapore discussed running a farm equipped with artificial intelligence (AI) technology. The double storey, Blue Aqua Smart Farm is on a 1.6ha site in Singapore, and is fully automated and uses AI. The farm utilises mostly solar energy, with much of the work carried out by robots. Culture tanks are tall-4m height, and the farm aims for a production of 50-100kg/m$^3$, using zero water exchange. A challenge is to train staff to run the AI system efficiently. Blue Aqua is also continuously incorporating intricate functions into its AI system to enable it to understand and perform more effectively the complex systems in the farm.


*The conference program included a farm tour to a shrimp farm in Nakhon Nayok Province*

## Advances in aquaculture husbandry and management

With regards to global tilapia production and markets, **Dr Kevin Fitzimmons**, University of Arizona, US, said, "World tilapia production grew to 6,510,700 tonnes in 2017. I predict that global production will continue to increase at a relatively steady rate of 6-7% per year, and by 2028 the estimated production is expected to be 9 million tonnes". Globally, tilapia production continues to expand, with China ranked as the largest producer, consumer and exporter. Indonesia and Egypt are also important producers; Bangladesh has also risen from the ranks, producing 300,000 tonnes in 2018, without decreasing the production of other fish species. "India has finally allowed the culture of tilapia, and the production there is expected to expand in the coming years," added Fitzimmons. In Vietnam, tilapia consumption is rising quickly but demand for tilapia in the US and Europe is falling due to adverse statements made largely in social media on its nutritional status, ranking it worse than bacon. Tilapia skin has also found new uses as fish leather for clothes, shoes, chairs and flowers.

*Dr Kevin Fitzimmons (left) predicted that by 2028, global tilapia production will rise to 9 million tonnes. Photo credit. JB Bernardo, AIT.*

**Dr Malasari Khumsri**, Department of Fisheries, Bangkok, Thailand presented on the pilot application of an ecological carrying capacity assessment tool for tilapia cage culture in Noi River, Chinat Province, Thailand. "Nile tilapia *Oreochromis niloticus* is the most farmed species in Thailand but its rapid expansion over the last decade has given rise to fears that the farming system used is not sustainable and may have exceeded the carrying capacity of the culture site," said Malasari, when detailing lessons learnt on the use of the ecological carrying capacity assessment (ECCA) tool developed by a FAO consultant.

The ECCA tool uses a Legovic Box Model which requires the input of both primary and secondary data. The primary data used included: phosphorous (P) and nitrogen (N) amounts entering the water body; water exchange in the Noi River; number of cages in the river; sampling design for water quality; water quality data; feed sampling and feed data; household survey; and tilapia production data. The secondary data collected were: boundaries of catchment area; water flow from the dam sites into the river; annual rainfall for Chinat Province; human population within the catchment area; agriculture production and estimation of land use in the catchment area. She pointed out that the use of the ECCA tool is relatively simple as it is based only on the P and N levels. "As a linear model, we have some doubts on whether it can handle very complex situations and therefore may require adjustments for use in Thailand. We have five species of fish cultured in the Noi River. How can the ECCA tool be used in this multi-species situation? There are two distinct seasons in the Chinat Province; should assessment be carried out separately during the two seasons?"

## Advances in aquaculture nutrition

The roles of antioxidants in aquatic animals and their application in aquafeed were discussed by **Professor Yew-Hu Chien**, National Taiwan Ocean University, Taiwan. He started his presentation with a lecture on stress, reactive oxygen species (ROS), antioxidants defence against ROS, and resistance to stress. He followed up with a hypothesis that through evolution, aquatic animals may have to develop a more efficient antioxidant defensive system than terrestrial animals to counter more oxidative stress in the aquatic environment. This is because of the relative disadvantage of aquatic animals to conduct aerobic metabolism over terrestrial animals.

"Aquatic animals have extremely poor accessibility to oxygen in comparison with terrestrial animals. In water, dissolved oxygen (DO) is less than 10ppm whereas in air, oxygen makes up 20% of the atmosphere," said Chien. There is poor utilisation of carbohydrates for energy in aquatic organisms. "When exposed to ROS, there is a high risk of lipid peroxidation in feeds. Therefore, we need to increase antioxidant levels of aquafeeds, so that farmed aquatic animals can increase their antioxidant capacity through nutritional and dietary enhancements."

Professor **Wing-Keong Ng**, Universiti Sains Malaysia, said that organic acids are potential substitutes for antibiotic growth promoters in aquafeeds. These include short-chain fatty acids (C1-C7), volatile fatty acids and weak carboxylic acids. Organic acids used in fish feeds include formic acid salts, lactic acid salts, malic acid and butyric acid. Trials on *Penaeus monodon* shrimp carried out in collaboration with commercial feed companies and farms showed that organic mixtures can be used to control pathogenic bacteria and molds in aquafeeds thereby extending the shelf-life and safety of these feeds. The right type and level of dietary organic acids can have a positive impact on fish and shrimp growth. This is through improving nutrient utilisation efficiency, reducing microbial loads in aquatic environments, improving water quality and reducing spread of diseases. They are also beneficial in recirculation systems.

