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AQUA CULTURE

Asia Pacific

Aquafeeds in Asia in 2017

Ecuador's shrimp farming industry

Managing shrimp moulting

A responsibility to be sustainable

Immunomodulatory effects of ß-glucans

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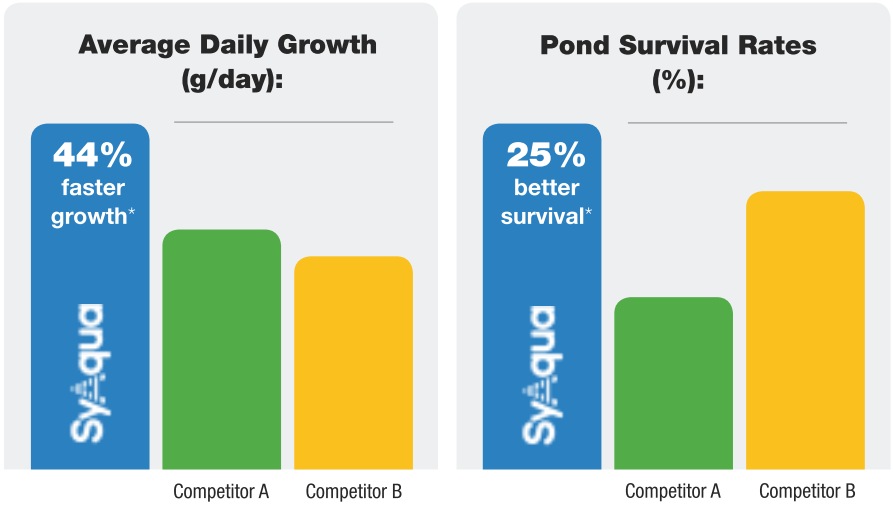

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Zuridah Merican

Shrimp Aquaculture: Need for Change

The Aquaculture Roundtable Series (TARS) 2018 will focus on shrimp aquaculture with the theme "Need for Change" and why so, you may ask. What has happened that makes change so pertinent and urgent? What circumstances are driving this need for change? Let's take a step back and compare today versus 2010 which was arguably the best year for farmed shrimp production in Asia. In 2010, Thailand was a leader in both technology and volumes, producing 620,000 tonnes. In 2017, Thailand produced 50% of this volume after being hit by EMS and later WFS and EHP in addition to WSSV which was always around. Thailand is representative of all the Asian producing countries and it is ahead of the curve. It is the role model of what is in store for other countries, so do not kid yourself by saying country X or Y will not go down the same path.

In 2010, survival rates were at 80% but today with diseases (of all acronyms), survival rates are down to perhaps 50-60% and this is only of the successful ponds as many succumb to culling, emergency and forced harvests. This has a major impact on the cost of production (COP). In 2010, COP per kg was USD 3.50, today it is USD4.50 per kg. In 2017, international prices for shrimp held firm but in 2018, prices began falling due to the demand-supply balance. While demand has stagnated, supply has increased from Central America and India. Shrimp farming is about to become non-profitable and the more volume we produce, the more money we lose. This affects all stakeholders and support industries as well, so we cannot carry on with the status quo.

In the early years of 2000, when *P. monodon* was facing WSSV and MBV, countries switched to *P. vannamei* and that saved the industry. India was the last on that curve and in 2017, produced an impressive 600,000 tonnes. But *P. vannamei* is now facing huge disease issues. Switching back to *P.monodon* is only a 'band-aid' option. It is not a solution and we are not facing the problem head-on.

So where are the problems? Firstly, we are testing the carrying capacity of the pond ecosystem without knowing it. We are all fixated on tonnage/ha and ignoring the environment and ecosystem. With high density stocking (e.g. 200 PL/m^2), high faecal output and excess feed waste only worsen the problem. Secondly, we produce post larvae in a clean and controlled environment and then stock them into the open pond environment. Poor survivals prompted the industry to move from this two-phase to three-phase farming; adding a nursery phase. However, many simply stock the post larvae into a smaller pond at much higher stocking densities, calling this a nursery. To borrow a phrase from Robins McIntosh, this is a 'hotbed of diseases'. A nursery should be an extension of sterile hatchery in controlled conditions. Early stage care and nutrition are as important to shrimp as they are for humans. Thirdly, we know the trigger points for disease – the main factor is stress caused by changing water parameters. Water quality should be kept as constant (as possible) during the whole culture cycle so controlled conditions against weather and sludge accumulation will be a major positive contributor.

Genetics and nutrition have made contributions to the industry but each face their own predicament with farmers. Farmers expect good shrimp genetics to solve all their problems while allowing them to carry on with complacency. It is too easy to blame poor genetics for all the health and disease issues. Feed and feed additive companies have been trying to introduce functional feeds to address stressful conditions, just like in salmon, sea bream and seabass farming. Despite facing problems, shrimp farmers do not see the need or are not willing to pay for such feeds but yet seem willing to top-dress feeds with additives. Shrimp feed has remained in the USD 1.10/kg range for the past 35 years, so where is the room to include functional ingredients? Aqua Culture Asia Pacific does not profess to have the answers to these problems but we believe that TARS 2018 offers a platform for all stakeholders to discuss and seek viable solutions.

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Rise of marine biotechnology in aquaculture

The aquaculture sector plays a very important role in Taiwan's GDP, contributing to NTD 30 billion (USD 1 billion) annually. The major species cultured include the tilapia, eels, groupers and milkfish. The industry employs 33-35,000 farmers and supporting workforce, and thus it is very important to sustain aquaculture growth. **Dr Ching-Fong Chang**, Professor and President of the National Taiwan Ocean University (NTOU) said in his plenary during the opening of the Asian–Pacific Aquaculture (APA 2018) Conference and Trade Show, that there should be innovation for aquaculture sustainability and food safety. He detailed the past and current developments in the industry in Taiwan and highlighted several achievements which will help fish farming not only in Taiwan but also in the region.

The 3-day APA 2018 was a first for Taiwan. The last time the event was held in East Asia was in Jeju, Korea, together with World Aquaculture 2015. APA 2018 was held from 24 to 26 April at the Taipei International Convention Centre. It was organised by the Asian-Pacific Chapter of the World Aquaculture Society together with NTOU, and was supported by the Ministry of Science and Technology, Taiwan and Fisheries Agency, Council of Agriculture, Taiwan. The Gold sponsor was Sheng Long Bio-Tech International, and the conference sponsor was Grobest Feeds.

Looking back, the history of aquaculture in Taiwan has been rather chequered. "In 1987, we had a peak production of shrimp, the highest at 100,000 tonnes (Chang et al, 2018), then in the 1990s, it was the peak production for the eel *Anguilla japonicus*. In 2012-2013, it was the turn of the grouper but today, grouper production has plateaued in Taiwan while China is presently seeing peak production. In 2009, we had typhoon Morakat, which caused production to plummet," said Chang.

"Our advancing and successful phase was in 1963 to 1987 followed by a struggling and transitional stage in 1988 to 1992. Now we are in the 'emigration and adjustment' phase which started in 1993. In the 1960s, we underwent an extensive culture phase with developments in artificial propagation and then moved to semi-intensive and intensive culture in the 1970s to 1990s. Since the 2000s, we have been promoting environmentally friendly culture."

On some challenges, Chang highlighted the dependence on wild elvers for Taiwan's eel farming industry. Research to close the cycle has been too costly. "We have gone through the eel's lifecycle and found the puberty block which makes it very difficult. The difficulties in eel fry production is a big issue for the future of eel culture in Taiwan."

Food safety is a focus in Taiwan

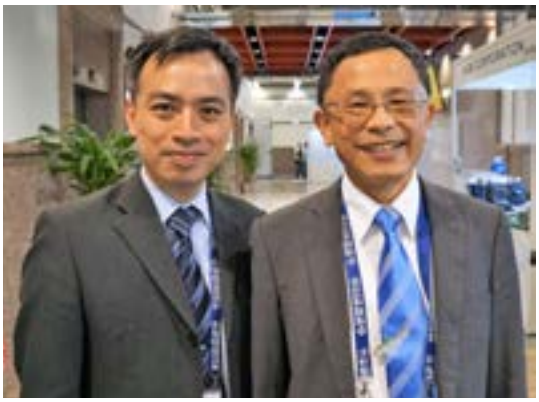
"Our understanding is that it is not the product but the process; the production, handling, preparation and storage of food in a way to best reduce the risk of individuals getting sick from food borne disease. Food safety is a global concern covering several areas of everyday life."

Chang concluded his presentation with these words, "To get the best, we need to have a good sustainable system. Sustainable aquaculture is our goal. Aquaculture needs to fulfill the 3E principles, economic, social (equity) and environmental."

Disease control in groupers

"Marine biotechnology can be used in vaccine development. Although we are making inroads, we still need more research to prevent outbreaks," said Chang. "Vaccines are only used at 7% in fish farming to prevent outbreaks. In the case of grouper production, nervous necrosis virus (NNV) and iridovirus affect production. NNV affects the larval stages while iridovirus affect the later stages. These two viruses can cause 90-100% mortality of a stock."

The infection models and pathways of the diseases are the subject of research, mainly at NTOU and National Cheng Kung University (NCKU). Chang said that NTOU scientists have developed oral vaccines for CGIV (China grouper iridovirus) and TGIV (Taiwan grouper iridovirus). To prevent infection of NNV, they worked on the RNA interference for oral delivery with lipids. "Our vaccine strategy for the grouper is to reduce NNV susceptibility in the broodstock, fry and the fingerling stages with passive immunisation and maternal immunisation via injection. We reduce iridovirus susceptibility via active immunisation with a



Dr Ching-Fong Chang (right) with Allen Ming-Hsun Wu, Regional Manager, Aquaculture, Asia Pacific, Nutriad.

Professor I.C Liao, NTOU (second left) with the U.S. Soybean Export Council team, from left; Hoang Nguyen Vo, Aquaculture, Vietnam, Hsiang-Pin Lan, Asia Marine Aquaculture and Chuchai Kanjanamayoon, Aquaculture, Thailand.

commercial inactivated vaccine at three levels, fry, fingerling and adult. Subunit vaccines are under development."

During the conference, many oral and poster presentations focussed on marine biotechnology in managing NNV and iridovirus in various groupers. At NCKU, researchers investigated the adaptive immune system in the mucosal associated lymphoid tissues (MALTs). Observing the level of a cloned immunoglobulin (Ig), Chou et al. (2018) showed the mucosal immune response in fish larvae under NNV treatment. The result pointed to a possible role of mucosal immunity in orange-spotted grouper. NTOU researchers reported on the strategy to overcome these diseases in adult fish. This is via the more conventional immune stimulants containing oligodeoxynucleotide (ODN) which can promote the functionality of immune cells, such as phagocytosis. They can also be used as adjuvant in combination with various forms of anti-viral vaccines to promote the efficacy of the vaccines. These nucleic acid stimulants can be delivered into the animals via injection, or ingestion of feed additive, hence demonstrating the potential application of the compounds in commercial feed additives and vaccines (Chiou et al., 2018).

Another research at NCKU suggested that the ISKNV strain can easily infect giant grouper via viral replication. Then, Fas-mediated death signalling was triggered by ISKNV. This provided a new insight into iridovirus pathogenesis (Chen and Hong, 2018). Working in NTOU, Kua and Lu (2018) discussed how antigen processing and presentation play important roles in adaptive immunity through transcriptome analysis at different metamorphosis stages of the orange spotted grouper. Higher temperature has been linked to NNV infections via virus proliferation and transmission is seasonal. Lai et al. (2018) reported that IRF-4 from the interferon regulatory factor (IRF) family may be an important factor correlating viral-induced immune response with temperature modulation in orange-spotted grouper. When fish larvae were exposed to low (20°C) and high (36°C) temperatures, the expression of osgIRF4 is elevated drastically which supports its thermogenic role.

Chemokines are considered important to both innate and adaptive immunities. Analysis of CC chemokine genes in various fish species revealed that the number of CC chemokine genes and their tissue expression patterns vary greatly. Using next generation sequencing technology to perform transcriptome analysis in the spleen of *Epinephelus coioides* infected with grouper iridovirus (GIV), Leu et al. (2018) from NTOU showed that after GIV infection, a vast array of immune-related gene exhibited changed expression, and these included several CC chemokine genes. This demonstrated the importance of chemokines to the immunity of *E. coioides*.

Insights into microbial management in aquaculture farming

Peter De Schryver

As the biggest problem in aquaculture farming is pathogenic diseases, the team led by Dr Patrick Sorgeloos at Ghent University, Belgium is encouraging farmers and hatchery operators to move away from empirical management of the farming ecosystem to more knowledge-based management. By this they mean a focus on microbial management in hatcheries and at the farm level. At the APA2018 plenary, **Dr Peter De Schryver**, who is now with Inve Aquaculture, Thailand, said, "In our current management of pond and hatchery ecosystems, we are already culturing microbes which can either be good or bad for the fish or shrimp. To be sustainable, we need to learn to use the microbes to our advantage. There are advances in microbial research and tools to detect microbes at the molecular level, i.e. genes in the bacteria, to determine biodiversity in the culture system."

"Unpredictability that is often seen with survival rates in fish hatcheries, such as 1 to 63% in seabream hatcheries, are most often due to randomness of the microbes in the system. If we study the system, we will find a mix of bacteria in three groups: neutral/beneficial bacteria, harmful bacteria (obligate pathogens) and potentially harmful bacteria or opportunists. We want to eliminate all obligates, and obtain a dominance of the beneficial over the opportunistic bacteria. Biosecurity is essential in this.

Microbially matured water is characterised by a dominance of slow-growing bacteria with a limited nutrient supply per bacterium, the so-called K strategists. They eliminate the niches for fast growing bacteria, the r strategists, which include many

Nguyen Thi Minh Huong, Behn Meyer Viet Nam Co,.Ltd (centre, front row) with her team and customers from Vietnam comprising feed millers and aquafarmers. Third left is Nguyen Van Son, Vice Director General of the new Sao Mai Super Feed (see page 28).

Salmon with double the omega-3 content

Leading aquaculture producers Kvarøy and Blue Circle Foods together with feed company BioMar have announced the production of salmon with a 100% increase in marine omega-3 content, the lowest levels of marine contaminants in the market and a record breaking fish-in, fish-out ratio of 0.47 to 1. This improvement is attributed to the companies' 'In the Blue feed', which utilises sustainably optimised ingredients such as microalgae, marine ingredients derived from trimmings of wild-caught fish processed for human consumption and reduces the reliance on wild fish stocks. Unlike traditional aquafeed ingredients, In the Blue's fish oil undergoes a special cleaning process to remove environmental contaminants including PCBs and dioxins. The feed does not include GMOs, added hormones, antibiotics and synthetic pigments. The salmon is available as Blue Circle Foods and Changing Seas branded smoked salmon. In the Blue was publicly launched in 2016 as a joint project between Blue Circle Foods, Kvarøy, BioMar and Whole Foods. The feed earned Blue Circle Foods' farmed salmon a "Good Alternative" rating from Monterey Bay's Seafood Watch, and meets Whole Food Market's Responsibly Farmed Standards.

Tilapia Science award submissions due by August 3, 2018

MSD Animal Health has announced its sponsorship of the 2018 High Quality Tilapia Science Award in support of research in tilapia health, production and welfare. The company will award one recent graduate in veterinary or animal science with the opportunity to present their research at MSD Animal Health High Quality Tilapia meeting to be held in October 2018 in São Paulo, Brazil. To apply, candidates must submit a 300-word summary of their research project, resume and a brief letter describing why their work contributes to the improvement of the tilapia industry to HQAquaAward@merck.com. Applications must be submitted by August 3, 2018. Eligible graduates must have completed, a minimum of a bachelor's degree in the past 12 months and have completed research for an applied project in either veterinary or animal science with an emphasis on tilapia. Topics of interest include antibiotic reduction, welfare, precision medicine, innovations in aquaculture, infectious diseases, and parasite challenges and solutions. The winner will be notified by September 7, 2018.

Commercial partnership to scale IoT start-up globally

Nutreco has taken a 25% share in Eruvaka, an India-based Internet of Things (IoT) company that develops connected devices and mobile-based decision tools to help aquaculture farmers reduce risk and increase productivity. It has entered into a commercial partnership to help scale up Eruvaka globally. Eruvaka, founded in 2012 by Indian entrepreneur Sreeram Raavi has products for farmers to actively monitor pond parameters with remotely control automated equipment to significantly reduce farming risk and increases feed efficiency, shrimp growth and farm profitability. The investment is in line with Nutreco's mission of 'Feeding the Future'; the company's ambition to contribute to producing enough nutritious and high-quality food for a growing population in a sustainable way. Its aquaculture division Skretting will work directly with Eruvaka to implement the latest in precision farming technology, firstly in Latin America. The technology will be incorporated into AquaSim, Skretting's suite of customised performance tools, to allow local shrimp farmers to remotely ensure accurate dosages of the right feed when their stock requires it, avoiding over- or under-feeding. Skretting's General Manager in Ecuador, Carlos Miranda Illingworth said, "In Ecuador we have been able to lower the feed conversion ratio and shorten the production cycle of shrimp thanks to satiation feeding, thereby doubling production without huge intensification. The Eruvaka solution will ensure we can work in this way with many more farms in future."

continued from p5.

disease-causing Vibrio spp. "With disinfection, we eliminate bacteria but when we refill and seed bacteria, we are introducing new bacteria. The r-strategist bacteria grow fast and the speed of growth will depend on the operational strategy of the culture system used."

On how to control opportunistic bacteria in hatchery tanks, De Schryver suggested the use of recirculation technology with biofilters to increase water retention in the system, improve removal of organic material and allow the K-strategists to develop and dominate over r-strategists bacteria. "This is a kind of microbial management tool. It reduces risks but does not mean that there are no bad bacteria; it merely means a balance. With flow through systems, we actually create microbial instability and force slow growing bacteria (k-strategists) to be washed out."

EMS and microbial diversity

De Schryver discussed the application of microbial management to mitigate outbreaks of early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND). He said that the pathogen *Vibrio parahaemolyticus* (Vp) is an opportunistic bacteria species and can survive without a host. "In the current pond strategy of total disinfection of pond bottom and water to kill possible vectors we actually encourage the r-strategist bacteria to peak after fertilisation. Under current conditions there is thus a substantial chance we are introducing post larvae when r-strategist bacteria dominate. The new infrastructures with shrimp toilets and recirculation at farm level means that we are promoting microbial maturation and keep organic loads at a constant level.

"Other methods to obtain dominance of K-strategists over opportunists is the use of well selected probiotics, which in addition can provide antagonistic effects. Bioflocs also give stability and conditioning effect to the tank or pond system. We suggest stocking shrimp post larvae in systems with a mature microbiota (such as algae-rich green waters and microbially matured water systems), as environments primarily colonised by slow-growing harmless bacteria might be the best guarantee in the prevention of EMS/AHPND outbreaks," concluded De Schryver.

References are available on request

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Ecuadorian shrimp farming: From failure to success

By Herve Lucien-Brun

Success came with domestication and selection for WSSV tolerant stocks, allowing for good survival rates despite the presence of pathogens, selection for robustness in the hatchery production cycle and farmers' exigence on post larvae quality.

Ecuador, a small Latin American country, with almost 277,000 km^2 of land area and 2,200 km of coast line is one of the world's major players in farmed shrimp production. In 2015, production was almost 350,000 tonnes. If we look at the shrimp production ratios relative to the land surface (Figure 1) or to the length of the coastline of the shrimp producing countries, Ecuador leads in production (kg/km^2).

Shrimp farming in Ecuador started in 1969 with the extensive culture method, using wild post larvae collected from estuaries and beaches. Culture is over for 4 and 8 months to reach marketable size. The size of ponds ranged from 10 ha to over 50 ha. Today, almost 185,000 ha of ponds are dedicated to shrimp production, mostly in and around Guayaquil (Figure 2 and 3). Shrimp farms range from less than 10 ha to more than 2,000 ha in area. The number of shrimp farms categorised under the various sizes in the different provinces is shown in Table 1.

Table 1. Number of Ecuadorian shrimp farms categorised under size and province.

Provinces / Unit size of farms (ha)	Guayas & Santa Helena	Manabi	El Oro	Esmeralda	Total	
					N°	%
0-10	148	203	166	88	605	20
10-20	107	146	215	82	550	18
20-30	118	94	153	38	403	13
30-40	79	43	93	29	244	8
40-50	112	50	87	17	266	9
50-100	229	38	127	21	415	14
100-250	330	28	71	14	443	15
250-500	60	3	6	11	80	3
500-1,000	24	-	4	2	30	1
1,000-2,000	8	-	-	1	9	0
UP 2,000	1	-	-	-	1	0
Total	**1,216**	**605**	**922**	**303**	**3,046**	**100**

Most shrimp farms are located in the Guayas. Water quality can vary in most farms depending on their location in the delta and the time of year. During the winter and rainy season, the temperature is elevated but the salinity is very low, almost 0 ppt in many farms. During the dry summer season, the temperature is lower and the salinity higher (from 10 ppt to 36 ppt).

During the late 1970s and early 1980s, the farming method moved towards semi-intensive culture systems. There was increased water exchange through the implementation of pumping stations, and shrimp were fed with compound feed produced by local companies. During this period, Ecuadorian shrimp farmers relied almost entirely on wild post larvae collected by 900,000 artisanal fishermen to stock their ponds.

Shrimp farms in the Guayas

In 1984, following the very strong El Niño phenomena in 1983 and the lack of wild post larvae, farm owners began to build hatcheries. By the late 1980s more than 65 large hatcheries and numerous small ones were built, mostly along the Peninsula de Santa Helena. Biologists of many nationalities were involved in the construction of these hatcheries, mainly Ecuadorian, American, Mexican, English, French and Filipino. A large majority of these hatcheries were built following the AQUACOP or the Galveston design. By 2014, a total of 110 hatcheries registered by the Ecuadorian National Institute of Fisheries were able to produce more than 5 billion post larvae/month.

Apart from a few farms (between 2 to 4) owned by foreign companies, shrimp farming in Ecuador was mostly funded by Ecuadorian investors. The production of farmed shrimp in Ecuador gradually rose despite some disease outbreaks, such as the seagull syndrome in 1989 and particularly the taura syndrome virus (TSV) in 1993. However, it was especially the white spot syndrome virus (WSSV) outbreak during 1999-2000s which was a real turning point in the history of shrimp farming in Ecuador. (Figure 4).

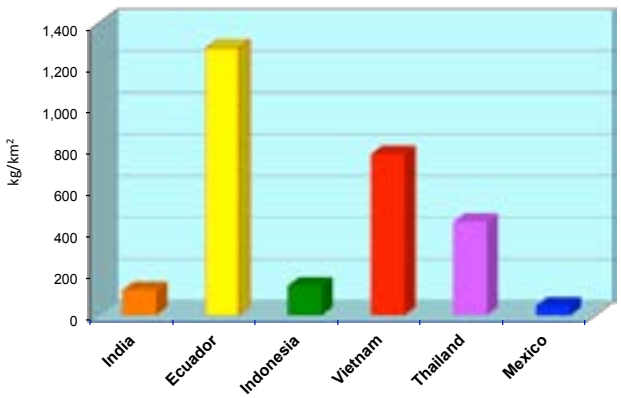

Figure 1. Comparison of the ratio of national farmed shrimp production (kg) to country land area (km^2) in 2015.

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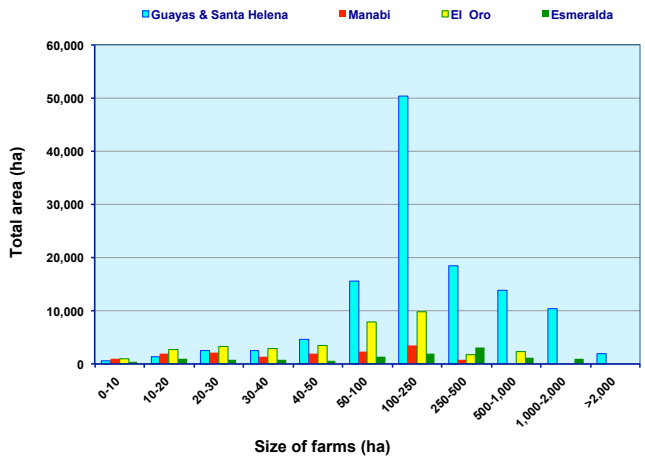

Figure 2. Distribution of shrimp farm per unit size in the Ecuadorian provinces.

Figure 3. Illustration of the farm density in the delta of Guayas, (Photo credit: David Kawahigashi).

Post larvae supply

Before 1999, there was a debate on whether to use wild post larvae or those from the hatcheries. Almost all hatcheries stocked wild caught broodstock in their maturation tanks and even ready to spawn females which fishermen delivered daily to the hatcheries.

Most farmers preferred wild post larvae, because it was much easier to negotiate prices with fishermen rather than with hatchery biologists. Farmers, when buying post larvae in a hatchery, were always very concerned with post larvae quality and they used to record carefully the post larvae quality and the results of the stress test.

Attention has always been on post larvae acclimatisation to pond water quality and not only on salinity or temperature. For that, farms were equipped with fixed or mobile acclimatisation stations. Acclimatisation is to gradually change the water used for transport with the water of the destination pond. This can last for up to 48 hours depending on the water quality of the rearing tank.

During this period, domestication and genetic selection technologies were not available. Some companies tried to import specific pathogen free (SPF) broodstock from Hawaii, but it had always ended in failure with heavy mortality of the imported shrimp. So, the concept of SPF was not considered in the country and they selected families of broodstock from their own ponds.

Post TSV

After the TSV outbreak some of the big farms began to look at shrimp culture differently. At the end of 1999 to 2000, crop failures caused by WSSV reached critical levels and the question of survival of the industry was widely discussed. As most of the available land to develop new shrimp farms were already taken up, it was almost impossible to open new ponds which normally are less susceptible to disease. To limit the impact on the drop in profits following the decreased production, most of the major farms reduced their costs by sharing fixed costs facilities such as hatcheries and processing plants. They started to improve technology by working at several levels of the production chain.

