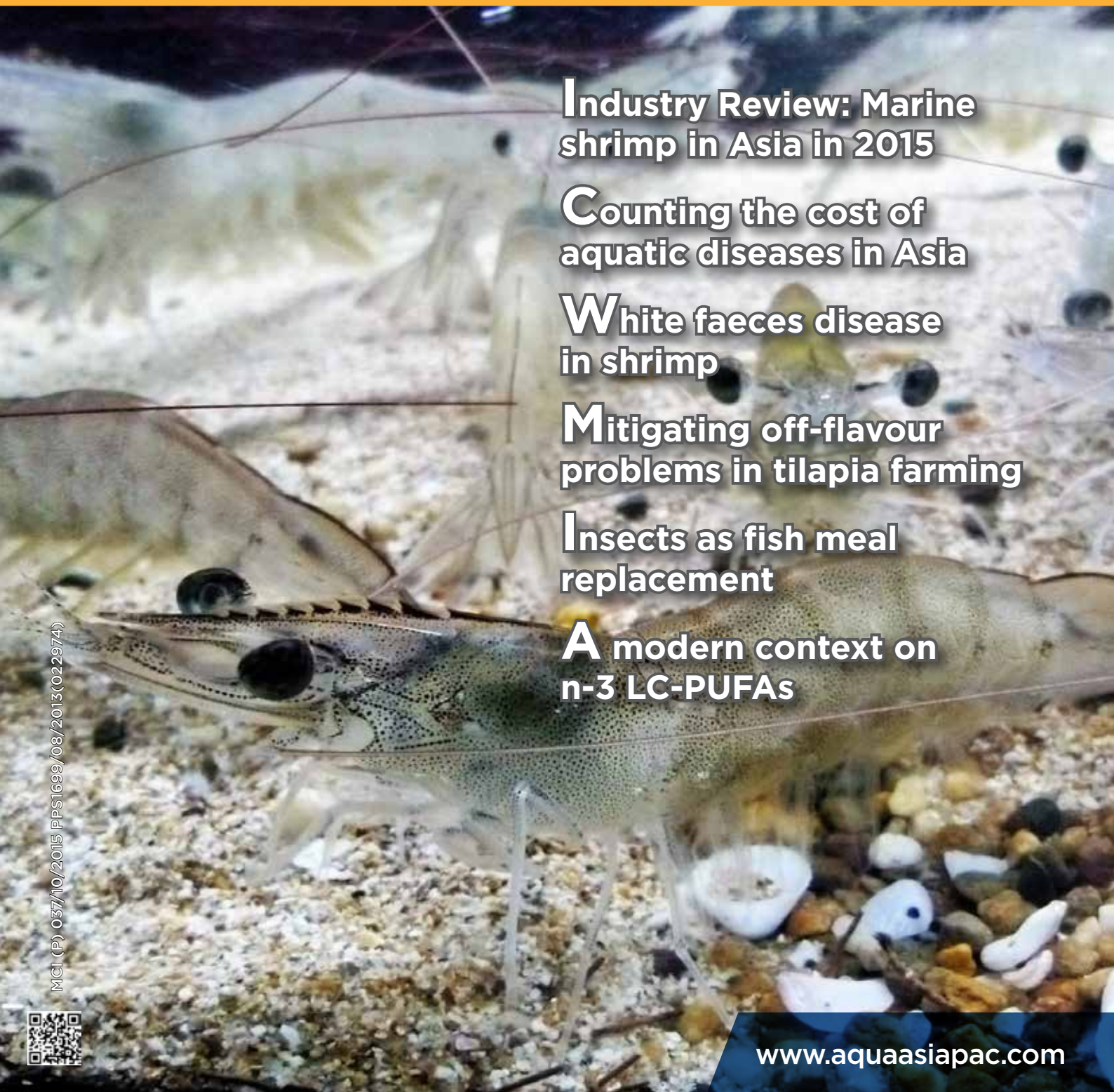
ISBN 1793 -0561

JANUARY/FEBRUARY2016

Volume 12 Number 1

AQUA CULTURE

Asia Pacific



Industry Review: Marine shrimp in Asia in 2015

Counting the cost of aquatic diseases in Asia

White faeces disease in shrimp

Mitigating off-flavour problems in tilapia farming

Insects as fish meal replacement

A modern context on n-3 LC-PUFAs

MCI (P) 037/10/2015 PPS1699/08/2013(022974)

www.aquaasiapac.com

Grow with Gold Coin

GOLD COIN 金錢 SPECIALITIES

Since 1984, GOLD COIN is committed to research, sustainability and good customer service.

visit our website
www.goldcoin-group.com

At **GOLD COIN**, we are committed to provide superior shrimp feeds to ensure your business success. Using only the highest quality raw materials and manufactured under strict quality controls, we offer a range of feeds* to consistently meet the various levels of production systems. Our strict policy of opposing the use of antibiotics in our feed is congruent with the growing demand by consumers for traceability.

- **GOLD SUPREME** for superior growth and feed efficiency. Health enhancement with proprietary ENCAP® Immune enhancer
- **GOLD FORTE/GOLD VERTEX** are specially formulated for the intensive culture of white shrimp *Penaeus vannamei* in Asian conditions
- **GOLD CLASSIC/GOLD ELITE** are our flagship products that meet all nutrient requirements of *Penaeus monodon* shrimp under normal conditions
- **GOLD ROYALE** is used in highly intensive conditions by the most discerning farmer
- **ENCAP®** Hatchery Feeds have prime quality ingredients micro-encapsulated within a digestible yet water stable membrane

Some products may not be available in your country. For details on Gold Coin range of shrimp feed and other Gold Coin Aquaculture products, please contact our regional offices.

HEADQUARTERS - Gold Coin Holding Limited Sdn Bhd. Suite 9-6, Level 9, Wisma UOA Damansara II No.6 Jalan Changkat Semantan Damansara Heights 50490, Kuala Lumpur, Malaysia Tel: +603 2092 1999 Fax: +603 2092 1919 email: general@goldcoin-group.com

MALAYSIA *(SELANGOR)* - Gold Coin Specialities Sdn Bhd/Gold Coin Biotechnologies Sdn Bhd, Tel: +603 3102 3070-2 Fax: +603 3102 3090 email: ler.chongmeng@yahoo.com

INDONESIA *(WEST JAVA)* - P.T. Gold Coin Indonesia, Aqua Division, Tel: +62 21 885 3668 Fax: +62 21 884 1947 email: m.bima@goldcoin-id.com

THAILAND *(SONGKHLA)* - Gold Coin Specialities (Thailand) Co Ltd, Tel: +66 74 483 600/5 Fax: +66 74 483 493 email: w.pradipat@goldcoin-th.com

INDIA *(CHENNAI)* - Gold Coin Biotechnologies Sdn. Bhd. India Liaison Office, Tel: +91 44 2486 8433 Fax: +91 44 2486 2091 email: v.ravi@goldcoin-id.com

Contents

Volume 12, Number 1 January/February 2016 MCI (P) 037/10/2015 ISBN 1793 -056

Vannamei shrimp, picture courtesy of Soraphat Panakorn, Thailand

Editor/Publisher
Zuridah Merican, PhD
Tel: +60122053130
Email: zuridah@aquaasiapac.com

Editorial Coordination
Corporate Media Services P L
Tel: +65 6327 8825/6327 8824
Fax: +65 6223 7314
Email: irene@corpmediapl.com
Web: www.corpmediapl.com

Design and Layout
Words Worth Media Management Pte Ltd
Email: sales@wordsworth.com.sg
Web: www.wordsworth.com.sg

AQUA Culture Asia Pacific is published bimonthly by

Aqua Research

Aqua Research Pte Ltd
3 Pickering Street,
#02-36 Nankin Row,
China Square Central,
Singapore 048660
Web: www.aquaasiapac.com
Tel: +65 9151 2420
Fax: +65 6223 7314

Printed in Singapore by
Print & Print Pte Ltd
3011 Bedok Industrial Park E
#03-2000, Singapore 489977

Subscriptions
Subscribe via the website at www.aquaasiapac.com or complete the enclosed form and mail with payment. Subscriptions can begin at any time. Subscriptions rate/year (6 issues): Asia SGD 70, Other zones: SGD 100
Email: subscribe@aquaasiapac.com
Tel: +65 9151 2420
Fax: +65 6223 7314

Aqua Culture Asia Pacific Online
View E-magazine
Download past issues

Route 2016: highway or country road?

Zuridah Merican

The World Bank has just revised downwards the world's GDP growth and everyone is watching China's slowing growth with trepidation as we step into 2016. The US Federal Reserve rate hike and slump in commodity prices are going have a significant impact on emerging economies that include major aquaculture producers in Asia. Aquaculture, like any industry, is demand-led and dependant on the major markets. The US is still recovering while the EU is in the doldrums. The weakening of China and Japan's currencies against the USD will set the tone for buying power of these countries.

Despite GOAL's prediction, the shrimp industry is not going to recover and grow significantly in 2016. The industry will have to learn to live with diseases such as WSSV, EMS and EHP. As feed, broodstock supply and commodity prices are dictated in USD, productions costs will increase. The lower survival rates will result in volatility and variability of output that will not fit into the production plan. FCRs will vary widely and this will be the new normal. We anticipate a huge debate on which route to take to mitigate diseases, in terms of genetics. Should Asia continue with Specific Pathogen Free (SPF) broodstock or follow the Central American route of SP tolerant and resistant broodstock? According to one school of thought, there seem to be no light at the end of the tunnel for those taking the SPF route. During our analysis of the shrimp production trends for 2015, we observed that stakeholders were already making a link between post larvae quality and broodstock brands. There have been complaints of weaker post larvae with the recent SPF generations.

With *P. vannamei* facing so many disease issues, there is a new wave on *P. monodon* culture. The industry should not be dependent on a single species and both species should find their own niche in the market.

The marine fish industry in Asia needs to grow. This is a particular industry which offers potential, opportunities and less competition today. However, this is a segment that has not reached a threshold level or economies of scale to attract the support segments. AAP has always advocated that there are just too many species out there today resulting in the loss of focus and synergy. AAP continues to encourage integration and industrialisation but does not see this happening in 2016.

The freshwater fish industry will be dominated by the tilapia and pangasius sectors. While tilapia is well accepted in the US market, there is still a trust deficit when it comes to tilapia of China origin with the perception that antibiotic use is rampant. Both tilapia and pangasius have done well in the export market due to processing capability of the respective sectors and this should be the role model for the marine fish industry to follow. Tilapia still has a long way to go in penetrating the EU market and this is where generic marketing of the fish may help. In Hainan, China, producers see that they need to change and after several years, the efforts of CAPPMA and WWF-China are now bearing fruit with two producers attaining ASC certification. But, more needs to be done for tilapia from China, and done quickly for better access to EU markets.

With the strength of the USD, emerging countries will see opportunities to export their aquaculture products but there remains a gap and trust deficit. Antibiotics and chemical residues have hogged the news on seafood products of Asian origin. Whether it is shrimp or fish, producers need to understand that gaining trust and confidence of the consumer is vital for the long-term sustainability and legacy of the business for the next generation of farmers too. Image building and food safety should be a top priority for any responsible food producer. The push in 2016 should be education and awareness on the consequences of using antibiotics, not only in the final product but for all along the supply chain.

In Asian aquaculture, we have been looking at three engines of growth, namely marine shrimp, tilapia and the pangasius. Can we begin to build a 4th engine with a single marine species with economies of scale in 2016?

From all of us at Aqua Culture Asia Pacific and the TARS team, we wish you a HAPPY AND PROSPEROUS NEW YEAR.

OUR MISSION

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

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

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

The Aquaculture Roundtable Series
17-18 August 2016

TARS 2016 will be on Shrimp Aquaculture & the New Normal. It will be held from 17-18 August in Phuket, Thailand. For updates, visit: www.tarsaquaculture.com

The best Introducing

BALANCE

SAFE REDUCTION OF LIVE FEED

* Maximize your profits with the proven best balance between live feed and dry diets.

New

FRIPPAK® FRESH

#1 CAR #2 CD #3 CD

PROVEN QUALITY Gold PROVEN QUALITY

*as shown in lab-scale experiments & large commercial culture runs (> 2 billion fry per year) in Thailand, Mexico, Nicaragua and Vietnam. We recommend the use of **SEP-*Art*** *Artemia* cysts for pure, fast, easy and environmentally friendly *Artemia* harvesting.

INVE

For more information: www.inveaquaculture.com

INVE AQUACULTURE

shapingaquaculturetogether

Expect more vannamei shrimp from the Philippines in 2016

Philippines shrimp growers, now equally comfortable with the vannamei as with the monodon shrimp are optimistic that the upward trend in vannamei shrimp production will continue. At the 10th PhilShrimp Congress, the call was to be efficient and competitive with regional producers, as the domestic markets may not be able to absorb this extra production.

The 10th National Philippines Shrimp Congress was a gathering of shrimp growers and hatchery operators, small and large, together with other stakeholders. In 2015, it was held for the first time in General Santos City (Gensan) on the island of Mindanao from November 11-13, 2015. It was organised by the Philippine Shrimp Industry Inc. (PHILSHRIMP) and SARGEN (Sarangani-General Santos) Shrimp Stakeholders Association Inc. together with the Bureau of Fisheries and Aquatic Resources (BFAR).

PhilShrimp president Roberto Gatuslao said, "The epicentre of the Philippines shrimp industry has been moving south to Mindanao with investments into new farms and expansion of existing ones, especially in region 12 or Soccsksargen. The industry in Mindanao has shifted from extensive farming of the monodon shrimp to more intensive farming of the vannamei shrimp."

The expansion is in the strip from Gensan to Davao in the south. Top players involved in shrimp and marine fish production include Alsons Aqua Corporation, Saragani Agriculture Company, San Andres Aquaculture Corp, Sanacor and the aquaculture division of RDEX Fishing. Charoen Pokphand (CP) Philippines is expanding with a hatchery, a 200 ha farm as well as with contract farming.

In 2014, shrimp farms and other stakeholders in Gensan and in nearby Sarangani Province formed the SARGEN (Sarangani-General Santos) Shrimp Stakeholders Association to boost shrimp production and set industry standards. Roger E. Rivera, who is also PhilShrimp vice president for Mindanao and chairman of the 2015 congress, was the interim president. "We started with 15 members with over 200 ha shrimp farms in Gensan and Sarangani and producing 3,000 tonnes of shrimp annually. Now we have 30 members comprising feed millers, processors, hatchery and growers.

Roger Rivera (seated, second left) with PhilShrimp directors and shrimp growers. Seated from left, Bob Gatuslao, Atty. Jake S. Vergara, vice president for Luzon, Raoul Q. Flores, director for Visayas, Jay Vergara, second generation shrimp grower in Calatagan, Batangas, Luzon, Jose Go, BNH Aquaculture Corp, which supplies aquaculture equipment in the Philippines. Standing, from right, Rose Olaer, Department of Science and Technology, and Amelyn Bravo, shrimp grower in Bacolod, Negros Occidental.

Philip Ong (centre) and Patricia Rico (fourth left), vice president for sales and marketing at the Tateh booth. The company has introduced its Tateh Tech, which encourages growers to go back to basics in aquaculture and lower stocking density for a profitable future.

"We need to form a group with the same interest so that we can communicate and learn from one another. If we do not communicate, we will be competing with one another and this is not healthy for any industry. Together we face the same issues such as the high cost of electricity. If BFAR wants us to focus on the export markets, we would like some assistance similar to the practice in some Asean countries. Fortunately, our industry is well regulated and so we are less worried about diseases," added Rivera in the Brunei Times.