*Professor Wing-Keong Ng discussed organic acids as potential substitutes for antibiotic growth promoters in aquafeeds. Photo credit. JB Bernardo, AIT.*

*Pelleted feed prepared with squid ink presented at the trade show.*

Ynsect, France has selected the mealworm *Tenebrio molitor* for its insect meal production because the mealworm is gregarious, nocturnal and has high protein content at nearly 55% (dry matter basis). **Dr Guillaume Daoulas** said that the company has a long farming history globally. Its insect meal is used in petfood and for human consumption in some countries. "When mealworms reach maturity, we process 95% of them and the remaining 5% is kept to reproduce for the next generation. In this way, we do not need to depend on outside sources for starter stock."

The vertical insect farm is automated and equipped with the latest patented technology, where embedded sensors are able to collect

*This is the farm in Nakhon Nayok Province where Veerasun Prayotamornkul uses aquamimicry to culture L. vannamei.*

data and control conditions such as humidity and temperature. Mealworms are automatically fed and cleaned; the system also collects mature larvae and eliminates castings to ensure hygiene and homogeneity of life stages. The farm produces meal and oils: Premium YnMeal™ and YnOil™. Farm trials on juvenile *L. vannamei* showed that the inclusion of the meal improves shrimp's resistance against EMS and trials with juvenile rainbow trout *Onchorynchus mykiss* showed better growth by up to 30%.

## Aquamimicry in aquaculture: updated results and success stories

For sustainable aquaculture, **Veerasun Prayotamornkul**, Thai Organic Shrimp Group, Thailand, and **Glen Cho**, Amishrimp South Korea, discussed successes with aquamimcry in aquaculture. Aquamimicry is defined as the intersection of aquatic biology and technology synergistically working together in mimicking the nature of aquatic ecosystems to create living organisms for the wellbeing and development of aquatic animals. Veerasun shared his experiences at his outdoor Lom Rak Organic Farm in Nakhon Nayok Province where he cultures the white shrimp *L. vannamei*.

He said that his pond conditions mimic that of the estuary; water in his ponds have constant pH and a high oxidation reduction potential (ORP). He stressed the importance of rejuvenating the soil at the pond bottom and managing the culture system using biodynamics as guidelines. Salinity of his culture ponds is 2ppt, and he does not use any chemicals (antibiotics and disinfectants) in his farm. Prior to stocking his ponds with post larvae (PL8), he first cultures live feed (mixture of rotifers, copepods and daphnia) in the ponds using fermented rice bran as feed. The young shrimp are fed with live feed for 3-4 weeks, before they are fed a pelleted feed. Shrimp are harvested after 70 days of culture (DOC 70), and he manages four crops/year from each of his pond. Survival rate averages 87% with a feed conversion ratio of 1.034: 1. Harvest size averaged 13g with76 pieces/kg. So far, he has not encountered any disease problems in his farm.

Dr Glen Cho highlighted the success of his aquamimicry indoor super intensive shrimp *L. vannamei* organic farming system in South Korea. His farm also uses fermented rice bran, which helps in water management and enhances the growth of live feed along with the shrimp. With the use of live feed in the initial stage of culture, use of formulated feed is reduced by 20-30% compared to the conventional culture method. According to Cho, his restaurant customers liked his shrimp and say that they taste better than king crabs.

## Special farmers' forum on shrimp farming

In this special session, the panel comprised **Dr U. Win Latt**, **Dr Chalor Limsuwan** and **Veerasun Prayotamornkul**. Limsuwan started the session with a presentation on the status of white faeces syndrome (WFS) disease in Thailand. WFS is currently, the most serious disease in China, Vietnam, Malaysia, Indonesia, India and Thailand. "WFS is found everywhere, regardless of the farm location, pond water salinity, stocking density and farm management. Losses in farm production are high." Prior to infection with WFS, stocked post larvae have gregarine-like aggregated transformed microvilli (ATM) in the hepatopancreas. Limsuwan said that ATM is the main cause of problems with WFS and in turn, the suspicion is feed quality. "Today, shrimp feed in Thailand only has 5-8% protein and most of protein source is SBM. SBM has anti-nutritional factors (ANFs) which damage microvilli". To decrease the effects of ANFs in SBM, he suggested fermentation of SBM with bacteria such as *Lactobacillus* and *Bacillus spp*. Fermentation reduces these ANFs- lectins, oligosaccharides, and β-conglycinin to a safe level. But there are conditions such as ensuring that the bacteria used are of pure strains and that fermented SBM does not totally replace the fish meal. He added that currently, some farmers add probiotics to the feed.