A major and significant measure was to prohibit the importation of livestock and frozen food that could potentially be disease vectors and the use of wild broodstock and/or wild post larvae. For more efficient biosecurity, the production is most often divided into four phases as below but some smaller farms still continue with a single phase culture:

- Hatchery: 15-18 days, nauplii to PL9 (≈ 500 PL/g)
- Nursery: 15 days, PL9 to PL24 (≈ 15 PL/g)
  Pre-growing during 15 to 25 days up to 0.6 to 1 g. These are mostly intensive in covered raceways and semi-intensive in small earthen ponds
- Grow-out in large earthen ponds during 90 to 120 days to reach harvest size 18 to 22 g.

The main measures taken by the major companies to revive the growth of the Ecuadorian shrimp industry are summarised below.

Broodstock and family base selection

Considering that most of the pathogens are present in the farm environment, Ecuadorian shrimp breeders began to select strains of shrimp with high survival in their environmentally-friendly managed shrimp farms, while respecting the biodiversity. The first criterion of selection was survival. The second was selection of fast growing breeders for faster growth and reproduction indicators in hatchery.

Based on this concept, the breeding companies selected shrimp from ponds according to their survival performances after selection for external physical conditions and a strict health analysis. Two schemes were used to create the families: double cousins and some groups also used molecular marker technology

Feeding methods, from feed trays (left), using blowers (middle) to AQ1 feeders (right).

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after a mass selection of the original lines. This second technique allowed growth of all the family together and reduced the investment for facilities. Resistance or the tolerance of the families to the main diseases, WSSV, TSV and early mortality syndrome-EMS, are routinely checked by challenge tests. Crossing these families, according to the situation of the farm or specific purposes of the breeders, produces the lines used as broodstock in maturation.

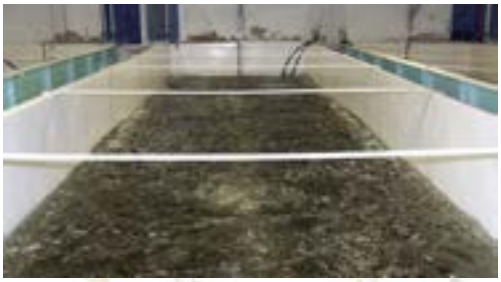
After a first conditioning of at least 15 days following the arrival of the broodstock in the hatchery, the animals are cleaned off pathogens using feed supplemented with oxytetracycline (OTC). Then the broodstock are selected, tagged and then transferred to maturation tanks. During all these steps, probiotics and stress reducers are used together with high quality fresh feeds (bloodworms, *Artemia* biomass, molluscs) and special pellets.

After spawning, each female is returned to their original maturation tank after been closely controlled and all the production indicators, including speed of gonadal development and number of spawns are registered. Before the transfer to larval rearing tanks, the nauplii are selected twice at stages N2 and N5 by phototropism, to only keep the most active and most robust larvae. Before transfer to the larvae room, the nauplii are thoroughly rinsed for at least 20 minutes with a 1µ filtered and UV sterilized water, and then are disinfected in an iodine bath for 3 minutes at 50 ppm.

Hatchery systems

As mentioned earlier, most of the Ecuadorian hatcheries are designed following the AQUACOP or the Galveston method: long deep tanks with V or U bottom with a single line of aeration and a system to control the water temperature. The tanks are filled with 1µ filtered and UV sterilised seawater. The N5 are stocked in larvae tanks at a high density, almost 250 to 300 N5/L. Initially the water level in the tank is low but the level is increased daily step by step. The larvae are fed with microalgae, micro particles and *Artemia* nauplii. Larval rearing techniques include the frequent use of probiotics which has replaced the prophylactic treatments with antibiotics. Post larvae (PL 9-10) are transferred to large nursery tanks at lower density where they receive micro particulate feed and *Artemia* nauplii.

Every day, the larvae are observed and the quality index, swimming activity, necrosis percentage, deformities, cells of the hepatopancreas, digestive tract content, etc are monitored. All parameters, water quality and algae density are checked twice daily.



Post larvae tank with AQUACOP technology.

Empty larval tank with aeration line not installed.

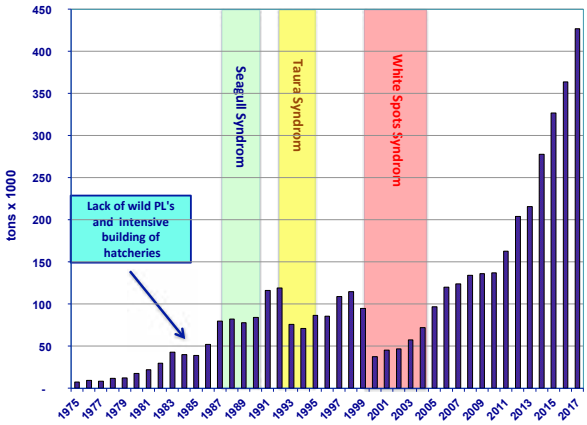


Figure 4. Exports farmed shrimp from Ecuador. Note: almost 30% of the production is exported as headlesss or value added products. To estimate the exact production of whole shrimp, export figures were topped up by 32% to 30%. Source: Estaditica S.A. (info@estadistic.com).

Prior to any transfer, the weight (PL/g) is controlled. Other quality parameters such as grade dispersion, digestive tract content, muscular mass index, swimming activity, internal and external morphology, and ectoparasites, total bacterial and Vibrio spp. counts are monitored. A stress test (salinity) is also applied. All unsatisfactory batches of post larvae are destroyed. Thanks to these strict controls, farms receive only robust and suitable quality post larvae.

Covered pre-growing raceways in an Ecuadorian shrimp farm.

Pre-growing in covered raceways

The post larvae are acclimated to the water conditions of the pre-growing ponds before transferring. Most farms have installed raceways in greenhouses for pre-growing. These raceways use filtered and UV water, and adopt recirculation systems with semi-biofloc technology with very strong aeration. The objectives of this pre-growing step, today widely used in Latin America, especially in Mexico are to:

- Reduce the replacement of water, reduce temperature variations and the risk of pathogen introductions;
- Control the levels of toxic nitrogen components;
- Maintain Vibrio and *Pseudomonas* spp. to as low a level as possible;
- Decrease the accumulation of organic matter and avoid the settlement of biofloc that could generate toxic hydrogen sulphide and/or methane; and
- Decrease stress in the juveniles.

Semacua Hatchery

Raceway nursery in a shrimp hatchery

Greenhouses for raceway nursery on farm

When they reach an average body weight of 0.6 to 1 g, after 20 to 30 days, the juveniles are checked for quality. Qualified juveniles are transferred to earthen on-growing ponds.

On growing: pond maintenance and feeding strategy

For the on-growing phase, Ecuadorian farmers do not intensify stocking as is done in many other countries. They continue to raise shrimp in semi-intensive systems with initial stocking density ranging from 8 to 25 juveniles/m^2. The stocking density depends on farm conditions, and is related to the size of ponds and their location relative to the ocean. Two aspects of management are carefully scrutinised since the WSSV outbreaks: management of the pond bottom and feeding strategy.

In Ecuador, earthen ponds have sandy clay soil. Usually, pond sediment consists of a mixture of settled organic matter, such as dead animals or plant fragments and faecal matter, live benthic organisms including algae, protozoa, nematodes, worms, gastropods or insect larvae, and inorganic minerals. The pond bottom soil, and in particular the mud layer, is considered to be a "chemical laboratory" and the "primary nutrient store" of the pond ecosystem, and as such plays a vital role in the maintenance of pond productivity. Pond soil is constantly analysed to determine its quality and chemical composition.

After each harvest, the organic matter is not mechanically removed but remains in the pond to biodegrade. Ponds are sun dried and ploughed to break the sediment so as to optimise the aerobic condition of the sediment and permit the bacteria to mineralise the organic matter. Probiotics are added to accelerate this process and to reduce the presence of Vibrio and *Pseudomonas* spp.

Soil pH and its alkalinity are increased by the addition of lime prior to soil turnover. However, the success of pond fertilisation and feeding strategy, in many instances, depends upon the initial drying and/or chemical treatment of the pond bottom with lime. The reservoir and canal of the farm are also treated likewise, at least once a year.

Traditionally, in Ecuador, feed pellets are broadcasted from a canoe, as homogeneously as possible on the entire surface of the pond. Feeding is once or twice a day. The daily ration was determined empirically according to the experience of the farm manager and estimation of the shrimp biomass present in the pond. With this technique the feed conversion ratio (FCR) was high, 1.7 to 2.4 with high feed wastage resulting in high pond pollution.

This strategy was then improved by using feed tray samples and adapting the daily ration. Nevertheless, the weak point of this technique is the small number of feedings per day but also the difficulty to estimate properly the real population in the pond, which is crucial to properly feed the whole crop.

The feeding strategy then changed to the use of feeding trays to distribute all the feed in the ponds. This method, initially developed in Peru (M. Viacaca, 1995) allows for a more accurate estimation of the effective feed consumption and more efficient adjustments of the daily ration. This method reduced FCR to lower than 1.3:1 and even sometimes to 1:1.

Some farms changed to using blower feeders to feed at least three times a day, while some farmers switched to automatic feeders, broadcasting pellets in smaller quantities but more often, at least 150 times a day. The latter limits the loss of extra feed. Shrimp in all the ponds were checked with feed tray samples. More recently, a new Australian technology (AQ1) is widely used in Ecuadorian shrimp ponds. This system calculates the feeding ration and automatically distributes the feed according to the calculated frequency based on the demand associated with sound records from the population in the pond while feeding.

This system improves the efficiency in production that could transform the industry by reducing the production cost and pond pollution through the reduction in uneaten feed. With the use of the sound feeding system in ponds, it has been possible to observe a decrease in feed conversion up to 30%; the survival could be improved by 50%, growth rate increased by 15% and the number of partial harvests was reduced.

Conclusion

Consequent to the WSSV epidemic, Ecuadorian shrimp farmers realised that only domestication will give a sufficient level of biosecurity to limit the risks of pathogens. This domestication allowed them to develop a certain tolerance (not resistance), to these diseases and also to improve the farm performances. Farmers benefitted from the genetic selection of breeding lines which led to good survival rates despite the presence of pathogens. The weakness is that broodstock are still farmed in the ponds, bringing the risk of reintroducing new and unknown diseases. Success is also due to the selection for robustness in the hatchery production cycle where healthy PL4 contribute to the high growth and survival in on-growing farms. The farmers are also very particular on the post larvae quality; they do not accept post larvae of doubtful quality.

With these measures, Ecuador significantly increased its production after the dramatic outbreak of WSSV. All stakeholders in the shrimp industry made efforts to establish strict control strategies and to be very demanding on the quality of their own work. Success came with local investments and work of the Ecuadorian producers; achieved without any government support.

References are available on request

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A successful shrimp nursery management at the BC farm in Thailand

By Saran Kayankarnnavee and Olivier Decamp

The nursery design, rearing and transfer protocol was fine-tuned over 3 years.

With the outbreaks of early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND) in numerous shrimp producing countries, farmers re-evaluated their production protocols and set-up. This included a renewed focus on ways to manage the microbial communities and more specifically Vibrio. The first step was a stricter implementation of biosecurity protocols with the screening of broodstock and post larvae, the use of more efficient biocide to control Vibrio biofilms, and the application of quality probiotics not only to compete with Vibrio but also to prevent the accumulation of organic wastes in the tank or pond.

Another development has been the renewed interest in nursery systems. Looking at the various shrimp nursery designs found in Latin America and Asia, farmers build systems that were applicable to their business model. This means that a wide range of set-ups can be found; consequently this has led to confusion on the choice for an optimal shrimp nursery system , i.e. performance and efficacy of shrimp nursery system. Some farmers focus on a short cycle, where nursery is used for acclimating animals before stocking. Others focus on growing animals in order to stock stronger animals and reduce the duration of the production cycle in the grow-out pond.

Here, we report on a successful design and management of the shrimp nursery at BC Farm, a private farm located in Surat Thani in southern Thailand, the most important shrimp producing area of Thailand. BC Farm, started producing vannamei shrimp in 2012. It has received certificates, such as the Best Aquaculture Practice.

The shrimp nursery at BC Farm

The current design of the farm, revised after the outbreak of EMS/AHPND, has an area of 15.4 ha for water treatment and reservoir and an area of 9.1 ha for farming. In addition, they built up a nursery system comprising 38 HDPE tanks, each holding 3.5 tonnes of water. Water is pumped from a pond where it is treated with trichlorfon and potassium permanganate. Following treatment, the water is moved to the reservoir where it is kept until it is transferred to the nursery tanks or the grow-out ponds. In the case of the nursery tanks, the water is first passed through a 400 gsm polyester wadding filter.

View of the shrimp nursery system, with 2 polyester wadding filter tanks, at the back, covering rows of 38 nursery tanks. Staff is seen performing water exchange.

Their nursery approach is high stocking density of post larvae PL15 (25-35 PL/L) a rearing period of 2-3 weeks depending on the conditions in the farm with a harvest size of 150 mg. The importance of rearing post larvae at a high stocking density and delivering strong juveniles to the ponds led the management of BC Farm to rely on quality diets (FRiPPAK Raceway), health booster (Sano S-PAK) and high water exchange. The feeding protocol (8 times/day) is adopted daily based on the analysis of post larvae made by the in-house laboratory (Table 1). Criteria include microscopical observations of the larval development, including the hepatopancreas and microbiological analyses.

The balance between the diet and the health booster is adjusted accordingly. When growth rate is below expectation, a higher percentage of the feed is included in the mixture. When first signs of poor health appear, a higher percentage of the health booster is included in the mixture.

Table 1. Nursery feeding table

PL (days)	1-5	6-10	11-15	16-20	21-30
Feeding	*Artemia* Sano S-Pak 2/5	Sano S-Pak 2/5 FRiPPAK 500	Sano S-Pak 2/5 FRiPPAK 500 FRiPPAK 700	Sano S-Pak 2/5 FRiPPAK 700 FRiPPAK 1000	FRiPPAK 1000 Shrimp feed
Feeding Times: 6 AM, 10 AM, 1 PM, 4 PM, 7 PM, 10 PM, 1 AM, 3 AM					
Remark	2 spoons of *Artemia* with 55g Sano S-Pak 2/5, For 120,000-150,000 PL				
	3 spoons of *Artemia* with 66g Sano S-Pak 2/5, For 160,000-200,000 PL				
	3 spoons of *Artemia* with 88g Sano S-Pak 2/5, For 200,000-300,000 PL				
	See the waste at the bottom of tank to adjust the feeding quantity				

The frequent use of quality diets and health boosters support the growth of healthy animals. However, to avoid any adverse impact of ammonia, high water exchange (80%) is performed twice daily. For each water exchange, technicians clean the side wall of the tank to remove any biofilm to maintain optimal conditions. After each water exchange, the bottom of the nursery tank is clean, without any waste. Although time consuming, this step is critical to their decision to stock large numbers of post larvae.

At the end of the 2-3 week nursery cycle, juveniles are transferred to the grow-out pond. The efficient teamwork involves the enumeration of post larvae density, the harvest from the nursery tank to tanks on a pick-up truck, after which juveniles are transported, with oxygen to the grow-out ponds located at a distance of up to 1 km.

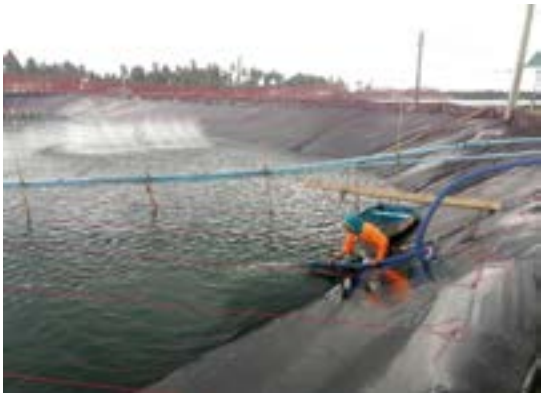
The juveniles are then stocked in fully-lined ponds, under

Staff cleaning the side walls of the nursery tank to remove any biofilm to maintain optimal conditions during the water exchange procedure.

Transportation of juveniles (minimum PL21) from the nursery area to the grow-out pond.

strict biosecurity measures, at a final stocking density of 150 juveniles/m^2. The juveniles will be cultured between 2 and 3 months depending upon the targeted harvest size.

In order to keep decent margins, farmers must consider survival rates and feed conversion ratios, but also more importantly, develop a sustainable system with consistent harvest volumes and less frequent crop losses. The nursery design and rearing protocol at BC farm were fine-tuned over 3 years.



Transfer of post larvae from the tanks on the pick-up truck to the lined grow-out ponds.

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Managing shrimp moulting

By Soraphat Panakorn

Understanding the interactions of minerals and roles of pH, dissolved oxygen and water quality is crucial for shrimp to moult well.

The natural environment of the marine shrimp has a high concentration of minerals. Shrimp grow by moulting, forming a new shell under the old one which is then discarded. The new shell then hardens. This process allows the shrimp to grow. Without this moulting process shrimp will not grow. Failure to moult means the end of life for the shrimp.

In their natural habitat, shrimp are able to search for a suitable place to moult. The only problem they face is coming into contact with a predator; to avoid this vulnerable situation, a shrimp needs to go through the moulting process quickly. The requirements for moulting are: plenty of minerals and oxygen, and absence of toxic gases. When we move shrimp into a culture pond, the limitations are: inadequate space, minerals and oxygen, and the presence of toxic gases which are produced when organic matter in the pond is not properly managed. These limitations may result in death after moulting from soft shell, a scar may be left on the shell, or shrimp may then have a blue or thinner shell.

In this article, I will share some opinions and information on moult management for a better understanding of the moulting process and will introduce solutions for some problems.

Know the shell

A shrimp shell is an exoskeleton, an armour or shield to protect its flesh from predators and disease infection. It is also to keep the soft body in a shrimp form. Without this shell, shrimp will just have a worm-like look. The shrimp shell comprises two components; it is 55% inorganic mostly calcium and magnesium and other trace elements. The other 45% comprises chitin (chitino protein complex made of carbohydrate and protein) and also sensory systems which gives the shrimp the ability to detect environmental changes and to be able to adjust accordingly.

Benefits of moulting

When shrimp removes the old shell and forms a new one, it is not just only for growth but also to remove any scar, wound, infection, dirt, shell parasites, and parts such as a damaged leg or an antenna. It then gets a new and perfect body again. This is part of natural selection, to select the best and screen out weaker shrimp.

Pre-moulting

Before moulting, shrimp will be at its least vulnerable condition; the shell is very hard, and the flesh has optimal energy and is nutritionally complete. If the shrimp is not ready, it will not moult since this can result in death.

Requirements during moulting

During moulting, the shrimp will consume oxygen at a rate double that at regular times. It needs to use energy to moult; if oxygen supply is short it may die. The other condition is that shrimp needs pH lower than 8.3 to be able to extract minerals from the old shell; otherwise it cannot form a new shell. It needs a clean and safe place to rest and build up the new exoskeleton, absence of toxic gases (hydrogen sulphide-H_2S) and sludge, and have enough dissolved oxygen in the resting place. It needs a proper mineral ratio of magnesium, calcium and potassium and a protein diet to rebuild the body structure after moulting.

The day after a moult, shells floating with some dead shrimp.

Signs and predictions

Normally shrimp will not moult altogether at the same time. Usually, they tend to moult during high tide or full moon. For example, if the moult is supposed to occur on day 7 with only 10 shrimp moulting out of a population of 100, but if day 5 happened to be a high tide day, more shrimp will then moult on day 5, that is about 30-40 shrimp will moult in one day. During the day, in a pond with a high pH (above 8.3), shrimp will wait until pH drops to 8.3 to start moulting which will normally occur in the evening.

After mass moulting, the farmer always detects sloughed shrimp shells and long trails of foam or bubble. The new shrimp shell looks clean, is transparent and thin. However, due to a limited supply of minerals in the water which the shrimp has used for moulting during the night, there may be possibility of a plankton crash, which will happen within 2-3 days after moulting. It is important that the shrimp farmer detects the big moulting (day 5 in the example above) and be prepared for it. The data given in Table 1 can help farmers determine when the next moult will come.

Table 1. Moulting interval.

DOC	Number of moults	Total/ month	Lead time (day)	Body weight (g)	Length (cm)	Size shrimp/ kg
1-7	7	16-18	1	0.66	3.5	1,500
8-15	4		2	1	4.7	1,000
16-30	5		3	2	6.1	500
31-45	2	4-6	7	5	8.4	200
46-60	2		8	10	10.8	100
61-90	3	3-4	9	16	12.8	60

Source: Dr Boonyarat Pratumchart, Department of Aquatic Science, Faculty of Science, Burapha University and Dr Chalor Limsuwan, Aquaculture Business Research Centre, Kasetsart University, Thailand.

A newly moulted shrimp looks clean and transparent with soft shell.

On the predicted day of a moult, feed consumption should be reduced by 10-30%. Once predicted, the farmer must provide full and continuous aeration and prepare some key minerals to be made available immediately for the shrimp to moult. If pH is higher than 8.3, the farmer should wait for pH to decrease to apply minerals. But if the water pH is always low, the farmer will need to mix the minerals in a tank beside the pond and slowly add this continuously via a pipe in front of the paddle wheel during the day. Each time, during moulting, there is a possibility that the alkalinity will drop as ions are used to form a new shell. In such a case, it is necessary to bring the alkalinity back to normal levels, of around 100-120 ppm by applying sodium bicarbonate.

Moulting steps

Intermoult

During this time the shrimp shell is clean and hard but pale in colour. The muscle is a bit loose, flesh tasteless and there is low mineral content in the body and by weight and the hepatopancreas will shrink by 1.02% of the body weight. During the intermoult, shrimp will be accumulating minerals and nutrients in the blood stream and hepatopancreas from the water and the feed. At this stage, it mainly assimilates trace elements. This is the longest time in the moult cycle. Depending on the size of the shrimp; bigger shrimp will take a longer time and shrimp weight will increase slowly until it gets ready for the next moult. (Table 1).

Premoult

When shrimp is ready to moult (at this stage the shrimp hepatopancreas is biggest at about 1.17% of the body weight since it accumulates nutrients), shrimp will start using nutrients from the hepatopancreas to form a soft new shell under the old shell at the epidermis layer. At the inner layer, chitin and major minerals such as Mg and Ca, will be extracted from the old shell and deposited in the new shell (this step needs a pH lower than 8.3). This amount of mineralisation is not enough to make the new shell too hard, but just enough to form a layer of film. This period will take about 6 hours for 10-15 g shrimp.

Ecdysis or moult

When a new shell is completely formed internally and the old shell is brittle enough, shrimp will start to pump water into the body to make the body bigger and crack the old shell at the top part of the first abdominal segment. The shrimp bends its body and jumps suddenly to shake out the old shell. The size and weight will suddenly increase but the flesh is still soft.

Cannibalism occurs when shrimp has a soft shell.

Part of the shell left after a moult.

Early post moult and post moult

Newly moulted shrimp will have limited energy; it cannot swim or walk far and can make just two or three jumps to escape from a predator. The moulted shrimp needs to extract minerals from water (which is the key supplier of minerals) to harden their new shell as quickly as possible, normally less than 1 hour. If it takes longer the chances of being cannibalised is higher.

Essential factors for moulting

A proper mineral ratio, pH lower than 8.3 and double the amount of oxygen are prerequisites for moulting. Some farmers might try using some moulting stimulant or hormone, but I would strongly not recommend this. If we force shrimp to moult when they are not ready, it will lead to mortality. The farmer will not know that there are less shrimp in the pond, but might find less feed consumption and low survival rate at harvest.

General moulting problems

In moult mortality, it is common to find in shrimp, white muscles along with clear and thin and soft shells. The possible causes are: shortage of oxygen, shortage of a major mineral, improper mineral ratio, low alkalinity, or exposure to H_2S toxic gas. Farmers need to maintain a proper alkalinity of at least 120 ppm and keep a correct ratio of Mg/Ca/K. It is imperative to ensure that there is plenty of oxygen and absence of H_2S at the pond bottom. It is recommended to use probiotics to eliminate H_2S effectively.

Thin shell and/or soft shell is mainly caused by a shortage of minerals. Even though shrimp in the earlier moulting are not seriously affected, this is an indicator that the remaining shrimp in the pond will be badly affected in the subsequent moult. The farmer should mix some trace elements into the feed to provide the major minerals during moulting. At the same time, the alkalinity should be maintained at 120 ppm.

A plankton crash can also occur when a mineral that the phytoplankton needs in the day has been used up by the shrimp during moulting at night. On the first day after a moult, the farmer can detect a small change in pH. On the second day, the water colour is paler and the pH drops slightly and on the third day, the water colour becomes darker, and there is more foam at the water surface and the pH drops more than on the previous day. A plankton crash usually leads to many serious problems later. To prevent this from occurring, the farmer needs to monitor the mineral content, pH and alkalinity.

Incomplete moulting is mainly caused by either an imbalance, improper mineral ratio or shrimp with insufficient energy to finish moulting. Some shrimp with a wound on the shell will not complete a moult. An example is when there is taura syndrome virus infection (TSV) or vibriosis infection on the shell.

Rainfall can also trigger a moulting problem. Rain water with a low pH will make shrimp moult but at the same time, most of the pond will also have less oxygen, high toxic gases, cold water and shortage of minerals. Farmers will need to apply lime to maintain the pH and to prevent shrimp from moulting. To do this, the farmer should not stop aeration but cut down on feeding, and check pH and alkalinity every 2-3 hours during heavy rainfall. If there is an out of control situation, a probiotic that can control H_2S should be applied.