The theme for this 3-day conference and trade show was "maximising benefits of shrimp culture for a modern globally competitive industry". There were 30 presentations from local and regional experts covering key issues in shrimp farming. Production and health management were priority topics and the message by Asis G Perez, BFAR director, was for Philippine producers to "achieve a sustainable and equitable shrimp industry recognised internationally."

Production trends

In the last two years, white spot syndrome virus - WSSV devastated smaller farms; some of them gave up farming or their farms remained idle. BFAR's statistics indicated that out of the 50,000 ha of shrimp ponds, only 4,806 ha were operating and its registry of shrimp farms in 2014 totalled 545. Among them were 324 registered vannamei shrimp farms (2,577 ha) and 184 monodon shrimp farms (2,228.5 ha). The rest were non-registered farms but as they obtained supplies of post larvae from accredited/certified hatcheries, their presence was recorded (Usero & Apostol-Albaladejo, 2015).

"In general the average stocking density is 80 post larvae (PL)/m^2 in the summer months and during the colder months, 50-60 PL/m^2," said Neil Raphael S Jamon, HPML manager, Hoc Po Feeds Corporation. "Most farms operate two cycles per year. Some farms are trying a nursery stage to increase to 4 cycles/year. Two small farms in Luzon, are trying out higher stocking density such as 250 PL/m^2."

"It is now common in large farms to use 0.75 mm HDPE liners which allow farmers to stock more shrimp (100 PL/m^2 from

Abraham Ang, retired shrimp grower (right) with Ramon Alegre, director for the PhilShrimp hatchery sector.

Bob Gatuslao (left) with Hernan Lim, CEO, Hoc Po Feeds Corp, Philippines.

70-80 PL/m^2). During this renovation process, they deepened the ponds but still at less than 2 m."

"In Luzon, some farmers made large profits in 2013-2014 when local prices were very high. Now as local prices have been reduced to almost half, some farms are just maintaining production and have not been aggressive in increasing production. Unlike in many parts of Asia, the Philippine peso did not devalue much and did not benefit with the rising USD for exports. Aside from the fact that processors do not have contracts to fill, prices in USD in international markets are still not attractive for them to buy from farmers," said Philip Ong, PhilShrimp director for Luzon and CEO of Tateh Feeds. Ong added that his customers in Luzon are continuing with shrimp farming, either monoculture or polyculture with fish.

Christopher Co, PhilShrimp director for Visayas and CEO of Overseas Feeds in Cebu said, "Most of the production in the Visayas is channelled to larger towns such as Cebu and Manila. The target size is usually 16 g shrimp. When we see smaller shrimp in the market, we know that there has been a problem at the supply farm. Here we have seen a few farmers giving up and leasing out farms to others."

Today industry estimates that 20 large players contribute almost 80% of the production of vannamei shrimp. Almost all of the shrimp produced is for the local market and prices start at PHP 170/kg (USD 3.7/kg) for size 100/kg. The cost of production ranges from PHP140-170/kg (USD 3-3.7/kg), the breakeven shrimp size is 16 g with ex-farm price of PHP 200/kg (USD 4.3). Most of the demand is for shrimp size 17-20 g. During the holidays, the demand is for 'party shrimp', the larger shrimp size of 30 g. Farm gate prices have declined but the drop is not reflected on the retail side. In Gensan, small packs of shrimp are sold at PHP 50 (USD 1.1) which is affordable for a family meal," said Co.

Shrimp from Gensan

In the last two years, large farms have been expanding pond areas, by either developing new areas or by acquisitions. Some smaller farms affected by WSSV have stopped operations. During the congress, Martini Berguia, technical head of RDEX Aqua and Marfeno Y Tan, chairman, SAFI group which operates the Sanacor farms, presented an overview of farming practices in farms in Gensan and Saragani, respectively. In their opinion, among the three top shrimp producing regions, Mindanao has the potential to expand production further.

RDEX is integrated with processing facilities for seafood from aquaculture and capture fisheries with the processed products meant for export to US, Japan and Korea. The aquaculture business comprises a 100 ha shrimp farm where 75% of ponds are lined with 0.75 mm HDPE, and sea cages for farming milkfish Chanos chanos. In his presentation on intensive farming of vannamei shrimp, Berguia described some practices at the company's five farms. Pond sizes range from 3,000 to 6,300 m^2 and depths of 1.3-1.6 m. In recent crops, stocking density ranged from a high of 173 PL/m^2 in lined ponds to 90 PL/m^2 in unlined ponds. Harvest sizes ranged from 16 g for 108 days of culture (DOC) and 98% survival, to 17.3 g after DOC 120 and 97% survival in unlined ponds. FCR ranged from 1.33 to 1.23.

Rivera who is also COO of RDEX Food International, Phils Inc said that since the 1980s, the company has been producing monodon shrimp and exporting to Japan.

"We enjoyed this for 15 years but then switched to vannamei shrimp. The operations are the same but stocking density has increased to an average of 140 PL/m^2. We did try 200 PL/m^2 too. Our market size is from 14 g to 18 g shrimp for the local market. If we produce for export, we harvest 22 g shrimp. Here in the south, we can manage three crops a year. Survival is high at 95%. Post larvae (PL12) cost 26-28 centavos each (USD 5.65/1000)."

"RDEX will be a stronger player in the shrimp farming business. In two years, we expect to line all our ponds and this will be in line with our focus of less impact on the environment. We will also expand with production in Bohol with a 30 ha farm. This will serve the domestic shrimp market."

On the introduction of automation in his farm, Rivera said, "Although I have seen some auto feeders in shrimp farms elsewhere, here we have a social obligation to keep our workforce. Some 75% of our assets are these people working for us. We enjoy a good relationship with our staff and need to preserve this for the success of our business"

(Related article & information: Reflections on past experiences with shrimp vibriosis, p12 and production trends in 2015, p43)

AquAdvantage® Salmon in US and Canada

After more than two decades, the US Food and Drug Administration (FDA) has approved on November 2015, AquAdvantage® Salmon, AquaBounty Technologies' Atlantic salmon that has been genetically enhanced to reach market size in less time than conventional farmed Atlantic salmon. In December, AquaBounty Technologies also announced the decision of the Canadian Minister of Environment and Health to allow production of AquAdvantage® Salmon in Canada for commercial use. Ronald L. Stotish, CEO, said that AquAdvantage Salmon is a game-changer that brings healthy and nutritious food to consumers in an environmentally responsible manner without damaging the oceans and other marine habitats. On the decision in Canada, he said, "This reflected the opinion that our salmon eggs are not harmful to the environment or human health when produced in contained facilities. This should allay any remaining fears consumers may have about our fish. The ruling also affirms that Canada has one of the most stringent regulatory systems in the world." AquaBounty Technologies is a biotechnology company focused on enhancing productivity in aquaculture.

New Taiwanese feed mill in the Philippines

In December 2015, Taiwan's leading feed enterprise, Grobest Holdings Limited inaugurated Grobest Feeds Philippines Inc with an investment of USD 15 million for feed production in Gerona, Tarlac, Luzon. The facility will have a production capacity of 150,000 tonnes per year (tpy) of aquatic feeds and 200,000 tpy of livestock feeds. The feed production facility would employ up to 200 local workers and indirectly benefit thousands of stakeholders in the aquaculture sector. Local farmers will also benefit, as Grobest will use locally produced agriculture products for its raw materials. Grobest said that it will bring innovative technologies as well as technical expertise while the Philippines provides a skilled labour force.

Growth of tilapia in Egypt

As part of its commitment to grow aquaculture in Egypt, Nutreco is investing in additional tilapia fish feed capacity. In November, it opened an additional line in its existing Egyptian plant in the Nile Delta. The investment enables Skretting, Nutreco's aqua feed business arm, to triple its tilapia fish feed capacity in Egypt to 150,000 tpy and extend its market leadership. Skretting has also entered into a five-year research partnership with the WorldFish Center to support the sustainable development of aquaculture in the region. The partnership will focus on tilapia nutrition and testing of new, local ingredients for fish feed. The construction of an advanced trial unit with a recirculation system is part of the partnership.

Egypt is the world's second largest producer of tilapia fish and production is expected to grow further from 1.3 million tonnes in 2014 to 2 million tonnes in 2020. The extra capacity allows Skretting to better serve the Egyptian tilapia sector with high quality fish feed, as well as technical expertise and support. Tilapia farmers are increasingly demanding extruded fish feed and is moving towards resource efficient tilapia production with less effect on the environment.

IFC loan for expansion of shrimp farming

The International Finance Corporation (IFC), the private sector arm of the World Bank Group, has provided a USD 10 million loan to Operadora y Procesadora de Productos Marinos Omarsa S.A., one of the biggest shrimp farming and exporting operations in Ecuador, to assist it with its expansion plans. Sandro Coglitore, general manager of Omarsa, said that IFC has confidence in Omarsa as the company has a philosophy of sustainable production. He added that IFC's investment will allow Omarsa to continue its expansion plans and will add to the economic growth of the country, creating 400 new jobs for Ecuadorians by 2016. Omarsa was the first shrimp farm in the world to receive Aquaculture Stewardship Council (ASC) certification. In addition, Omarsa is implementing the Best Aquaculture Practices (BAP) in its hatcheries, farms and processing plant. These certifications convinced IFC to invest in shrimp farming, after a long absence.

IFC's support for Omarsa will strengthen the export sector in Ecuador, where shrimp exports represent the second largest export category in the country after oil and its derivatives. In 2014, the shrimp sector accounted for 10% of Ecuador's total exports and 37% of its non-oil exports. IFC's strategy in Ecuador focuses on providing financing and technical assistance to companies that have a strong and positive impact on the export sector while at the same time trying to support projects that cover climate change, create jobs and benefit the most disadvantaged population groups (source: shrimpnews.com).

PensionDanmark invests in New Danish Agribusiness Fund

PensionDanmark will invest DKK 200 million (USD 29.1 million) in the new DKK 700 million (USD 102 million) Danish Agribusiness Fund (DAF). The aim of the fund is to invest in projects and companies that will ensure a higher quantity and quality of food in developing countries. It is expected to generate investments of close to DKK 6 billion to improve production, distribution and food sales in developing countries. It will invest in projects throughout the entire value chain from farm to fork, where a Danish commercial interest is included, thereby increasing the export of Danish technology and know-how. CEO Torben Möger Pedersen, said, "Like the Danish Climate Investment Fund, the Danish Agribusiness Fund is a good example of how public and private capital can work together to address global societal challenges in a way that provide benefits to both Danish companies and investors. The two funds illustrate that the best form of development aid is to provide business opportunities".

This new fund consists of DKK 88 million from development aid, DKK 212 million from Investment Fund for Developing Countries (IFU), DKK 200 million from PensionDanmark and PKA respectively. The Danish Agribusiness Fund will invest capital in projects in Asia, Africa, Latin America and parts of Europe. The fund will be operated on market conditions and will ensure the investors a competitive return. IFU with experience from 1,200 investments in more than 100 countries in Africa, Asia, Latin America and parts of Europe will manage the DAF.

SHENG LONG

HAID GROUP

Moving Forward With Sheng Long

Cashing In On Tomorrow

Sheng Long, your professional and trusted aquaculture partner.

We provide the winning combination of high-quality aquafeeds and shrimp larvae along with technical assistance in all aspects for your success.

SHENG LONG BIO-TECH INTERNATIONAL CO., LTD
Block A-05, Duc Hoa 1 Lucky Industrial Park, Hamlet 5,
Duc Hoa Dong Commune, Duc Hoa Dist., Long An Province, Vietnam
Tel: (84-72) 3761358 - 3779741 **Fax:** (84-72) 3761359
Email: sales.shenglong@gmail.com **Website:** http://www.shenglongbt.com

ISO 22000 : 2005
HACCP

White faeces disease in shrimp

By Poh Yong Thong

Despite its presence since 2010, little is known of this disease now impacting shrimp farming in Asia.

Ecological disturbances in particular by global warming have resulted in the rise of surface water temperatures. In addition, the eutrophication of many coastal waters is due to increased shrimp farming intensity spurred by more than 2 years of attractive shrimp prices. These two conditions contributed to the onset of many new viral, bacterial and fungal shrimp diseases. A silent disease which has an impact in shrimp farms in most parts of Asia is the white faeces disease or WFD.

Present since 2010 in Thailand, Dr Chalor Limsuwan, Kasetsart University attributed this new pathological entity to unusually high temperatures of more than 32˚C and high stocking densities which brought about increased levels of organic matter in the pond (Limsuwan, 2010). Around the same time, shrimp farms in Peninsular Malaysia, particularly in Sitiawan, in the state of Perak were infected with this disease. The spread of the disease died down for a while in 2012 but resurfaced since the end of 2014, first in West Sumbawa but spread to East Java, Jogjakarta and Lampung in Indonesia, and also in Thailand and Malaysia.

What is WFD

WFD becomes apparent when the digestive system of the shrimp malfunctions and the faeces turns from the normal brownish colour to pale white. The hepatopancreas becomes whitish and soft. The white faeces appear to be more buoyant than normal faeces and float on the water surface, appearing like faecal strings as shown in the photo below. Limsuwan (2010) said that in addition to the white faeces, infected shrimp show a loose exoskeleton and are also infested by epibiotic protozoa that cause a dark discolouration of the gills.

Shrimp infected by WFD exhibit marked reduction in feed intake and a severe infection of WFD may result in up to 60% mortality.

What do we know?

Here I discuss pre 2014 and post 2014 findings presented at seminars and in the literature on WFD in Asia. In 2010, Limsuwan reported the presence of *Vibrio parahaemolyticus, V. fluvialis,*

Short pale white to yellow faecal strings from shrimp with white faeces disease floating on the water surface. Picture courtesy of Arfindee, technical manager, Gold Coin Thailand

A comparison of the gut of WFD infected shrimp (right) with the gut of a normal shrimp. Picture courtesy of Iwan Sutanto, chairman of Shrimp Club Indonesia.

V. alginolyticus and *V. mimicus* in the faecal analysis of WFD shrimp. Then, during the latter part of 2010, Limsuwan et al. (2010) further found *V. vulnificus, V. fluvialis, V. parahaemolyticus, V. alginolyticus, V. mimicus, V. cholerae* (non01) and *Photobacterium damselae (V. damselae)* in the haemolymph and intestines of WFD shrimp. In addition, in Vietnam, Ha et al. (2010) reported that the causative agent of WFD was the microsporidian *Enterocytozoon hepatopenaei* or EHP.

In June 2014, the team of Visanu Boonyawiwat, Kasetsart University and Timothy W. Flegel, Mahidol University, Thailand (Sriurairatana, et al. 2014) revealed that the microvilli of WFD shrimp peeled away from HP tubule epithelial cells and then aggregated in the tubule lumen – hence they coined the term ATM (aggregated transformed microvilli). The vermiform-like bodies showed no cellular structure and were unlikely to be cellular microbiota. The cause of ATM is currently unknown, but the loss of microvilli and subsequent cell lysis indicate that their formation is a pathological process.

The authors further suggested that the disease in the prevalence of ATM has been coincidental with the increase in early mortality syndrome (EMS) or acute hepatopancreatic necrosis (AHPND) outbreaks. The causative agent of AHPND is *V. parahaemolyticus* which produces the toxin (which is regulated by quorum sensing or QS) that in turn causes sloughing of HP tubule epithelial cells. Thus, we may ask whether the same EMS toxin at low dosages is responsible for the formation of ATM or a mild form of WFD.

In summary, WFD could be due to an infestation of Vibrio bacteria, the dreadful microsporidia EHP or the physical sloughing off of hepatopancreatic tubules due to possibly a bacterial toxin. The exact causative agent to date is still unknown.