During the question and answer session which followed, participants sought further clarification on the application of aquamimicry in shrimp farming. On the preparation of fermented rice bran (FRB) prepared in aquamimicry shrimp farming, Veerasun

*The panel at the farmer's session on shrimp farming; from left; Dr Chalor Limsuwan, Dr U. Win Latt, and Veerasun Prayotamornkul. Photo credit. JB Bernardo, AIT.*

*Murat Yigit and Thierry Chopin. Yigit discussed risk to humans, trace metals in fish and mussels from copper alloy mesh cage system and Chopin presented on integrated multi-trophic aquaculture (IMTA). Photo credit. JB Bernardo, AIT.*

explained that in Thailand, polished rice bran is used and care must be taken to make sure it is not rancid. The rice bran is first ground to a fine powder and then sieved through a 100 mesh filter bag. It is then added to water at a ratio of 1: 5 (ground rice bran: water). If fresh water is used, 1-3% of salt is added to the mixture. *Bacillus* probiotics or hydrolytic enzymes are then added and the mixture is aerated and allowed to soak for 24 hours, after which it is ready to be applied to shrimp culture ponds. After soaking for 24 hours, the pH of FRB can decrease to 3.2-3.8, and sodium bicarbonate (about 10%) is used to buffer this mixture. FRB pH is maintained at around 6.5-7.5. Copepods will bloom within 2 weeks; depending on the water source, water temperature and pond management protocol, the copepod bloom may form as early as 2 days.

Another question was on problems with disease in aquamimicry shrimp ponds. The answer was that so far, disease has never been a problem, and the aquamimicry system has been in operation for 10 years now. "WSSV for example cannot live freely in water for more than 7 days. If one pond has WSSV in the aquamimicry farm, the water from the infected pond is pumped into an empty pond. The virus in the pond can then be eradicated by raising the temperature of the pond water to 32°C for up to 2 weeks," said Veerasun.

With regards to shrimp farming in India, Veerasun is of the opinion that most farms in India do not have enough aerators in their ponds. He said that installing 1 HP aerator can take care of 440kg of shrimp if the pond bottom is clean. Veerasun emphasised, "Farmers in India should give more attention to ensure that healthy post larvae are used in the farms."

If soybean meal (SBM) has disadvantages such as palatability and ANFs, why use them in aquaculture? The response was that SBM continues to be used despite the above because of its high protein content, favourable amino acid profile, comparatively low price and widespread availability. Fermenting SBM can, however, reduce or eliminate the anti-nutritional components of the meal while enhancing protein content, and improving protein absorption and feed intake.

On whether EMS is still a serious disease in Thailand, Limsuwan replied, "EMS is still prevalent in Thailand but WFS has now become the most serious problem." Twenty years ago, WFS was reported in cultured *P. monodon*, but this problem was overcome by providing more aeration to the diseased pond. But presently with *L. vannamei*, this solution did not work.

On the type of probiotics recommended for use in aquamimicry shrimp farming, the type of probiotics selected must be able to control the *Vibrio* population, and must be able to produce hemicellulose, lipase and phytase. It is important also to check for the presence of bacteria in the feed trays every day.

# ONE: The Alltech Ideas Conference

**Alltech** announced that its annual ONE: The Alltech Ideas Conference ((ONE19) will feature species sessions with global perspective on the agriculture industry. ONE19 will be held on May 19–21 in Lexington, Kentucky, USA and will bring together producers and industry experts from around the world to share insights and solutions to today's most pressing issues within the global agriculture industry.

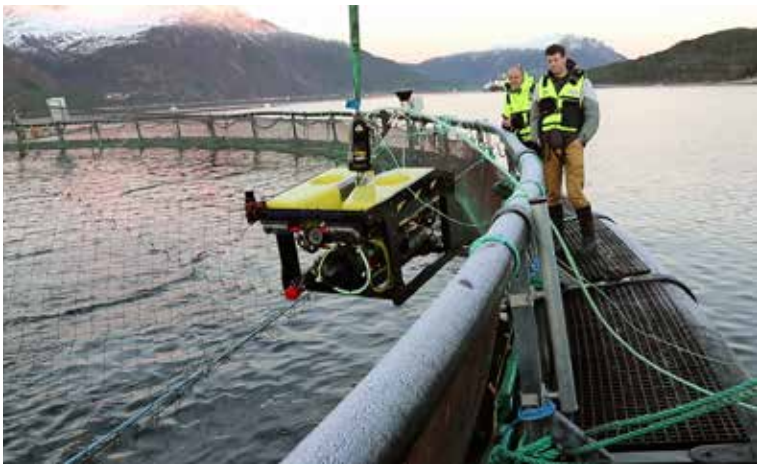
Alltech invites everyday heroes united by the search for inspiration, motivation and ONE meaningful idea are invited to explore over 60 topics slated for discussion. The conference will feature agriculture focus sessions including topics in areas such as for the beef, dairy, poultry, pig and aquaculture. Presentations in the aquaculture session will include:

- SalmoSim: Building a Salmon Gut from Scratch by Raminta Kazlauskaite, PhD researcher, University of Glasgow and Dr Martin Llewellyn, research scientist, University of Glasgow
- Digi-Fish: The Future of Aquaculture Aidan Connolly, CEO and president, Cainthus
- New Diets, New Solutions by Dr Katerina Kousoulaki, senior researcher, Nofima AS
- There are Plenty of Fish in the Sea...Right? by Frits Berkers, manager of the Alltech Coppens Aqua Centre, Alltech Coppens
- RAS Systems: The Perfect Environment for Fish by Roy Charsley, CEO, Dunkeld Trout Hatcheries (Pty) Ltd

Other focus sessions include business, the future of food, brewing and distilling, and lifestyle sessions focused on pet, equine, and health and wellness. Keynote speakers who will anchor plenary sessions include Bear Grylls and Chris Zook. Grylls, one of the most recognised faces of survival and outdoor adventure, will take the ONE19 mainstage. Grylls starred in seven seasons of the Discovery Channel's Emmy Award-nominated "Man vs Wild" television series, which became one of the most watched shows on the planet. Joining the line-up is Chris Zook, best-selling author of books on leadership and business strategy and an advisory partner at the renowned consulting firm Bain & Company. Zook specializes in guiding companies to find new sources of profitable growth and renew themselves internally to become more adaptive and entrepreneurial.

Now in its 35th year, Alltech's conference is attended annually by nearly 4,000 people from over 70 countries. one.alltech.com

# Proof on underwater robotics tracking capability in aquaculture trial



Joint trials by Norwegian research institute **SINTEF Ocean** and marine resource technology company **Sonardyne International Ltd**. have proven the ability for an acoustic positioning system to track underwater robots as they move through industrial-scale fish pens. Being able to accurately track remotely operated vehicles (ROVs) in aquaculture operations, including cage and mooring inspection and removing perished fish, will help operators to increase efficiency and productivity and reduce the need for divers.

Until now, there has been a misperception that acoustic tracking systems do not work in fish farm applications, due to the volume and density of fish within the pens or cages. Fish have an air-filled swim bladder that helps them regulate their buoyancy and this organ can interfere with the transmission and reception of acoustic signals from the surface to an ROV. In a farm with up to 200,000 fish in any cage, it has been thought that this could pose significant challenges for some acoustic based systems.

In the trials, at the Korsneset SINTEF ACE site near Trondheim, Norway, a Micro-Ranger 2 Ultra-Short BaseLine (USBL) positioning system was used to track an Argus Mini ROV through a pen containing an estimated 150,000-200,000 salmon. Micro-Ranger 2 is Sonardyne's latest USBL positioning system, designed for users with no previous experience of USBL equipment. It features a small acoustic transceiver deployed from a vessel or pontoon and an acoustic transponder attached to the ROV. Micro-Ranger 2 uses Sonardyne's Wideband 2 acoustic signals combined with highly sensitive receivers, which can detect the unique acoustic signals, even in challenging acoustic environments.

Elizabeth Paull, Business Development manager at Sonardyne, said, "The demonstration, with SINTEF, showed that our systems function to their usual high standards in low to medium fish densities, both inside and outside of the cage, with the ROV being tracked consistently and accurately. When tracking the ROV through the highest density of fish, the frequency of position updates did decrease, but, the positioning of the ROV was still accurate when acoustic paths were available. And, by moving the ROV away from the net, the frequency of updates could be improved.

"These positive results mean that those in the aquaculture industry can now use Micro-Ranger 2 for ROV tracking, knowing that the system will track even with high densities of fish," added Paull. "This means that items of interest, such as holes or tears in the net, can be located and then relocated quickly and easily, reducing the time needed to make repairs." www.sonardyne.com

# A first in Malaysia, Next-Gen Sequencing

**GeneSeq** is a new subsidiary of Lab-Ind Resource (LIR Biotech) and is the first company in Malaysia to employ the latest molecular technology, Next-Gen Sequencing (NGS), in the food and agriculture industry in Malaysia.