In some cases, a scar on the shell caused by the rostrum of another shrimp will no longer be there by the next moulting. Possible causes for deformity are malnutrition such as the lack of essential vitamins or an infection such as the bamboo shrimp virus. If this happens, feed supplements should be used and if this not does work, it is worth abandoning the crop.

Proper mineral management

Shrimp needs some 23 minerals. The major minerals are calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P) and sodium chloride (NaCl). The minor elements are iron (Fe), manganese (Mn), copper (Cu), zinc (Zn), iodine (I), cobalt (Co), caesium (Cs), nickel (Ni), selenium(Se), fluoride (F), molybdenum (Mo), tin (Sn), chromium (Cr), strontium (Sr), vanadium (V) and silica (Si). The Mg/Ca/K ratio must be 40/15/13. For example, at 10 ppt, the farmer must maintain the water with 400 ppm Mg, 150 ppm Ca and 130 ppm K. Therefore, checking the mineral value constantly is essential especially for a farm stocking higher density than 100 PL/m^2.

All of the minerals above are required in specific amounts. The absence of one mineral could lead to the deactivation of other minerals as shown in the mineral wheel table (Figure 1). Companies market minerals in two ways. First the minerals are supplied in the form of compounds such as $MgSO_4$, $CaCl_2$, $MgCl_2$ or lime etc. The compounds are blended in the correct ratio with all the essential major minerals (Ca, P, K, Mg, S, Na and Cl) in a 20 kg pack and used by direct application to the water. The second product consists of 16 trace elements and essential minerals comprising Fe, Mn, Cu, Zn, I, Co, Cs, Ni, Se, F, Mo, Sn, Cr, Sr, V and Si mixed in a 1 kg pack for top dressing of feed at the farm site.

Essentially, farmers must understand the need for these minerals and provide a good quality product for shrimp to avoid a problem with mineral shortage. Furthermore, to benefit the shrimp, minerals should be applied at the right time when shrimp needs them, such as when it is moulting. The form and source of the minerals also require attention and farmers should seek guidance from experts.

Salt

Salt (sodium chloride) is a mineral source that farmers can use even though the salinity in the grow-out pond can be high (over 35 ppt.) At a high stocking density such as 150 PL/m^2 or more, even though in highly saline conditions, trace minerals are still required. In cases where some minerals are inactive, special minerals to compensate for these are needed. A general rule is to mix 20g salt with 100 mL of water, and top dress 1kg of feed.

Application of lime provides the hardness as a base to maintain alkalinity and minerals levels.

Table 2. Comparison in composition of mineral ions in a culture pond and in the natural environment

Mineral ions in shrimp culture at 30 ppt			Mineral ions in natural environment				
Mineral (mg/L)	White shrimp	Black tiger shrimp	Minerals (ppm)	River	Underground water	Sea water	Rain water
Na	7500	8000	Ca^{2+}	17.8	<100	400	1
Cl	10500	10000	Mg^{2+}	4.6	<50	1300	1
Ca	550	600	Na^{+}	8.7	<200	10500	3
Mg	6000	500	K^{+}	17	<10000	400	0.5
K	390	400	SO_4^{2+}	13.3	<300	1500	2
P	400	15	Cl-	10	10-1000	19,000	5
S	Nd	500	HCO_3^{-}	67	<500	145	0
Mn	0.2	5	CO_3^{2-}		<10		0
Cu	270	190					

Special benefits from moulting

When shrimp moult, it is not only the outer carapace that has been removed but part of the stomach is also renewed. Shrimp will get a new stomach surface free from bacteria. Usually, many bacteria will be colonising around the inner layer of the stomach. If the bacteria are pathogenic, they will start to gradually infect the hepatopancreas. To get away from any infection, moulting is a way to reset the stomach condition, if shrimp is still strong enough and able to moult. Many farmers apply beneficial bacteria with feed that can control Vibrio at the first meal after a moult and continue for 3-4 meals to make sure that the stomach will be free from pathogenic bacteria.

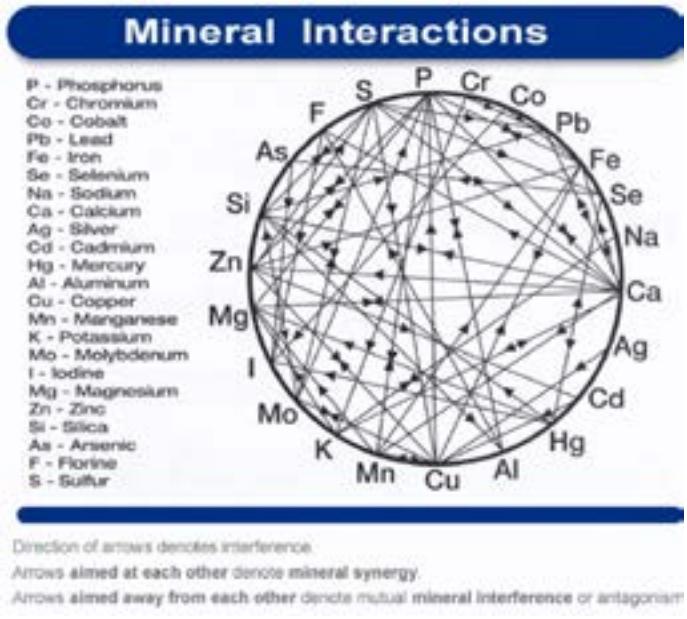

Figure 1. Mineral Interactions wheel. Source:criticalelements.au.com

Post moulting

What should a farmer do after moulting? In the case of feeds, supplementing with effective probiotic bacteria is beneficial. Vitamins, minerals and protein extracts will help to bring shrimp back to optimal conditions and prevent adverse impacts on the shrimp when there is a sudden change in environmental conditions. In the case of water, pH, alkalinity and mineral contents should be checked. If some value is not correct, there should be an immediate mitigation step.

My message

Mineral and moult management are necessary steps even if stocking is done in high saline waters as shrimp are stocked at far higher density compared to that in the wild. Poor or mis-management could bring down a chance of success. To manage this properly is not that hard, we just need to understand the science of moulting.

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Aquafeeds in Asia: More players less demand in 2017

By Zuridah Merican

The rise in shrimp feed production in India contrasted with stagnant and lower freshwater fish feed demand in many parts of Asia as fish prices decline.

In 2017, developments in the aquafeed industry in Asia can be described as such. India's shrimp feed production increased to more than a million tonnes. However, this high demand for shrimp feed continued to attract new players resulting in a possible 200% overcapacity. On the other extreme is the decline in local production in Malaysia and rising competition from imports of shrimp and marine fish feeds. Overcapacity is reported all over Asia particularly with the entry of new players. China's major aquafeed players are moving out to tap potential markets in Asia, contributing to the worries of local players trying to survive in an already crowded market. In China, the government's strict environmental policies and food safety regulations continue to affect the aquafeed business.

With regards to bottlenecks, producers cited rising costs of raw materials linked to rising commodity prices and the strengthening of the US dollar. Producers counter the situation by increasing feed prices and changing feed formulations. However, in some countries with very low fish prices, there is resistance from farmers for any price increases; feed millers then try to maintain costs by adjusting formulations to retain sales. "In China, there is an increased use of soybean meal and soy protein concentrate to replace fish meal but with addition of hydrolysed fish protein and taurine etc," said Zhou Enhua, Aquaculture Technical Manager, US Soybean Export Council. Other producers cite replacements of fish meal with a range of products from poultry meals, swine meals, plant protein meals and insect meals.

Fish meal free feeds

The inclusion rates of fish meal in shrimp feeds have been reduced to 20% and less than 10% in fish feeds in Indonesia. According to the Indonesian Feed Mill Association (GPMT) data, imports of fish meal were more than 250,000 tonnes in 2017. However, Erwin Suwendi, Head of Nutrition and QC, Aquaculture Division, Japfa Group, said that in the case of certain freshwater fish feeds, the company has managed to market commercially fish meal free feeds. "We have been conducting this FM/FO replacement study many years back and currently is extending to other commercial species."

"Low phosphorus diet means that the diet is closely meeting the nutrient requirements of the fish, yet it's not exceeding.." - Erwin Suwendi

Slow sinking marine fish feed on display at the Sheng Long Bio-Tech International stand at Asian-Pacific Aquaculture 2018, Taipei, Taiwan.

At TARS 2017, Erwin said,"Japfa Comfeed is the first company to produce low phosphorus tilapia feed. Low phosphorus diet means that the diet is closely meeting the nutrient requirement of the fish, yet it's not exceeding. JAPFA is the only company from Indonesia invited to participate in the Free Fishmeal/Fishoil Feed (F3) challenge in the US."

The challenge require a feed company to develop and sell feeds without fish meal/fish oil. During the recent Aquafeed Horizons Asia 2018 conference in Bangkok, Dr Kevin Fitzsimmons from the University of Arizona, a challenge sponsor, presented details on the next challenge, which is fish oil free feed, "In this contest, companies producing algae products, single cell bacteria and yeast products, insect farmers and animal by-products companies will compete to determine which among them will be able to sell the most of their qualifying oil products to be used in aquafeeds. The prize for this contest has already risen beyond USD100,000 with groups and individuals adding to the amount via crowd source funding at the F3 challenge (f3challenge.org)." At the last F3 challenge, China's Evergreen Group won the first prize of USD200,100 by selling more than 83,000 tonnes of tilapia and carp feeds with no fish meal or oil in 18 months.

"There has been a continuous expansion in feed milling capacity in shrimp. So, feed manufacturers are unable to raise shrimp feed prices. There has been no respite in the fish farming situation also." - Victor Arul Suresh

Replacing fish meal and fish oil is a top agenda among most aquafeed millers because of the requirement for sustainability. In Indonesia, a producer reported the difficulty in procuring 65% CP fish meal. Feed millers find that they cannot replace fish meal at the same cost for the same growth performance especially in shrimp. "Fish meal and fish oil reduction in feed is not the

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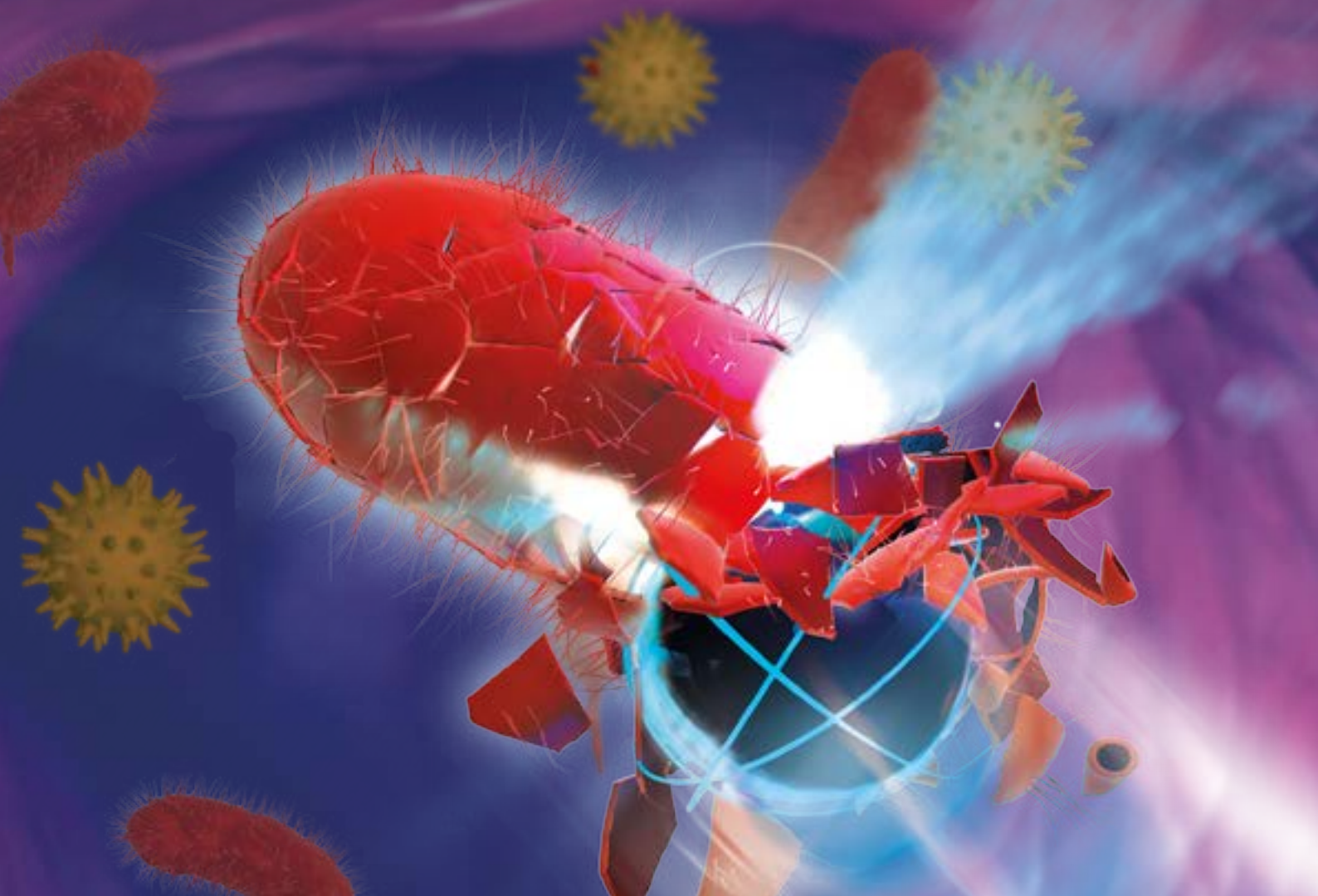

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Ton Hovers, Director of Business Development, De Heus (centre) with the De Heus team at the 11th National Shrimp Congress in November 2017. From the left: Jo Garde and Mark Newman, Consultant, De Heus Animal Nutrition Phils. Inc.; Freek Huskens, Feed Consultant and Kelvin Kahn, De Heus Vietnam. Newman presented on Innovations in Marine Shrimp Nutrition and Feeding

challenge in feed production because of the continuing R&D efforts to find alternative raw materials to replace fish meal and fish oil for optimum growth of shrimp and fish. The real challenge is how to reduce the feed cost with the alternative raw material," said Dr Chen Ming Dang, Charoen Pokphand Foods Ltd (CPF), Thailand.

Formulators cannot use least cost formulations and all replacements lack attractants and require the addition of amino acids and fatty acids. Fish meal is thought to possess an unknown growth factor. New alternatives for fish oil are algae-based oil but these are expensive for the moment. There are various

Table 1. Industry estimates [1] on feed consumption in 2017 (tonnes) in selected countries in Asia.

	Feed consumption in 2017 in tonnes		
Country	Shrimp feeds	Fish feeds	Marine fish feeds
China	1,200,000 -1,650,000 ↓	15,400,000-16,000,000	3,000,000-3,500,000 ↑
Thailand	450,000 ↓	450,000 ↓	45,000
Vietnam	450,000-500,000	2,700,000-2,800,000 ↑	-
Indonesia	330,000 ↓	1,262,752 ↑	-
India	1,030,000 ↑	870,000 ↓	-
Malaysia	85,000	96,000	-

[1] Estimates by feed industry and other stakeholders. Arrows indicate changes in volumes versus 2016. No arrow indicates no change or adjusted figures with regards to the report for 2016 in issue May/June 2017, Aqua Culture Asia Pacific.

Thailand- Fish feeds comprising feeds for tilapia 30% and *Clarias* catfish, 35%

Vietnam-90% for pangasius fish, estimated at 1.2-1.4 million tonnes of fish

Indonesia- Aquafeed Division, Indonesian Feed Mill Association (GPMT)

India- Fish feeds, pangasius (500,000 tonnes), pacu (250,000 tonnes) and carps (100,000 tonnes)

Malaysia-includes shrimp and marine fish feeds imported from Thailand, Taiwan and Vietnam

India- includes 40,000-50,000 tonnes of imported shrimp feeds, mainly from Vietnam

alternatives for fish meal, ranging from single cell proteins, fermented soybean meal, soy protein concentrates, krill meal and insect meals. With the exception of krill meal, other replacements require the addition of amino acids to mimic fish meal. Insect meal production is gaining traction in Asia with local production facilities being established, but in some countries, producers face registration issues.

The search for replacement is most critical for the industry in Thailand, faced with the illegal, unreported and unregulated (IUU) fishing issue, although there has been progress by the Thai government to address this. In 2017, the European Commission (EC) issued a 'yellow card' warning to Vietnam over IUU fishing which prompted the Vietnam Association of Seafood Exporters and Producers (VASEP) to organise a seminar during Vietfish 2018, to tap stakeholders' views and also experiences from Thailand. In Thailand, the Sustainability Standard for Feed Raw Material Office, CPF, said, "Thailand had made considerable progress in addressing the problem of illegal fishing practices with progress on the more effective enforcement of old and new regulations. In parallel with the government's effort, the Seafood Task Force (STF) comprising US/EU retailers, Thai manufacturers and NGOs, has also made progress to ensure non-IUU ingredients and good labour practices in their supply chain."

Functional feeds

At the roundtable session during TARS 2016 covering the shrimp aquaculture industry, feed industry stakeholders underlined the need for functional feeds and feed additives to mitigate diseases as well as to address general shrimp and fish health. In Asia, few functional feeds are declared as functional feed or are aggressively promoted as commercially successful. However, this did not imply that there are no functional feeds in use or no R&D on functional feeds. In comparison, the salmon is one mainstream product for which feed companies have developed many functional feeds to meet the need of farms. In the Mediterranean, feeds for seabass and seabream farming have evolved towards some functional claims: health, environmental and seasonal needs.

The challenges faced by feed millers include continued production without sufficient demand or urgent production in response to an emergency request from a farm to address a problem. The other poser is whether so many functional feed types can be produced/marketed to address all the diverse systems in use in Southeast Asia. Shrimp is farmed in very different conditions and density and it is impractical for feed companies to meet the demands for the many varied recipes.

At the farm level, the question is whether feed companies can absorb or justify the higher feed cost since cost conscious farmers perceive functional feeds as more expensive than standard feeds, despite the benefits. This is because farmers based their decisions on cost per kg of feed rather than cost per kg of fish or shrimp. Other issues raised were measurability, predictability on performance, liability and trust. The non-disclosure of additives in feeds to the farmer could be because of secrecy and competition. It could be because some feed millers want to see a track record of repeatable success before they really launch a functional feed product.

However, with several feed additive companies marketing in Asia, it is probable that feeds already contain functional ingredients. The trust deficit is demonstrated by many farmers top dressing feeds. Today, many feed millers overcome this by supplying formulated probiotics for gut health such as NutriFeast and Nutrigut produced by The Waterbase in India. The probiotics are to be applied during each feeding to control pathogenic bacteria in the gut. In contrast, there is the iFeed by Deepak Nexgen which has immune boosters in its ingredient list. In

"Shrimp feed consumption dropped as a result of closure of farms in Lampung. It was also constrained by singular outbreaks of white faeces disease, WSSV, infectious myonecrosis virus or their combinations.."
- Haris Muhtadi

Visiting Victam Asia 2018 in Bangkok, Marlito C Uy and Erwin Calimpusan, Alturas Group, Philippines, with Ramesh G, Wenger, India (centre)

the Philippines, Tateh Feeds announced that it has an advance growth booster for four functions; molt booster, immuno booster, health gut and appetite stimulant (Tateh Newsfeed, 2017). In India, Growel Feeds recently launched its Nutriva™F15, an extruded functional feed for the vannamei shrimp, and is the second company to do so after Grobest Feeds. Nutriva™F15 has patented immunity enhancing nature-derived molecules that stimulate immunity and actively work against pathogens. It is recommended for all meals when stress or disease threats are expected.

Shrimp feeds

In 2017, **India** was a leading producer with more than one million tonnes. "2017 was a good year for the shrimp feed industry due to the growth of the shrimp farming sector and stable and relatively low ingredient prices. However, 2018 has started with ominous signs for the aquafeed industry. Fish meal and soya prices rose to very high levels. Shrimp production was affected by the periodic occurrence of white spot syndrome virus-WSSV in the first few months. Farm gate prices of shrimp have fallen forcing farmers to reconsider stocking. There has been a continuous expansion in feed milling capacity in shrimp. So, feed manufacturers are unable to raise shrimp feed prices. There has been no respite in the fish farming situation also," said Dr Victor Arul Suresh, Aquafeed Consultant.

Feed conversion ratio (FCR) was calculated at more than 2:1 based on shrimp production of 600,000 tonnes and 2.3:1 based on a lower estimate of 550,000 tonnes which stakeholders noted that this implied either an inefficient farming industry or poor feed efficiency. Shrimp production costs in India rose to USD4.42/kg in 2017 due to the lower survival rates of 55% and longer days of culture of 110-150 days for 18-22 g shrimp. Feed costs increased as the success rate was only 60% in 2017. In contrast, farmers reported an average FCR of 1.6 with the best at 1.2 to 1.3. Despite poor production figures, shrimp farms in **Malaysia** reported an FCR of 1.6 for successful ponds and 2.2 for non- performing ponds. A market survey gave average values of 1.8.

"At a salinity between 15 - 25 ppt, farmers using Sheng Long's shrimp feed reported FCR 1.1 to 1.2 with a stocking density of 50-60 PL/m^2. Shrimp size was 20-25 g in 90-100 days. At higher salinity, of 35-40 ppt, such as in coastal areas in Tamil Nadu, farmers can get 20-25g in 100-120 days with a FCR of 1.4 to 1.5. Recently in Sirkali, Tamilnadu, our farmers could achieve size 60/kg (16.7g) in 60 -80 days,"said Kumaresan, Manager, Sheng Long Bio-Tech (India) Pvt.

Two years ago, IB (Indian Broiler) India, diversified into shrimp feed production and began to produce extruded shrimp feeds. Gulrez Alam, Director, IB Group, said that it has now returned to pelleting shrimp feeds. In 2017, it produced 20,000 tonnes of shrimp feeds alongside 250,000 tonnes of fish feeds. "IB's shrimp feed business is growing at 100% per year," added Gulrez.

In **Indonesia**, the estimated consumption in 2017 was 330,000 tonnes of shrimp feed, comprising 290,000 tonnes of feeds for the vannamei shrimp and 40,000 tonnes for the monodon shrimp. Haris Muhtadi, Head of the Aquaculture Division at GPMT noted that shrimp feed consumption dropped as a result of closure of farms in Lampung. It was also constrained by singular outbreaks of white faeces disease, WSSV, infectious myonecrosis virus or their combinations as well as the lack of infrastructure for development of shrimp farms in new areas. The projection for 2018 is a growth of 5-7% with new investments in shrimp farming in Jabar, Lampung Barat, Sumbawa, Lombok, Bangka and Bengkulu. "New investors in the shrimp farming sector still see that the shrimp price is consistently high. But we see the effect of diseases and farmer's lower margins," said Rudy Purwono, Director at PT Matahari Sakti. The company is already marketing extruded starter feeds and will soon venture to produce larger sizes extruded feeds for the shrimp grow-out market. "The advantage will be higher digestibility and better palatability," added Rudy.

More than feeds

In **Vietnam**, compared to 2016, the shrimp feed market increased by 25% to 450,000 to 500,000 tonnes. Production was led by Grobest Feeds, Charoen Pokphand Vietnam, Uni President Vietnam (UPV) and Sheng Long Bio-Tech International. "Because of heavy mortality with early mortality syndrome (EMS) which reduced survival from 70% to only 10%, we can see the range of FCR from 0.9 to >2.0. The average is 1.3. The best FCR is only achievable in the southwest with low salinity of 3-5 ppt and stocking density of 50 PL/m^2 and size 100/kg in 45 days. The survival must be higher than 85%," said Hai-Hua Liou, Director at UPV. "The cost of production has risen to USD3.3 to 3.5/kg to produce size 100/kg and our main target is to help farmers reduce cost".

Liou added "In 2017, the biggest challenge was how to get the shrimp to survive when the culture situation was not conducive. Using the same feed, we found that FCR can change drastically and the farmer will blame the feed. Therefore, we began to work closely with the farmers and developed shrimp health products such as probiotics to help in the farming, and *Lactobacillus* for gut health to prevent vibriosis. Our dealers work with farms to apply probiotics directly into ponds as the product cannot withstand high feed processing temperatures. For more than 2 years, farmers have been using disinfectants in ponds, killing off bad bacteria. Now, we ask them to apply probiotics."

With regards to farm conditions, the vannamei shrimp cannot withstand highly polluted waters and following the concept that post larvae need a clean environment, farms are also encouraged to use probiotics and alternatively exchange water 24/7. In some instances, ponds are lined with 0.5mm HDPE liners and use ground water as the water source.

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Rudy Purwono (second left) with Anwar Hasan, Biomin (left) and participants from Indonesia at Asian-Pacific Aquaculture 2018, Taipei, Taiwan

Ma Patricia Rico, President, Santeh Feeds Corporation, Philippines (middle) and team at the 11th National Shrimp Congress in November 2017.

Fish feeds

The largest fish feed market in Asia, **China** produced around 16 million tonnes of fish feeds, comprising feeds for the carps, tilapia, white Amur bream *Parabramis pekinensis*, snakehead and California bass. Feeds for the various marine fish species include those for the seabass, pompanao and eels. Tilapia feed consumption totalled 1.4 -1.7 million tonnes despite low international prices for the fish. An interesting development in China was the massive imports of pangasius fillet from Vietnam. This boosted the demand in Vietnam and fish prices rose to a 10-year high. It has also created interest in China to farm the fish such that the feed usage reached 20,000 tonnes in 2017. Farms in China sourced juveniles from within and outside the country. Industry expects a surge in pangasius production which could increase feed demand by up to 200% in 2018.