Possible causes

As presented in a workshop organised by the Shrimp Club Indonesia in Surabaya in October, 2015, based on studies by industry in Indonesia, Dr Arief Taslihan, Centre for Development of Brackish Water Aquaculture (BBPBAP), Jepara, Anwar Hasan, Biomin Indonesia and Sidrotun Naim S, Surya University, said that the triggers of WFD are usually:

- An algae crash with rising total ammonia nitrogen (TAN)
- Cyanophyta being replaced by dinoflagellata and ciliata/ protozoa
- High organic load (>100 ppm)
- High total Vibrio count in water > 1 x 10^2 CFU/mL
- Pond water with low transparency of <20 cm

BERNAQUA

World aquaculture
Ocialis
Feeding a sustainable future

From the hatchery to the ponds...

HATCHERY FEED

SHRIMP FEED

FISH FEED

Distributors

Australia | Bangladesh | China | Cambodia | Malaysia | Vietnam

Indonesia | Thailand | India | Taiwan | South Korea | Philippines

Florian Renault +84 (0) 919 698 861
Contact in Asia: florian@invivo-nsa.asia

www.invivo-nsa.asia
www.bernaqua.com

a brand of invivo Animal Nutrition and Health

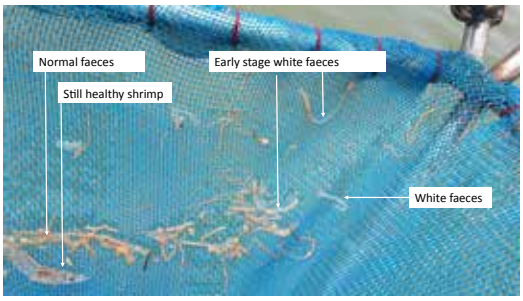
- High alkalinity >200 ppm or <80 ppm,
- Prolonged low dissolved oxygen at <3.0 ppm

In its June 1, 2015 bulletin, feed producer PT Matahari Sakti reported that the total organic matter (TOM) in Indonesian sea water has increased to >50 ppm and this favours the growth of pathogenic bacteria which cause diseases. It stated that the environment is overloaded and cannot self-purify itself resulting in the imbalance in the ecosystem.

Prevention is better than cure

As until today, the exact cause of shrimp WFD is still unknown, the best that shrimp farmers can do to combat this disease is prevention. This means farmers must be on the alert for the possible onset of WFD, and they must be more observant. The first recommendation issued by Thai experts was for farmers to decrease the stocking density during the hot season. This will result in a decrease in bottom organic matter and a reduction in the Vibrio loading in the pond bottom. Some have mitigated the disease by using probiotics containing *Bacillus subtilis* that block the growth of Vibrio bacteria.

To prevent WFD, start with thorough pond preparation, complete sterilisation of water, limit use of organic inputs to prevent excessively fertile water and pond bottom, stringent control of feed and careful monitoring of Vibrio and water quality. It is important to detect the disease as early as possible before more of the shrimp lose appetite. Constant observation and surveillance in particular during night time is necessary. The discovery of partial white strands of faeces as shown in photo below is cause for alarm.



Early detection of WFD is important to combat the disease.

Feed management

In feeding shrimp, we use sinking pellets which sink to the pond bottom. It takes time for a skilled worker to master the dispensation of the exact amount of feed to shrimp. Too little feed will affect growth and health but too much feed will result in high organic load, ammonia, hydrogen sulphide and pathogenic bacteria in the pond.

Uneaten feed and excessive excreta produced from excessive feeding will result in high organic matter in the pond, producing not only harmful gases such as ammonia and hydrogen sulphide which deteriorate the water quality, but also supplying food for the proliferation of pathogenic bacteria and harmful algae.

Feeding shrimp is a big challenge because the feed sinks into the water and cannot be seen.

It is thus imperative that the shrimp farmer is able to dispense an optimal amount of feed to the shrimp pond by meticulous monitoring of feed trays. The feed trays are ingenious tools invented by the Taiwanese in the 1980s and are very useful in fine tuning the daily dispensing of feed in response to the daily changes in weather and water quality which affect the appetite of the shrimp.

Treatment of WFD

If the pond is infected by WFD, the following treatment can be attempted. This treatment protocol was developed and has been shown to be effective in some ponds.

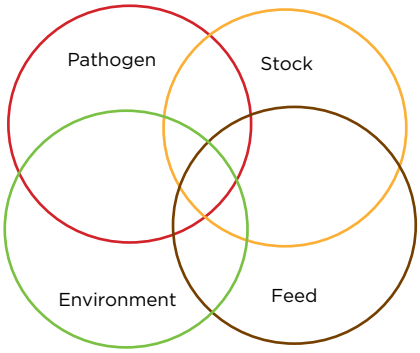
- Reduce immediately the feed amount or even stop feeding for the whole day
- Run as many aerators as possible. Add additional aerators if available
- Blend 80 g fresh garlic/kg feed in a blender, mix with 150 ml of freshwater and top-dress the feed for 1 day's feeding
- In lieu of garlic, add Potassium permanganate or $KMNO_4$ to the feed at 5-10 ppm, for the daily feed ration
- Add a reputable probiotic at 3 times the normal rate to the pond
- The next day, add the same probiotics such as *Bacillus* to the feed and feed for a day
- Repeat the alternative top-dressing of garlic and reputable probiotics for 5 days.

Conclusion

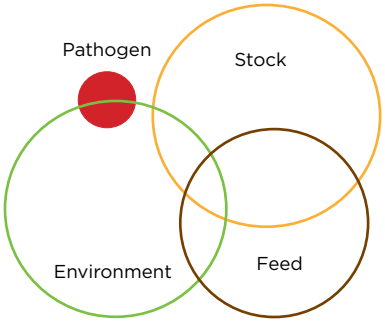
Shrimp farmers must be aware that shrimp farming management and technology are constantly changing. What used to work previously may no longer be applicable due to the change

in weather conditions and the eutrophication of the coastal ecosystem. Today, shrimp farmers who cling to past farming husbandry will find it hard to succeed. A critical aspect to this adaptation is feed management. Due to the deteriorating coastal waters containing a much higher organic load, the carrying capacity of the pond will be reduced. Excess uneaten feed will produce ammonia and hydrogen sulphide which act as feed for pathogenic bacteria. Shrimp farmers who learn and adapt will stand a better chance of success.

Snieszko (see below) had aptly illustrated the principle of disease prevention by his epidemiological triad. One more dimension has to be added to Snieszko's epidemiological triad. Feed management should be added as the 4th dimension. The principle of disease prevention is the epidemiological quadruplets, which is illustrated here:



The ultimate aim in shrimp health management is to reduce or dwarf the growth of pathogens by reducing excessive nutrient loading to the ecosystem through stringent feed management while optimising the quality of the environment as well as safeguarding the health status of the stock via genetics and nutrition. Ideally we want to have a situation pictorially presented as below:



Poh Yong Thong is assistant director, Nutrition and Technical Service at Gold Coin Aquaculture Division. He is based in Selangor, Malaysia. Email: yt.poh@goldcoin-group.com or poyoto2002@yahoo.com

References

Ha, N.T., Ha, D.T., Thuy, N.T., Lien, V.T.K., 2010. Occurrence of a microsporidian *Enterocytozoon hepatopenaei* associated with white feces syndrome (WFS) in cultured black tiger shrimp *(Penaeus monodon)* in Vietnam. Aquatic Animal Health, https://aquahealth.wordpress.com.

Limsuwan, C. (2010). White faeces disease in Thailand. Boletines Nicovita. www.nicovita.pe

Somboon, M., Purirvirojkul, W., Limsuwan, C., Chuchirid, N. 2012. Effect of *Vibrio* spp. in white feces infected shrimp in Chantaburi, Thailand. Kasetsart University Fisheries Research Bulletin 2012 Vol. 36 No. 1 pp 7-15

Sriurairatana S, Boonyawiwat V, Gangnonngiw W, Laosutthipong C, Hiranchan J. 2014. White faeces syndrome of shrimp arises from transformation, sloughing and aggregation of hepatopancreatic microvilli into vermiform bodies superficially resembling gregarines. PLoS ONE 9(6): e99170.doi:10.1371/journal.pone.0099170

Reflections on past experiences with shrimp vibriosis

Experiences in managing disease in the past are now used to mitigate new diseases.

Stakeholders in the Philippines often recount their experiences with green water technology to mitigate luminous vibriosis in the 1990s. Green water technology where the pond water is conditioned by tilapia was conceived in 1995-1996. Using green water technology with the high saline tolerant (18-25 ppt) Jewel tilapia (*Oreochromis urolepsis honorum* X *O. mossambicus*) was also used as a preventive measure against recurrences of white spot syndrome (WSSV) in 2004.

Industry is convinced that such experiences are now helping them sail through challenges not only with WSSV but also the more recent acute hepatopancreatic necrosis disease (AHPND). This is through the use of green water technology. Roselyn Usero, Negros Prawn Producers Cooperative in her presentation on this technology to mitigate diseases, said that *AHPND* was officially reported in January 2015 in some vannamei and monodon shrimp hatcheries in the provinces of Cebu, Quezon, Pangasinan and Zamboanga del Norte. "Later in the year, *AHPND* was reported at two farms farming vannamei and monodon shrimp in Bacolod, Negros Occidental in May, 2015 at days of culture (DOC) 30 and to date there has been no recovery," said Dr Leobert de la Peña, Aquaculture Department, SEAFDEC. In the case of the farm in Bacolod City, mortality occurred at DOC 30. There were cases too in Luzon but details were not available.

Roselyn C Usero (second right) with from right, Dr Celia R. Lavilla-Pitogo, Maria Abegail G Apostol-Albaladejo and Dr Juan Albaladejo, BFAR. Recently, Usero and Apostol-Albaladejo published the book on Philippine shrimp grow-out farm management practices against acute hepatopancreatic necrosis disease (AHPND) with emphasis on green water technology. The book is a testament to the public private partnership in the Philippines as the industry was threatened with luminous bacteria in 1992 and WSSV in 1998.

De la Peña also reported AHPND in farms farming the monodon and vannamei shrimp in Bohol. Mortality of monodon shrimp was 40% after 56-94 days with low stocking density at 23 PL/m^2. In the vannamei shrimp farm, the mortality occurred after 56-94 days also. Shrimp was stocked at 50 PL/m^2. The farm had emergency harvests. The farm carried out a total dry out of ponds over

2 months similar to what they did when they had WSSV outbreaks. De la Peña and his co- authors suggested that AHPND can also occur at late stages of culture (de la Peña, et al, 2015).

This was in spite of a BFAR and industry quick action in 2012 to prevent AHPND (as well as infectious myonecrosis virus-IMNV) from entering the Philippines. PhilShrimp suggested a ban on imports of live shrimp and vannamei shrimp broodstock, and within 2 weeks of the suggestion, BFAR banned such imports from countries with records of these diseases.

"We used three PCR methods, including commercially available1-step IQ2000 AHPND/EMS Toxin 1 Detection and Prevention System (GeneReach Biotechnology, Taiwan), optimised nested PCR using AP4 primers (Sritunyalucksana et al., 2015) and TUMSAT-Vp3 (Tinwongger et al., 2014), to confirm the AHPND disease. At these two farms, we looked at the pattern of outbreaks and found that this occurred when the temperature was very high at 27.5 to 29°C with salinity at 38-39 ppt. The lowest salinity reading was 36 ppt. The water source had *Vibrio parahaemolyticus* at 2.5 x 10^2 CFU/mL. In the case of the monodon shrimp farm, AHPND was present together with WSSV. The latest AHPND toxin positive cases were in Negros which were diagnosed by BFAR in September this year. The samples were from north and south of Negros Occidental. This involved four cases of adult *P. vannamei* shrimp and two cases of water samples."

"At one farm in Bacolod which had a case of AHPND in September, we implemented the green water technology. Shrimp were stocked at 80 PL/m^2. In our latest sampling in November, when the shrimp were 14.5 g, survival was estimated at 100%.

"AHPND is already present in some key producing areas in the Philippines but we are convinced that it can be prevented and managed through implementation of established protocols. Today, other than these reports, AHPND has remained less virulent possibly because it was managed with green water technology, in the same way as luminous vibriosis caused by *Vibrio harveyi*," added Usero.

References

de la Peña LD, Cabillon NAR, Catedral DD, Amar EC and others (2015) Acute hepatopancreatic necrosis disease (AHPND) outbreaks in *Penaeus vannamei* and *P. monodon* cultured in the Philippines. Dis Aquat Org 116:251-254

Usero, R.C., Apostol-Albaladejo, M.A.G., 2015. Philippine shrimp grow-out farm management practices against acute hepatopancreatic necrosis disease (AHPND) with emphasis on green water technology. Published by BFAR and NPPC, 2015.

Sritunyalucksana, K., Dangtip, S., Sanguanrut, P., Sirikharin, R., Taengchaiyaphum, S., Thitamadee, S., Mavichak, R., Proespraiwong, P., Flegel, T.W. 2015. A two-tube, nested PCR detection method for AHPND bacteria. NACA.

Tinwongger, S., Proespraiwong, P., Thawonsuwan, J., Sriwanayos, P., Kongkumnerd, J., Chaweepack, T., Mavichak, R., Unajak, S., Nozaki, R., Kondo, H., Hirono. I., 2014. Development of PCR diagnosis for shrimp acute hepatopancreatic necrosis disease (AHPND) strain of *Vibrio parahaemolyticus*. Fish Pathol, 49:159-164.

Biosolutions International and Inve Aquaculture teams during the PhilShrimp trade show, from left, Maryann Solis, Biosultions Sales manager, Jake Jacinto, Biosolutions Special Accounts manager, Patrick Lavens , Inve Aquaculture director, Belgium, Michael Janssens, Inve Aquaculture, SE Asia manager, Chandrasekar Sankaranarayanan, Inve Aquaculture Country manager, India and Jun Zamora Biosolutions, president. In 2014, the group started Shrimp School Philippines in Dagupan City, as a corporate social responsibility project. In her presentation on 'Sustainable aquaculture practices to mitigate the risks of WSSV and AHPND outbreaks', Gina Regalado explained how the school has been able to impart their proven technology of semi closed system to 95 future farm technicians.

Counting the cost of aquatic disease in Asia

By Andy Shinn, Jarunan Pratoomyot, Pikul Jiravanichapisal, Christian Delannoy, Niroj Kijphakapanith, Giuseppe Paladini and Don Griffiths

The true cost of each disease outbreak is complicated by an intricate interplay of environmental and management-based factors, from the direct losses in stock, through to indirect losses in the downstream industry.

As Asia's aquaculture production continues to rise, so have the losses associated with disease outbreaks. The drive to intensify production and to maximise short-term profits may mean that investment in appropriate biosecurity measures is reduced, thereby exposing aquaculture enterprises to an increased risk of disease. In this article, we consider some of the losses associated with current pathogen events that impact on Asia's crustacean and tilapia industries and focus on selected viral, bacterial, fungal, and parasite infections as examples.

An impressive growth but...

Over the period from 2001 to 2013, Asia's aquaculture industry has grown at an impressive average 6.85% year-on-year, and increasing its output 2.37 times from 37.59 million tonnes in 2001 to 88.90 million tonnes in 2013. The production increased 8.64% annually over the 2012-2013 period.

Although, there has not been a suggested drop in total output since 1961, the production, sustainability and economic viability of each aquaculture enterprise, can be significantly impacted upon by a broad spectrum of obligate or opportunistic aquatic pathogens. This is appropriately demonstrated by the historical growth of the shrimp industry, which has been characterised by cycles of booms followed by busts caused by disease outbreaks. First were viral agents throughout the 1990s (e.g. by yellow head virus (YHV), Taura syndrome virus (TSV) and white spot syndrome virus (WSSV). Since 2010 to present, it is the bacterial agents (e.g. isolates of *Vibrio parahaemolyticus* with a toxin gene bearing plasmid responsible for acute hepatopancreatic necrosis disease (AHPND), and most recently the fungal pathogen - the microsporidian *Enterocytozoon hepatopenaei* which is the causative agent of hepatopancreatic microsporidiosis (HPM).