*NGS sequencer Illumina's iSeq100 at the GeneSeq laboratory*

This technology allows for the identification of hundreds and potentially thousands of different species (plants/herbs/animals) within a sample. This technology, along with the team of highly trained scientists, makes it possible for comprehensive detection, monitoring, and screening with a quick turn-around time to be conducted. The data generated through NGS will provide companies with the power to make better informed decisions to meet the necessary manufacturing, regulatory and safety guidelines.

"In aquaculture, NGS can be applied to hatcheries. Changes in the microbiome of the water due either to the presence of potentially pathogenic bacteria or other contaminants can be detected. This provides a comprehensive disease prevention and disease detection method for aquaculture producers," said Josiah Liew, Business Development associate at LIR Biotech.

LIR Biotech is a dynamic biotechnology company based in Bukit Beruntung, Selangor. It houses an ISO 17025:2017 accredited laboratory that specialises in nucleic acid (DNA/RNA) testing and molecular methodologies, including conventional PCR and RT-PCR. LIR Biotech is the market leader in molecular testing for the aquaculture industry in Malaysia. Through their commitment to excellence, the team at LIR Biotech has worked on multiple development projects all around South and South East Asia. In 2018, LIR was named as the first certified partner laboratory for CEVA Sante Animale in Asia.
www.mylabind.wixsite.com/labtesting2u

# Team to accelerate global market development

**Veramaris** has completed the hiring process for its global business development team. Six seasoned professionals have recently joined Dutch-based firm Veramaris to accelerate the launch of its natural marine algal oil rich in the two essential omega-3 fatty acids EPA and DHA for sustainable animal nutrition. They are experienced in aquaculture, human nutrition, and stakeholder dialogues across the value chain:


Karim Kumaly


Ian Carr


Lalen Dogan

- Ian Carr, Global Business Development Director
- Lalen Dogan, Asia Pacific Business Development Director
- Gaelle Husser, Global Business Development Director
- Christian Martin, Global Business Development Director
- Steven Severino, New Business Development Director
- Jorge Torres, Latin America Business Development Director

The new team will strengthen the market position and roll-out of Veramaris' natural marine algal oil, globally. "I am looking forward to working with our highly committed and experienced talents on solving the global challenge of reconciling economic growth with the urgent need to conserve finite natural resources. Collaborating with partners along the value chain, we will together do our best to support the sustainability of aquaculture, to provide healthy and nutritious food for all", said Karim Kurmaly, CEO at Veramaris.

Veramaris produces its natural marine algal oil at three sites on two continents, North America and Europe. The third and largest facility in Blair, Nebraska, is currently under construction and expected to come on stream mid-2019 to supply commercial quantities of algal oil. Veramaris' highly concentrated algal oil will, enable the aquaculture industry to keep up with the increasing demand for omega-3 fatty acids EPA and DHA, and reduce its dependence on fish oil obtained from wild fish stocks. www.veramaris.com

# Global conference for recirculating aquaculture systems

Leading RAS experts from around the world are speaking at RAStech 2019, the premier conference for recirculating aquaculture systems, to be held on May 13-14 in Washington, D.C., USA.

Formerly the International Conference on Recirculating Aquaculture, RAStech 2019 features a line-up of education sessions designed to provide the latest in RAS research, technology development, best practices and implementation. "Whether you are a current user of RAS technology or considering implementing a RAS project, or even thinking about investing in this market, you will find this event very relevant to you," said David Kuhn, associate professor in the aquaculture research and extension programs, department of food science and technology at Virginia Tech.

RAStech is jointly hosted by Annex Business Media, publishers of Hatchery International and RAStech magazine, and Virginia Tech. Oxygen Solutions and Veolia Water Technologies are the platinum sponsors.

"We are working with different associations and organizations in the aquaculture industry to develop the education sessions and ensure that we continue to provide a high quality education conference for our attendees," Kuhn added.

Innovation is vital to the growth and success of recirculating aquaculture systems. RAStech 2019 features education sessions that highlight the latest innovations and case studies in RAS engineering, aquaponics, fish health management, biosecurity, and energy management. Plus, some great sessions on raising marine species in RAS environments, RAS feeds management and much more.

This international event also features a tradeshow showcasing the latest in RAS products and services from around the world, providing attendees a first-hand look at new technologies that can help boost their RAS projects. With two full days of learning and networking, RAStech 2019 is an international aquaculture conference not to be missed. Registration is limited to just 250 attendees. www.ras-tec.com

# Commercial scale insect protein factory in Vietnam

**Entobel**, a pioneer biotech company specialising in insect-based feed, established its production activities in Vietnam in 2013. After more than five years of R&D, the two Belgian co-founders Alexandre de Caters and Gaetan Crielaard have officially announced that Entobel has raised €1 million in funding. Strategic local investors, as well as Western European investors, took part in this round of funding which will allow Entobel to build its first commercial-scale insect protein factory in Vietnam and prepare for global expansion.