The white Amur bream is the latest popular species using 800,000 tonnes of feed but in contrast to the pangasius catfish, it is not expected to increase in volume. Some newly farmed species of interest are the California bass and the crayfish *Procambrus clarkii*. Industry said that the feed market is benefiting from high fish/shrimp prices and could raise prices in line with rising raw material costs. However, in the future, fish farming in cages may decline with the very strict environmental policies and prohibition on the installation of cages in large lakes. Prices for extruded grass carp feed were USD0.43/kg and USD0.38/kg for pelleted feeds. Tilapia feed cost USD0.65-0.85/kg when extruded and USD0.5-0.6/kg for pelleted feeds.

Vietnam's fish feed market grew rapidly in 2017. This excluded farm-made feeds. "Farm-made feeds are for feeding mainly marine fish," said Nguyen Thi Minh Huong, Manager, Behn Meyer Vietnam. "There was a surge in the production of the pangasius as fish prices reached a high of VND25,000/kg as compared to a low of VND18,200/kg in early 2017. A total of 1.2-1.4 million tonnes of fish were produced using 2.8 million tonnes of feed. "Feed prices have increased but as the price of fish has increased too, farmers accepted the higher feed prices." said Huong. The leading producers for pangasius feeds are Proconco, Viet Thang and Green Feed. There are new players in this feed market in 2017, including Sao Mai Super Feed which has a 350,000 tpy capacity and IDI which has a total capacity of 360,000 tpy. IDI is a pangasius fish integrator with processing facilities and farms. In 2017, the feed plant was expected to supply 150,000 tonnes of aquafeeds (42% of capacity), all for internal use.

In Malaysia, Indonesia and India, industry players do not expect growth in the freshwater fish farming sector. In **Malaysia**, consumption in 2017 remained stable. Low prices for the tilapia and for the *Clarias* catfish affected feed sales. Small scale catfish farmers shift to using farm-made feeds when fish prices fall below their production costs.

"In India, it was not as good a year for the fish feed industry as the area for freshwater fish farming in the state of Andhra Pradesh shrank due to the expansion of shrimp farming and lower prices for pangasius in the West Bengal market. There has been no respite in the fish farming situation also. Freshwater farming expanded in states other than Andhra Pradesh but most feed manufacturers are located in Andhra Pradesh and high logistics cost impacted margins for feed manufacturers," said Suresh.

In 2017, there was a large impact on sales of extruded and pelleted feeds for the pangasius fish in India as fish prices dropped. Pangasius feed prices were INR35/kg (0.52/kg) and INR25/kg (0.37/kg) for extruded and pelleted feeds, respectively whereas fish prices dropped to INR38/kg. A feed miller indicated the possibility of fish feed sales dropping to half of that in 2016. Added to this, many ponds in Andhra Pradesh were converted

to farming vannamei shrimp, reducing the market for pangasius fish feeds. As feed millers already faced high credit risks with pangasius fish farmers, an industry stakeholder added that it is possible that only the fish traders are farming the fish and that in the future, there may be more monoculture of vannamei with rohu fish using pelleted feeds.

Indonesia is a large producer of the *Clarias* catfish. Annual production by small-scale farmers is around 400,000 to 450,000 tonnes (Azam, 2018). It is also a large producer of the tilapia and at the largest tilapia farm PT Aqua Nusantara, only extruded feeds are used to protect the lake environment." Feed consumption is expected to increase by only 2-3% in 2018, largely because of the implementation of the zoning regulation for fish farming in lakes, mainly Jatiluhur, Cirata and Toba," said Haris. He added that upwelling in lakes will continue. "From the point of view of water usage, the *Clarias* catfish can grow well in limited water with production of 30-100kg/m^3 and its farming serves as a source of fish supply, with freshwater resources becoming limited," said Azam Zaidy from the Association of Catfish Farmers Indonesia. Feed demand for both these catfish is expected to rise by 3-5% in 2018.

Hai-Hua Liou (left) with James Hung (second right) and Kuek Sian Chai (third right) and the Uni President Vietnam team at the 11th National Shrimp Congress in November 2017.

Organic growth and expansion

In **India**, the leading shrimp feed miller Avanti, together with CPF and Growel Feeds took 70% of the shrimp feed market in 2017. Industry is also crowded with many players in the 15,000 to 45,000 tpy capacity range. Avanti, a dedicated shrimp feed producer with five plants in the east coast (all in Andhra Pradesh) and one in Gujarat in the west coast is also expected to expand to supply feeds to the newer shrimp farming areas in Orissa and West Bengal, according to Mohanty S, Deputy General Manager at Avanti Feeds Ltd, during AquaIndia 2018. Avanti also expects the production to increase 10% in 2018. It already has two shrimp processing plants in Andhra Pradesh. Growel Feeds is the only feed company with a dedicated R&D centre and team as well as a farm to monitor the results of its feeds. It exports both shrimp and fish feeds to 12 countries globally. Cargill added a second feed plant in India in 2017.

The newer feed producers such as BMR, Dewi Seafoods and Falcon which have diversifed upstream from the shrimp processing business generally have buy back schemes with

In Vietnam, a new fish feed producer is Sao Mai Super Feed which has a 350,000 tpy capacity.

Kumaresan (third right) with Maple Hung (right) and Jeff Jie Cheng Chuang (fourth right), Sheng Long Bio-tech International, Vietnam together with speaker Grace Lo Chu Fang, National Cheng Kung University, Taiwan at AquaIndia 2018.

farms. In India, Dewi Seafoods which already has two feed plants in Rajamundry is expected to set up a plant in Ongole.

In 2017, shrimp feed imports into India were by Sheng Long, UPV, Evergreen, Tongwei and De Heus. Vietnam's Sheng Long is expected to start local feed production at its feed plant and operate a hatchery in Tamil Nadu in 2018. Evergreen which established itself in Egypt with tilapia and other fish feed production, is also seeking to enter the Indian feed market. Current and expanding markets for India feed millers are shrimp and fish feed markets in Bangladesh (tilapia & pangasius feeds), Myanmar, Sri Lanka, Middle East and Africa (tilapia and catfish *Clarias gariepinus*).

Sheng Long is also expanding within **Vietnam** with a new plant by 2019, adding to the current two plants. UPV opened its feed market in Thailand supplying 40% crude protein seabass feeds for intensive culture of seabass in Thailand. UPV has continued to supply marine fish feeds to farms in Vietnam and also exported 12,000 tonnes of fish feeds for the grouper and seabass farms in Malaysia.

The concern within industry in several countries since 2016 was the influx of foreign feed millers to set up shrimp and fish feed production, despite a general overcapacity in these countries. Six new players are expected to enter the industry in **Indonesia**:

Johnny Lu (left) and the Green Era Bio-Tech Corp, Philippines team which produces Biogreen Vannamei Feeds with spray-on multistrain probiotics for stocking density of 100-150 PL/m².

Thailand's Thai Union, China's Guangdong Haid, Tongwei and Evergreen and Vietnam's Neovia. In May 2018, a seafoodsource.com blog said that the leading Chinese aquafeed player in China, Guangdong Haid has signed a cooperation partnership with Swiss-based equipment maker Bühler to build a feed plant in Indonesia, focussing on the shrimp feed market.

Denmark's Aller Aqua opened a feed mill in Qingdao, **China**, in November 2017 while Biomar has a joint venture with Tongwei. Dutch animal feed producer De Heus which has two aquafeed plants in Vinh Long and Hanoi in Vietnam is looking at local production in Indonesia, the Philippines and India. De Heus is already exporting 6,000 tonnes of 0.5 to 0.8 mm fish starter feeds to Bangladesh. Neovia is already exporting shrimp feeds to Bangladesh, India, Indonesia and the Philippines and is looking at options to produce locally in some of them.

The main players in **Malaysia** producing shrimp and fish feeds are Asia Aquaculture (part of CPF Thailand), Gold Coin, Dindings, Cargill, Leong Hup, and Vio Star, a subsidiary of Taiwan's Grobest Feeds. The Evergreen group working together with the major marine fish producer, GST, is expected to start production of both fish and shrimp feeds by May 2018. In 2017, a major part of the shrimp and fish feeds used in the country were imported feeds from Vietnam, Thailand and Taiwan. Shrimp farmers, especially in East Malaysia, favour feeds imported from Vietnam citing better quality feeds and a shorter sea freight time than from Peninsular Malaysia. Malaysian stakeholders, in general, indicated a poor outlook for feed consumption in 2018. They do not expect demand to grow as shrimp farms face diseases while prices of freshwater fish continue to be low. Only the marine fish sector may grow.

Shrimp feed costs

In 2017, as shrimp prices continued at the highs of 2016, shrimp feed price was of little concern for farmers. Locally produced shrimp feed prices in Malaysia hovered at MYR4.60/kg or USD1.1/kg based on 2017 exchange rates. Imported shrimp feeds cost are also competitively priced at the same levels. Some farms opted for a functional feed from Vio Star for the monodon shrimp sold at MYR6/kg (USD1.42/kg). In India, the farmer may pay INR71-72/kg (USD1.1/kg) for grow-out vannamei shrimp feeds. Prices have remained stable for the last 2 years. According to Dhanunjaya Goud, Regional Aquaculture Manager-Asia, Lallemand Animal Nutrition, India, said that despite rapid changes in exchange rates affecting costs of raw materials, the older and established

Dr Wiboon Lapjatupon, Inteqc Feed Co., Ltd, Thailand and sons, the second generation for one of Thailand's leading feed companies.

players are keeping to low feed prices while the newer players are inclined to raising prices. Prices were much higher for marine shrimp feeds in China: USD1.2-1.5/kg for vannamei and monodon shrimp feeds.

Early in 2017, prices for seven brands of feeds in Indonesia ranged from IDR14,000 to 18,000/kg (USD1.05 to 1.34, budidayaudang.com). Aside from the impact of the higher US dollar on prices for all raw materials, Erwin said, "All our import tariffs and taxes on almost all feed raw materials are making our feed costs higher too. In 2018, we are already seeing price increase by IDR500/kg for shrimp grower feeds and IDR650/kg for shrimp starter feeds".

Acknowledgements

In addition to those quoted in the text, the author would like to thank many others for sharing their insights on recent developments in the industry and requested anonymity.

The Growel Innovation Centre in Andhra Pradesh. In India, Growel Feeds is the only feed company with a dedicated R&D centre and team as well as a farm to monitor the results of its feeds.

2018 Alltech Global Feed Survey

The estimates for world feed production in 2017 was 1.07 billion tonnes and aquafeeds accounted for 4% of global feed production.

The 2018 Alltech Global Feed Survey, released in January 2018 estimated that global feed tonnage was 1.07 billion tonnes in 2017. The growth was strong at 2.57% over 2016. The feed industry, valued at USD 430 billion, has seen 13% growth over the past five years, equating to an average of 2.49 % per annum.

The seventh edition of the annual survey is the most comprehensive ever, now covering 144 countries and more than 30,000 feed mills. The results show that China and the US remain the top two countries, producing one-third of all animal feed.

"Now in its seventh year of analysis, the Alltech Global Feed Survey continues to serve as a valuable report on the state of the global feed industry," said Aidan Connolly, Chief Innovation Officer and Vice President of corporate accounts at Alltech. "In addition to its insights into the feed industry, it serves as a barometer for agriculture as a whole and oftentimes demonstrates the economic strength of the countries included in the survey."

The Alltech Global Feed Survey assesses compound feed production and prices through information collected by Alltech's global sales team and in partnership with local feed associations in the last quarter of 2017. It is intended to serve as an information resource for policymakers, decision-makers and industry stakeholders.

The Asia-Pacific region accounted for more than 35 % of the world's feed tonnage. China remained the top feed-producing country in the world with 186.86 million tonnes, a slight decline in overall feed production compared to 2016.

Aquafeeds

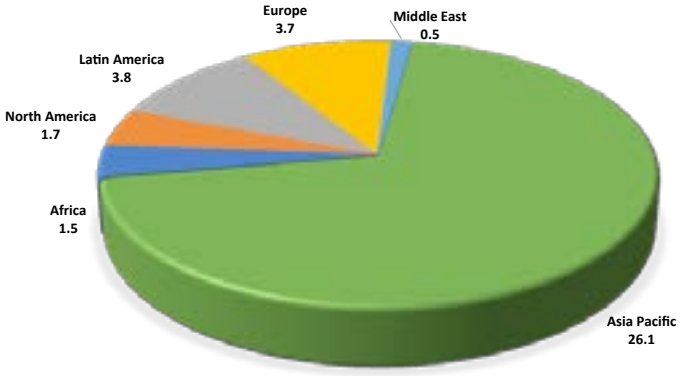
Aquafeeds remained stable overall in 2017. Seventy % of aquafeed production was in Asia-Pacific. The numbers showed a slight decline in the Asia-Pacific region, but an increase in Europe, Latin America and the Middle East. African countries mainly increased aquafeed production, but one of the larger producers, Egypt, saw a decline. Brazil, Chile and Peru led the increase in production in Latin America, as did Iran in the Middle East. China reported a decline of 5% this year and in 2016, which could be linked to government controls on feeding practices and food safety, such as the administration of antibiotics. India showed 8% growth in aquafeeds for shrimp, prawns, carp and catfish. Five % of India's feed market in 2017 was aquafeeds.

Carp leads the production of aquafeed, followed by shrimp and tilapia. Catfish, salmon and trout also ranked on the species feed indicator, though to lesser degrees. The continued weakness of aquaculture in China and to a lesser degree in the rest of Asia Pacific, has been linked to changes in consumption, disease outbreaks and a consolidation of the industry. Additionally, government controls on feeding practices and food safety, particularly the administration of antibiotics, may be having an influence on production levels

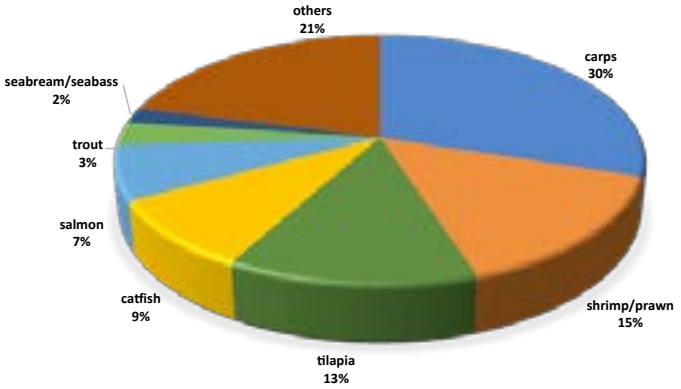
Vietnam also reported a decrease of about 9%. Indonesia fell 17% as did Taiwan and Japan, each reporting drops of 9% and 3%, respectively. These trends have been in progress over several years and reflect disease outbreaks, particularly in shrimp, and a growing consolidation of the industry into fewer larger and more sophisticated farms.

"The Alltech Global Feed Survey provides valuable data and insights on the health of the feed industry and agriculture as a whole," said Connolly. "As such, we will continue to offer the findings of the feed survey freely in an effort to demonstrate the significance of the animal feed industry in feeding a growing global population, sustainably and affordably." www.alltech.com

Aquafeed production by region (tonnes).



Top 7 aquaculture species in 2017



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Krill: a cost effective replacement for fish meal in shrimp diets

Even with a decade of research experience, Dr Alberto J.P. Nunes, is still discovering new ways in which krill meal can be beneficial to the growth of vannamei shrimp.

Alberto P Nunes[1], Picture courtesy of SAP.

Discussing his latest research, **Dr Alberto J.P. Nunes**, Associate Professor at the LABOMAR aquaculture facilities in Brazil outlines how krill meal can help improve feed efficiency and reduce the dependence on fishmeal and other costly ingredients.

With years of research into the application of krill meal in shrimp feeds, you have helped identify and establish the benefits of using krill. What does this latest study bring to the table?

Nunes: Having established that the inclusion of krill meal in shrimp feed can increase both the attractiveness and palatability of the feed, along with improving growth, we wanted to take the next logical step, looking at feed efficiency.

In simple terms, we wanted to gauge just how much fish meal could potentially be replaced by soybean meal, when small amounts of krill meal are added to the diet, looking specifically at juvenile whiteleg shrimp, *Litopenaeus vannamei*. In this study, shrimp were challenged under a 37 ppt salinity. This is a much higher water salinity than the optimal range of 20 to 25 ppt for this species. However, many shrimp farming areas suffer from high salinity which causes loss in feed efficiency.

So, what exactly was the composition of the shrimp diet used in your study?

Starting with a control diet of 15.0% fish meal, 36.4% soybean meal, 3.0% fish oil, 1.0% squid meal, 0.63% L-Lysine, 0.14% DL-Methionine, 0.26% L-Threonine, and 0.01% cholesterol, we made three additional diets containing krill. Substituting half of the fishmeal with soybean meal, we then added either 1%, 3% or 5% krill meal, at the expense of the squid meal and cholesterol.

What were the research's findings?

We found that the inclusion of 5% dietary krill meal in shrimp diets is enough to significantly reduce their dependence on fishmeal and other costly ingredients under a high salinity condition. Our research also showed that shrimp performance was unaffected, due to the improved feed intake you get when you add krill meal to feed.

In addition, comparing the 1%, 3% and 5% krill diets against the control diet, both the feed conversion ratio (FCR) and the amount of feed delivered were significantly reduced when shrimp were fed 3% and 5% krill meal.

Did the inclusion of krill meal have any effect on survival rates or final body weight?

At the end of the grow-out period, we found that survival rate was unaffected by diet. We did however see that final shrimp body weight significantly dropped with the fish meal replacement, but stabilised at 5% krill meal, compared to the control diet. Daily weight gain and final shrimp yield were not statistically different.

Talk us through how the research was conducted.

We stocked 100 animals/m^2 in 30 outdoor tanks of 1.0 m^3 (1.02 m^2 of bottom area) and reared for 65 days with experimental diets, after a 6-day acclimation period. Shrimp were fed using an automatic feeding device between 07:30 am and 05:30 pm. We then transferred harvested shrimp to five indoor tanks of 0.5 m^3, stocked at 88 animals/m^2 in order to measure feed preference.

We fed twice daily for a week, using four trays per tank, feed preference was based on feed-intake responses. Offering all diets simultaneously in the same rearing tank, each different diet was placed individually in a feeding tray resting on the tank bottom opposite to each other.

The implications of this research could be significant for the industry.

Indeed, allowing the use of less fishmeal and other costly ingredients, with no effect on shrimp survival rates or final body weight, krill meal's proven ability to improve feed efficiency will be enormously beneficial to many feed mills. However, these findings are particularly valuable to farmers that face hypersalinity conditions, seasonally or continuously. We have been able to demonstrate a similar effect in a previous study using astaxanthin krill oil. However, this is the first time we document a similar effect with krill meal.

[1] Dr Alberto J.P. Nunes presented at the conference held in conjunction with AquaIndia 2017 on "Key Topics in Aquaculture Nutrition." The title was Formulating shrimp feeds: lessons from scientific research and he showed how nutrition research and scientific formulation can really reap performance improvements within the context of new more intensive farming techniques such as nursery production systems and raceways. See pages 38-41.

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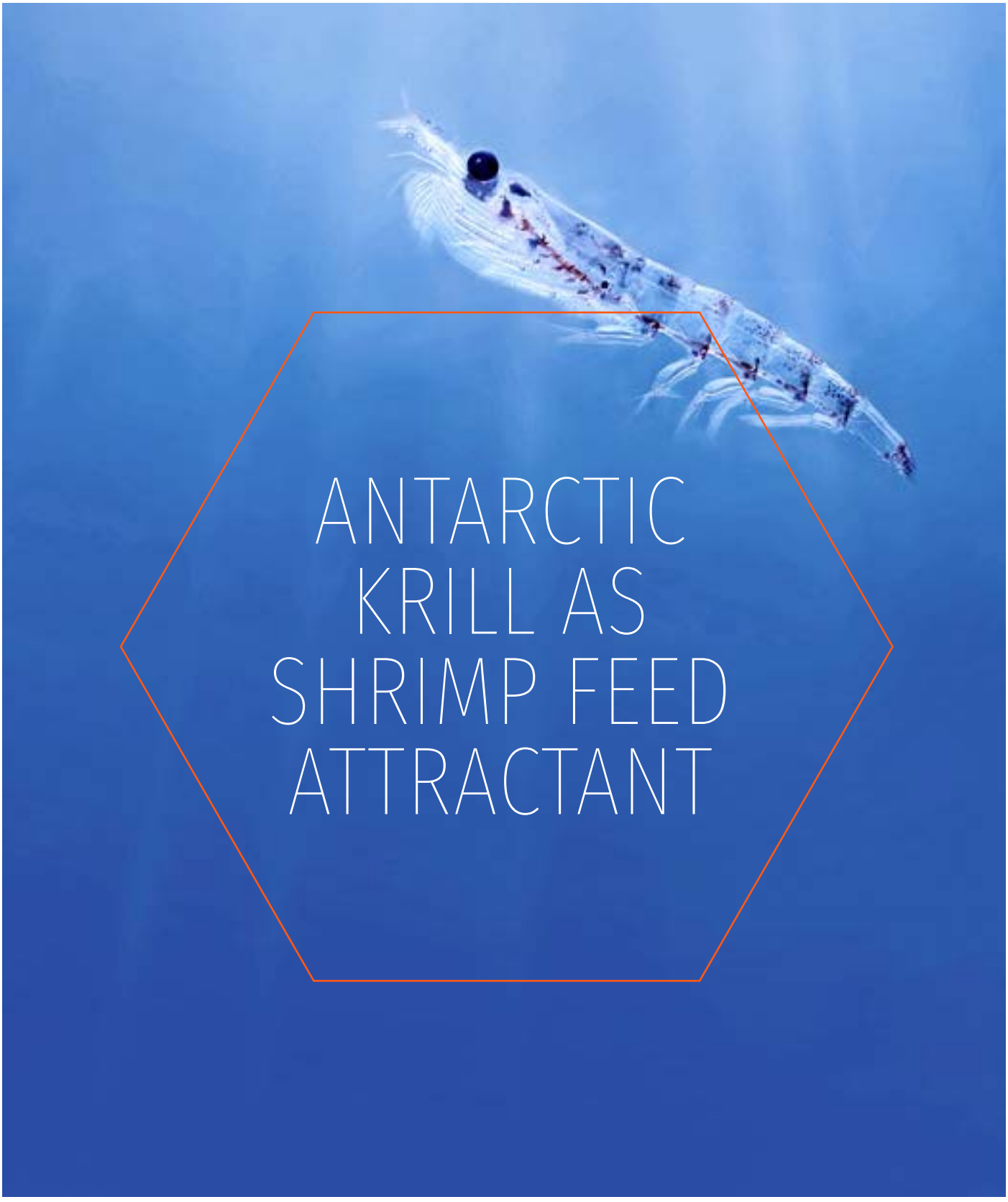

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β-glucans: immunomodulatory effects and mortality control

by Melina Bonato

Supplementation at the early growth stage of fish modulates the immune system response to infections.

For a long time, the most common method to deal with outbreaks of bacterial infections in aquaculture was the administration of antibiotics. However, aquaculture faces serious problems due to various adverse effects of these drugs such as the accumulation of antibiotics in the tissue and environmental microbial flora. Moreover, the use antibiotics or vaccines for fish is expensive and in many farms its use is unavailable (Yousefian and Amiri, 2009). Thus, the use of ingredients or additives incorporated into the feed to improve the survival rate, disease resistance and growth of fish and shrimp has been used more frequently and with successful results.

Fish, similar to mammals, have innate and adaptive immune systems. Innate immune systems are responsible for primary responses; these responses are fast, non-specific, and with no memory against recontaminations. In constrast, adaptive immune systems are responsible for specific responses which are intense responses with specific antibodies for each pathogen.

The most widely known cells in the innate immune system are the macrophages, neutrophils, dendritic cells and natural killer cells (Sharma, 2003). Toll-like receptors, located on the surface of immunological cells, recognise microbial patterns and induce an immediate innate immune response. After this activation and phagocytosis, the phagocyte presents a processed fragment of the pathogen to the adaptive immune system and stimulates an anti-pathogen response. Therefore, the phagocytes are called antigen-presenting cells. The recognition of pathogens by the innate immune system triggers immediate innate defenses and activation of the adaptive immune response (Lee & Iwasaki, 2007).

β-glucans

The yeast cell wall from *Saccharomyces cerevisiae*, originating from sugarcane fermentation for ethanol production, contains around 35% of β-glucans and 20% of mannan oligosaccharides (MOS). β-glucans are known as immune system modulators or stimulants, because when they come in contact with the phagocytes, which recognise the β-1,3 and 1,6 bindings (Petravic-Tominac et al., 2010), the latter are stimulated and will produce some cytokines, which will start a chain reaction inducing an immunomodulation and improving the response capacity of the innate immune system.

Enhancing the innate immune system response is especially important in animals during initial growth, reproductive phases, stress periods, and with environmental challenges. It acts as a prophylactic agent and increases animal resistance, and hence minimises further damages (such as a drop in performance or high mortality rates). Intensive animal production is highly challengingenvironment, thus the strengthening of the immunological system can be one of the keys towards for greater productivity.

MOS is known for their pathogen agglutination capacity (mainly those with type 1 fimbria), as well as, diverse gram-negative strains. MOS offers a binding site for pathogens, preventing the colonisation of the intestinal epithelium, and these agglutinated bacteria will be excreted together with the indigestible part of the fibre.

Innate immunity in the tilapia

In a recent study conducted at the Faculty of Veterinary Medicine, Cairo University, Egypt, by Abu-Elala et al. (data not published), tilapia *Oreochromis niloticus* (body weight, 50.7±0.8g) were divided into three experimental groups: control, 0.1% of *S. cerevisiae* yeast cell wall YCW, and 0.2% of YCW. There were 90 fish for each treatment with 3 replicates. During 2 months, the performance of fish was measured every 2 weeks, and at the end of the trial, 5 fish/replicate were euthanised in order to evaluate clinicopathological, oxidant and antioxidant parameters, relative quantitative PCR of immune gene expression, phagocytic activity (%) and index, and lysozyme activity (μg/mL). After 2 months, fish were challenged against gram-positive bacteria *Lacococcus gravaeie*, and gram-negative *Aeromonas hydrophila* and the mortality rates were observed over a one week period.