For many pathogens, their occurrence and impact on production can be unpredictable/sporadic, whilst others may be predictable/regular. While these infections may result in the direct loss of stock and incur costs associated with the control and management of infections once established, for predictable infections there are also costs associated with the implementation and maintenance of biosecurity/preventative measures, prophylactic treatment, regular screening and management. Calculating the true cost of each disease outbreak therefore is complicated by an intricate interplay of a diverse array of environmental and management-based factors that can have repercussions through the entire production pipeline from the direct losses in stock, through the associated downstream industry, and on the livelihoods of those affected.

Impact of crustacean and tilapia diseases in Asia

So what is the current picture of disease outbreaks across Asia? Well, while it is not possible to address the impacts of each pathogen within this short article, we provide a summary of pathogen presence across the 42 Southeast Asian aquaculture-active states over the last three years (Table 1).

For certain pathogens like Streptococcus, the figures cited are most likely underestimated. From this summary, some of the losses currently incurred within Asia's crustacean and tilapia industries are considered by focusing on selected viral (e.g. WSSV), bacterial (e.g. *V. parahaemolyticus*; *Streptococcus* spp.), fungal (e.g. microsporidian *E. hepatopenaei*), and parasite infections as examples.

> **"....the current AHPND outbreak has cost the Thai industry in excess of USD 5.01 billion to date (based on the value of lost tonnage)."**

Table 1. Summary of occurrences of selected diseases in Asian aquaculture in the last three years

Disease	No of countries reporting outbreaks	Asian host species that can be affected
AHPND – acute hepatopancreatic necrosis disease (specific isolates of *V. parahaemolyticus*)	4	*Litopenaeus vannamei; Penaeus chinensis; P. monodon*
IHHNV-infectious hypodermal and hematopoietic necrosis virus	7	*L. vannamei; P. chinensis; P. indicus; P. japonicus; P. merguiensis; P. monodon*
EHP-*E. hepatopenaei*	5	*L. vannamei; P. monodon; P. japonicus (suspected)*
IMNV- infectious myonecrosis virus	1	*L. vannamei; P. monodon*
TSV-Taura syndrome virus	4	*L. vannamei; P. chinensis; P. monodon*
WSSV-white spot syndrome virus	13	*Charybdis feriatus; Cherax quadricarinatus; L. vannamei; Metapenaeus spp.; P. chinensis; P. indicus; P. japonicus; P. merguiensis; P. monodon; Portunus pelagicus; Scylla serrata; and other decapods*
WT-white tail (MrNV & XSV)	3	*Macrobrachium rosenbergii*
YHV-yellow head virus	4	*L. vannamei; Metapenaeus ensis; P. merguiensis; P. monodon*
EUS-epizootic ulcerative syndrome (*Aphanomyces invaderis &A. piscicida*)	4*	*>100 fish species incl. Oreochromis niloticus*
Streptococcus spp. (e.g. *S. agalactiae & S. iniae*)	9+*	Multiple fish hosts incl. *Epinephelus lanceolatus; Lates calcarifer; O. aureus; O. niloticus; Schizothorax prenanti; Seriola quinqueradiata; Trachinotus blochii.*

香港城市大學
City University of Hong Kong

UNIVERSITY of STIRLING

City University of Hong Kong's School of Veterinary Medicine working jointly with the University of Stirling, Scotland will be introducing an **MSc course in AQUATIC PRODUCTION AND VETERINARY HEALTH** in September 2016. A team of experienced staff of veterinary and higher education from Hong Kong and Scotland has created this MSc programme.

The programme covers professional subject areas such as:

- Aquatic Animal Biology and Health
- Aquatic Animal Production Systems
- Bacterial, Viral, and Parastic Diseases
- Aquatic Animal Reproduction and Genetics
- Aquatic Animals in the Environment
- Epidemiology and Health Control
- Systemic Pathology
- Immunology
- Ecotoxicology
- Research Project

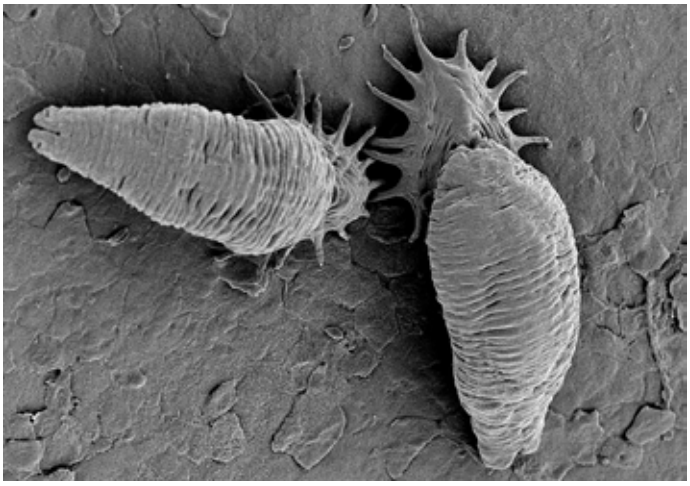
Principles of the science of **AQUATIC PRODUCTION AND VETERINARY HEALTH** are central to this programme. Graduates will have a thorough understanding of aquatic animals' needs, the environment they live in, various productions systems and the relevant disease conditions that can occur. Graduates will be able to plan and deliver the best possible health outcomes.

About the MSc Programme

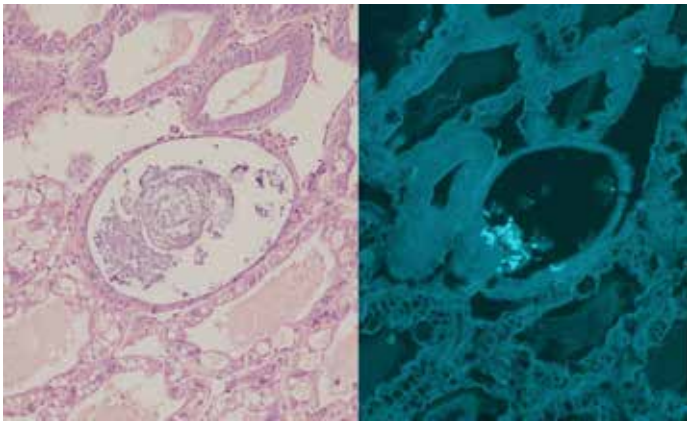
Duration	:	1 year
Mode of Teaching & Learning	:	Full time, face-to-face & thesis research project
Proposed Start Date	:	September 2016
Programme Details	:	http://www.cityu.edu.hk/svm/links/msapvh.asp

School of Veterinary Medicine

Enquiry : svmenquiry@cityu.edu.hk
Telephone : (852) 3442 6361
Fax : (852) 3442 0589



Gyrodactylus sp. (Monogenea) skin flukes are commonly encountered on the gills and external surfaces of juvenile Nile tilapia.



The microsporidian E. hepatopenaei (EHP) the cusative agent of hepatopancreatic microsporidiosis (HPM) within the hepatopancreas of whiteleg shrimp, showing how they appear under normal light (left) and fluorescence microscopy (right).

Losses within the shrimp industry

AHPND

The current Asian outbreak of AHPND, which first appeared in China in 2009, Vietnam in 2010, Malaysia in 2011 and, then Thailand in 2012 has proven to be devastating. If the situation in Thailand is considered and assuming that the Thai production of *Litopenaeus vannamei*, in the absence of other disease events, had been maintained at its last peak of 603,227 tonnes in 2011, then the current AHPND outbreak has cost the Thai industry in excess of USD 5.01 billion to date (based on the value of lost tonnage).

Elsewhere, the current status of AHPND in the Vietnamese Mekong Delta suggests that 2,318 ha for *Penaeus monodon* culture and 2,309 ha for *L. vannamei* have had infections this past year (i.e. throughout 2015). If the following are assumed;

- 38% and 52.7% of the total area was used for semi-intensive culture for *P. monodon* and *L. vannamei* respectively; the remaining area was extensive production;
- *P. monodon* sites were stocked at 15 post larvae (PL)/m^2 (semi-intensive) and 8 PL/m^2 (extensive); the *L. vannamei* sites at 100 PL/m^2 (semi-intensive) and 70 PL/m^2 (extensive);
- one crop was lost from each site within 40 days of transfer (i.e. a T_{50} of 20 days is used); and,
- apply a labour rate of USD 5.77 ha/day.

Then the losses, including other factors (e.g. feed costs etc), can be simply estimated at USD 1.84 million for *P. monodon* which translates into a loss of USD 796/ha. In the case of *L. vannamei*, losses were calculated at USD 8.93 million which was USD 3,867/ha because of the higher stocking densities typical in *L. vannamei* production systems.

WSSV

Robust data on the losses due to WSSV also exist for the Mekong Delta with 2,510 ha of ponds used for *P. monodon* culture and 1,397 ha of ponds for *L. vannamei* reported as having had infections in 2014. By applying the same assumptions and a 2% daily loss over a 109 day grow-out period, then losses of *P. monodon* were in the region of USD 2.37 million which was USD 943/ha. For *L. vannamei*, it was USD 5.65 million or USD 4,041/ha.

EHP

There are, of course, levels of complexity to consider in modelling and estimating the costs of each disease, and figures are based on the quality of datasets available. In light of this, the impact of EHP on the Asian shrimp industry serves as an appropriate example. This enigmatic, fungal pathogen, that only infects the tubule epithelial cells of the hepatopancreas, reputedly does not cause mortality but results in the severe retardation of growth.

The current economic impact of this parasite within China, India, Malaysia, Thailand and Vietnam requires establishing. Estimates can be supported through the provision of national statistics regarding the area of ponds affected and detailed farm production data from infected sites. Some reports from farm producers, however, are emerging. *L. vannamei* growth is reported to arrest at around 12 g, capping production at approximately 9 tonnes/ha as opposed to the nominal target of 12 tonnes/ha. The decision to harvest early means that farm gate prices for the smaller size shrimp are a third lower at USD 3.50/kg instead of USD 5.30/kg for 18 g shrimp. The net result is that production costs are not covered. There is a loss of USD 4,500/ha or a loss of USD 32,000/ha over normal production economics if the shrimp are grown on to the planned harvest size. In the absence of pathogens and, assuming the normal growth of stock and a survival of >70%, then a food conversion ratio (FCR) of 1.5 might be expected. If EHP is present and slowed growth from 12 g onwards is noted, then FCRs can rise – the final value of which will be dictated by the severity of infection in the stock, the monitoring frequency and by management decisions regarding when to harvest (i.e. when FCRs rise outside the acceptable range to the point where decisions regarding harvesting have to be made).

Losses within the tilapia industry

If some of the disease costs within the tilapia industry are considered, then there are both evident and, perhaps, ignored losses. Streptococcal-based infections, with significant resultant mortalities, have been reported from a large number of Asian countries. Thai sites, for example, reported losing 20% of production in the hot season, with a minimum 7.5% total loss across the industry. This is 16,270 tonnes valued at USD 26.57 million. In Bangladesh, mortalities attributable to *Streptococcus* were estimated at >26% at certain sites. If these are representative nationally, then losses can be estimated at 20,910 tonnes valued at USD 36.67 million. Elsewhere, in China the reported mortality range was 80-90% at sites within Leizhou Bay, where production is estimated at 394,600 tonnes. An undisclosed site elsewhere in Asia reported losing 50,000 tonnes of stock valued at USD 81.65 million.

Streptococcus spp. infection of a Nile tilapia with marked bilateral exophthalmia.

WSSV evident by the characteristic white spots, seen here on the carapace of a whiteleg shrimp.

If we extrapolate from the production in 2014 by applying a 10.68% year-on-year increase, then Asia's tilapia industry looks set to top 4.11 million tonnes for 2015. If a 7.5% mortality across Asia is assumed, except for countries such as Bangladesh and the Philippines, where smaller size fish are harvested, and where a loss of 3.75% can be applied, then the losses to streptococcal infections could be in the region of 289,440 tonnes valued at USD 480 million (applying an average Asian price of USD 1,657/tonne).

Impact of sporadic mortalities

Alongside some of the major disease events discussed above, many of the smaller magnitude, sporadic mortality events that can be attributed to less specific diseases, which can result from low water quality or poor fish handling and welfare that might be ameliorated through improved husbandry practices, are also worth considering. Although most of these losses are ignored and/or unreported, either because of the smaller scale of these losses or because of the general acceptance that they fall within the typical, accepted margins of loss in production, their collective impact on aquaculture production can be very significant. The value of stock lost may arguably exceed the economic impact of many major pathogens.

As an example, the losses of juvenile Nile tilapia due to parasitic infections were studied at four Thai commercial farms over a 12-month period. Assuming the following survival rates at each stage of production:

- 77.5% egg hatch rate;
- 77.8% survival from hatched eggs to the swim-up fry stage;
- 78.9% survival of swim-up fry to 21 day post-mono-sex fry and,
- 83.3% survival of the 21 day mono-sex fry to 2.5 cm nursery sized fish.

By applying a 20% loss due to parasitic agents to each life cycle stage, the total loss to Asia's tilapia industry is in the region of USD 13.5-18.5 million annually. This is the total of USD 4.1-5.7 million loss at the nursery stage; USD 5.0-6.8 million loss at the mono-sex stage; and USD 4.4-6.0 million loss at the swim-up stage.

Concluding remarks

Estimating the costs of disease events within the shrimp and tilapia industries is complicated, not only by the magnitude of each industry and the number of animals/sites involved, but also by the frequency of disease reporting and the access to quality farm data. Minimal investment in preventative measures, lapses in biosecurity rigour, lack of regular farm health assessments, inconsistent disinfection practices and/or complacency, consequentially exposes sites to higher risks of pathogen introduction that may result in frequent disease episodes and loss.

For intensive systems, even occasional lapses in biosecurity can result in devastating losses. Although Asia's *L. vannamei* shrimp and tilapia industries continue to rise, averaging 7.93% and 10.82% year-on-year over 2009-2013 period, the long-term trends suggest that rate of growth for both is decreasing. While this slowing growth may be imposed by the availability of new sites for culture and access to resources etc, the correlation of disease risk and loss with the intensification of each industry cannot be ignored and must be addressed through appropriate biosecurity, health management and control programs if Asia is to maximise its aquaculture potential by minimising losses.

The authors are based in Fish Vet Group Asia Ltd (FVGAL), Bangkok, Thailand; Benchmark Animal Health (BAH), UK; Burapha University (BUU), Thailand; and, Institute of Aquaculture (IoA), University of Stirling, UK.
Andy Shinn, PhD is senior scientist (FVGAL; BAH; IoA)
Jarunan Pratoomyot, PhD is senior scientist (BUU)
Pikul Jiravanichpaisal, PhD is senior scientist (FVGAL)
Christian Delannoy, PhD is vaccine development manager (BAH)
Niroj Kijphakapanith, is veterinarian (FVGAL)
Giuseppe Paladini, PhD is lecturer (IoA)
Don Griffiths, is operations director (FVGAL)
Email contact: andy.shinn@fishvetgroup.com; don.griffiths@fishvetgroup.com

Increasing yield and mitigating off-flavour problems in tilapia farming

By Warren Andrew Turner, Nathan Atkinson, Michael Kreis and David C. Little

This is using PE-lined ponds with RAS technology and shading

Earthen ponds are most commonly used for grow-out of Nile tilapia in the tropics. This is often the most cost-effective method for farming this fish. The downside is that yields are fairly low, at between 4-7 tonnes/ha, since there is a limit to the rate at which phytoplankton, the main utilisers of waste in this system, can remove nitrogen. Increasing levels of phytoplankton lead to reduced sunlight penetration of the water column. Since phytoplankton rely on sunlight for photosynthesis, they inhibit their own growth as they become too dense.