The commercial factory in Vietnam with a capacity of 1,000 tonnes H-Meal/year. Entobel's H-Meal is a 60% protein ingredient made from insect larvae (*Hermetia illucens*) and has been proven to be a great alternative to fishmeal. Trials have been performed with H-Meal to feed shrimp and several fish species including snakehead and tilapia.

The semi-automated factory will be ISO22000 and GMP certified. The first commercial batches will be available by mid-2019 and full capacity will be reached by end 2019. Entobel products complies with EU standards regarding insect feedstock, sourcing only traceable plant-based by-products. More than one hundred raw materials were tested at Entobel's pilot site in order to determine the most efficient and cost-effective insect diet.

De Caters and Crielaard foresee a bright future for Entobel and believe in the outstanding metrics of the newly built factory. Demand for an alternative protein is significant and keeps increasing day by day as the feed industry aims to become more sustainable. Next will be a 10,000 tonnes H-Meal factory in Vietnam in 2020 and prepare for expansion to other countries in Southeast Asia and Latin America. The biotech company is globally well positioned to become a major stakeholder in the insect protein industry thanks to its low capex and opex model. A research centre will also be established to improve insect rearing and processing technologies. To achieve this ambitious goal, Entobel continues looking for strategic partners and investors. www.entobel.com

# Meeting the booming demand in insect processing

**Bühler Insect Technology Solutions**, a pioneering provider of integrated solutions for insect rearing and processing, will join focus with **Alfa Laval**, a world leader in heat transfer, separation and fluid handling. Together, they will offer advanced modular insect plant solutions to the booming insect industry. An increased focus on sustainability are strong drivers for the emerging insect industry which reported over USD 300 million of investments in 2018.

Andreas Aepli, CEO Bühler Insect Technology Solutions, and Sumit Pingle, vice president Agro & Protein Systems at Alfa Laval, signed the exclusive partnership on in February. Aepli said, "In Alfa Laval we are proud to have found a partner who shares our approach and vision in this exciting new industry. Thanks to this collaboration, we can further increase the efficiency and reliability of our solutions, setting high standards for the industry right from the start." Pingle added, "With the combined offering, we are in a unique position to provide the best insect processing solution in the market with unmatched product quality and safety."

Bühler Insect Technology Solutions and Alfa Laval aim to leverage each company's technology capabilities, engineering know-how and market access. The two companies have jointly developed tailored solutions for heat transfer, solid and lipid separation, and fluid transfer that can be integrated seamlessly into modular insect plant solutions. These highly flexible solutions allow insect producers to easily ramp up production as demand increases. The products will be offered exclusively through Bühler Insect Technology Solutions.

*At the signing ceremony, Andreas Aepli and Sumit Pingle.*

The two companies will also cooperate on further R&D, marketing and after-sales services. Nish Patel, president of Alfa Laval's Food & Water Division, said, "We are looking forward to bringing our expertise from other applications to this dynamic new market. The collaboration with Bühler allows us to combine our proven technology with a complete, integrated solution – and serve the customers better than either of us could on our own." Dieter Voegtli, president of the global sales and service organisation at Bühler Group, added, "With installation works for the first industrial-scale insect plant in Europe nearing completion, we will soon have an operating proof point of the viability of our insect process technology in an industrial setting." www.buhlergroup.com

# A place in the 2019 Global Cleantech 100

Out of over 13,000 innovators from over 90 countries, **Calysta**, an innovator in sustainable products to improve worldwide food security, was named by Cleantech Group in the prestigious 2019 Global Cleantech 100. The Global Cleantech 100 is an annual guide to the leading companies and themes in sustainable innovation. It features the private, independent, for-profit companies best positioned to solve tomorrow's clean technology challenges. This year marks the 10th edition of the list.

"Calysta is honoured to be named to the 2019 Global Cleantech 100, recognising our development of FeedKind® protein as an innovative, sustainable feed for fish, pets and livestock," said Alan Shaw, PhD., Calysta president and CEO. "FeedKind is the first scalable alternative protein requiring no wild caught fish or agricultural land, contributing to global food security."

The list combines Cleantech Group's research data with qualitative judgements from nominations and insight from a global 87-member expert panel comprised of leading investors and experts from corporations and industrials active in technology and innovation scouting. From pioneers and veterans to new entrants, the expert panel broadly represents the global cleantech community and results in a list with a powerful base of respect and support from many important players within the cleantech innovation ecosystem. The list is sponsored by Chubb.