No significant differences ($P>0.05$) were found among treatments for performance results; however, non-significant numerical increases were observed. YCW improved clinicopathological results (WBCs, GPT, GOT, TP and globulin) as well as, relative quantitative PCR expression of IL1-β and phagocytic and lysozyme activities ($P<0.05$). A reduction of G-reductase enzymatic activities was observed, and 0.2% of YCW supplementation increased catalase enzyme. After the challenge with both the bacteria, mortality decreased ($P<0.05$) in both groups with YCW supplementation (Table 1).

In conclusion, the inclusion of both 0.1 and 0.2% of YCW improved clinicopathological response and innate immunity. YCW supplementation decreased oxidative enzyme activity and mortality rates when the fish were challenged with *L. gravaeie* and *A. hydrophila*, compared to the control group.

There are other studies published on the benefits of YCW supplementation in aquaculture. Ebrahimi et al. (2011) studied common carp fingerlings (*Cyprinus carpio*) infected with *A. hydrophila* and found a significant increase in survival rates and the number of leucocytes, and an improvement in the feed conversion ratio in treatment groups fed diets with YCW from 1 to 2.5%. Ebrahimi (2010) reported a decrease in total bacteria count in the intestine and an increase in the survival rate and improvement in feed conversion ratio for *Rutilus frisii kutum* fingerlings fed with YCW from 0.5 to 2.5%. Karimzadeh et al. (2013) found an improvement in survival rate, final body weight, and feed conversion ratio, as well as a decrease in total bacteria counts in the intestine in *Rutilus kutum* larvae at 0.5% of YCW supplementation.

Enhancing and modulating the innate immune system may be one of the strategies to combat infections, reduce mortality and improve productivity. If dietary YCW is supplemented at the early growth stage of the animal, the immune system will be modulated

and alerted to many infections. The action of β-glucan occurs at the innate immune system. In other words, this is where the first immune response to pathogen contamination occurs, thus avoiding a large expenditure of energy to mobilise the adaptive immune system to prevent a decrease in production and an increase in the rate of mortality.

Table 1. Performance, clinicopathological results, oxidative stress, expression of immune-related genes, innate immunity and mortality parameters of *O. niloticus* in three different treatments: control diet, and diets with 0.1% and 0.2% of *S. cerevisiae* yeast cell wall (YCW)

Parameters	Control	0.1% YCW	0.2%YCW
Final body weight (g) after 2 months	94.86	118.5	120.8
Weight gain (g)	48.1	67.8	70.4
Feed Conversion Ratio	2.1	1.73	1.66
WBCs	$130^{a} \pm 18.0$	$201^{b} \pm 17.4$	$156^{a} \pm 4.4$
GPT	$19^{a} \pm 1.1$	$23^{a} \pm 0.9$	$31^{b} \pm 1.2$
GOT	$52^{a} \pm 3.2$	$54^{a} \pm 2.3$	$74^{b} \pm 2.3$
TP	$2.23^{a} \pm 0.08$	$2.97^{b} \pm 0.08$	$2.27^{a} \pm 0.08$
Globulin	$1.34^{a} \pm 0.05$	$2.08^{b} \pm 0.03$	$1.27^{a} \pm 0.08$
Catalase	$588.73^{a} \pm 42.0$	$402.27^{b} \pm 25.4$	$618.3^{a} \pm 60.7$
G-redutase	$269.27^{a} \pm 20.6$	$142.00^{c} \pm 3.5$	$192.93^{b} \pm 21.2$
IL1-β	0^{b}	$7.5^{b} \pm 1.1$	$16^{a} \pm 1.3$
Phagocytic activity (%)	57^{b}	61^{a}	70^{a}
Phagocytic index	1.8^{b}	1.75^{b}	2.5^{a}
Lysozyme activity (µg/mL)	435.8^{b}	450.95^{a}	464.3^{a}
Mortality (%) *L. gravaeie*	90^{b}	50^{a}	60^{a}
Mortality (%) *A. hydrophila*	100^{b}	40^{a}	50^{a}

^{ab} Means with different letters in the same row differ significantly by Tukey test (P<0.05). WBCs: white blood cells. GPT: glutamate pyruvate transaminase. GOT: Glutamate oxalacetate transaminase. TP: Total protein.

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Melina Bonato is R&D coordinator at ICC Brazil. She has a Ph.D. in Animal Science. Since 2013 she has been coordinating the research and development department at the ICC Brazil, which is focused on yeast-based products studying animal nutrition, immune responses, health, and performance.
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Better fundamentals and practices in fish and shrimp nutrition

By Martin Guerin

A full house attendance underscores the industry's need to know about aquaculture nutrition, its challenges and shaping up aquaculture nutritionists of the future.

As India has comfortably held its position as the world's top exporter of farmed shrimp for the last two years, with its feed industry producing more than 1 million tonnes of shrimp feed and close to 500,000 tonnes of formulated commercial fish feed, the holding of an important international aquaculture nutrition conference in that country was befitting; what more for an industry with further growth ambitions relying in large part on quality feeds.

On the eve of Aqua India, a biennial popular industry-wide conference, the Society of Aquaculture Professionals (SAP) organised a aquafeed symposium entitled "Key Topics in Aquaculture Nutrition." It was convened by Dr Victor Arul Suresh, United Research, Singapore. The objective was to boost an exchange of knowledge and expertise in aquaculture nutrition among industry professionals, academics, and students. It had the conviction that better fundamentals and practices in fish and shrimp nutrition can help the industry achieve greater heights.

This symposium clearly indicated a deep need from the industry as demands for registration by interested participants largely exceeded the allocation of 100 seats initially planned by SAP. In the end the organisers had to accomodate 130 registered participants at maximum conference room capacity, and the full-house attendance was probably personally rewarding for the speakers who had come to share their experiences. The attendance revealed a good mix of professionals from feed companies (Charoen Pokphand Foods, Growel Feeds, Deepak-Nexgen, The Waterbase and others) and feed additive companies (Adisseo, AkerBiomarine, Bentoli, DSM, Kemin and Nutriad) were sponsors of the event, as well as researchers, farmers, students and technical consultants.

Over 50 years of aquaculture nutrition

Dr Sadasivam (Sachi) Kaushik, Chair of the European Research Area at the University of Las Palmas in Gran Canaria and an internationally renowned fish nutritionist, gave the first keynote address. He looked back at 50 years of aquaculture nutrition which helped lay down the fundamentals that the industry needs to build on. In his presentation, Kaushik reminded the audience that India's aquaculture expertise dated several centuries back, quoting the 12th century Sanskrit encyclopaedia treaty on how to feed fish.

While he reviewed the key nutrition concepts underlying aqua nutrition research, he also highlighted that modern aquaculture continued to face many challenges due to the diversity of species, the still insufficient level of nutrition knowledge, and the difficulty of turning nutrition science into successful and efficient fish and shrimp feeding and farming. Kaushik concluded by inviting as many of the participants as possible to attend the upcoming 18th International Symposium on Fish Nutrition and Feeding, to be held on June 3-7, 2018 in Las Palmas de Gran Canaria, Spain, with the hope that enough attendants from India could help sway the decision to hold the next event in India.

Dr Victor Arul Suresh (right) with Michael Jegan, Aquaculture Lead in United Research, Singapore. Jegan worked at Maram, a tilapia and ornamental fish culture venture in Saudi Arabia. He also won one of the 5 awards from Evonik for his thesis work on amino acid nutrition in tilapia.

Industry challenges in India

The second keynote address by this writer focused more on India's aquafeed industry challenges, identifying diseases, antibiotic residues, local fish meal shortage and high prices, and resulting high production costs as the main challenges. India's industry-wide shrimp feed conversion ratio (FCR) of 2.2 is alarming, and while India's production continues to expand in large part due to the expansion in farming area and possibly

Dr J. Biju Sam Kamalam, Scientist, ICAR-Directorate of Coldwater Fisheries Research, India speaking on advances in aquaculture nutrition research. Biju is a young aquaculture nutrition scientist who did his PhD in carbohydrate metabolism of trout at INRA, France.

Dr Rina Chakrabarti, Professor of Aquaculture Nutrition, Delhi University, moderating the session on research & education for advancing aquaculture nutrition.

Alexandros Samartzis (left) presented on amino acids in aquafeeds and Fuci Guo on enzyme applications in aquafeeds.

an increase in stocking density, the need to reduce the impact of diseases, prevent reoccurrence of international detection of antibiotic residues, and reduce feed costs is critical.

Role of feed additives

Focusing on these challenges, I illustrated how nutrition and health are related and how functional feeds or feed additives such as organic selenium (hydroxyl-selenomethionine) can help improve fish and shrimp health, aid resistance to stress and disease, and replace fish meal.

Later **Dr Fuci Guo**, DSM Nutritional Products, Asia Pacific and **Dr Alexandros Samartzis**, Evonik South East Asia, further expanded on these concepts showing how feed enzymes and amino acids can also help. Guo explained how phytase and xylanase, already widely used in land animal feeds, can improve plant proteins nutrient utilisation and FCR and reduce water pollution, while protease also assists in fish meal replacement strategy. Samartzis focused more on the role of synthetic essential amino acids in protein optimisation, reviewing the comparative biological values of various forms of methionine for fish and shrimp, and proposing AminoShrimp® tool to optimise shrimp feed performance. Prior to this, **Alexandre van Halteren**, Nutriad

From left; Narottam Prasad Sahu, Sadasivam Kaushik and Martin Guerin.

showed how optimising lipid nutrition through better digestion helped by natural emulsifiers, can improve feed performance.

Shrimp feed formulation

Dr Alberto Nunes, Associate Professor at Labomar, Brazil, gave a comprehensive lecture on feed formulation and practical nutrition for shrimp farming. He showed how nutrition research and scientific formulation can really reap performance improvements within the context of new more intensive farming techniques such as nursery production systems and raceways. Van Halteren reviewed the analyses results from Nutriad's recent survey of Indian commercial shrimp feeds to illustrate the variability in nutritional quality of feeds proposed to Indian shrimp farmers. This survey's results revealed feeds with crude protein ranging from 33.9% to 40.7% and crude fat from 5 to 7%, as well as highly variable amino acid profiles.

Public research perspective and building the next generation of aqua nutritionists

The late afternoon session of the conference was turned over to the academicians. **Dr Narrotam Sahu**, Professor & Head of Aquaculture Nutrition, Central Institute of Fisheries Education, Mumbai, highlighted the need to train more fish nutritionists fuelled by a growing need for formulated feeds. He pointed to the growing need for animal and fish protein against limited natural and agricultural resources, using the examples of limited capture fisheries or of India's limitations in supplying rice bran to support the demand from traditional carp farming and other competing activities relying on this agricultural by-product. Indeed, de-oiled rice bran (DORB) is the main component of farm-made carp feeds, which have a high FCR, while formulated feeds can be significantly more efficient and therefore reduce the FCR and need for rice bran. He further indicated that the training needs for aqua nutritionists should address changes in nutrition science induced by the growing importance of genetics, fish health and environmental impact and emerging technologies such as nano-particles or genomics.

Dr Biju Sam Kamalam, a young scientist at ICAR-Directorate off Coldwater Fisheries Research, continued by reviewing the topic 'recent advances in aquaculture nutrition'. He used the example of trout to show how "genetic X nutrition" interactions need to be integrated in research programs. For example in fish meal replacement strategies, selecting strains better adapted to plant protein utilisation can accelerate progress. Genetics can also affect fat deposition or carbohydrate metabolism. Nutritional programming during early life stages and/or maternal nutrition can also affect feed performance and fish resistance to disease challenges.

Finally, nutrigenomics, transcriptomics, proteomics, metabolomics, are nutrition research areas that salmonid nutrition is starting to look into. Metagenomics are also used to better understand how diet affects gut microbiota, gut health and as a result fish health. This review clearly showed the need for inter-disciplinary approach, meaning that aqua nutritionists of the future need to have such inter-disciplinary skills and collaborative approaches.

At the end of the question and answer sessions, a short exchange between the panel, organisers and participants highlighted the shared desire to repeat the sharing of expertise on a regular basis such holding an aquaculture nutrition symposium in India either on an annual basis or biennial basis.

Dr Muthu Ramakrishnan and Vilas Autade of DSM Nutritional Products (centre) receiving sponsors memento from P.S. Narendra of Growel Feeds.

Alexander van Halteren (centre) receiving his speaker souvenir from S. Muthukaruppan, Society of Aquaculture Professionals, India (SAP) and in the presence of Dr Rajaram, Deepak Nexgen Feeds (left)

The writer, who worked in India 10 years ago, wishes to conclude by expressing his satisfaction and respect for witnessing India's progress in shrimp farming to its current level over these past 10 years and to see that such a quality event could be held in Chennai, while also feeling concern that imperfect farming conditions and insufficiently scientific approach to shrimp farming could threaten the ability of India's industry to overcome its many challenges.

(All photos courtesy of Dr Victor Arul Suresh)

Martin Guerin has 30 years experience in commercial aqua nutrition, mostly in Asia. For 13 years, while at Gold Coin group, he headed aqua feed formulation, R&D, QA and other aqua technical activities until he founded Aquinov Services Sdn Bhd in 2016, working as a consultant in aquaculture nutrition. Email: martin.guerin.aqua@gmail.com

Aquaculture has a responsibility to be sustainable

By Thomas Wilson

This starts with reducing carbon and water footprint, better utilisation of feeds, and replacing fish oil with vegetable and omega-3 rich algal oils to meet consumer demands for the right LC-PUFA profiles in seafood.

The consumption of seafood products from aquaculture is a responsible choice when compared to the more popular wild caught seafood. Market demand for the latter often increases fishing pressure on unmanaged Asian stocks beyond sustainable levels. Furthermore, the illegal labour issues that were reported for fish meal production in Thailand were also associated with commercially-caught food fish exported from Asia to American and European markets (The Associated Press, 2015). The traceability of responsibly farmed fish and shrimp then becomes a market advantage.

Using typical methods for assessing sustainability, aquaculture activity has a much lower carbon footprint than other meat production systems, according to Hall et al. (2011). One of the benefits of raising fish and shrimp in water is greater efficiency in terms of weight gain/feed intake (lower feed conversion ratio, FCR) compared to either poultry or livestock, although aquafeeds do require higher protein levels and lower carbohydrate levels for optimal performance (Naylor et al., 2009).

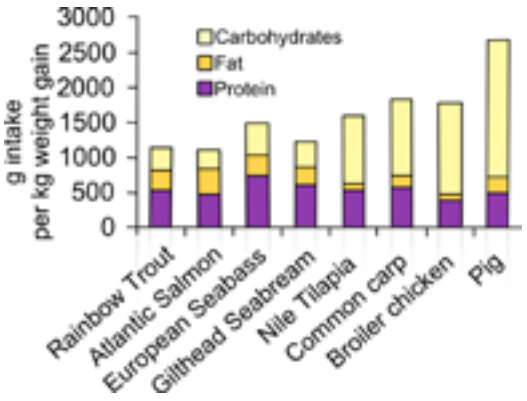

Figure 1. Aquafeeds have higher protein levels and lower carbohydrate levels than livestock feeds. Naylor et al., 2009.

Environmental impact

Traditionally, aquaculture has been criticised for high fish meal utilisation, but fish meal reduction is now underway in feeds for farmed aquatic species. Life cycle assessment (LCA) studies have shown that commercial fishing is a much more energy intensive industry than aquaculture or agriculture (Mungkung and Gheewala, 2007), so any significant fish meal reduction in feeds will also lower energy use and reduce carbon footprints. Industry attention has now shifted to several other areas of sustainability concerns: use of land and water resources which are already quite limited in Asia due to population growth and a cause of frequent conflicts in some regions, and fish oil replacement.

Land and water use

The one advantage that aquaculture has is that intensive production can produce more protein per unit area than any other form of meat production. Most aquaculture activity in inland areas is conducted on private land, and intensification allows for increased production without increasing farming areas. In near shore and coastal areas, aquaculture often occurs in communal or public areas, and conflicts over resource use are more common.

The direct environmental impact of aquaculture is primarily its water footprint:

- In terms of water usage as a rearing environment, it is used, but need not be consumed,
- Water loss due to evaporation of water in ponds,
- Water as a necessary input in production of farmed crops that end up as ingredients in aquafeeds, and
- Polluted water effluent from farms (and knock-on effects on dissolved oxygen and bottom sediment quality, and additionally, soil salinisation from shrimp farming).

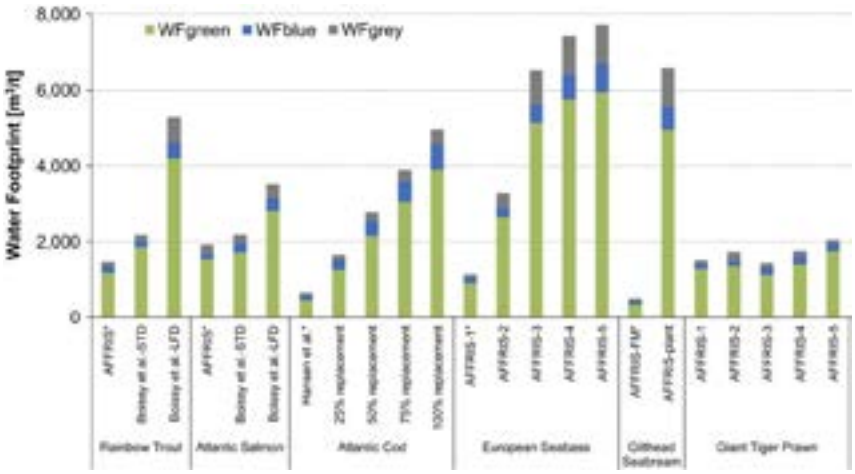

Figure 2. Estimated water footprints of several types of aquafeeds containing high to low levels of fish meal. WFgreen = Consumption of rainwater. WFblue = Consumption of surface and groundwater. WFgrey = The volume of freshwater that is required to assimilate the load of pollutants based on natural background concentrations and existing ambient water quality standards. Example formulations from FAO AFFRIS 2014. Source: Pahlow et al., 2015.

Water footprint

The overall contribution of each of the above factors to the total water footprint of a farm will depend on which system is in use, ponds or cages, and whether farming is in fresh, brackish or marine waters. It also depends on whether farm-made feeds or commercial feeds are used and whether the the farm is a closed system and has internal chemical/biological water treatments.

Pahlow et al. (2015) believe that reducing fish meal in aquafeeds will require a shift to using terrestrial proteins: either farmed animal proteins or high protein crops, which will increase the water footprint of aquafeeds (Figure 2). The authors commented that to conduct an LCA, it is necessary to understand the consequences of relying on increasing amounts of terrestrial ingredients in feeds for aquaculture production. They suggested that responsible feed formulation needs to take into account freshwater consumption and water pollution, since as aquaculture expands, water use and associated problems such as pesticide use for crop production will increase and will be attributed to aquaculture.

The five European seabass (*Dicentrarchus labrax*) feeds shown in Figure 2 contained from 52% (AFFRIS-1) down to 5% fish meal (AFFRIS-5), resulting in a large increase in the water footprint as plant protein content increases. For example, the lowest fish meal feed (AFFRIS-5) contained a combination of 20% corn gluten meal, 13% soybean meal, 10% rapeseed meal and 5% wheat gluten to replace protein lost by fish meal removal.

The five black tiger shrimp *Penaeus monodon* feeds shown contain from 34% fish meal (AFFRIS -1) down to 6% (AFFRIS-5), but the water footprint does not increase so much because all the shrimp feed formulas contained significant amounts of wheat flour (40% down to 17%), and soybean meal (40% down to 10%) and AFFRIS formulas 4-5 also contained 5% wheat gluten.

> **"If conducted responsibly, aquaculture has a clear advantage over meat production from poultry and livestock."**

The information in Table 1 shows that the water footprint of several species of fish farmed in dry areas depends on farm intensity and feed source (Brummett, 2007), but in general is lower when compared with the water footprint of various land animal proteins (Mekonnen and Hoekstra, 2010). If conducted responsibly, aquaculture has a clear advantage over meat production from poultry and livestock.

In the data on water footprints of feed ingredients (Table 2), it is apparent that the water footprint of feed will differ according to the plant proteins and carbohydrate sources that are incorporated into feed formulations. The inclusion of animal by-products requires consideration of the amount of water required to produce the fresh animal products in the first place, before they were processed into dehydrated protein meals with 8-10% moisture.

Increasing processed cereals, grains and oilseeds in feeds to replace fish meal will also increase grey water, or water required for treatment of wastewater generated by grain and oilseed processing. Additionally, higher fibre from plant ingredients in feed will often reduce feed digestibility, increasing nitrogen and carbon waste in farm effluent, which needs to be removed before reuse or discharge.

Table 1. Total water footprint of different types of fish production (Brummett, 2007, data from various authors) and different meats (based on global average 1996 -2005) Mekonnen and Hoekstra, 2010.

Product	Water footprint (L/kg)
Tilapia (fertilised ponds)	2,000
Tilapia (fed ponds)	2,800
Tilapia (fed cages)	760
Common Carp (fed ponds)	4,032
Channel Catfish (fed ponds)	2,882
Carp polyculture (fertilised ponds)	12,000
Carp polyculture (fed ponds)	5,000
Carp polyculture (fed aerated ponds)	2,250
Eggs	3,300
Chicken	4,330
Pork	5,990
Goat	5,520
Mutton	10,400
Beef	15,400

Table 2. Total water footprint (m^3 water/tonne) of different feed ingredients: global average 1996 -2005 (Mekonnen and Hoekstra, 2010).

Ingredient	Water Footprint (m^3 water/tonne of ingredient)	Provides
Wheat grain	2,036	Carbohydrate
Wheat flour	1,849	Carbohydrate
Wheat gluten	4,189	Protein
Broken rice	2,497	Carbohydrate
Corn maize	1,222	Carbohydrate
Corn starch	1,671	Carbohydrate
Cassava	564	Carbohydrate
Cassava starch	2,254	Carbohydrate
Soybeans	2,145	Protein
Soybean oilcake (SBM)	1,779	Protein
Peanut oilcake	1,484	Protein
Copra oilcake	834	Protein
Palm nut/kernel oilcake	833	Protein
Sunflower seed oilcake	1,356	Protein
Rapeseed oilcake	1,115	Protein
Cottonseed oilcake	860	Protein
Linseed oilcake	3,077	Protein

Improving ingredient utilisation

One of the ways of improving the utilisation of plant ingredients with low digestibility due to high fibre content is to use feed enzymes such as xylanase, mannanase and glucanase to break down non-starch polysaccharides and other indigestible fibrous cell wall components. Many of the oilseed meals with concentrated protein often have high phytic acid content. The use of phytase is recommended if these ingredients are used in significant amounts, since breaking down phytic acid will increase the availability of proteins, amino acids, phosphorus and trace minerals (Zn, Cu, Fe, Mn) in feeds. Protease enzyme has the potential to improve the protein and amino acid digestibility of every protein source in a feed, whether it is of animal or plant origin. Selecting the appropriate enzyme or blend of enzymes to use requires knowledge of the dietary fibre components and phytic acid content of each plant ingredient in the feed, since enzymes are only beneficial if the feed contains the right substrates.

The potential of feed enzymes to support improved feed efficiency is well documented, and if widely adopted by the aquafeed industry, the benefits would be significant. In a recent report making a business case for intensive shrimp farming (WWF, 2017), the World Wildlife Fund estimated that based on worldwide production of 3.6 million tonnes of shrimp, a reduction in feed conversion (FCR) of 0.1 would conserve 106,000 ha of land, 141 million m^3 of water, 468,000 tonnes of wild fish, and 3.6 million gigajoules (G) of energy. While technical issues in shrimp feed production still limit the use of enzymes, research efforts to solve the problems are underway, and future addition of enzymes to shrimp feeds and improvement of feed efficiency (lower FCR) is expected.

Table 3. Recommendations for dietary intake of LC-PUFAs in adults (after Aranceta and Pérez-Rodrigo 2012).

Region	Organisation	EPA+DHA	Equivalence
International	FAO/WHO 2008	0.25 – 2.0 g/day	2 servings fish/week
	WHO 2003	0.40 – 1.0 g/day	2 servings fish/week
	ISSFAL 1999-2004	> 0.50 g/day	
North America	AHA 2006/2009	0.50 – 1.0 g/day	2 servings fatty fish/ week
	ADA/DOC 2007	0.50 g/day	
Europe	EFSA 2010	0.25 g/day	
	ESC 2007	1 g/day	2 servings fatty fish/ week
	COMA 1991	0.45 g/week	2 servings fish/week
	DHC 2001-2006	0.45 g/week	2 servings fish/week
Asia-Pacific	NHRC 2006	0.145 g/day	

WHO, World Health Organisation; ISSFAL, International Society for the Study of Fatty Acids and Lipids; AHA, American Heart Association; ADA, American Dietetic Association; DOC, Dietitians of Canada; EFSA, European Food Safety Authority; ESC, European Society of Cardiology; COMA, Committee on Medical Aspects of Food Policy (UK); DHC, Dutch Health Council: NHRC, National Health and Medical Research Council (Australia)

Fish oil replacement

Marine fish oil is valued in foods, feeds, and nutritional supplements for its delivery of the essential lipids (aka LC-PUFAs or long chain polyunsaturated fatty acids), EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) in human nutrition. Many governments recommend eating 2 servings/week of marine fatty fish (tuna, mackerel, salmon etc.) to obtain sufficient amounts of EPA and DHA (Table 3).

DHA has a number of well-known functions in humans. It plays a role in maintaining structural and functional integrity of cell membranes throughout the body when it is incorporated into phospholipids, but is particularly important in brain development and neurological functions like information processing and cognitive ability, and these are impaired if intake is not adequate. Human behavioural problems, such as slow learning, depression, increased aggressiveness and violence have all been attributed to low DHA intake (Hamazaki et al., 1999 and 2002; Thienprasert, 2006; Weiser et al., 2016). DHA is also important for fertility and visual acuity (Masuda, 2003).