Furthermore, muddy or musty off-flavours are common due to geosmin and 2-MIB metabolites produced by actynomycetes and cyanobacteria (blue-green algae). The latter group is very common in tilapia ponds. Fish with off-flavour have a lower market value and make export of tilapia to countries where non-spicy food is prevalent highly problematic. Water exchange can be used as a solution to both these problems, but pumping costs can be high and discharge of waste water into waterways is not an acceptable practice in many countries.

BFT versus RAS

Nam Sai Farms, established in Prachinburi Province, Thailand in 1994, is a large 100 ha tilapia hatchery. Nam Sai has conducted various trials over the years, some in collaboration with the Institute of Aquaculture, University of Stirling. From earlier research it was found that muddy off-flavour was found to be very common in tilapia produced in earthen ponds in central Thailand, particularly in the dry season. The acid clay soil and use of green water grow-out systems, in which blue-green algae are very common, are likely contributory factors to the off-flavour problem.

Two alternative grow-out systems, biofloc technology (BFT) and simple recirculating aquaculture systems (RAS) were tested in a collaborative trial in 2006. It was found that high suspended solid loadings in BFT were detrimental to fish growth and health. Tilapia growth and food conversion performance was found to be much better in RAS where suspended solids were removed by settling, and dissolved ammonia by nitrifying bacteria in a biofilter based on plastic biomedia. The downside of the latter was the high pumping costs.

RAS pond design

Based on these experiences, Nam Sai came up with an RAS pond system in which fish waste products could be removed in the pond itself without the need of pumping water through a filtration system and using only blowers for aeration and water movement. Ponds were shaded to control or eliminate phytoplankton. This is used as a strategy to mitigate off-flavour; 68.6% of sunlight was reduced using a single layer of shade netting, and 99.4% with a double layer. The ponds were lined with 1 mm polyethylene (PE) to prevent soil water turbidity, improve water quality and avoid any off-flavours arising from earthen pond bottoms.

Plastic biomedia (12 mm diameter 4 spoked wheel) with a reported surface area of 900 m^2 per m^3 of volume was chosen as a substrate for nitrifying bacteria to convert toxic dissolved ammonia to nitrite and then to non-toxic nitrate. Enclosed in a 2 m diameter circular cage in the middle of each pond, the biomedia was constantly circulated by rising air bubbles emanating from aerotubes attached to the bottom of the cage. The cage itself was raised on legs 1 inch (2.5 cm) above the pond bottom. This allowed settled solid wastes, consisting mainly of fish faeces, to move towards a central 8 inch (20cm) PVC pipe where they could be removed with a submersible pump every few days.

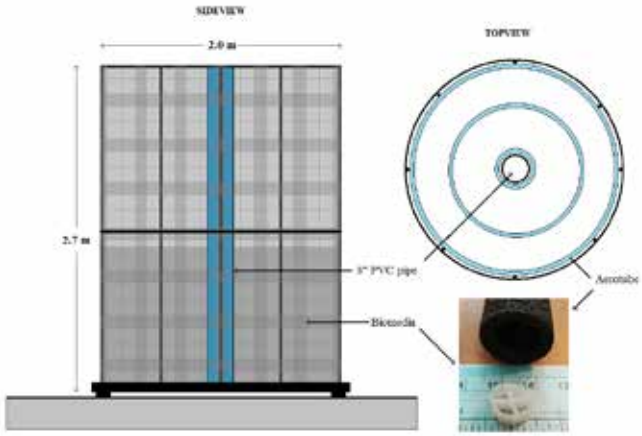


Figure 1. Side and top views of biofilter cage.

Aeration and some circular flow in the pond was created using a cheap and simple air-lift design consisting of a pillow-shaped diffuser at the bottom of a square column (60 cm wide x 30 cm deep, height depending on water depth) formed by using a stainless steel rod and covered in an air-proof material. A gap at the bottom on one side allowed water intake and a curved top and exit hole on the opposite side allowed directional water flow. The whole structure was held down on a slab of concrete to prevent it from floating away. However, it could be detached to allow for netting of the pond.

Two shading levels, achieved using a single or double layer, were used to control or eliminate phytoplankton .

The trial design

A total of six ponds were constructed, three of which were covered with a single layer of 60% black shade netting and the other three covered with two layers to remove the majority of light. There were eight air lift pumps and a single biofilter installed in each pond. This allowed triplicates of each shade treatment and was compared to a control treatment of three earthen ponds that were unshaded, stocked at low density and without any aeration.

Red tilapia (F1 hybrid Taiwanese x Thai strain) were stocked in all PE-lined ponds at a relatively high density of 2.35 fish/m^3 and in earthen ponds at a regular density of 0.85 fish/m^3. A single 3 x 4 x 1.2 m deep cage was stocked with 310 fish as a second control for taste testing purposes.

The fish were cultured from 107 g up to 600 g over a period of 4 months from November 4, 2013 to March 29, 2014 during the cold season in Thailand. Feeding was carried out 3 times per day by giving as much feed as the fish would eat in a 15 minute period. Feed consists of a floating commercial feed containing 30% crude protein and 6% fat. All ponds were run under zero-exchange conditions and water was only added to replace loss from removal of settled solids and evaporation. Sampling of fish for individual size and length was initially carried out every 2 weeks, but was reduced to 4 weeks after a month, as sampling was stressful to fish and reduced feed consumption.

At the end of the trial all fish were weighed and sold. An organoleptic assessment was made at Nam Sai by two trained taste testers (Grobest Corporation Ltd., Thailand). Samples of the trial fish were compared with cage-reared red tilapia from Nam Sai reservoir and the nearby Ban Pakong River as well as with fish retailed at Tesco Lotus supermarket in Prachinburi town. Fish were prepared by filleting and dividing into approximately 12 g samples before microwaving in a food grade, microwave-proof HDPE plastic container.

Table 1. Summary of trial pond parameters.

Treatment	Pond No	Pond dimensions			Biomedia (m^3)	No. of fish stocked	Density (fish/m^3)
		Area (m^2)	Depth (m)	Vol. (m^3)			
Low shading	PE1	1,014	1.60	1,623	3.40	3,811	2.35
	PE3	1,043	2.00	2,086	4.37	4,897	2.35
	PE5	946	1.75	1,655	3.47	3,886	2.35
High shading	PE2	1,001	1.65	1,652	3.46	3,878	2.35
	PE4	995	1.60	1,591	3.33	3,734	2.35
	PE6	1,044	2.10	2,192	4.59	5,146	2.35
Earthen pond	E1	1,050	1.20	1,260	-	1,068	0.85
	E2	1,140	1.20	1,368	-	1,163	0.85
	E3	1,290	1.20	1,548	-	1,315	0.85

Fish performance and water quality

Red tilapia grown in low and high shaded PE-lined ponds exhibited very similar performance in terms of growth, survival, feed conversion ratio (FCR) and overall production. Growth in earthen ponds was slower, despite being stocked at a much lower density, and survival was poor. FCR as a result was very high. Interestingly, for the first 3 months, growth of fish in the earthen ponds was similar to that in the PE ponds, but subsequently, growth slowed down. We attributed this to increasingly high total suspended solids, particularly in pond E3, due to suspended clay particles. Chlorophyll a levels were very low in both pond E1 and E3 and inorganic fertiliser (15-15-15) was added to all earthen ponds from February onwards to try and improve phytoplankton levels and general water quality. Unfortunately, the high clay turbidity was not favourable for light penetration and was only successful in pond E2.

Photo of biomedia cage and air-lift aerators prior to filling pond.

Table 2. Details of fish stocked, final weight, survival, average daily growth (ADG), FCR and density.

Treatment	Pond No	Pond dimensions			Fish remaining			Survival (%)	ADG (g/day)	FCR	Density (fish/m^3)
		Area (m^2)	Depth (m)	Vol. (m^3)	Wt. (kg)	Number	Size (g)				
Low shading	PE1	397.0	3,811	104	2,377.2	3,363	707	88.3	4.16	1.58	1.46
	PE3	513.5	4,897	105	3,033.9	4,654	652	95.0	3.77	1.61	1.45
	PE5	404.0	3,886	104	2,106.2	3,369	625	86.7	3.59	1.72	1.27
Mean		**438.1**	**4,198**	**104**	**2,505.8**	**3,795**	**661**	**90.0**	**3.84**	**1.64**	**1.40**
High shading	PE2	405.4	3,878	105	2,128.5	2,894	736	74.6	4.35	1.76	1.29
	PE4	389.1	3,734	104	2,272.1	3,310	686	88.6	4.02	1.60	1.43
	PE6	538.7	5,146	105	2,920.1	4,942	591	96.0	3.35	1.56	1.33
Mean		**444.4**	**4,253**	**104**	**2,440.2**	**3,715**	**671**	**86.4**	**3.91**	**1.64**	**1.35**
Earthen pond	E1	105.0	1,068	98	255.1	495	515	46.4	2.87	2.29	0.20
	E2	112.0	1,163	96	277.0	590	470	50.7	2.57	3.17	0.20
	E3	130.2	1,315	99	313.4	671	467	51.1	2.54	2.85	0.20
Mean		**115.7**	**1,182**	**98**	**281.8**	**585**	**484**	**49.4**	**2.66**	**2.77**	**0.20**

Farming, it's what we do.

"I have used NuPro from Alltech from day one and have seen great results in weekly growth. Recently I switched to Bioplex® organic minerals from Alltech in my shrimp and fish farm. Alltech products are really good quality and gave excellent results, hence I recommend them to others."

— Obul Reddy, Gudivada, Andhra Pradesh

For more information please email
AquaAP@alltech.com or visit
Alltech.com/aquaculture

Alltech®

Alltech.com AlltechAP @AlltechAP

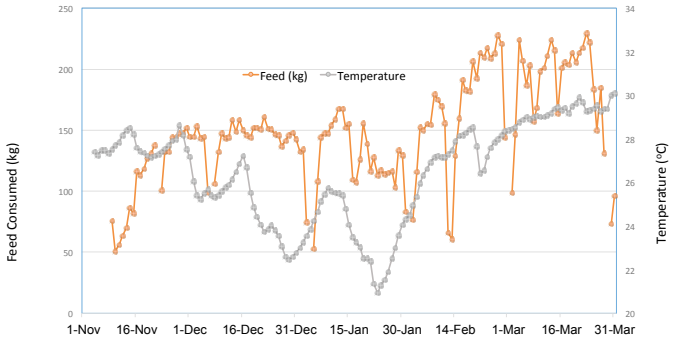


Figure 2. Plot of mean daily temperature at 10 cm depth against total feed fed for all ponds per day combined.

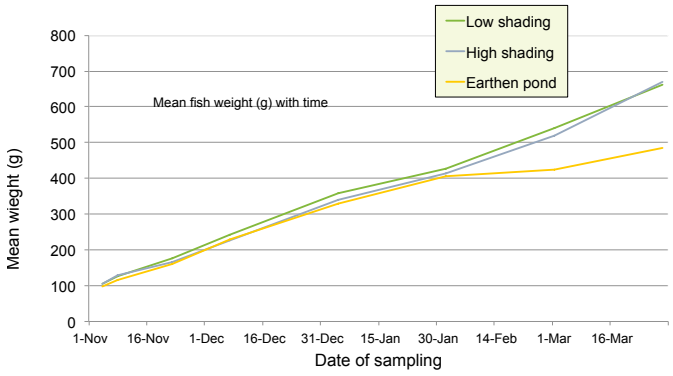


Figure 3. Mean fish weight (g) with time

It can be seen from the graph of feed consumption against mean daily water temperature that between mid-December and end-January, mean daily temperature was only 21-26˚C. Feed consumption was depressed and this no doubt reduced growth rate and increased FCR.

Severe mortalities occurred in the earthen ponds after the onset of cold weather. This was most likely due to bacterial disease. All fish in both the low and high shaded PE ponds were unaffected despite the water temperature being lower. The single mortality spike in the high shaded treatment was due to a blower failure. Surprisingly, the impact of blower failure in the low shaded ponds are less as dissolved oxygen (DO) levels were higher due to photosynthesis by phytoplankton.

In our opinion, we can expect better performance if the trial had been carried out when temperatures were more ideal between the months of February and November. The daily temperature fluctuation and mean daily temperature would be lower with increasing level of shading. This would have big advantages in controlling infections of *Streptococcus agalactiae* which typically causes significant tilapia mortality during the hot season from April to July in Thailand when water temperatures regularly exceed 35˚ C in unshaded ponds.

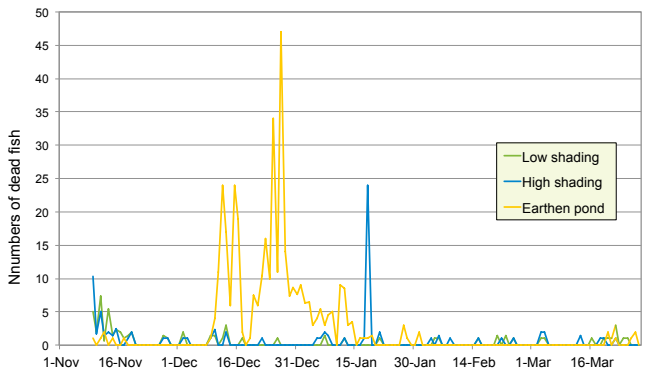


Figure 4. Plot of mean daily fish mortality per treatment.

PAR (photosynthetically active radiation) readings indicated that 68.6% of the sunlight was removed in the low shaded ponds. This was still sufficient to develop a dense phytoplankton bloom with mean chlorophyll levels of 299 µg/L. The double layer of shade netting in the high shaded ponds was sufficient to remove 99.4% of the light and mean chlorophyll a levels were only 12 µg/L.

Ammonia levels were unexpectedly higher in the earthen ponds and the biomedia in the PE-lined ponds was found to be colonised by nitrifying bacteria very quickly and was very efficient at converting ammonia to nitrate. No spikes of ammonia were seen in any of the PE-lined ponds which only registered a few intermittent small spikes of nitrite. Nitrate levels were highest in the high shaded ponds, as nitrogen was removed by phytoplankton in the low shaded and earthen ponds.

Table 3. Water quality parameters in trial ponds.

		Pond treatments		
Water quality parameter		**Low shading**	**High shading**	**Earthen pond**
Temperature (˚C)	Mean	26.3	25.8	27.0
	Minimum	20.3	21.0	19.7
	Maximum	30.5	29.5	32.6
	Mean daily change	0.7	0.4	2.2
DO 50 cm (mg/L)	Minimum	4.5	4.5	1.0
	Maximum	10.6	11.1	8.2
	Mean	7.5	7.4	3.3
pH	Minimum	6.7	6.8	6.2
	Maximum	8.4	8.3	8.3
	Mean	7.6	7.6	7.6
NH_3 (mg/L)	Maximum	1.25	0.96	4.34
	Mean	0.53	0.43	1.08
Nitrite (mg/L)	Maximum	3.78	3.67	2.54
	Mean	0.38	0.54	0.32
Nitrate (mg/L)	Maximum	11.67	41.67	4.17
	Mean	2.50	10.41	0.46
Phosphate (mg/L)	Mean	6.04	6.16	5.40
Alkalinity (mg/L)	Minimum	68	68	28
	Maximum	112	107	136
	Mean	88	86	59
PAR	Minimum	71	1	231
	Maximum	751	17	2,130
	Mean	491	10	1,565
Chlorophyll a (µg/L)	Minimum	59.1	5.0	3.7
	Maximum	428.4	40.4	193.9
	Mean	299.0	12.1	121.8
TSS (mg/L)	Maximum	111.6	47.1	236.9
	Mean	82.2	29.5	151.7
Secchi disk (cm)	Mean	28.7	74.9	12.7

Dissolved oxygen levels were maintained above 4.5 mg/L in both high and low shaded PE-lined ponds, whilst in earthen ponds the DO dropped low in the early morning since no aeration was provided.