"Our tenth edition is dominated by innovations for the future of food and mobility, and a decentralised and digitised future not only for energy, but for the industrial world more generally," said Richard Youngman, CEO, Cleantech Group. "This is a far cry from the dominance of hardware, solar and biofuels in the inaugural Global Cleantech 100 in 2009." www.cleantech.com

# Aquaculture for Health, Wealth and Happiness

*Shri Tarun Shridhar*

*Dr Theng Dar Teng*

**Plenary Speakers at APA'19**

The Asian Pacific Chapter of the World Aquaculture Society (APC-WAS) together with the Tamil Nadu Dr J. Jayalalithaa Fisheries University (TNJFU) is organising the Asian Pacific Aquaculture 2019 conference and trade show (APA19) at the Chennai Trade Centre (CTC), Chennai, India from June 19 to 21, 2019. The first plenary speaker will be **Theng Dar Teng**, His Excellency Ambassador to the Sultanate of Oman. The second plenary speaker will be **Shri Tarun Shridhar**, IAS, Secretary to the Department of Animal Husbandry, Dairy and Fisheries in the Union Ministry of Agriculture and Farmers Welfare, India.

Teng will introduce the conference theme "Aquaculture for Health, Wealth and Happiness" with a global scenario of aquaculture and its outlook in 2030 to all APA'19 participants. Teng is a well-known public and private sector figure in Singapore and the ASEAN region, and since 2008, he has been serving as Singapore's Non-Resident Ambassador to the Sultanate of Oman.

With a focus on aquaculture, hi-tech farming, and food technology, Teng is also serving as the adviser on Southeast Asian affairs to the Shizuoka Prefecture, and global business advisor to the Miyagi Prefecture in Japan. Teng is the distinguished adviser to the School of Applied Science, Temasek Polytechnic to support research, innovation and enterprise (RIE) initiatives in aquaculture.

**Shri Tarun Shridhar** will highlight the potential of Indian aquaculture production and its exemplary performance towards the blue revolution target of the country. He handles affairs of government, which involves the framing and implementation of policy in consultation with the concerned minister of the country. Shri Tarun Shridhar also had a chequered career as joint secretary (Fisheries) in the Union Ministry of Agriculture and Farmers Welfare from 2008 to 2013. He was instrumental in introducing specific pathogen free vannamei shrimp culture in India making the country a major global producer. More information at www.was.org for conference/www.marevent.com for the trade show.

# ISTA 12

The Twelfth International Symposium on Tilapia in Aquaculture will be held in conjunction with the upcoming APA 2019 held from June 19-21. ISTA 12 will include sessions on tilapia genetics and breeding, heath and disease, production systems, nutrition, processing and marketing, and country reports. The technical events will be accompanied by social events including a dinner and a contest encouraging local eateries to compete with their best tilapia dishes and voted by the attendees. Press and social media will be used to widely circulate information on ISTA meetings and tilapia farming and consumption in India and abroad.

ISTA meetings are convened every three years at different locations around the world. These symposia are organised by an international coordinating committee and then hosted by a local committee. It is expected that the speakers will be from more than 40 countries, as in previous ISTA events. The last ISTA was held in Surabaya, Indonesia.

Abstracts for ISTA 12 can be submitted at
https://www.was.org/meetings/default.aspx?code=APA2019
Register at:
https://www.was.org/meetings/default.aspx?code=APA2019 .

# Aqua Culture Asia Pacific in *2019*

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| **Industry Review** *Developments, outlook, demand & supply* | Aqua Feed Production | Tilapia | Functional Feeds | Catfish & Freshwater Fish |
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# NordicRAS back to back with Aquaculture Europe 2019

The European Aquaculture Society and NordicRAS have made an agreement to hold their events in conjunction with each other at the Estrel Hotel and Congress Centre in Berlin in October. The 5th NordicRAS workshop will be held on Monday October 7 and Tuesday 8 morning, leading directly into Aquaculture Europe 2019 (AE2019), which starts on the evening of the October 7, and end on October 10. The RAS sessions of AE2019 will start from the October 8 to avoid crossover and allow NordicRAS attendees to participate in AE2019.

The underlying idea is to have a strong focus on RAS in a hosting country where it is a key strategical development objective. For participants, this would allow to attend both events and hence save time and travel. Those taking part in both events will also have a discounted registration fee.

The aims of the Nordic Network on Recirculating Aquaculture Systems are to coordinate and strengthen research and development of recirculating aquaculture systems (RAS) in Nordic countries. The network welcomes all with an interest in recirculating aquaculture systems, including interested parties outside the Nordic Countries.