EPA, through its involvement with eicosanoids, prostaglandins and clotting time of blood platelets, is associated with good health of the heart and circulatory system, including reduction of high blood pressure, reduced risk of coronary heart disease and blood clots causing ischemic stroke and deep vein thrombosis.

Consequently, consumers have the belief that consumption of seafood containing LC-PUFAs will make them healthy and happy, and they have the expectation that farmed fish will provide the same benefits as wild fish. Farmed fish such as salmon tend to have lower percentages of these LC-PUFAs in their body lipids than wild fish, but because farmed salmon typically have considerably higher fattiness when compared with wild fish, the total LC-PUFAs consumed per serving of fish can be equal to, or even higher than that obtained from wild fish. When marine fish are limited or not available, it is also possible to supplement LC-PUFAs to farmed freshwater fish, which when consumed, provide a source of dietary LC-PUFAs in their tissues.

Marine fish oils are another concentrated source of EPA and DHA, but the problem is that worldwide production of fish oil has been stable for a number of years, with little chance of any future increase. Aquafeeds have provided LC-PUFAs to fish mainly through the use of fish meal and fish oil, but even as aquaculture's expansion continues, sustainability issues are pressuring the aquafeed industry to reduce or remove fish meal and fish oil altogether. The overall recommendation is that due to limited supplies and high cost, future use of fish meal and fish oil should be reserved for broodstock, hatchery and starter feeds for all species and a shift to lower trophic level species (fed carps, tilapia and catfish) is being encouraged to make aquaculture even more sustainable, since grower feeds for these fish can easily support growth without fish meal. So in the absence of fish meal and fish oil, how can the expectations of consumers for farmed fish to contain healthy PUFAs be met?

The European aquafeed industry benefited from the RAFOA I and II (Researching Alternatives to Fish Oil in Aquaculture) programs which ran from 2001-2014. Montero et al. (2004)

determined that replacing up to 60% - 80% of dietary fish oil (FO) with vegetable oils (VO) in feeds containing only a small amount of fish meal and low levels of LC-PUFAs did not have any significant impact on growth, taste, or texture in Atlantic salmon, European seabass, gilthead seabream, rainbow trout and turbot during most of the farming cycle. FO can be saved by feeding it only during the finishing stages of fish culture to "wash out" the VOs, and raise LC-PUFAs to levels equal to those found in wild fish, thereby meeting consumer expectations.

Blends of several VOs are generally preferred, with the intention of creating a fatty acid profile similar to FO, minus the LC-PUFAs. Rapeseed oil (RO) or Canola oil (CO), palm oil (PO), linseed oil (LO) are commonly used, and some alternative sources such as oil from *Camelina sativa*, a Canadian crop high in omega-3 linoleic acid, are being increasingly used. A general rule of thumb is to select VOs high in α-linolenic acid, an omega-3 lipid that can be converted by most fish to EPA, or monounsaturated fatty acids which can be converted to energy as well as deposited in tissues and present a low risk of oxidation.

Finisher diets with FO

Research by Izquierdo et al. (2004), investigated the influence of blending LO 60/40 and 80/20 with FO, soybean oil (SO) 60/40 with FO, and RO 60/40 with FO on the fatty acid profile of gilthead seabream for 200 days during a 300-day feeding trial (Figure 3). In this instance, tissue DHA levels fell until 200 days, when fish were switched back to a 100% fish oil diet to flush out the VOs. Within 60 days, tissue DHA levels increased to those found in wild fish. Similar results were found for EPA, although EPA levels did not recover even after 90 days of feeding only FO. Menoyo et al. (2004) reported there were no differences detected in either flesh colour or flesh texture between treatments, indicating that consumers would be unlikely to tell the difference.

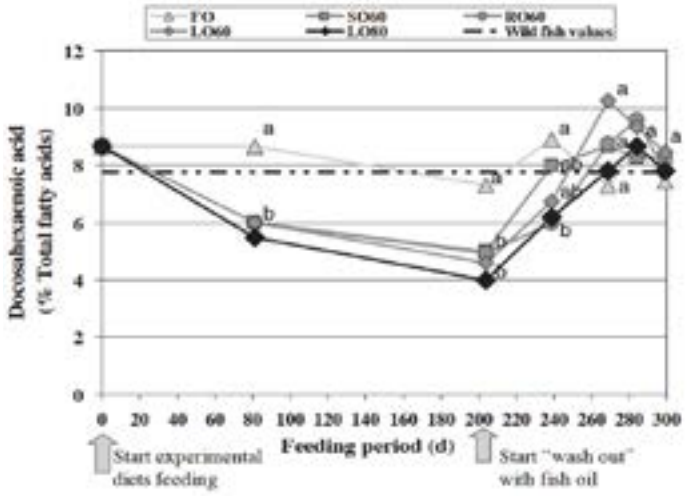

Figure 3. Effect of feeding vegetable oils followed by fish oil on docosahexaenoic acid (DHA) content (g/100 g fatty acids) of gilthead seabream fillet. Source: Izquierdo et al. 2005.

Central role of DHA

In order to remove that last portion (20%-40%) of FO from feed, an alternative source of LC-PUFAs needs to be found. This is because EPA and DHA cannot be left out completely, otherwise membrane integrity, and function of the neurological, circulatory and immune systems will be negatively affected. While EPA is important in membrane structure and endocrine function, it does not have the central role in the neurological system that DHA does. Furthermore, research has shown that EPA can be supplied metabolically through elongation and desaturation of α-linolenic acid supplied by VOs (canola, rapeseed, camelina, flaxseed), but further elongation beyond EPA to provide adequate DHA is not possible or has been shown to be severely inadequate.

The most probable source of sustainable EPA and DHA will be from the heterotrophic culture of various species of marine single-cell algae (*Schizochytrium, Thraustochytrium*). The only high DHA product available for a number of years for aquaculture has been a drum-dried algal biomass made from cultured *Schizochytrium* called AquaGrow Gold®, produced by Martek Biosciences Corporation, now part of Royal DSM NV. More recently, a number of companies are producing similar products in anticipation of meeting the high demand for aquaculture.

The only constraint with using algal biomass to supplement DHA has been its high cost. Fortunately, there have been some large investments made in both the USA and European Union in the production of LC-PUFA rich ingredients from algae. With more products, more production volume and increased competition, it is likely the cost of EPA and DHA supplementation to feed will come down to affordable levels. In addition to the algal biomass products, Veramaris, (a new joint-venture company formed by DSM and Evonik with a new factory starting up in the US in 2019) intends to produce DHA and EPA-rich algal oil. This will appeal to the salmon farming industry, since it can be blended into vegetable oils and top-coated onto feeds with existing equipment and processes. Limited testing in the salmon feed industry has already proven the benefit and convenience of this approach.

In conclusion, the European experience with several species of marine fish and rainbow trout with regards to fish meal and fish oil replacement over a number of years has shown that significant reductions of fish meal and fish oil are possible without impacting growth performance and product quality of fish in any significant way while still providing necessary LC-PUFAs for human health. With comparable research efforts and the willingness of the feed industry in Asia to embrace change, similar results should be achievable in the Asian region.

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Largemouth bass farming in China

By Xiaoxi Luo

An overview of the farming and challenges with feed and disease management.

The farming of the largemouth bass *Micropterus salmoides* in China started in the late 1970s, following its success in artificial reproduction. It was initially farmed in ponds and cages. However, after the 18th National Party Congress in 2012, with concerns on environmental impacts, cage culture was strictly controlled and gradually prohibited. Therefore, at present, largemouth bass is cultured in ponds.

Most largemouth bass farming is in Guangdong province, usually at high density, stocking at 5,000 to 12,000 juveniles/mu (75,000-180,000 juveniles/ha). They are usually cultured in intensive systems with high-input and high-output. In other provinces, such as Jiangsu and Zhejiang, largemouth bass is farmed at medium-density (2,000 to 30,000 juveniles/mu or 30,000-450,000 juveniles/ha). In Suzhou City, the average size of largemouth bass juvenile is 7 to 12 cm and stocking density is 2,000 to 3,000 juveniles/mu (30,000-45,000 juveniles/ha). The fish is cultured with silver carp *Hypophthalmichthys molitrix* and bighead carp *Hypophthalmichthys nobilis* at 25 to 45 juveniles/mu (378-681 juveniles/ha) and yellow catfish 300 fingerlings/mu (4,500 fingerlings/ha). The other polyculture model is with the silver carp and bighead carp at 80 fish/mu (1,200 fish/ha) and the crucian carp 150 fingerlings/mu (2,250 fingerlings /ha).

In the last 2 years, largemouth bass farmers in Jiangsu and Zhejiang have been using a pond-based recirculating culture model as well as the crab polyculture model with very high production at 1 tonne/mu (15 tonnes/ha).

A largemouth bass pond polyculture follows the traditional water use; water is drained out and changed after harvest. During the culture period, water quality is maintained by treating with chemicals and probiotics. Water is rarely changed. Ponds are drained only once a year but if there is deterioration of water quality or a disease outbreak, the water will be changed immediately.

Largemouth bass pond polyculture

Largemouth bass juveniles sizes 7 to 12 cm

Feeds and feeding

Largemouth bass is a carnivorous fish. At present, they are fed chilled young fish combined with some artificial feed. In Guangdong, farmers feed the young largemouth bass fry with artificial feed. After the fish reach 100g, they are gradually fed chilled young fish until harvest. Daily, the farmers buy the chilled fish from the seafood market early in the morning.

However, a small number of traditional pond culture farmers feed the fish with artificial feed throughout the culture period of 6 months. In both pond recirculating culture and the crab polyculture models, fish are fed artificial feed. A survey in 2016 indicated that there is no problem in using artificial feed throughout the culture of the largemouth bass in Guangdong, Jiangsu, Zhejiang, and Sichuan. There are more than 30 feed companies producing an estimated 40,000 tonnes of largemouth bass feed for sale in the Pearl River Delta.

> **“As farming expands, problems in farming large mouth bass have become more and more apparent..”**

Diseases

As farming expands, problems in farming largemouth bass have become more and more apparent. Nowadays, the diseases in largemouth bass farming are appearing more often and the cost of treatment is getting higher. In the first year of its grow-out, the largemouth bass culture in a new pond is usually successful (survival rate 90%) with good results. But in the second year, the fish become prone to diseases. There are three main types of diseases in largemouth bass. Firstly, there are the external parasites, *Trichodina*, *Apiosoma*, *Chilodonella* sp and parasites in the intestines such as the sporozoans. Secondly, there are the bacterial diseases, such as gill rot, enteritis, furunculosis and body ulcers. Thirdly, the large mouth bass can be infected with

Bacterial disease of largemouth bass. In the past 2 years, necrosis diseases and sporozoan infestations often occurred concurrently and were difficult to treat.

viral diseases such as the iridovirus disease.

In the past 2 years, necrosis diseases and sporozoan infestations often occurred concurrently and were difficult to treat. Generally, the daily mortality was more than a dozen fish in each pond. If hundreds of deaths occurred in successive days, farmers would generally choose to sell the fish and clear the ponds. Last year, the culture encountered serious mortality caused by white body disease at the time of fry transfer. Furthermore, more than 100-200 largemouth bass weighing 50 to 150g were found dead in many ponds every day in Foshan City at this early stage of pond culture. Iridovirus specific gene fragments were detected by PCR in the tissue samples of sick fish.

Conclusion

With the development of largemouth bass farming, we need more research on the nutritional requirements of this fish as well as on the improvement of feed processing technology. The objective is to promote the use of extruded feed for this fish. Furthermore, as the area for largemouth bass farming has been increasing year by year while the farming environment has gradually deteriorated, farmers have been working to ensure success by improving farming technologies.

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Stakeholder collaboration between Europe and Southeast Asia to advance aquaculture

By David Little, Patrick Sorgeloos and David Basset

EURASTiP has a new look at how universities and industry in Southeast Asia and Europe collaborate for stronger commercial partnerships based on innovative research and better trained workforce.

International meetings in Kuala Lumpur, Dubrovnik and Indonesia, have introduced the EURASTiP international support and cooperation action funded under the EU's Horizon 2020 Programme to the aquaculture communities in Southeast Asia and Europe.

The main driver behind this initiative is the belief that by working together through multi stakeholder platforms (MSP) the aquaculture sector can prioritise the necessary research and innovation requirements to develop successful sustainable aquaculture. This includes stronger commercial partnerships, closer links with scientists, better trained students entering an increasingly diverse workforce and well orientated policy makers.

Through EATiP (the European Aquaculture Technology and Innovation Platform www.eatip.eu), European aquaculture has been using the multi-stakeholder platform (MSP) approach for 10 years; a key objective of EURASTiP is to evaluate and prepare for the transfer of this working methodology to Asia. The project is supporting such multi-stakeholder platform development in three 'pilot' countries – Bangladesh, Thailand and Vietnam.

Collaboration between the European and Asian sectors is not new but we hope this project will reinvigorate old partnerships and develop new ones, ensuring a commercial sector, that has driven aquaculture development in both regions, is built on a prioritised research and innovation agenda.

The project should also allow some rethinking of the relationship between European and Southeast Asian countries and challenge the notion of a zero-sum game - that growth and development of aquaculture in Southeast Asia undermines the potential for aquaculture in Europe. The evidence instead points to major opportunities for mutually beneficial cooperation. Whereas aquaculture growth has been dynamic in key areas of Southeast Asia, it has remained flat in Europe (if we ignore growth of salmonids production). Intensification of aquaculture systems in Asia are giving rise to new challenges that are opportunities for European commercial interests.

In contrast to common belief, most farmed seafood production is not being exported but rather satisfying local demand. Nor is it about smallholders meeting their subsistence needs while corporate entities manage the export trade. A recent article points to the 'missing middle' of most analyses; substantive growth has mostly been based on commercial production feeding poorer and middleclass consumers in Asia. This type of aquaculture, typically based on local investment and knowhow, is intensifying and urgently requires stronger linkages to innovative nutrition, health and genetic improvement.

Dr Putth Songsangjinda (centre) and Thai Department of Fisheries colleagues with Thawit Chauychuwong, Facilitator of the Thai MSP and Pau Badia, Project Manager, FairAgora Asia at the Trat Province Shrimp Farming Club Fair.

.. "an umbrella that can support communication and targeted action throughout the sector.."

Core stakeholder meetings

The project so far has supported a local coordinating partner to initiate core stakeholder meetings where key priorities for the sector are being identified. The ground for this were prepared by a stakeholder mapping exercise where the key players in the sector were identified and their current relationships assessed. Local ownership from the beginning is critical since the project has the ambition for the three pilots to not only serve as demonstrations for other countries in Asia but also to be able to sustain beyond the limited project funding. For that to happen benefits to those involved must be demonstrable and worthwhile.

Such collaboration has typically revolved around the needs of producers (e.g. producer groups or clubs), or specific interest groups (e.g. processors and exporters associations). These often had important impacts and demonstrate why collaboration can be rewarding. The aim of promoting multi-stakeholder platforms (MSP) is to complement these on-going initiatives and organisations with an umbrella that can support communication and targeted action throughout the sector. For example if the region had a proactive MSP in place prior to the recent acute hepatopancreatic necrosis disease (AHPND) pandemic in farmed shrimp, could we have taken action to control it and mitigate its worse impacts much earlier? Hindsight is a wonderful thing but could national MSPs communicating across national borders have stimulated a better regional response, more urgently designed and conducted research?

Negative perceptions on aquaculture

In the past aquaculture has sometimes suffered negative perceptions from media and consumers and MSPs can also be proactive in sharing more up to date information and telling the

Dr Dinh Te Nhan and Luong Le of Nong Lam University, Vietnam team conducting interviews as part of stakeholder mapping.

> .. “ proactive in sharing more up to date information and telling the sectors story.. ”

sectors story. Over time, bringing contrary or critical voices into MSPs can be an important step towards improving understanding of the sector to the wider community. National MSPs led by commercial interests that could identify and recruit dynamic individuals from throughout the value chain, and relevant government and non-government organisations (NGOs) that have influence in the sectors, should focus actions where they are most needed and allow for better planning to go forward.

The concept is NOT to set up resource intensive ‘talking shops’ but rather to support communication that leads to real collective action. MSPs should improve dealing with challenges but also improve the sector’s capacity to embrace opportunities. EURASTiP aims to support MSP start-up activities and partnership development between companies and academia, within the pilot MSP countries, among Asian countries and ASEAN-FEN network and between Asia and Europe. Such activities include funded brokerage events, internships and industry and academic exchanges. More information: www.eurastip.eu/exchanges or www.eurastip.eu/brokerage. More general information on the project is available at www.eurastip.eu

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Look to markets in Asia

Local markets are the bigger consumers of Asian farmed fish, not the Western countries where demand has been hit by adverse publicity.

Last November, during the 2017 DSM Nutritional Products conference in Ho Chi Minh, **Anne-Laurence Huillery**, Thetis Aquaculture Support, presented on the trade in farmed seafood from Southeast Asia. Farmed products from Asia comprise mainly the carps, pangasius catfish, tilapia, milkfish, marine shrimp (both vannamei and monodon shrimp) and high value marine fish. There are 4 types of markets: local markets; export markets within Asia; traditional and western markets (US, European Union and Japan); and interestingly, the small but significant supply chain of live marine fish farmed in Malaysia, Indonesia and Philippines and sent to markets in Hong Kong/China and Singapore.

“Unfortunately, we pay less attention to the demands of these local markets which absorb a significant proportion of production.”
– Anne-Laurence Huillery

Huillery, who is based in Vietnam and is very familiar with aquaculture and the seafood trade within Asia, noted that, “Often here in Asia we focus on the demands by the traditional markets but in fact, most of the farmed seafood produced in Asia are consumed within Asia. Unfortunately, we pay less attention to the demands of these local markets which absorb a significant proportion of production.”

Using production data from FAO FishstatJ 2015, Huillery described the aquaculture production by country and the seafood trade of farmed fish and shrimp. Myanmar produced 600,000 tonnes of farmed fish and 100,000 tonnes of mainly farmed rohu was exported to Bangladesh. Philippines’ production which included 384,425 tonnes of milkfish and pangasius, was all consumed locally. Most of the 1.15 million tonnes of tilapia produced in Indonesia was also consumed locally.

In the case of Vietnam, 90% of farmed pangasius (1,174,402 tonnes in 2015) was processed for export. It was difficult to determine the actual volume of exports as weight of seafood was reported as fillet weight. Vietnam exported almost all the vannamei shrimp (318,302 tonnes) and monodon shrimp (223,430 tonnes) produced. The difficulty is with ascertaining the proportion of capture and farmed products. Similarly, Thailand processed and exported 80-90% of its 2015 farmed marine shrimp production.

Shift to Asian markets

On where do these farmed products go? Huillery detailed some interesting facts. “Exports are mainly to within Asia, particularly China. Exports to western markets have stagnated or are decreasing. We should not expect increases especially with the tilapia into the US market, after a US talk show denounced tilapia as bad for health. We also do not expect volumes of shrimp imports into the US to increase either.” On the contrary, Asian demand for tilapia has continued to grow in recent years.

Harvesting pangasius catfish in Vietnam. In the first part of 2017, China became the main importer of the pangasius from Vietnam.

Huillery added, “In the first part of 2017, China became the main importer of the pangasius from Vietnam. Since 2012, China and Hong Kong have become a net importer of shrimp from Vietnam. Globally, China is now a net importer of 1 million tonnes of shrimp.

“Marine fish producers are focusing on the niche live fish market. Groupers are the main species. Currently there are no fresh chilled or frozen products to compete with salmon and high-end white fish fillets segments. For the Chinese market, the focus is food safety, and there is little demand for sustainability which is a big thing in the US and EU markets.”

Current issues in western markets

“Many years ago, we talked about traceability, certification and quality but today these are standard requirements. Demand has shifted to feed safety. Today, buyers pose questions on what is in the feed. The concern is on GMO (genetically modified

Vietnam's production of fillet and whole red tilapia and pangasius at Vietfish 2017

In Asia, importance is placed on freshness and live fish, such as the marbled goby on display at a seafood restaurant in Malaysia.

organisms), land animal-based ingredients (e.g. meat and bone meal) and poultry meal. These fears are connected to the mad cow debacle in Europe more than two decades ago, and the avian flu virus.

There is a problem of reputation of Asian seafood in western markets such as in the US and Europe. Asian products have long been considered as "cheap" products. As these are transparent markets, information spreads very fast, including fake news. "Worries such as addition of melamine to increase protein composition in feed still persist, despite that to date, we still do not know the effects of such inclusions in human health. There are issues related to reputation. Some 8-9 years ago, an internet report on pangasius production on French television misinterpreted information on supply chain for the pangasius. In this case, the word fish meal was translated in laymen terms as 'meal from dead fish', which was unpleasant to the consumer. Injections with the hormone HCG (human chorionic gonadotropin) for the spawning process which is scientifically accepted, is however horrific for the consumer. In the end, these are more to do with perceptions with seafood from Asia.

"The western market is very sensitive especially on whether farmed fish can replace capture fish. Although in general, aquaculture itself is socially responsible, issues such as the use of slave labour in the IUU case has implications for aquaculture. Animal welfare on how we kill the fish is gaining traction too." Huillery referred to the 2017 Cargill survey where 88% of American consumers surveyed were willing to pay more for seafood certified as sustainably and responsibly sourced seafood.

Asian seafood markets

There are lots of opportunities to market seafood within Asia. Fish is consumed in several different ways; from live fish, chilled and frozen whole fish or fillets, to fried/salted and value added products. In Asia, even the young are trained to eat whole fish and are not afraid of fish bones. "In Asia, even processors who focus on export markets know and have local market connections, at least for the sales of by-products such as swim bladders, stomachs, fish balls made with trimming by-products, and dried skins."

The consumption of seafood in most Asian countries was higher than the global average of 19.3 kg/capita/year in 2013 (FAO data). "In Asia, fish can be a cheap commodity as an everyday meal to a premium serving at wedding receptions and at special festivals. However, the main issue with fish is the importance placed on freshness and when fish dead from diseases are sold in markets, this is easily determined."

In Vietnam, since 2007, there have been several food scandals which all were related to processing. This caused a loss of confidence and only when these are settled, will there be more trust in the production. Until then, there will continue to be questions and new issues on the production chain. In agriculture, the trend is for traceable products and there are certified products such as GlobalGap certified rice. It will probably happen to seafood too, but the push factor is not there when there has been no scandal on seafood.

Huillery's take home messages were:

"The presumption is that local markets have lower requirements. However, it is just that demands from these local consumers are not very distinct and that these markets are not dominated (by major buyers) as in Europe and US.

"The internet savvy millennials may turn away from seafood based on information they read online. As they communicate quickly, the impact of adverse news on any seafood will be quick. We have little data on the seafood consumption of the millennials but as evident in agriculture, this generation is disconnected and easily turned away on seeing animal slaughter practices. We cannot let this group be disconnected with aquaculture."

Genetics and breeding in Chinese aquaculture

Collection of papers published in the Journal of the World Aquaculture Society in April 2018

China, the world leader in aquaculture production, has for centuries been home to selective breeding efforts for several important aquaculture species. Many advances have been made in aquaculture genetics and breeding in China over the last two decades. Intensive research programs on genetics and breeding have resulted in the development of 182 novel varieties that have been approved by the Ministry of Agriculture in China.

Professor Shaojun Liu, of the State Key Laboratory of Developmental Biology of Freshwater Fish, College of Life Sciences, Hunan Normal University, Changsha, Hunan, China, and Professors Chenghui Wang and Chenhong Li, of the Key Laboratory of Freshwater Aquatic Genetic Resources, Ministry of Agriculture, National Demonstration Center for Experimental Fisheries Science Education, and Shanghai Engineering Research Center of Aquaculture, Shanghai Ocean University, Shanghai, China, have guest edited a special issue on Genetics and Breeding in Chinese Aquaculture, published in the Journal of the World Aquaculture Society in April, 2018.

The collection of papers published in this special issue covers topics that range from selective breeding, hybridization, gynogenesis, sex control and manipulation, to the characterization of genes associated with important traits related to aquaculture performance. An editorial by the guest editors summarizes the progress that has been made in China

Harvesting Chinese mitten crab

Packing Chinese mitten crab

in genetics and breeding of aquaculture species. The special issue includes two review papers, one on genetic advances in tilapia sex control and manipulation and the other on genetic improvement and breeding practices on the Chinese mitten crab. Applied studies in this issue focus on common carp and crucian carp, while fundamental studies published address genetic advances in a variety of species that include: freshwater prawns, olive flounder, hybrid grouper, grass carp, mirror carp, ricefield eel, freshwater sleeper, and pearl oysters.

This special issue of the Journal of the World Aquaculture Society is a timely showcase for recent progress in aquaculture genetics and breeding in China. Members of the World Aquaculture Society can access these papers for free by first logging in to the WAS Member's only area of the web site at www.was.org and then selecting "View Articles" under the "Journal of WAS" heading on the Publications tab or you can scroll down and click on the photo of the JWAS in the right margin of the page. Those who are not yet members of the World Aquaculture Society can either join the society at www.was.org, or otherwise find these and other papers at www.onlinelibrary.wiley.com.

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This article was contributed by Dr Carole Engle, Executive Editor, Journal of the World Aquaculture Society

Taste Panel for the Chinese mitten crab

Release of a new premium larval fish diet

INVE Aquaculture has announced the launch of a new innovation, 'Natura', a new premium diet range for early-stage marine fish larvae. Specially formulated for easy transition from live feed to compound diets, the product has been developed to simplify the weaning process. The new formulation provides key nutritional components, resulting in the superior commercial production of healthy and performant juveniles.