Table 4. Results of organoleptic tests.

Treatment	Replicate	Odour (0-50)	Taste and texture (0-50)	Total score
Low shading	PE1	48	50	98
	PE3	50	45	95
	PE5	50	50	100
Mean		49.3	48.3	97.7
High shading	PE2	50	45	95
	PE4	45	42	87
	PE6	48	45	93
Mean		47.7	44	91.7
Earthen pond	E1	43	46	89
	E2	50	47	97
	E3	50	48	98
Mean		47.7	47	94.7
Reservoir cage		49	50	99
River cage		48	48	96
Tesco Lotus		33	43	76
Note: Total scores >85 = Very good, 75-84 = Good, 61-74 = Acceptable, ≤60 = Reject				

Tilapia in a low shaded pond during the trial.

The organoleptic testing (odour, taste and texture) carried out by Grobest Corporation Ltd. staff indicated that fish tasted very good from all ponds, including the earthen ponds (Table 4). This shows that tilapia cultured in earthen ponds can taste very good. One of the reasons in this case could have been the low levels of phytoplankton due to the high soil turbidity. Interestingly, fish from the low shading ponds, which had very high phytoplankton levels, scored very high.

Conclusions

This trial indicated that the RAS PE-lined pond technology certainly has great potential as a grow-out or fattening system to produce tilapia with good taste suitable for export. The final density of fish at harvest was approximately 1.4 kg of fish/m^3, which is three times the density possible in earthen ponds without water exchange. The downside is the cost of construction and electricity needed for aeration. Savings were made in terms of the reduced amount of land required for rearing, reduced losses due to disease and easier management, since more fish are raised in a smaller space.

Future development of the system

Nam Sai now has a plan to modify and upscale the system to enable efficient removal of solids, reduce costs of shading, improve efficiency of aeration, and provide good water flow for fish exercise purposes, as well as make the system easier to manage. Alarm systems and better blower back-up systems would also be incorporated to reduce the risk of aeration system failure.

Based on a 6,000 m^3 design, the new system could produce between 30-120 tonnes of fish per pond based on a production level of 5-20 kg/m^3. Nam Sai and Stirling University are now looking for a private partner who would be willing to invest in six of these ponds so that research work can go ahead.

Acknowledgements

Warren Andrew Turner, managing director of Nam Sai Farms Co. Ltd. was responsible for the system design with assistance from **Renatus Remmerswaal**, Aquaculture and Engineering Consultancy.
Email: warrennamsai@gmail.com

Dr David C. Little from the University of Stirling, Scotland was involved in planning, monitoring and analysis of data.

Nathan Atkinson was responsible for day-to-day running.

Michael Kreis organised the taste-testing as part of his MSc. in Aquaculture at Stirling University.

Arlene Nietes Satapornvanit and **Dr Kriengkrai Satapornvanit** provided support as part of the Sustaining Ethical Aquaculture Trade (SEAT) project 466, which is co-funded by the European Commission within the Seventh Framework 467 Programme, Sustainable Development Global Change and Ecosystem (project 468 no. 222889). www.seatglobal.eu

Warren Andrew Turner

Low inclusions of krill meal spare cholesterol in diets for juvenile shrimp

Cholesterol is an essential nutrient for marine shrimp. However, shrimp do not have the ability to produce cholesterol through the intake of other nutrients contained in the feed. Commercial feeds that lack cholesterol or have a cholesterol below what shrimp requires, can lead to slower growth and higher mortality rates.

Recently, a 10-week feeding trial conducted at LABOMAR aquaculture facilities in North-eastern Brazil concluded that cholesterol can be spared by including low levels of krill meal in diets for juvenile white shrimp *Litopenaeus vannamei*. The study results showed that as low as 3% krill meal in shrimp grower feeds will significantly enhance shrimp final body weight, survival rate, yield, feed intake and feed conversion ratio. In addition to improving the shrimp growth performance, krill meal also reduced the feed cost in comparison to a diet with cholesterol supplementation.

Krill meal

Krill *Euphausia superba* are small shrimp-like crustaceans, which live in large schools in the cold, pristine waters of the Antarctica. Aker BioMarine produces krill meal and krill oil that have high levels of bioactive ingredients, in particular omega-3 bound phospholipids, highly unsaturated fatty acids, EPA (eicosapentaenoic acid), DHA (docosahexaenoic acid) and astaxanthin, which is a strong antioxidant.

The Convention of the Conservation of Antarctic Marine Living Resources (CCAMLR), is an international treaty that continues to oversee and regulate krill fishing and is endorsed by 25 member countries. Today the catch level is about one third of its permissible level.

Cholesterol in shrimp diets

Cholesterol in shrimp feeds acts as a component of cell membranes and as a metabolic precursor of steroid and molting hormones. Different species of penaeid shrimp require different levels of cholesterol in their diets. Cholesterol requirements can range from less than 0.1% to 1.0% of the diet.

Cholesterol is available in very small amounts in ingredients produced from terrestrial animal by-products and marine protein sources. Cholesterol is also extracted and purified from wool grease from farmed sheep, primarily from New Zealand. Limited cholesterol suppliers worldwide lead to fluctuating prices depending on the wool demand, e.g., from the clothing industry. In recent years, the price for cholesterol from extracted wool grease has increased drastically.

Gong et al. (2000) have demonstrated an interaction between dietary cholesterol and phospholipids in diets for the shrimp *Litopenaeus vannamei*. Cholesterol requirements in diets for this species decline with higher levels of supplemental phospholipids.

Krill meal as a supplement in shrimp diets

Krill meal is one of the few commercially available protein ingredients that not only deliver proteins, but also provides high levels of long-chain polyunsaturated fatty acids, cholesterol and phospholipids at low dietary inclusion levels. Moreover, besides krill being a source of essential nutrients, its inclusion in feeds increases palatability, growth and performance of shrimp. In studies conducted in Australia, krill meal acted as a feeding effector and growth accelerator in diets for the tiger shrimp, *Penaeus monodon* (Smith et al., 2005; Williams et al., 2005). As it is a relatively new ingredient, little is known on the potential of krill to replace key nutrients in shrimp feeds.

Based on the fact that krill meal contains a significant amount of phospholipids, a trial was designed to evaluate if minimum dietary inclusions could spare cholesterol supplement in shrimp diets. The study included 2,350 juvenile shrimp with average weights of 2.00 g (± 0.14 g). Shrimp were raised in 30 clear water tanks of 0.5 m^3 with 45 animals in each tank. Each dietary treatment was assigned to five replicate tanks with continuous water filtration and recirculation.

Six diets were formulated as described in Table 1. The three experimental diets were similar to the negative control (NEG), but with krill meal inclusion levels at 1, 2 and 3% of the diets costing USD 758/tonne, USD 772/tonne and USD 786/tonne, respectively.

Table 1. Ingredient composition (% of diet, as is basis) of experimental diets.

Diets	Fish meal inclusion rate	Cholesterol supplementation	Krill meal inclusion rate	Cost of feed per tonne in USD
Reference (REF)	18%	0.08%	2%	1,017
Positive Control (POS)	5%	0.09%	0%	837
Negative control (NEG)	18%	0.0%	2%	744
1% krill meal	18%	0.0%	1%	758
2% krill meal	18%	0.0%	2%	772
3% krill meal	18%	0.0%	3%	786

These were compared against a reference diet (REF) formulated to contain 18% fish meal, combined with 0.08% cholesterol supplementation and 2% krill meal, costing USD 1,017/tonne; a positive control diet (POS) containing 5% fish meal combined with 0.09% cholesterol supplementation, but no krill meal, costing USD 837/tonne and negative control diet (NEG) designed to be nearly equivalent to the positive control diet (POS), but lacking cholesterol supplementation, costing USD 744/tonne.

Shrimp were fed four times daily for 69 days. Final shrimp survival, body weight, weekly growth rates, gained yield, feed intake and feed conversion ratio (FCR) for each dietary treatment were assessed.

Results

At harvest, shrimp performance was significantly influenced by dietary treatment (Table 1). Higher nutrient levels in the reference

> **"It seems to be enough to include 2% of krill meal in shrimp diets to counteract the negative effects of not including cholesterol."**
> **– Alberto Nunes**

diet resulted in the highest yield, growth per week and final body weight at harvest, whereas the lack of cholesterol in the negative control diet led to the highest mortality rate.

"It was interesting to note that white shrimp that received diets in which krill meal replaced fish meal and other ingredients performed as well as shrimp that received a basal control diet without cholesterol," commented Dr Alberto Nunes, the shrimp nutritionist leader at LABOMAR. The best results were achieved with diets containing 2 or 3% krill meal, whereas no significant difference could be observed between the 2 and 3% krill meal inclusion.

Nunes highlighted, "It seems to be enough to include 2% of krill meal in shrimp diets to counteract the negative effects of not including cholesterol."

"In addition to the krill meal results on shrimp performance, krill meal also reduces other costly ingredients, including fish meal, fish oil, and soy lecithin in shrimp diets," concluded Nunes.

In conclusion, the promising results of the shrimp feeding trial and the all-in-one advantage of krill meal delivering simultaneously proteins, omega-3 fatty acids, phospholipids and cholesterol gives it a unique advantage in the aqua feed market.

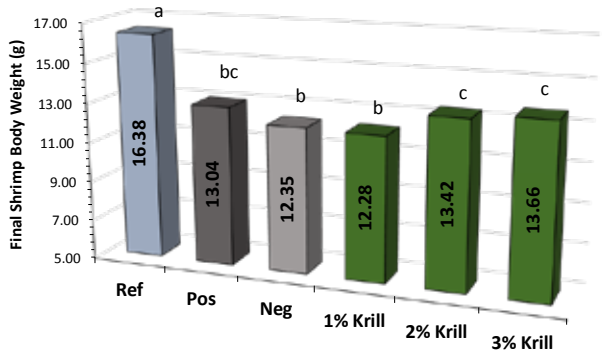


Figure 1. Final shrimp body weight (mean ± standard error) of *L. vannamei* after 69 days of rearing. Common letters denote non-statistically significant difference according to Tukey´s HSD at $\alpha = 0.05$

Table 2. Performance of juvenile white shrimp fed with graded levels of krill meal in replacement of dietary cholesterol. Data represents the means (± standard deviation) of 30 tanks. Common letters denote non-statistically significant difference according to Tukey´s HSD at $\alpha = 0.05$. Water salinity, pH and temperature were 35 ± 1 g/L (n = 1,530), 7.67 ± 0.13 (n = 1,500) and 28.2 ± 1.0oC (n = 1,528), respectively.

Dietary Treatment	Final Survival (%)	Gained Yield (g/m^2)	Feed Intake (g/ shrimp)	FCR	Growth (g/ week)
Reference (REF)	97.8 ± 11.2 a	1,106 ± 28 a	23.4 ± 0.5 a	1.67 ± 0.03 a	1.46 ± 0.10 a
Positive Control (POS)	80.9 ± 9.0 b	674 ± 110 b	21.5 ± 0.9 b	2.56 ± 0.34 b	1.12 ± 0.07 b
Negative control (NEG)	73.8 ± 10.8 b	564 ± 123 b	20.8 ± 0.9 b	3.03 ± 0.71 b	1.05 ± 0.12 b
1% krill meal	79.3 ± 6.8 b	611 ± 82 b	20.8 ± 0.2 b	2.71 ± 0.34 b	1.04 ± 0.04 b
2% krill meal	76.3 ± 1.3 b	650 ± 8 b	21.2 ± 0.2 b	2.57 ± 0.01 ab	1.16 ± 0.03 b
3% krill meal	81.5 ± 11.0 ab	721 ± 131 b	22.1 ± 0.8 ab	2.47 ± 0.39 ab	1.18 ± 0.09 b
ANOVA *P*	0.004	< 0.0001	< 0.0001	0.002	< 0.0001

References

Gong, H., Lawrence, A.L., Jiang, D.-H., Castille, F.L., Gatlin III, D.M. 2000. Lipid nutrition of juvenile *Litopenaeus vannamei* I. Dietary cholesterol and de-oiled soy lecithin requirements and their interaction. *Aquaculture*, 190: 305–324.

Smith, D.M., Tabrett, S.J., Barclay, M.C., Irvin, S.J., 2005. The efficacy of ingredients included in shrimp feeds to stimulate intake. *Aquaculture Nutrition*, 11: 263-271.

Williams, K.C., Smith, D.M., Barclay, M.C., Tabretta, S.J., Riding, G. 2005. Evidence of a growth factor in some crustacean-based feedingredients in diets for the giant tiger shrimp *Penaeus monodon.Aquaculture*, 250: 377-390.

Re-examining feeds and water quality

By Thomas R. Zeigler and Chris Stock

Feed efficiency and FCR management, critical for shrimp health should change with current shrimp and challenging farming conditions

Water quality, along with aqua feed, are the most important factors affecting shrimp performance and health in shrimp aquaculture systems. However, even with readily available technical information on the importance of maintaining optimum water quality in shrimp aquaculture systems, including remedial technologies, we still hear of the many reports of crop failures or low production resulting from undesirable water environments.

Shrimp aquaculture production conditions have changed over the last 4 decades. Advanced genetic breeding programs allow shrimp to grow faster. The types of containments used for production have evolved, as have management methods, and stocking densities have increased significantly. We now have higher biomass harvested per unit of time and space. These developing changes are necessary in order to maintain an economically viable and growing shrimp aquaculture industry.

In order to accommodate many of these changes, the feeding rates have increased resulting in higher oxygen demand, greater CO_2 production, higher ammonia and nitrite production. Unless managed, the consequence is increased levels of dissolved, suspended and settled solids. These can rapidly reach concentrations that the animals cannot tolerate.

> **"FCRs must be evaluated in real time, such as on a daily or weekly basis in order to be relevant."**

A primary cost of production, feed either as uneaten, undigested or as metabolic byproducts, is the major contributor to the rapid decline of water quality. In turn, this can quickly promote disease outbreaks. Accordingly, feed and feeding techniques require continuous review and improvement.

Feed efficiency

A feed with a high feed conversion ratio or FCR results in less of the feed going to shrimp growth and more of the feed going into the water environment. FCRs must be evaluated in real time, such as on a daily or weekly basis in order to be relevant. If one just uses the FCR values at the end of a crop, this number has economic importance, but its value in terms of measuring feed efficiency is compromised because of the impact of mortality, unless, the weight of the mortality is added to the weight of the crop. It is suggested that if real time FCRs approach 1.4 :1 then this is an indicator that there is opportunity to improve.

When properly used, feed trays provide valuable feedback to monitor and adjust feed consumption rates and overall population and animal health.

By applying best feed formulation and manufacturing practices in conjunction with carefully monitored feed management techniques today's feeds are capable of resulting in a real time FCR of 1.1:1 in most commercially produced shrimp. This should be our goal in managing our shrimp production practices

Waste production

The prediction on waste products generation from aquaculture was studied by Dr George Klontz and associates in 1978. Table 1 clearly illustrates that an increase in FCR by 0.2 units increases the amount of solids by approximately 8.5 kg/100 kg of feed fed or an increase in FCR from 1.2 to 1.6 increases the amount of water solids by 20 kg/100 kg of aqua feed applied to the pond. However, the quantity of waste predicted is reported as solid waste and does not consider soluble wastes. The extra waste must be dealt with in some way or another, to maintain optimal water quality. Although the researchers conducted their work with trout, it is suggested that as the FCRs increase the relative increase in the amount of solids produced would be similar for most aquaculture species including shrimp.

Managing FCRs

How can farmers improve FCRs without compromising the performance, growth rate and survival of shrimp? This should be a continuing, top-priority objective of management. Several important tools and techniques can be applied to accomplish these objectives. The most important ones are mentioned below.