AE2019 takes the theme "Our Future - Growing from Water." AE2019 covers the full scope and diversity of European aquaculture. The thematic plenary and technical parallel sessions will comprise submitted oral and poster presentations. AE2019 will also feature an international trade exhibition, industry forums, student sessions and activities, satellite workshops and updates on EU research. www.nordicras.net and www.aquaeas.eu

**AE2019 contacts**

Conference: ae2019@aquaeas.eu | Registration: worldaqua@was.org | Booths/Sponsors: mario@marevent.com

# 4th Annual Practical Short Course on Extruded Pet Foods and Treats

## July 8-11, 2019, Texas A&M, USA

This 3-day Practical Short Course on Extruded Pet Foods and Treats will be presented in July 8-11, 2019 at Texas A&M University by staff, industry representatives, and consultants. The program will cover information on material handling, preconditioning, extrusion of pet foods, extruded and non-extruded treats, raw material, extrusion hardware, automation, product analysis, meat handling in pet food, drying, cooling and enrobing, food safety, pet food and treat shelf life, and trouble shooting. Practical demonstration of pet food and treats on single and twin screw extruders. Reservations are accepted on a first-come basis.

More information: https://perdc.tamu.edu/event/extruded-pet-foods-and-treats-short-course/ or contact: Dr Mian N. Riaz, Email: mnriaz@tamu.edu

# Shrimp Pathology Short Course 2019

## June 10-15, 2019, Aquaculture Pathology Laboratory, University of Arizona, USA

The Aquaculture Pathology Laboratory at the University of Arizona will be hosting the annual Shrimp Pathology Short Course from June 10-15, 2019. It will be held at the Aquaculture Pathology Laboratory, University of Arizona, Tuscon, Arizona. In 2018, the course covered the following:

- Major shrimp diseases listed by World Animal Health Organisation (OIE); Methods of disease prevention and/or treatment and development of biosecurity and quarantine protocols.
- Laboratory and demonstrations will include sample preparations for histology and PCR; PCR/RT-PCR for diagnosis of WSSV, AHPND, EHP, TSV; qPCR/qRT-PCR for diagnosis of WSSV, AHPND, TSV; Laboratory bioassay, and AHPND; review of histopathology of viral and bacterial diseases.

Contact program coordinator Patty Marinez for the short course application: pmarinez@email.arizona.edu

# 2019

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 7-11
**Aquaculture 2019**
**New Orleans, Louisiana USA**
www.was.org

### March 13-15
**VIV Asia 2019**
**Bangkok, Thailand**
www.vivasia.nl

### March 12-14
**Annual Seminar on Marine Science and Aquaculture (ICOMSA2019)**
**Kota Kinabalu, Sabah, Malaysia**
www.ums.edu.my/ipmbv2/icomsa/

### April 8-12
**12th Asian Fisheries & Aquaculture Forum (12AFAF)**
**Iloilo City, Philippines**
www.asianfisheriessociety.org

### May 7-9
**Seafood Expo Global 2019**
**Brussels, Belgium**
www.seafoodexpo.com

### May 13–14
**RASTECH**
**Washington, DC, USA**
www.RAS-tec.com

### June 19-22
**Asian-Pacific Aquaculture 2019**
**Chennai, India**
www.was.org

### June 26-28
**Aquaculture Philippines 2019**
**Pasay City, Metro Manila**
www.livestockphilippines.com

### August 14-15
**TARS 2019: Aquafeeds**
**Bali, Indonesia**
www.tarsaquaculture.com

### August 29-31
**Vietfish 2019**
**Ho Chi Minh City**
http://vietfish.com.vn

### August 28-30
**14th Shanghai International Fisheries and Seafood Exhibition**
https://www.worldseafoodshanghai.com

### September 3-5
**Seafood Expo Asia**
**Wanchai, Hong Kong**
www.seafoodexpo.com/asia/

### October 7-10
**Aquaculture Europe**
**Berlin, Germany**
www.aquaeas.eu

### October 21-24
**Global Outlook for Aquaculture Leadership (GOAL)**
**Chennai, India**
www.aquaculturealliance.org/goal/

### November 12-14
**INFOFISH World Shrimp Trade Conference and Exposition**
**Bangkok, Thailand**
www.shrimp.infofish.org

### November 19-22
**LACQUA19**
**San José, Costa Rica**
www.was.org

# ASIAN PACIFIC AQUACULTURE 2019

## Aquaculture for Health, Wealth and Happiness

**June 19 -21, 2019**
**Chennai Trade Center**
**Chennai**
**Tamil Nadu - India**


**This event includes:**

- Asian Pacific Aquaculture 2019
- ISTA 2019

**Hosted by:** Tamil Nadu Dr.J.Jayalalithaa Fisheries University
**Organized by:** World Aquaculture Society - Asian Pacific Chapter

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**For more information contact conference manager:**
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**worldaqua@was.org - www.was.org**
**Trade show & Sponsorship: mario@marevent.com -**


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