To develop a diet of outstanding quality, INVE Aquaculture's nutrition specialists found their inspiration from nature itself, dedicating special attention to key characteristics such as attractiveness, digestibility and nutrient balance. Combined with an adjusted and flexible feeding protocol, these aspects are the key to producing healthy and performant fry. For the initial stages of larval development, Natura is a floating, slowly sinking feed to obtain satisfactory feed acquisition and feed uptake.

"The new Natura diets are available in 4 different sizes used from co-feeding to post-weaning. Larvae fed with Natura show superior acceptance of formulated feed," said Alessandro Moretti, Product Manager Fish Hatcheries, INVE Aquaculture

At the initial stages of larval development when no functional stomach is present, fish larvae rely on cytosolic enzymes, later switching to brush border enzymes and pepsin production. The Natura diet range has been developed using carefully selected protein sources for the early stages of the fish larvae. Not only proteins of sustainable marine origin are used, but also adequate protein sources in hydrolyzed form to obtain the most optimal uptake of amino acids and peptides in the initial stages of larval development. This together with high quality n-3 HUFA inclusion promotes larval development, juvenile growth, survival and quality.

"Feed digestibility is of great importance, especially at the initial stages of larval development when the digestive tract is under development," added Moretti. For optimal ease of use, Natura diets can be fed daily over multiple rations according to the larval age, fish density and water temperature. They are ideally supplemented with enriched rotifers and/or Artemia. www.inveaquaculture.com/www.benchmarkplc.com

Research consortium to collaborate on personalized nutrition

BASF is the latest member to join the Personalized Nutrition & Health consortium founded by TNO and Wageningen University & Research. The consortium researches the capabilities needed to enable personalized nutrition and health advice on a large scale. BASF will contribute to the consortium's research fields with its health ingredients brand, Newtrition®, and use its scientific capabilities on optimized micronutrient intake for improvement of health and prevention of diseases along all stages of life. This presents an opportunity for Newtrition to collaborate with partners in the industry to bring personalized solutions to the market.

Fostering an ecosystem to advance personalized nutrition, the consortium takes an integrated approach that involves partners across the value chain working closely together to arrive at tailored, scientifically grounded marketable solutions. Personalized nutrition and health advice helps people make optimized choices, that suit their body's needs, personality and social environment. Newtrition is continuously expanding its footprint with ecosystems that can drive the growth of the market and deliver the right nutrients to the right people at the right time.

"This collaboration is a key milestone in our commitment to shape the future with ecosystems that foster the progress of personalized nutrition and health." said François Scheffler, Head of BASF Global Human Nutrition. "We are passionate about developing innovations that can enable each one of us to reach our full potential with science-based choices underpinned by personal needs."

Over the coming years the consortium aims to place in the hands of its members the technology, knowledge and insights that can guide the development of groundbreaking, personalized products and services. Newtrition is keen to collaborate in projects that advance research on personalized nutrition and aims to bring science driven solutions to the commercial markets. The consortium is the ideal platform for translating expertise in diagnostics, digital health advice and physical product intervention into compelling products for consumers.

"We welcome BASF to our international research consortium," says Dr. Peter van Dijken, Managing Director TNO 'Healthy Living'. "Their worldwide presence and focus on science-based advice suits us very well."

Dr Raoul Bino, Managing Director, Agrotechnology & Food Science Groups, Wageningen University & Research added "We believe that personalized nutrition can guide people towards healthy behavioral patterns. It has enormous potential for preventing and possibly even curing non-communicable diseases and other lifestyle disorders."

BASF, one of the market leaders in the human nutrition industry, offers a broad portfolio of essential nutrients for disease prevention under the Newtrition brand, e.g. vitamins, beta-carotenoids and highly concentrated omega-3 fatty acids. www.basf.com

Protease in aquafeeds

On March 28, at an elaborate dinner reception, Canada based, **Jefo Nutrition Inc**, launched their protease enzyme complex AG175™ following its registration for aquafeeds in Thailand. This included a seminar "Protease in Aquafeed: A new Horizon". Jefo invited customers and industry from the region attending Victam 2018. Jefo was established in 1983 by Mr. Jean Fontaine, President. In the 1980s, it introduced the Jefo Matrix Technology, a protective technology revolutionising the efficiency of feed ingredients, which is now essential for today's peak animal nutrition.

In his presentation on the brief history of AG175™, a unique solution in aquaculture, Dr M A Kabir Chowdhury, Global Product Manager – Aquaculture, Jefo Nutrition recounted the early work on the trout which gave 6 times more absorption of proteins. Kabir also thanked Dr Albert Tacon, aquafeed consultant for the early nutritional work on enzymes in aquaculture. Jefo's R&D spread is from University of Saskatchewan and University of Guelph in Canada to Shanghai Ocean University, China. Applications are now in 27 species, the most recent in frog diets in Vietnam and crocodile diets in Brazil. These enzymes are included in extruded and pelleted feeds for aquatic animals raised in cold temperate waters as well as in tropical warm water.

Dr Xiang Jun Leng, Professor at Shanghai Ocean University, China elaborated on his 12-year cooperation with Jefo. His presentation on protease in fish and shrimp diets gave a perspective from China on the decade long experience. Covering the development in China's aquafeed industry, Xiang said that China's aquafeed production totaled 18 million tonnes in 2017. Alternative ingredients for the replacement of fish meal included animal proteins such as meat and bone meal and blood meal. The replacement of fish meal with these ingredients results in changes in essential amino acids, lower feed digestibility and feed palatability. The solution has been dietary inclusions of proteases. Xiang showed results of diets for the black seabream where fish meal was partially replaced by cottonseed meal at 10% or 15% without any significant effects on weight gain and feed conversion ratio (FCR) when the protease was included

Dr Orapint Jintasataporn, Professor at Kasetsart University, Thailand, gave her perspective on enzymes in aquafeeds with special reference to protease. Orapint cited some highlights from research; exogenous enzymes are now accepted as a class of feed additives to overcome anti nutritional factors (ANFs) and improve digestibility. Enzymes increase digestibility thus reduces waste from feeds which benefits the environment. The efficacy of enzymes is related to type of enzymes and processing temperatures. Enzyme leaching losses is higher in top coated pellets as opposed to when the enzymes is added into the mix. Efficacy of enzymes is related to type of enzyme or substrate. As carnivorous fish have low tolerance for carbohydrates and utilise poorly fibrous structures as a source of energy, Orapint quoted research with exogenous feed enzymes targeted at degradation of non-starch polysaccharides (NSP) and could help to improve the nutritive value of these components.

Orapint concluded that if we shift to using low quality feed ingredients and add a cocktail of enzymes, there will be more benefits. However, as the temperature range for activity from 0-30 mins was at 30°C to 120°C, relative activity drops to only 30% at 120°C. At 75°C, 72% of protease function was clear after 30 mins. Her message was to increase the amount of enzymes required to match its relative activity for efficient diets.

Dr Orapint Jintasataporn said that exogenous enzymes are now accepted as a class of feed additives to overcome anti nutritional factors (ANFs) and improve digestibility.

Dr Xiang-Jun Leng (right) with Jefo's Dr Supornchai Sri-Nhonghang, Territory Manager-Thailand

Jean Fontaine (second left) and Dr M A Kabir Chowdhury (left) with members of the feed industry in Thailand.

Jefo honoured the media; Suzi Dominy, Aquafeed.com (third left) and Dr Zuridah Merican, Aqua Culture Asia Pacific (second right). The Jefo team comprised from left; M A Kabir Chowdhury, Adam Naylor (Sales Director-SEA), Jean Fontaine and Dr Supornchai Sri-Nhonghang.

Innovation at the heart of VICTAM Asia 2018

This was the early verdict of visitors, conference delegates and exhibitors alike, said the organisers of Victam International BV. The exhibition and series of accompanying conferences were held at the Bangkok International Trade and Exhibition Centre (BITEC) from March 27-29, 2018.

Visitors were pleased at the number of exhibitors, the wide range of products on display, especially the newly launched products, and the high quality of the exhibition stands, as well as the professionalism of the show staff. The event saw the presence of 228 exhibitors and co-exhibitors from 33 countries. Likewise, exhibitors were very satisfied with the visitors in attendance, noting the serious discussions and negotiations conducted both with existing clients as well as new potential clients that they had met at the show. Exhibitors also commented on the very high quality of the visitors and the wide range of countries from which they came.

In all there were 6,987 visits from 67 countries over the three days of the conference. A high proportion of the visitors, 45%, were from outside Thailand. These figures clearly reflect this event's status as a top international showcase for the feed and grain industries in Asia.

The newly introduced business match-making program helped exhibitors and visitors get the most out of the exhibition. This program focussed on high quality meetings and consisted of a combination of an online tool, which allowed exhibitors and visitors to plan their appointments efficiently and efficiently, as well as a personal approach by matchmaking consultants. Conference delegates also confirmed the quality of the papers presented at the numerous conferences. The conferences had extensive programs which were well received.

There was also the 'World Feed Industry Perspectives' conference, where speakers from IFIF (Alexandra de Athayde), Dr Eckel Animal Nutrition GmbH & Co. KG (Dr Bernhard Eckel), the Thai Feed Mill Association (Boontham Aramsiriwat), the Vietnam Feed Association (La Van Kinh) and Feed Latina (Marcio Ceccantini) and the Department of Livestock (Kitti Koobkaew) addressed the audience of senior executives from the international animal feed industry. During the network reception the winners of the coveted GRAPAS Innovation Awards were announced. The three winners were Geelen Counterflow Electrical Dryer, Henry Simon' Rollermill of Satake, and the Atta Process with PesaMill from Bühler.

The team from DSM Nutritional Products, from left: Nuanpa Ariyapinyo, Regional Marketing Coordinator Asia Pacific; Dr Rutchanee Chotikachinda, Aquaculture Researcher; Robert Redman, General Manager-Thailand and Indochina and Huynh Man Khoi, Account Manager-Vietnam. Second right is Richard DeBeor, Victam International.

The newsroom reported semi-live from the show floor to allow those that could not attend to still be part of the action. Speakers, visitors and exhibitors were interviewed about their expertise and the news crew made running reports about the event. Reports are available on Victam International's YouTube channel. Future events announced include: VICTAM International 2019, to be held in Cologne, Germany, from June 12- 14, 2019, and VICTAM Asia in Bangkok from 24 - 26 March 2020. www.victam.com.

Feed equipment manufacturer Wenger, USA gave visitors a new virtual reality experience at their booth. From left: Charles Engrem, Director of Aquafeed Process, USA; Marc Wenger, Aquaculture Process VP of CIC & Service, USA; Paul, Chen, Sales Engineer, Wenger, Taiwan; Dr Ramesh G, Technical Sales, Wenger India and Jonathan Iman, International Project Manager- Corporate Project Services, USA. . Ramesh presented on 'Advances in micro aquafeed extrusion' at the 11th Aquafeed Horizons held on the first day of VICTAM Asia 2018.

Visitors from Pentagreen Marketing, Bangladesh, Shamsul Hadi Khan (left) and Fakir Ahsan Towhid.

Processing shrimp feeds

Taiwan's IDAH is a feed equipment and solution provider for many aquafeed plants around Asia as well as globally. During VICTAM 2018, the company organised a one-day interactive seminar where its technical teams discussed the latest technology applied in aqua feed production and also covered some troubleshooting issues in shrimp and fish feed production. Danny Chang, General Manager of IDAH also shared his experiences on how to optimise production. The seminar was oversubscribed with standing room only. Participants came from all over Asia and attracted the shrimp industry from India, where the speed in feed production has increased in line with the demand from farmers increasing shrimp production. The seminar covered three areas: innovative

At the IDAH booth, from left Albert Wang, Danny Chang and Morning Huang.

Haiko Zuidhoff presenting to the crowd attending the launch at the Trouw Nutrition booth.

design in energy management, odour control in aqua feed plants; trends in shrimp feed pelleting; and dryer selection. Chang said, "Making good feeds is not just using good raw materials. It is 60% in choosing the right machinery to process the pellets." Customers are looking for solutions to reduce moisture. "As we add water in the raw material for pelleting, we then need to reduce moisture from 16-17% to at least 12%. This means we need to remove 3-4% of moisture for the final product." On processing of pellets for shrimp feed, Chang noted that the cutting of pellets should not result in any cracks. "Water stability is important and the IDAH way is to put the pellets into water to check for cracks and outlook of the pellets after an hour. Water stability of 2-2.5 hours is the standard." www.idah.com

Biomin Asia Pacific at VICTAM Asia 2018, from left, Anwar Hasan, Regional Technical Manager – Aquaculture, Amelia Low, Regional Marketing & Communications, Dr Jan Vanbrabant, Managing Director and Edward Manchester, Regional Director.

Real time information of feed ingredients

At the Trouw Nutrition booth, Haiko Zuidhoff, Managing Director of Cluster Asia introduced the NutriOpt On-site Adviser which gives real time information of feed ingredients for fast decisions. This is a portable online service which combines a hand-held scanner and a mobile application, which links to the NutriOpt nutrition data base. After a quick scanning process on site of 10 minutes, the mobile device will send data to the cloud. It then creates a comprehensive report of the sample based on information in the cloud-based database. The report also comes with a recommendation to improve performance. The report can be incorporated into the least cost formulation and may provide a saving of € 2/tonne of feed.

Zuidhoff said that in the current environment where genetics, research with *in vivo* and *in vitro* trials, and feeding all combined to meet production targets, the competitive edge now lies with precision feeding. An increasing number of professionals strive towards improving performance and profitability. They want to be able to assess quality of the different products and would like to be certain rather than guess the quality of the product for their day to day management. www.trouwnutrition.com

Demonstration of the hand held scanner.

Feed additive for shrimp health

At the Dr. Eckel booth, Dr Bernhard Eckel, Vice President at Dr. Eckel Animal Nutrition, explained the innovative feed additive Anta®Ox Aqua. This is a biological additive and a source of flavonoids. It was found to be very effective in shrimp against Vibrio infections. Studies conducted at the Faculty of Fisheries at Kasetsart University, Thailand demonstrated that, under laboratory conditions, when the animals were challenged with Vibrio spp, supplementation with the product improved survival rates. According to Eckel, the mode of action is reduction of inflammation in the shrimp.

The effect of the additive is reduction in inflammation at the hepatopancreas level and reduced mortality. Eckel added that the company developed the product to be heat stable and can be extruded at 120°C. Currently, the effect of the product in shrimp has been documented and plans are in place to research

Dr Bernhard Eckel (right) with Philippines Country Manager Dr Noel Cuyno.

its effects on tilapia. In Thailand, feedmillers incorporate the product, sold in 25 kg bags, into feeds. In India, it is sold in 1 kg bags and farmers top-dress the additive onto feeds. Registration of the product is ongoing in Indonesia. "The major application for this product is for health of the animal," added Eckel. At the World Feed Industry Perspectives Conference which was held on the last day of Victam Asia, Eckel was invited to speak on the opportunities for animal feed business in Thailand. On their website, Eckel said that the team was very pleased with the three exciting days, full of great discussions, valuable encounters, thrilling discoveries and successful meetings.

"We at are particularly pleased with the presentation of our flagship product Anta®Ox Aqua along with the launch of the new product video, showing its distinctive all-natural composition and outstanding properties," said Eckel.

"Once again, Dr. Eckel's product philosophy of offering innovative alternatives to antibiotics in feed has been proven right by announcements from a number of Asian countries that they are planning to prohibit AGPs in the near future. Indonesia and Vietnam further proclaimed their plans to fortify consumer protection". www.dr-eckel.de

New formulation software

Format Solutions launched their new Microsoft-accredited formulation software, iNDIGO™, the next-generation software designed by formulators and nutritionists, combined with insights from the company's world-wide customer base. Using modern technology and approaches, iNDIGO™ shifts the emphasis towards enabling formulation to become a true business tool and play a key role in driving profitability. iNDIGO has a new, dynamic, user-friendly screen layout that features: flexible filter and search facilities to quickly find the data required; a wide range of data management tools and features, easily accessible in an easy to use workflow; full data visibility across production sites and time periods; detailed on-screen reports and graphics, including nutrient and cost contribution reports, variance reports, ingredient requirements summaries. www.formatsolutions.com

Feed additive solutions in Asia

Nutriad was an active participant at the recent Victam Asia 2018. BK Chew, APAC Director, explained that it was the first time Nutriad participated at Victam and highlighted the efficient set up which allowed Nutriad to participate in three major conferences Aqua Feed Horizons, FIAAP and GRAPAS at the same time.

Dr Glenn Alfred Ferriol, Area Manager for the Philippines, Indonesia & Malaysia presented on *"Mycotoxin Management in Stored Grains"* at GRAPAS, analysing the difference between controlling mould growth and managing the risk of mycotoxin contamination in grains. He emphasised that raw materials such as corn are already contaminated with mycotoxins right from the plantations and upon harvest, as was shown by the annual mycotoxin survey.

Depending on how long grains are stored silos, an appropriate anti-mould program needs to be applied to control mould growth, which in turn will help minimise the increase in the level of storage mycotoxins. The next step is to conduct confirmatory testing using a more accurate method (GC/LC-MS/MS) in testing the finished feeds or end products. Nutriad's app MYCOMAN® allows producers to determine and apply the right mycotoxin deactivators and dosage.

Nutriad offers an effective anti-mould product range (MOLD-NIL®), a complete range of mycotoxin deactivators (UNIKE®, TOXY-NIL PLUS® & TOXY-NIL®), and services like raw material screening to help asses and address the risk of mycotoxin contamination.

Daniel Ramirez, Business Development Manager Digestive Performance, presented on gut health at FIAAP. "Nutriad's ADIMIX® product range exploits the proven health benefits of butyrate and provides a cost-effective option to improve animal performance. ADIMIX® Precision enhances enteric development and intestinal health as well as nutrient absorption. It furthermore provides support for the control of *Salmonella* and *Campylobacter* infections," stated Ramirez. www.nutriad.com

Nutriad's team at Victam Asia 2018: Dr Glenn Alfred Ferriol (left) with, from third left, Daniel Ramirez, Dr Peter Coutteau, Business Unit Director Aquaculture, Ho Gim Chong, Product Manager Farm Products- Aquaculture, Poonmanee Kanjanaworakul, Sales Manager-Aquaculture, Thailand, BK Chew and Martin Guerin, Malaysia.

Scientific session on functional feed additives at APA 2018

The 2018 Asian-Pacific Aquaculture (APA) took place in Taipei from April 24-26 over 1,500 registered participants. APA18 was organised by the World Aquaculture Society – Asian Pacific Chapter - and hosted by the National Taiwan Ocean University. A specialist in species specific solutions for fish and shrimp, multinational **Nutriad** sponsored the scientific session on functional feed additives.

"Taiwan has been a pioneering country in modern aquaculture and although production is limited today in Taiwan itself, the expertise of many companies and consultants plays a key role in the development of aquaculture in Asia and worldwide", says Allen Wu, APAC Regional Manager Aquaculture with Nutriad, based in Taipei.

Nutriad selected APA18 as its platform for organising an aquaculture distributor meeting and a customer dining event. Also, Nutriad sponsored a scientific session on "*Functional feed for health management.*" "Actively participating in a scientific session provides an excellent opportunity for our central and regional aqua team to interact with our partners and customers in APAC and jointly learn about current market developments and new findings regarding the application of our functional feed additives for fish and shrimp," said Dr. Peter Coutteau, Nutriad Business Unit Director Aquaculture.

The well attended session was chaired by Coutteau and Dr Wang Han-Ching from the National Cheng Kung University, Taiwan. Professor Yu-Hung Lin from the National Pingtung University of Science and Technology, Taiwan presented a talk on *"Nutritional Concept in Plant-Based Aquafeed: A Brief Review for Cholesterol and Bile Salt"*, during which he presented innovative findings relating to the supplementation of bile salts in shrimp, to the role of molting hormones (ecdysteroids) and the enhanced expression of genes related to shrimp growth.

Dr Maria Mercè Isern i Subich, Nutriad's Business development Manager Aquaculture Health talked on *"Effect of Novel Feed Additive on Performance and Health Indicators during Natural Thermal Fluctuations in Gilthead Seabream Sparus aurata in Cage Culture"*. Functional feed additives could prepare seabream better for stress suffered during the winter and spring in the Mediterranean region, as evidenced by better growth performance, as well as a better mobilisation of fat reserves from liver and enhanced plasma/liver indicators during the warm-up in spring.

Dr Prakan Chiarahkhongman (CPF, Thailand) gave a presentation on *"The 3C Strategy: Antibiotic-Free Health Management Practices for Shrimp Farming in Thailand"* during which he updated the audience on the current knowledge of the major diseases affecting shrimp farming in Thailand, ie white spot syndrome virus (WSSV), acute hepatopancreatic necrosis disease (AHPND/EMS), white faeces syndrome (WFS), and *Enterocytozoon hepatopenaei* (EHP). Furthermore, he explained the prevention strategies currently practiced by the CPF group in Thailand.

Finally, Ho Gim Chong, Nutriad's Product Manager farm products Aquaculture in APAC, explained in his presentation on *"Farm Application of a Functional Feed Additives: An Essential Tool in The Health Management of White Faeces Syndrome in Asian Shrimp Farming"*, that the correct protocol and dosage, combining the in-feed application at the feed mill with topdressing application at the farm, is key to obtain full growth recovery following an episode of white faeces syndrome. www.nutriad.com

At the Nutriad booth, Peter Coutteau (right) with presenters, Maria Mercè Isern i Subich (left), Ho Gim Chong (middle) and Allen Wu (second right). Also in the picture are; Poonmanee Kanjanaworakul, Sales Manager-Aquaculture,Thailand (second left), Dr Waldo Nuez, Lead Scientist-Aquaculture (third left) and Alexander van Halteren, Business Development Manager Aquaculture Nutrition (third right).

New business unit, Kemin AquaKulture

Kemin AquaKulture is a new business unit for Kemin Industries (Kemin), a global ingredient company that uses science to touch more than 3.8 billion people every day with its products and services. Kemin AquaKulture was launched on 24 April 2018 in Taipei, Taiwan, in conjunction with Asian-Pacific Aquaculture (APA 2018) conference and tradeshow.

Kemin AquaKulture will direct the expertise Kemin has with inspired molecular solutions and its consumer insights toward the aquaculture industry. The company will use its 50-plus years of experience and innovation to apply its pioneering animal nutrition and health products and solutions to the aquatic species and aqua feed.

"Nearly half of human food consumption of animal protein is in the form of fish and/or shrimp. With the focus on sustainable production, producers are quickly moving from using wild caught to farmed fish," said G.S. Ramesh, Group President, Kemin Animal Nutrition and Health. "With this shift, the industry is expected to grow rapidly. For these reasons and a variety of others, we decided to make AquaKulture its own business unit."

Kemin AquaKulture will offer a variety of products and solutions to help customers prevent microbial spoilage, strengthen oxidative control, boost lipid nutrition, promote better health in aqua species by enhancing immunity and ensure water quality to optimise growth. This portfolio of programs will help aqua feed companies, aqua farms, fish meal producers and raw material suppliers to farm aqua species with better growth, uniformity and economic returns.

At the Kemin AquaKulture launch, Dr M Rajalekshmi, Senior Scientist, Kemin AquaKulture, highlighted some of the innovations that Kemin will be adapting for the aquaculture industry.

“A key research area in aquaculture is disease control, and the expertise of Kemin in phytomolecular research can be effectively applied to address it,” said Rajalekshmi. “New innovations at Kemin, such as using 1,3-β-glucans from *Euglena sp.* as immune enhancers and emerging technology for modulation of gut microbiome, may benefit the aquaculture industry.”

Rajalekshmi highlighted the key safety and efficacy considerations required for use of active microbials in aquaculture.

“For Kemin AquaKulture, our immediate attention in nutrition research is on enhancing lipid nutrition with the pioneering technology of lysophospholipids and improving trace mineral nutrition,” she said. “Another focus area for improving feed efficiency is the use of enzymes. We will continue our emphasis on feed quality with the application of safe and sustainable sources of antioxidants and antimicrobials.”

In addition to its pioneering scientific developments, Kemin innovation also extends to customer service, application technologies, quality and safety practices.

"Over the years, several Kemin Animal Nutrition and Health teams have successfully ventured into the aquaculture market," said Ramesh. “We're excited to now launch a complete AquaKulture business unit that will provide even greater resources to strengthen the quality of aqua feed and feed ingredients and improve the health and survival of aqua species. We look forward to serving those in the aquaculture industry."

Lauching the new busines unit; from left; Dr John Springate and K P Philip of Kemin AquaKulture, G S Ramesh – Group President of Kemin Animal Nutrition and Health and Riaan Van Dyk - Vice President Worldwide Marketing & Strategy of Kemin Industries.

Kemin Industries is a global ingredient manufacturer with more than 500 specialty ingredients made for the human and animal health, pet food, nutraceutical, food technology, crop technologies and textile industries. Kemin provides ingredients to feed a growing population with its commitment to the quality, safety and efficacy of food, feed and health-related products. Established in 1961, Kemin is a privately-held, family-owned and operated company with more than 2,500 employees globally and operations in 90 countries, including manufacturing facilities in Belgium, Brazil, China, India, Italy, Russia, Singapore, South Africa and the United States. www.kemin.com/aquaculture

(From left to right), Ryan Siew, Marketing Manager and Jocelyn Leung – MARCOM Executive, Kemin Animal Nutrition & Health, Asia Pacific; Dona Lin, Admin Manager, Kemin Animal Nutrition & Health, Taiwan; Dr Tan Boon Fei, Research Manager, Kemin Animal Nutrition & Health, Asia Pacific; Ning Widjaja, Aqua Business Manager of Kemin AquaKulture, Asia Pacific, Dr K V Chandrasekar, General Manager, Feed Technology of Kemin Animal Nutrition and Health, Asia Pacific and Jimmy Wichawet, Regional CP Key Account Manager of Kemin Animal Nutrition & Health, Asia Pacific.