Eliminate overfeeding

This is the single most important way to improve FCRs in shrimp farming. This involves selecting the appropriate, highly palatable, highly digestible and complete feed as well as selecting the right particle size. For the shrimp, more frequent feeding is better. However, it is important that shrimp can easily and quickly access the feed when delivered to them.

Nutrient dense feeds

Feed a nutrient dense feed formulated to avoid both nutrient excesses and nutrient deficiencies. The feed should be highly digestible and formulated using highly digestible ingredients. The scientific literature reports that the digestibility of dry matter and protein can vary as much as 20% or more for different sources of the same ingredient.

Gut health

Maintain optimum digestive track physiology and health. This is where the nutrients move from the feed into the lymphatic or the circulatory systems through the process of digestion and absorption. If the lining of the digestive track becomes irritated and dysfunctional- because of toxins, bacterial or parasitic infections - the digestive and absorptive processes can be significantly reduced and the digestibility of the feed becomes impaired, resulting in greater faecal waste.

Today's feeds are capable of producing real time FCRs of 1.1:1 in most commercially-produced shrimp and fish. This should be our goal in managing our aquaculture farms and production practices.

With faster-growing animals and higher biomass harvested per unit of time and space, new adaptations are needed to sustain an economically viable, shrimp aquaculture industry.

Avoid under feeding

Although it is well known that under-feeding gives a lower FCR value, this practice is definitely not recommended for several reasons. Hungry shrimp will consume the detritus that is on the bottom of the ponds and can be a significant source of disease. Hungry shrimp typically will aggressively consume small, weak or dead animals that can also be infected with pathogenic organisms. Lastly, if under-feeding is not very carefully controlled it will result in smaller, less uniform animals, greater overall size variability and lower biomass at harvest. The resulting economic loss can easily be greater than the value of the feed saved.

Relevance of water quality to EMS/ AHPND management

There is growing and strong anecdotal evidence that organic loads in pond bottoms, from uneaten feed, faeces and other sources, play a significant role in the occurrence of early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND), as a source of nutrients for pathogenic *Vibrio parahaemolyticus*. Therefore, farmers should adapt pond management methods and feed management to minimise organic loads in shrimp ponds. This is to keep the density of the EMS pathogen below 10^4 CFU/mL. No EMS toxicity has been reported to occur below this bacterial density.

To minimize organic loading of ponds, some of the more relevant management recommendations include the prevention of overfeeding, the digestion of excess organic matter using probiotic products, and the frequent/constant removal of uneaten feed and organic sludge from the pond bottoms.

Automated feeders can significantly improve feeding efficiency as well as shrimp growth, survival and FCR, in ponds of all sizes, when compared to traditional feed broadcasting methods. Shrimp learn to approach the feeding station, and only one unit is needed for every 500-750,000 shrimp at the high stocking densities typically used throughout Asia. In other shrimp farming regions like Latin America, with lower stocking densities and biomass, 1-2 units/ha can service the larger ponds used.

In addition, automated feeders can broadcast small pulses of feed pellets at varying time intervals. This means that most if not all pellets will be caught and consumed and very little feed waste accumulating on the pond bottom or dissolving in the water. The result is reduced organic waste and sludge buildup, better pond water and pond bottom quality. This reduces the potential for pathogenic bacteria like EMS-causing *Vibrio parahaemolyticus* populations to grow and reach threshold densities where toxin production is triggered.

For frequent or constant removal of uneaten feed and organic sludge from pond bottoms, a technique that is gaining popularity is the construction and operation of so-called 'pond toilets'. These are depressions on the pond bottom, usually at the centre of the pond or where or organic matter and sludge accumulates (which can be promoted and located by proper positioning of aerators). The sludge can be frequently or continuously pumped out from these depressions using hoses and PVC pipes and small pumps operated from pond dykes.

Concluding remarks

A clear understanding of the role feed and feeding have on water quality is important for shrimp farmers. A lower FCR number is better as it normally indicates higher levels of feed utilisation and lower levels of solids going into the water column. It can also indicate less feed wastage.

Preventing water quality problems through proper feeds and feeding should be the first priority as the cost of remediation can be quite significant. In either case, the water quality standards for optimum performance of aquatic animals must be maintained.

Table 1. Estimated solids* per 100 kg of feed fed. *Solids, kg 0.95 [kg fed - (kg fed x dietary efficiency)]. From G.W. Klontz, I.R. Brock & J.R. McNair (1978) in Aquaculture Techniques: Water Use and Discharge Quality.

FCR	Dietary efficiency %	Kg solids/ 100 kg feed fed
1.1	90.9	8.7
1.2	83.3	15.9
1.3	76.9	22.0
1.4	71.4	27.2
1.5	66.7	31.4
1.6	62.5	35.6
1.7	58.8	39.1
1.8	55.6	42.2
1.9	52.6	45.0
2.0	50.0	47.5
2.1	47.6	49.8
2.2	45.5	51.8
2.3	43.5	53.7
2.4	41.7	55.4
2.5	40.0	57.0

Thomas R. Zeigler

Thomas R. Zeigler, Ph.D is senior technical advisor as well as past president and chairman of Zeigler Bros, Inc, USA.
Email: tom.zeigler@zeiglerfeed.com

Chris Stock

Chris Stock, M.Sc is Sales manager - Eastern Hemisphere for Zeigler Bros., Inc.
Email: chris.stock@zeiglerfeed.com

filling the world's need for *Artemia*

EZArtemia

Liquid Artemia Replacement Diet

Biosecure - #1 Selling Replacement Diet

DISTRIBUTORS

Bangladesh
Grace Tone Limited
+880-2-885-7165
shahid.grace@agni.com

China
Best Care Bio-Tech Co. Ltd.
+86-4008-882-883
mxx_best@hotmail.com

India
Priyanka Enterprises
+91-99-4964-0666
priyankanlr2000@yahoo.co.in

Indonesia
PT Radiance
+62-21-634-7788
shrimpfeed@pt-radiance.com

Malaysia
Lantas Resources Sdn Bhd
+60-17-247-3640
wtx9406@yahoo.com

Philippines
Feedmix Specialist Inc. II
+63-2-636-1627
www.feedmix.com

Vietnam
Vinhthinh Biostadt JSC.
+848-3754-2464
www.vinhthinhbiostadt.com

ZEIGLER
nutrition through innovation

717-677-6181
www.zeiglerfeed.com
info@zeiglerfeed.com

contains Vpak

Product of USA

the alliance global aquaculture
founding member

Sustainable feed for the future: Insects as fish meal replacement

By Nathan Preteseille

Two producers provide insights into this new and developing industry.

An obvious look at our current feed and food production system points out the need for improvement in the sustainability of the supply chains. In this context, among other resources, such as algae or single cell proteins, insects show a high potential to fulfill our growing population requirements, which are not going to decrease with the 9 billion people expected on our planet by 2050 (Harinder P.S Makkar, 2014).

Stakeholders worldwide are jumping on the slowly but fast accelerating bandwagon of insects as feed and food sector. We can speak of about eight big established players ready to industrially produce insects as animal feed, but it is important first for insects to be accepted as a feed ingredient or food, especially in western countries. Limited by several factors and regulation, this very new and growing market has a current production of a few tonnes per day by the main industrial players. However, the global requirement is estimated to be about 500,000 tonnes of insect proteins produced per year within the next 10 years (EFSA report, 2015), and this is likely to be an under estimated figure as the demand is projected to increase from year to year.

The European Union is also supporting the growth of the 'entomoculture' sector through the PROteINSECT program, which focuses on the use of insects as animal feed from Research and Development to acceptance at the consumer level. Further development projects will address our major food and feed security issues.

Evolving an industry

In October 2015, the European Food Safety Authority-EFSA delivered the report long awaited by all stakeholders in the insect meal industry. The agency assesses the safety of using insects as food and feed, through microbiological, chemical and environmental considerations. Importantly, the report has emphasized that the risk of using insects in animal and aqua feed is no different from the use of other animal protein resources. However, it targets the risks found mostly in the farming and processing steps.

In this context, the substrates used to grow invertebrates are the main concern, especially if these originate from humans or animals. In Europe, regulatory control plays an important role. Animal manure, pre- and post- consumer wastes are not permitted to be used under any circumstances, as a rearing substrate, which is not always the case elsewhere. Although EFSA recognises that the extraction process of active ingredients remains the proprietary information of the production companies, it considers that it is a critical step for food safety control, leading to a potential need for regulatory measures.

From this first EFSA report on the use of insects for feed, regulatory control should be designed in order to allow further development of a growing sector, but also deeper investigations should be conducted to determine the interest in this food and feed resource. (Full details at http://www.efsa.europa.eu/en/efsajournal/pub/3989)

Insect meal from Protix

Nutritionally comparable to fish meal

Although the nutrient composition of insect meal is influenced by factors such as the substrate used for rearing the insects or the processing conditions, largely, the nutrient composition is comparable to that of fish meal. Insects have always been in the diet of aquatic species in the wild and they are already used in considerable amounts for example as shrimp brood stock feed. With this background and the need for fish meal replacement, increased consideration must be given to insects as a main feed ingredient for aquaculture.

Historically present in Asia

South-east Asia has a long history of farming insects for food. The use of insects in feeds is readily accepted in South-east Asia, and the technical know-how and feasibility for their culture are also available. This opportunity for the ASEAN to join and lead in the sustainable feed production projection should not be ignored. As an example, the black soldier fly (BSF) *Hermetia illucens* is present in the ASEAN countries but up to now its potential is underestimated and has not been tapped. The prepupae of BSF contains 350 g/kg of fat and 420 g/kg of protein on a dry basis. The use of insect meals as ingredients in fish feed has been studied since 2003, such as in the culture of the African catfish, tilapia and rainbow trout (Van Huis et al, 2013).

Cooperation to build on

In the context of global population growth and the need to ensure food security, an aquaculture sector facing huge challenges, and a new industry able to provide some answers to these issues, all stakeholders from the insect producing and aquaculture feed sectors should work together to develop sustainable and safe feed production.

Today, most of the entomoculture applied research for animal feed is being undertaken in Europe and the US, despite about 90% of the aquaculture market being located in Asia. Collaboration among European, American and Asian researchers is therefore a step in the right direction and should be encouraged. Aquaculture feed producers could invest in research and promote the use of insect meal in their feeding trials prior to being used on a commercial basis.

Present and future challenges

We could, at this point, raise current issues affecting Asia's aqua feed industry's supply of fish meal; the decrease in fish meal

supply due to the El Nino in 2015, the action taken against the use of illegal labour force on fishing vessels and increase in feed manufacturing costs. Such issues highlight the need for a new and more sustainable feed source. This is one of the main challenges addressed at the COP 21 agreement held in Paris, France in November 2015, to conserve our planet and its natural resources.

In this article, two main players from the entomoculture industry, Ynsect from France, and Protix from Holland, provide answers to some key questions which the aqua feed industry may have on the production of insect meal as a sustainable feed ingredient and on the challenges regarding its production.

Antoine Hubert is the CEO of Ynsect, France. The company was founded in 2011 and is building its first commercial plant near Dijon, France. The defatted insect protein meal - called TMP - is obtained by processing larvae *Tenebrio molitor* (meal worm) fed on cereal by products. The proximate composition is 70% highly digestible protein (75% of solubles below 12 kDa), 13% fat (mainly omega 6 and 9) and 2% ash.

Tarique Arsiwalla is founder of the Dutch company Protix. It uses larvae of the black soldier fly for the production of a range of products from whole insect meal to hydrolysed protein meals, whole and refined insect lipids and chitin powder. The proximate composition of the products varies depending on the processing steps taken; defatted protein products range from 58-66% protein with digestibility up to 95%.

Q: Which feed industry is the insect industry targeting based on priority?

Arsiwalla: "The aquaculture industry is clearly an area of focus for us. It makes sense to feed carnivorous fish and shrimp with insects, as they do in nature. Also we see that early-stage feeding can bring functional benefits, such as reduced mortality or increased stress resistance. In 2015 Protix started its first phase production in Chile, driven by the local opportunity in aquaculture. Besides aquaculture, we supply the European poultry industry with insect lipids and will also start supplying proteins in animal feed as soon as the European legislation allows."

Hubert: "The insect meal industry is first targeting the fish meal users as insect meals have a similar composition. Nowadays, aquaculture represents more than 70% of fish meal demand. This is consequently the first target for the insect industry."

Q: How do insect industry stakeholders expect to prove the value of insects to replace fish meal ?

Hubert: "Formulators and farmers will be convinced on four main criteria: volume, price, performance and quality. We realise that there is a need to produce large volumes to attract the industry. Per producer we need to produce at least 10,000 tonnes of insect meal per year to propose a competitive price in comparison to fish meal. We need to fulfill all quality criteria required by the industry and also prove that growth and digestibility performance to be at least as good or better as when using fish meal. At the same time we need to ensure maximal food safety. Acceptance and quality at the consumer level has to be taken into account."

Arsiwalla: "It is understandable that the aquaculture industry (feed millers as well as farmers) wants to be sure that the new

ingredient is safe and that it works from an economic point of view. For this reason we have done our own trials but also invite potential customers to conduct their own. In addition, we are happy to engage in dialogues on the suitable uses of our insect derived ingredients. From experience, these are in poultry, but certainly also in aquaculture. The other key concern was available volumes. This was an issue but has rapidly changed in 2015 where Protix, and possibly other companies, have started supplying both the pet food and poultry industries."

Q: Up to what level can insect meal replace fish meal and what are the main amino acids that are lacking?

Arsiwalla: "We have done trials on several fish species, including the pretty demanding Atlantic salmon. Our results show that fish meal can be replaced up to 100% in grower diets to achieve equal performance (97% growth versus control diet, at a lower feed conversion ratio (FCR). These results were achieved without having any alternative marine proteins in the diet. To achieve these results we added some DL-methionine while we reduced L-lysine by a similar amount in the formulation. The trial was done using one of Protix insect meals, from the black soldier fly species (harvested before pre-pupae stage), defatted without solvents and dried at low temperatures."

Hubert: "Many studies demonstrated the potential to replace fish meal by up to 50% in a fish, chicken or pork diet with insect products, in a whole, powdered, or defatted powdered form, with performance results comparable to commercial diets including fish meal. However, Ynsect showed that 100% replacement was possible for juvenile rainbow trout with our product TMP-Y465 resulting in higher growth performance. There was up to 30% increase in growth and about 20% reduction in FCR."

Q: Is it possible to modify the insect meal composition depending on the substrate and process used to produce the meal?

Hubert: "Yes, you can modify the composition in different ways. The choice of the substrate can have an influence on the fatty acid profile but not on the protein and amino acid. The larvae's transformation processes can have a higher impact on the protein level of the meal or its digestibility but will partially depend on the efficiency of the defatting and cooking processes."

Arsiwalla: "Yes. Insect lipids can be influenced to some extent by the substrate used. Nonetheless, certain fatty acids will always show up as these are metabolised by the insect. In the case of black soldier fly, such fatty acids are lauric and linoleic acid. The amino acid structure is hardly changed by substrate used. Also, we see that the ratio protein: lipids can vary depending on the substrate used. By using our lipid extraction technologies we are able not only to increase the protein content of the insect meals, but also to keep the composition stable over time."

Q: Did you ever conduct sensory analysis on fish fed with insects to compare with those fed a conventional diet?

Arsiwalla: "Yes. Nofima used a blind test panel to assess the smell, taste and texture of Atlantic salmon farmed on a diet without fish meal (100% Protix insect meal replacement) against a control diet which contained 20% fish meal. There was no significant difference to the fish meal diet across any of the 20-30 measured attributes."

Hubert: "Ynsect is a partner on the DESIRABLE project, which is under execution. Sensory analyses are planned with the partner INRA."