Upgrading, transformation and feed development

Guangdong Nutriera Group Co., Ltd reported a successful 'China Aquafeed Enterprises Product Upgrade and Operation Transformation Summit 2018' held in Huai'an Jiangsu on March 16-17. Invitees included the top 10 operational and technical experts in the feed industry to share their practical experiences. Nutriera also invited the executives from traditional manufacturing industries to share experiences in the aqua feed industry.

The forum focussed on the theme of upgrading, transformation of selected aspects of feed management, animal health products promotion, industrial chain construction, industrial financial practice and functional feeds development. It was jointly organised by Guangzhou Fishcloud Plus Co., Ltd and Nan Fang Media Group Agriculture Wealth Magazine.

Huai'an, Jiangsu has many excellent aqua feed enterprises in this city. The "Huai'an phenomenon" that appeared in the past two years has injected a bright landscape for the development of aquatic feeds. More than 500 industry peers from 23 provinces of China, the Philippines, Vietnam and other countries attended the event to jointly explore the "Huai'an phenomenon" and the future development of aquatic feed companies.

Gui Jianfang, academician of Chinese Academy of Sciences, Institute of Hydrobiology said that the state has put forward the development policy on fisheries which focuses mainly on farming. Ecological priorities and adjustments on the supply side have already led to major changes in the aquaculture industry. In order to adapt industry reforms to state policies, Gui pointed out that the aquaculture industry must fully upgrade for the future. Industry needs to reduce the impacts of chemical residues, eutrophication and organic load in the water environment, and the use of industrial products such as pesticides and fertilisers to produce more quality and safe aquatic products.

According to **Yi Xuanwen**, Board Secretary, Zhanjiang Guolian Aquatic Products Co., Ltd, China will be the leading consumer of seafood globally in the next 10 years. The growth rate will exceed the world average and by 2023, China's overall demand will exceed 70 million tonnes. This increase in consumption will surely push the drive to improve fish and shrimp farming. How should the aquafeed enterprises adapt to this change in farming?

From Left, Dr Zhang Song, Professor Gui Jianfang, Dr Yang Yong and Dr Andy Pei.

Discussing "Development tendency, opportunities and challenges of aqua feed industry", **Dr Yang Yong**, President of Guangdong Nutriera Group Co., Ltd pointed out that the aquafeed industry needs to focus on two aspects in the future. One is to develop the industrial chain, and the other is to carry out transformation and upgrading for feed products. Yang has fully grasped the development trend of the aquaculture industry in recent years. He also gave some forward-looking advice on the development of probiotic products.

The rapid developments of Nan Shan Feed Co., Ltd. of Jiangsu LongLife Group Co., Ltd in recent years have proved the point of Yang that upgrading is needed. Nan Shan Feed mainly produces aquatic pellets with annual sales volume of 44,000 tonnes before 2014. **Gu Ping**, the chairman of Nanshan keenly grasped the industrial development trend and introduced changes including extruded feed technology. Its growth rate is outstanding and the company aims to reach a sales volume of 200,000 tonnes in 2018. Taking the yellow head catfish feeds as an example, the sales volume in 2015 was only 400 tonnes, but exceeded an amazing 10,000 tonnes in 2017.

Entrepreneurships

Zhong Minglan

Huai'an Tianshen Argo-Aqua Co., Ltd was initially a small local company, but it has become the largest aquatic product enterprise in Jiangsu with its unique service mode. The General Manager, **Chen Deyong** shared the story of Tianshen development, especially the innovative service mode of '1 m wide and 1000 m deep'. A 1985 entrepreneur, **Zhong Minglan**, Chairman of Guangxi Yulin XinJian Farming Group Co., Ltd, stressed the importance of committed entrepreneurship; this company has provided a good example on how the aquatic feed enterprises can be successfully transformed in the industrial chain.

"In the process of rapid transformation and upgrading of small and medium-size enterprises, the supporting financial and other service platforms are very essential," said **Dr Yi Ganfeng**, President of DBN Fantastic Aquaculture Science & Technology Group Co., Ltd. He then presented the participants with a comprehensive service platform for fishery, via the use of Internet applications, where e-commerce can be used in the agriculture and aquaculture services.

Hou Yinmei

The ultimate goal of the transformation and upgrading of enterprises is to ensure the sustainability of benefits, the adjustment of operating systems, the improvement of product structure and the building of cutting-edge technologies. How to transform the mindset of employees remains a problem that all enterprises face. **Hou Yinmei**, HR Manager of Jiangsu Aucksun Co., Ltd introduced the successful results obtained by Jiangsu Aucksun Co., Ltd. through the introduction of the "internal company system". **Dr Andy Pei**, Global Technical Director of warm water aquaculture of Cargill Group shared the

Keynote Speakers at AQUA 2018

The keynote presentations will be given during the Plenary Session on Sunday, August 26 in the BERLIOZ Auditorium of Le Corum. The Plenary Session will be followed by the AQUA20178 Student Spotlight Awards.

Charoen Pokphand Foods – changing the face of Asian aquaculture

Robins McIntosh, Executive Vice President of Charoen Pokphand Foods PLC

Experiences over the past 2 decades in developing shrimp and tilapia aquaculture first in Thailand and later all over Asian countries, focusing on reasons for successes and failures, how to deal with technical issues (diseases, certification issues) as well as socio-economics, public perception, trade issues, etc.

Robins McIntosh is an executive vice president of the Charoen Pokphand Foods Public Company Limited (CPF), the largest integrated producer of aquaculture shrimp in the world. His responsibilities include management of the shrimp broodstock development and genetics programs. McIntosh joined CPF in 2001 and was tasked with the job of reviving the companies shrimp aquaculture division. As part of this process he over sighted the introduction of *P. vannamei* into Thailand, the development of specific pathogen free (SPF) *P. monodon*, and the modernization of hatcheries, and farms. His work at CPF increased shrimp production at the company from 5,000 tonnes to over 90,000 tonnes annually in 2010. These changes that were introduced into CPF eventually made their way into most of Asian shrimp culture turning a stagnant industry into one of the most dynamic growth stories ever in aquaculture.

Technological innovation in salmon farming

Øyvind Oaland, Global Director, R&D and Technical, Marine Harvest ASA

An insight into the current challenges that Marine Harvest is addressing and how technological innovations and new production platforms will facilitate sustainable growth.

Øyvind Oaland has served as head of the Global Research and Development department in Marine Harvest since 2008 and is member of the senior management team in Marine Harvest Group. He has long experience from research and technical area within salmon farming and processing and has been with Marine Harvest since 2000. Prior to taking the position as Global Director Research & Development in 2008, he held various positions within the group in the areas of fish health, food safety and product quality. Øyvind has a degree in Veterinary Medicine from the Norwegian School of Veterinary Science.

Updated information on www.aquaeas.eu or www.was.org. For sponsorship or the exhibition please contact mario@marevent.com.

Appointment

Strengthens technical support in Asia Pacific

Diana Aqua is expanding its expertise in aquaculture with **Dr Fabio Soller** joining the team as Technical Director Asia Pacific. Increasing Diana Aqua market footprint and supporting the business expansion through his technical and scientific skills are part of Soller's main responsibilities. Based in Bangkok, Soller is the reference for fish and shrimp technical support for Aquativ's activity in Asia Pacific and also provides the scientific communication links on the benefits of Aquativ products.

Soller received his PhD in Aquaculture Nutrition from Auburn University, USA in 2012 and has been involved in aquaculture through farm management, research, feed manufacturing support and teaching for 18 years. Soller started as Regional Manager and Technical Sales at Cargill, USA before taking the position of Director of the Aquatic Feeds & Nutrition Department at the Oceanic Institute in Hawaii.

Diana Aqua, part of Diana, a division of Symrise AG, develops and delivers advanced natural and sustainable functional marine ingredients for aquaculture enhancing the nutrition and health of farmed fish and shrimp. Its ranges of products are distributed under the AQUATIV brand. www.diana-aqua.com Email: fsoller@diana-aqua.com

continued from p62.

functional feeds development of Ewos. Through the adjustment and upgrade of the product structure, Cargill greatly improved the operating efficiency of the company.

Finally, **Dr Zhang Song**, Vice President of Guangdong Nutriera Group Co., Ltd conducted a detailed analysis of the ideas and strategies for the transformation and upgrade of aquatic feed enterprises. The analysis was well received by the participants.

This is the first conference organised by Fishcloud with industry. The original objective of the forum platform is to integrate industry resources and provide the industry with cutting-edge technology and ideas. 2018 will be a key year for the transformation and reform of aqua feed enterprises. Fishcloud will help the Chinese aquatic feed enterprises achieve the breakthrough. www.nutriera.cn

Aquaculture in Occitanie, France

This report compiled by members of the AQUA 2018 Steering and Local Organising Committees for the upcoming AQUA 2018 event ***#We R Aquaculture****, introduces the aquaculture of marine and freshwater fish, shellfish as well as Spirulina and other microalgae and macroalgae. Part I in issue March/April covered developments in shellfish and fish production as well as the R&D establishments. In this second part, the focus is on macro and microalgae for food, health, feed and cosmetics and future of aquaculture in France.*

Microalgae – a growing sector

In its 2014 national report (Brinker and Sternberg 2014), the EU Project EnAlgae and the national study carried out on behalf of ADEME (Kerlero de Rosbo and Bernard 2014) identified more than 200 private companies and about 30 academic institutions working with macroalgae and microalgae. The use of microalgae and macroalgae is very evenly distributed among French stakeholders (38% are working with microalgae and 38% are working with macroalgae). Nearly a quarter of all stakeholders (23%) are cultivating and processing both algae types (23% of the industrial stakeholders and 27% of research institutions). Based on the EnAlgae report, a considerable number of stakeholders work with cyanobacteria and, although they are not algae from a scientific perspective, they are often mentioned in the context of microalgal activities.

Production technologies are based on open or closed production systems:

- Open/ half-open production systems – open ponds, raceways and longlines
- Closed photobioreactor systems (PBR) - flat bed/plate/panel reactor, tubular reactor, bag/flexible tube reactor, rain creating stack system ("horizon") and fermentation (heterotrophic cultivation).

The major markets targeted by French macroalgae companies are primarily for food ingredients, pharmaceuticals, cosmetics and textile manufacturing, and secondarily for food products (animal and human sectors), produced from wild-harvested or open-pond grown product.

Microalgae in France are primarily used for food (e.g. *Spirulina*) and to a lesser extent for cosmetic and nutraceutical products and animal feed ingredients. Microalgae producers typically target more diverse markets than those dealing with macroalgae. The most promising markets for microalgae products are within the energy and chemical sectors in combination with bioremediation of industrial flue gases and wastewaters.

For algae, French research institutions address issues mainly relating to development of better, more efficient production systems, optimisation of growth conditions and development of biorefineries for biofuels and other new energy products such as algae-based hydrogen. Other research-based activities include environmental impact modelling and LCA analysis, abiotic and biotic interactions, bioprospecting and (to a much lesser extent) genetic engineering. In Occitanie (a new 'super region' of France, created in 2016 from the former regions of Languedoc-Roussillon and Midi-Pyrénées), research on algae is growing fast and now is structured under the Algadoc Network.

Innovative companies are established in the region in the microalgae production sector, for the sectors of chemistry, food, health, and cosmetics. The Trimatec Competitiveness Cluster organizes each year the event Algo'Réso, the rendez-vous for microalgae in the Mediterranean, the appointment of researchers and industrialists of the sector.

Planned growth of French aquaculture

Although production has stagnated in recent years and the oyster sector has been significantly affected by mortalities, the French government is placing a high priority on further developing the sector and there has been significant activity over recent years on developing growth strategies in all sectors and integrated marine spatial planning.

The national growth objectives for 2014-2020 in France are to increase by 2020:

- Production from 218,000 tonnes to 265,000 tonnes in 2020, a 22% increase over the 2007-2012 baseline average values.
- A 50% increase in production value, from € 682 million to 1,025 million.
- Increasing volumes of production; molluscs by 12%, freshwater fish by 28% and marine fish by 233%.

To read the full report and on the focus on L'Etang de Thau, one of the main Mediterranean lagoons, go to www.aquaeas.eu.org

References are available on request

Montpellier le Corum is the venue for the upcoming AQUA 2018, co-organised by EAS and WAS from August 26-28

Microalgae platform in Ifremer Palavas station © Ifremer Olivier Dugornay

Sciaenops ocellatus aquaculture in Caribbean Ifremer

Speckled seahorse in Thau Lagoon © Ifremer, Olivier Dugornay

Asian Pacific Aquaculture 2019 (APA'19) in Chennai, India

In December, World Aquaculture Society–Asian Pacific Chapter (WAS-APC) announced that the Asian Pacific Aquaculture (APA'19) will be held in Chennai, India from June 19-22, 2019. APA'19 with the theme *Aquaculture for Health, Wealth and Happiness*. will create a platform for academic, professional and governmental experts. The technical sessions at the APA19 will be organised in 8 conference rooms. The scientific posters will be in the exhibition hall with over 100 exhibition booths. The organiser will have several smaller rooms for business or project meetings. Many associations are expected to hold their annual meetings during the event.

The first meeting of the steering committee for APA'19 was held in December 2017 in Chennai, India. The meeting was hosted by the Tamil Nadu Fisheries University. Dr S. Felix, President-elect WAS-APC serves as the national conference chair and Dr Farshad Shishehchian, Past President of WAS-APC was selected as the international conference chair. Dr JK Jena, Deputy Director General-Fisheries of ICAR will facilitate the cooperation of all the central and state fisheries institutes.

The four APA19 program chairs: Dr Mohan Joseph Modayil; Dr Indrani Karunasagar; Dr JK Jena (ICAR) and Dr Stephan Sampath Kumar (TNFU) together will work on a high quality conference program. The APA19 venue will be the Chennai Trade Centre.

More information: www.was.org

For conference, email: worldaqua@ was.org / apcsec@was.org

For sponsorship or the exhibition email: mario@marevent.com (Mario Stael)

Dr S. Felix (centre left) with the APA'19 steering committee

Aqua Culture Asia Pacific in 2018

Volume 14 2018			
Number	**4 – July/August**	**5 – September/October**	**6 – November/December**
Issue focus *Trending issues and challenges for the next step*	Disease Management	Genetics & Genomics	Integration and supply chain
Industry Review *Trends and outlook, demand & supply*	Tilapia	Monodon shrimp	Catfish/General Freshwater
Feeds & Processing Technology *Technical contributions from feed industry*	Lipids & Minerals Nutrition	Feed Safety and Hygiene	Functional Feeds
Production Technology *Technical information and ideas*	SPF/SPR/SPT shrimp	Post-Harvest Technology	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	China	USA	Catfish
Aqua business *Feature articles*	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc		
Company/Product news	News from industry including local and regional trade shows		
Deadlines for Technical articles	**May 18**	**July 13**	**September 14**
Deadlines for Advert Booking	**May 25**	**July 20**	**September 21**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	***TARS 2018 Shrimp Aquaculture** August 15-16 Chiang Mai, Thailand **Vietfish 2018** August 22-24 Ho Chi Minh City, Vietnam **Aqua 2018** August 25-29 Montpellier, France	**The 8th International Conference of Aquaculture Indonesia (ICAI 2018)** October 25-27 Yogyakarta **Taiwan International Fisheries and Seafood Show** November 22-24 Kaohsiung	**Asian Aquaculture 2018** December 3-6 AIT, Bangkok, Thailand

THE AQUACULTURE ROUNDTABLESERIES® 2018
A shared vision for aquaculture in Asia
August 15-16 2018 • Shangri-La Hotel • Chiang Mai, Thailand

SHRIMP AQUACULTURE: NEED FOR CHANGE

Asia's Shrimp Aquaculture: Need for Change

Today, growth of shrimp aquaculture in Asia is moving at different speeds. This has not benefitted the entire value chain as gross margins remain thin due to low survival rates and disease outbreaks. The situation has since regressed, resulting in reduced productivity with massive increases in production cost.

"There is a need for change in production paradigms if Asia is to reach global production levels prior to the EMS crisis," says Zuridah Merican, editor of Aqua Culture Asia Pacific, and chairperson of TARS 2018.

The Aquaculture Roundtable Series (TARS 2018), to be held at the Shangri-la Hotel, Chiang Mai, Thailand from August 15-16, 2018 will be the fourth time the meeting will look at shrimp aquaculture in Asia. The two-day meeting features a vibrant program with the participation of international experts and key stakeholders from the industry and academia, who will share new knowledge, exchange insights and experiences at the plenary and interactive breakout sessions, a hard talk with young shrimp farmers, and panel discussions that have become hallmarks of this critical series.

TARS 2018 is the ideal platform for networking and dialogue among Asia's key players in the shrimp aquaculture sector, including CEOs, geneticists, farm and hatchery managers, integrators, feed producers, technologists, investors, marketers, as well as governments, NGOs and academia.

REGISTRATION IS LIMITED TO 200 PARTICIPANTS.
Early bird registration ends on **June 18 2018**. Walk-ins are not encouraged.

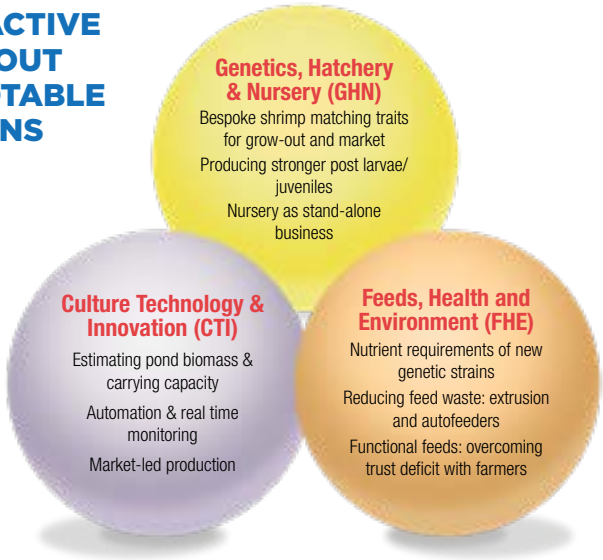
5 PLENARY SESSIONS

- State of Industry & Challenges in Asia
- Productivity in the Supply Chain
- Nutritional & Health Interventions
- Revival of the Black Tiger Shrimp
- Attracting Investments

HARD TALK WITH YOUNG SHRIMP FARMERS

Hard-hitting questions on new business and farming models, challenges and successes.

3 INTERACTIVE BREAKOUT ROUNDTABLE SESSIONS



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nutriad we add more

Diamond V The Trusted Experts In Nutrition & Health

BASF We create chemistry

BioMar

DSM

aquativ

Jefo

For more information:

conference@tarsaquaculture.com

www.tarsaquaculture.com

Speaker highlights (at press time)

State of the Shrimp Aquaculture Industry – Surviving in a Changing World

"The change we wish to see will be to reduce pond size, increase yields, diets and genetics that result in fewer days of grow-out, genetics that create even better tolerance to more pathogens in disease-free shrimp, and more modernization of hatcheries to create larger and healthier post larvae, and more emphasis on creating market stories and differentiated shrimp products."

Robins McIntosh, *Charoen Pokphand Foods Public Company, Thailand*

Science in Shrimp Farming and Recent Innovations in Hatchery and Production Systems in Vietnam

"With better adaptation to new farming protocols, it appears that shrimp farming in Vietnam has become more predictable, which explains the fast growth in shrimp production in recent years."

Loc Huu Tran, *ShrimpVetLaboratory, Vietnam*

Shrimp Farming in India – Fast & Furious, Controls and Caution to Growth

"The need of the hour is for more stakeholder effort to build a sustainable shrimp farming model that can cope with rising projections. Industry also needs to improve market access.."

S. Santhana Krishnan, *Marine Technologies, India*

The Road Towards a Sustainable Shrimp Industry in Latin America

".. despite the geographical proximity, experiences vary. Central American production is stabilizing after a number of years of turbulence, specifically in Ecuador where its resources and infrastructure are attracting investments."

John Tinsley, *BioMar A/S, Costa Rica*

Sustainable Approaches for Vannamei Shrimp Nursery Culture in Asia

"Microbial management via environmental control, constant application of high quality probiotics, and use of superior enriched diets are key approaches to achieving more consistent results to sustain a more robust business model."

Manuel Poulain, *INVE Aquaculture, Thailand*

Update on Current Shrimp Disease Threats in Asia: Managing Trigger Points in Diseases & Production Strategies

"Farmers in many countries deploy various strategies to manage the disease and try to understand more on the pathogens present in the farm environment."

Anwar Hasan, *Biomin, Singapore*

Mitigating Disease through Gut Health: Options Today

"Clearly gut health is a crucial concept to obtain best results in farming but we need much more research to find the best product, the optimal dose and even best combination of products to neutralize, attenuate or inhibit pathogens."

Serge Corneillie, *Diamond V, Japan*

A Nutritional Solution against White Spot Syndrome Virus on Pacific White Shrimp in Ecuador

"To reduce the impact on mortality of shrimp contaminated with WSSV, a nutritional solution was proposed and tested to improve shrimp immune status and survival against the WSSV challenge."

Thiago Soligo, *DSM Nutritional Products, Latin America*

Meeting Farming Expectations: Functional Ingredients for Modern Shrimp Feeds and Robust Animals

"Keeping shrimp interested in the diets for high feed intake, with good digestibility, growth and health is vital. In the long run, a properly balanced diet enhanced with these high-quality ingredients will lead to crucial returns to the feedmill and the farmer.."

Fabio Soller, *Diana-Aqua, Thailand*

WSD-resistant Monodon Shrimp: Part of the Solution

"We have successfully bred WSSV-resistant broodstocks. We also aim to use a gene stacking approach for additional desirable traits to enhance the commercial profitability of this shrimp."

Grace Chu-Fang Lo, *National Cheng Kung University, Taiwan*

Different Horses for Different Courses: Revisiting SPF/SPR/SPT

"Use of disease free and well managed genetically improved disease resistant populations offers the opportunity to stabilize shrimp production systems in Asia. Alternative SPF/SPR/SPT strategies based on experiences and possible implications for improved disease management strategies will be discussed."

Morten Rye, *Akvaforsk Genetics, Norway*

Go to tarsaquaculture.com for full program details

2018 Shrimp Pathology Short Course: Disease Diagnosis and Control in Marine Shrimp Culture

June 18-23, 2018, The University of Arizona, USA

Major shrimp diseases listed by World Animal Health Organization (OIE)	Methods of disease prevention and/or treatment
• White spot syndrome virus (WSSV) • The baculovirus diseases: monodon-type baculovirus (MBV) and baculovirus penaei (BP) • The parvovirus diseases: infectious hypodermal and hematopoietic necrosis virus (IHHNV), and hepatopancreatic virus (HPV) • RNA viruses infecting penaeid shrimp: Taura syndrome virus (TSV), yellow head virus (YHV), infectious myonecrosis (IMNV), Penaeus nodavirus (PvNV), and white tail disease (WTD) • Bacterial diseases: acute hepatopancreatic necrosis disease (AHPND; caused by some strains of Vibrio spp.), necrotizing hepatopancreatitis (NHP-B), and vibriosis. • Microsporidian diseases: *Enterocytozoon hepatopenaei* (EHP) and cotton shrimp disease	Development of biosecurity and quarantine protocols Labs and Demonstrations: Topics to be covered in the labs 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: AHPND Review of histopathology of viral and bacterial diseases.

Lectures, Labs and Demonstrations will be presented by Staff from the Aquaculture Pathology Laboratory: Arun K. Dhar, PhD: Associate Professor & Director, Aquaculture Pathology Laboratory, Molecular Virologist Luis Fernando Aranguren, PhD: Crustacean Pathologist Siddhartha Kanrar, PhD: Molecular Biologist and Bioinformatician Carlos Pantoja, PhD: Histopathologist Jasmine Millabas: Research Specialist Histotechnician Michelle Garfias: Research Specialist PCR Technician Kevin M. Gee: Research Specialist PCR Technician. West Campus Wet Lab Staff: Brenda Noble: Senior Research Specialist Paul Schofield: Research Specialist Tanner Padilla: Research Laboratory Aide

Registration Information: Registration is limited to 24. Deposit and Early Registration Deadline: USD100.00 by May 23, 2018. Apply to the Aquaculture Pathology Laboratory, School of Animal and Comparative Biomedical Sciences, University of Arizona, Tucson, AZ 85721, USA.

Mailing address: The University of Arizona Aquaculture Pathology Laboratory; BioScience West 1041
E. Lowell Street, Room 226 Tucson, Arizona 85721, USA.
Tel: 520-621-4438; Fax: 520-626-5602
Email: dhuie@email.arizona.edu; adhar@email.arizona.edu

2018

Details on the events below are available online at **http://www.aquaasiapac.com/news.php**
To have your event included in this section, email details to **zuridah@aquaasiapac.com**

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

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

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

August 15-16
TARS 2018: Shrimp Aquaculture
Chiang Mai, Thailand
www.tarsaquaculture.com

August 20-22
Food & Feed Extrusion Technology
Melbourne, Australia
www.foodstream.com.au

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

August 22-25
Aquarama 2018
Shanghai, China
www.aquarama.com.cn/en/

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

October 23-26
LAQUA 2018
Bogotá, Colombia
www.was.org

October 25-27
The 8th International Conference of Aquaculture Indonesia (ICAI 2018)
Yogyakarta
www.icai.aquaculture-mai.org

November 7-9
China Fisheries and Seafood Expo
Qingdao
www.chinaseafoodexpo.com

November 22-24
Taiwan International Fisheries and Seafood Show
Kaohsiung
www.taiwanfishery.com

December 3-6
Asian Aquaculture 2018
Bangkok, Thailand
info@asianaquaculture.org
www.asianaquaculture.org

2019

January 23-25
Brackishwater Aquaculture (BRAQCON 2019)
Chennai, India
Email:cibabraqcon2019@gmail.com

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

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

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

AQUA 2018

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

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

Uni-President

CREATES THE VALUE OF PRAWN

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

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UNI-PRESIDENT VIETNAM CO., LTD.

Establishing a Healthy and Happy Tomorrow