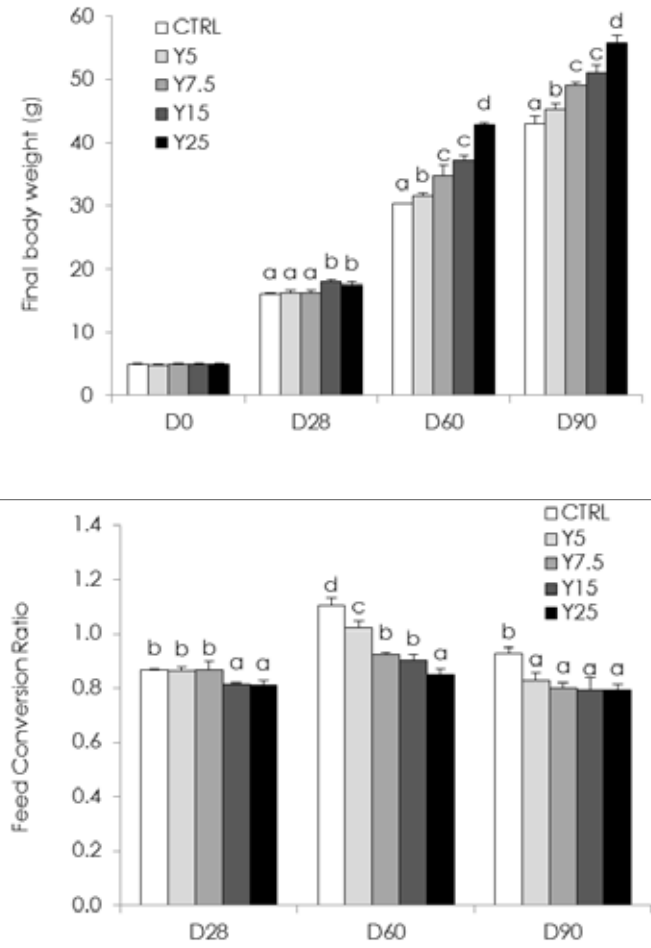


Figure 1. Ynsect product test. Changes to final body weight (FBW) and FCR of trout fed the various dietary treatments. Bars are means ±standard deviation (n=3). Bars with different superscripts differ significantly (P<0.05). The control diet comprised 25% fish meal, 8% of other marine-derived protein sources (squid meal and krill meal), while the remaining protein sources were soy protein concentrate, wheat gluten and corn gluten. Based on this formulation, four test diets (Y5, Y7.5, Y15 and Y25) were formulated, in which fish meal was replaced by Ynsect TMP-465 meal at 20, 30, 60 and 100%, respectively.

Conclusion

As is the case for any growing industry, support is likely to come from strong, well-established and interested stakeholders. Entomoculture is not going to provide the entire supply of protein meal tomorrow, but with the dedication of each player, it is potentially possible that it could do so in the near future.

Nathan Preteseille is with AETS consulting company through a French program (Business France). He works on the potential of insects as aquaculture feed.

Email: nathan.preteseille@aets-consultants.com

Yeast parietal fractions can mitigate AHPND infections in the white shrimp

By Dang Thi Hoang Oanh and Philippe Tacon

Efficacy was demonstrated in AHPND infected shrimp ponds in Soc Trang, Vietnam.

A previous trial at the University of Can Tho (CTU), Vietnam, showed that parietal fractions can be beneficial to shrimp infected with the causing agent of acute hepatopancreatic necrosis disease or AHNPD (Oanh & Tacon, 2015). This earlier trial was performed in controlled laboratory conditions and it verified the efficacy of parietal fractions from yeast and determined the optimum dose to reduce the level of mortality of shrimp infected with AHPND. However, this would not necessarily mean that the same efficacy is shown under farming conditions.

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

The objective of this follow-up study was to confirm the efficacy of the yeast parietal fractions in pond conditions as well as to determine the optimum dosage required under these culture conditions.

Experimental design

White leg shrimp *Penaeus vannamei* juveniles each weighing from 1 to 1.5 g were obtained from the shrimp hatchery and nursery at the College of Aquaculture and Fisheries, CTU. Shrimp were screened for white spot syndrome virus (WSSV), Taura syndrome virus (TSV) and *V. parahaemolyticus* to ensure they were free from these disease pathogens prior to transport to the experimental site and distributed to experimental hapas. Experimental shrimp were in good health before use and during the trial.

Trial ponds

The field trial was set up at a shrimp farm in Soc Trang province, Vietnam. AHPND infected ponds were determined by checking infected shrimp by histology with typical AHPND pathology. Experimental hapas (1 m x 1 m x 1 m) were set up in AHPND infected ponds (Figure 1). Healthy shrimp were transported from CTU to the experimental ponds and stocked at a density of 500 juveniles/hapa.

Experimental hapas

Cohabitation challenge

After stocking healthy shrimp in experimental hapas, AHPND infected shrimp in experimental pond were collected and stocked with healthy shrimp at a ratio 1:20.

Feed

The treatment diets were commercial pelleted feed supplemented with the yeast parietal fraction Safmannan® powder (Phileo Lesaffre, France) at an inclusion rate of 1 g/kg (Diet 1) and 2 g/kg (Diet 2), respectively. The control diet was commercial pelleted feed without any supplementation of yeast fractions (Table 1). There were three replicates for each diet treatment. Shrimp were fed with treatment diets and control diet 2 weeks before the *V. parahaemolyticus* challenge, and were fed with the same feeds after the challenge.

Table 1. Details on experimental set up to test the response to AHPND of juvenile white shrimp fed diets with yeast parietal fractions.

Treatment	Dose (g/kg in diet) of yeast parietal Safmannan®	Culture conditions
1	1	Cohabitation with AHPND shrimp in AHPND infected pond
2	2	Cohabitation with AHPND shrimp in AHPND infected pond
Control	0	Cohabitation with AHPND shrimp in AHPND infected pond

Data collection

Following the performance of the experimental trial, the following were analysed:

- Gross signs of AHPND and histopathology
- survival rate (%) after 21 days post challenge
- water parameters (pH, NH_4/NH_3 and dissolved oxygen).
- Data were analysed with Excel and SPSS programs.

Post cohabitation challenge

At 3 weeks post challenge, the control group (shrimp fed un-supplemented feed and challenged with AHPND) had a significant higher mortality rate in comparison to all remaining groups (Figure 1).

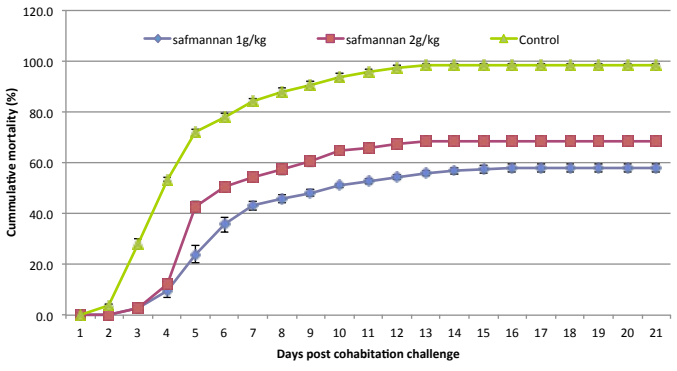


Figure 1. Cummulative mortality of experimental shrimp at 3 weeks post cohabitation challenge.

Shrimp fed yeast parietal fractions had lower mortality rates after cohabitation with AHPND infected shrimp compared to shrimp fed with un-supplemented feed (Figure 1, Table 2). Shrimp fed Diet 1 containing yeast fractions at dose 1 g/kg feed had significant lower average mortality rate (58%) than the group fed Diet 2 with the dose of 2 g/kg feed (68.7%). The control group showed the highest average mortality at 98.4%. This showed that feeding Safmannan® supplemented at a dose 1 g/kg feed had a better effect on experimental shrimp than the 2 g/kg feed supplementation.

Table 2. Summary of mortality of experimental shrimp at 3 weeks post challenge.

Treatment	Dose (g/kg in diet) of yeast parietal Safmannan®	Culture conditions	Mortality (%)
1	1	Cohabitation with AHPND shrimp in AHPND infected pond	58.0 ± 1.73[a]
2	2	Cohabitation with AHPND shrimp in AHPND infected pond	68.7 ± 1.45[b]
Control	0	Cohabitation with AHPND shrimp in AHPND infected pond	98.4 ± 0.53[c]
Letters (a, b, c): denotes a significant difference between treatments and control prawns at different time intervals using one-way ANOVA ($P < 0.05$).			

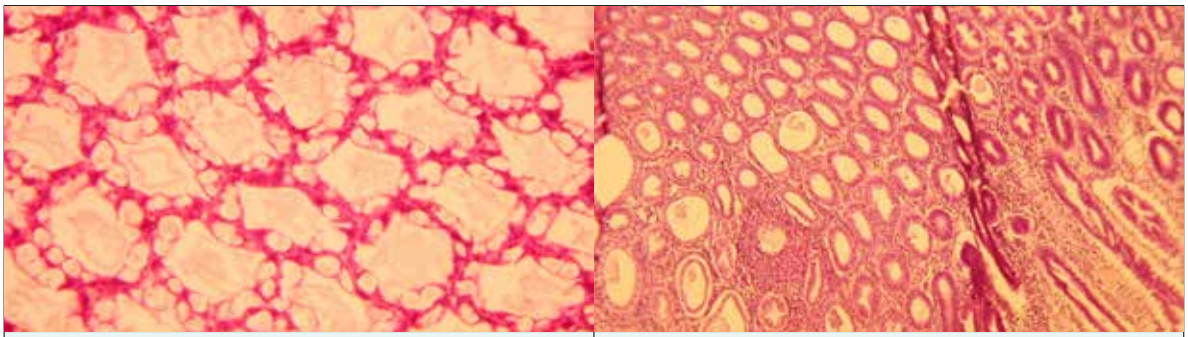
Gross signs of AHPND

Representative photos of gross signs and hepatopancreas (HP) of experimental shrimps at 3 days post challenge are shown in Figure 2. Shrimp in the control group displayed clinical signs such as anorexia, lethargy and pale colouration of the body and hepatopancreas. Empty gut was observed as early as 24 hours after the challenge. Shrimp in the two groups fed yeast fractions also demonstrated AHPND symptoms, but with less pronounced anorexia. A smaller proportion of shrimp in the treatment groups showed AHPND symptoms as compared to the control group.

Histopathology

At 3, 6 and 14-days post-challenge, 3 shrimp from each hapa were collected for histopathology. Representative illustrations are described in Figure 3.

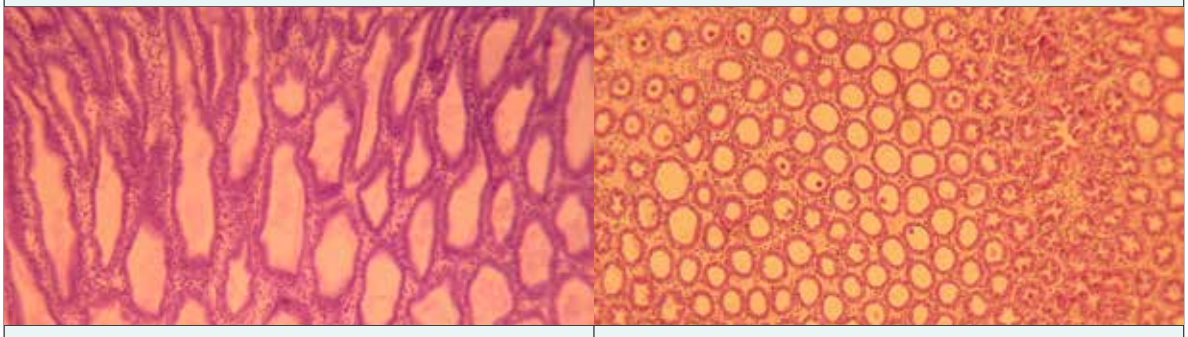
These results of histopathological analyses revealed that shrimp from all experimental groups displayed typical histopathology of AHPND. These included the rounding and sloughing of hepatopancreas epithelium cells due to *V. parahaemolyticus* toxin in a necrotising tubulus, surrounded by thick haemocytic encapsulation, severe haemocytic infiltration around hepatopancreas tubuli, sloughing of cells out of the hepatopancreas into the stomach combined with loss of celltypes (B-, F- and R-cells).



Healthy shrimp stocked in the hapas on day 1: normal histology of hepatopancreas, with differentiated cell types, notable B-cells with vacuoles.

At 3 days post challenge/sample from control group

Rounding and sloughing of HP epithelium cells in a necrotising tubulus, surrounded by thick haemocytic encapsulation, severe haemocytic infiltration around HP tubuli, sloughing of cells out of the HP into the stomach combined with loss of cell types (B, F and R cells).



At 3 days post challenge/sample from control group

Severe hemocytic infiltration around hepatopancreatic tubuli, sloughing of cells out of the hepatopancreas with loss of cell types (B-, F- and R-cells).

At 3 days post challenge /sample from group fed yeast parietal fractions

Here the loss of cell type differentiation was less pronounced (mainly less B-cells) compared to the control. Haemocytic infiltration was less profuse, with interstitial space appearing more fibrous

Figure 3. Representative images of histopathological analysis of shrimp in the trial.

Figure 2. Gross clinical signs and HP of experimental shrimp after 3 days post cohabitation challenge. (A, B and C) gross sign of shrimp in group 1, 2 and 3, respectively. (a, b and c) HP of shrimp in group 1, 2 and 3, respectively.

However, in groups fed with yeast fractions, this loss of cell type differentiation was less pronounced (mainly less B-cells) compared to the control. Haemocytic infiltration was less profuse, with interstitial space appearing more fibrous.

Environmental parameters

During 3 weeks post challenge, water parameters in the experimental pond were suitable for shrimp (30±1°C, pH 8.5±0.5, NH_3<0.1 mg/L and DO 4 mg/L). Therefore, mortality in experimental hapas was not caused by environmental stress.

Conclusion

In this trial performed with farm conditions we showed that feeding yeast fractions have beneficial effects in juvenile shrimp *Penaeus vannamei* with regard to AHPND symptoms, such as reduced mortality and histological signs of hepatopancreas regeneration. In these conditions, it was shown that Safmannan® had a better effect at a supplementation rate of 1 kg/tonne, This will help farmers alleviate losses with AHPND.

Reference

Oanh, Dang Thi Hoang and Tacon, P. 2015. Yeast parietal fractions enhance the immune response of shrimp towards AHPND infections, Aqua Culture Asia Pacific, Vol 11, 2015 (2) pp 26-30.(Ringo *et al*., 2012)

Dang Thi Hoang Oanh

Dang Thi Hoang Oanh is head, Department of Aquatic Pathology, College of Aquaculture and Fisheries, Can Tho University.

Philippe Tacon

Philippe Tacon is Global Aquaculture manager for Phileo Lesaffre Animal Care. Email: p.tacon@phileo.lesaffre.com

Supporting Asian aquaculture

Focus on nutritional challenges and omega-3 LC-PUFAs at specific life stages for fish and general gut health at the 21st DSM Aquaculture Conference.

For the past 20 years, the DSM Aquaculture Centre Asia Pacific in Bangkok has been bringing experts to impart knowledge on aqua nutrition to customers and to the industry in the region. During the last few years, it has adopted a more holistic approach and incorporated information on trends in the fish and shrimp farming business.

The program for the 21st conference held in November 2015 in Bangkok, Thailand comprised a morning session with two presentations on nutrition for specific life stages; perspectives on early life nutrition in fish and shrimp followed by omega 3 long chain fatty acid requirements for fish. An academic overview of gut health was also presented as we work towards improving intestinal health status through nutritional strategies for fish and shrimp.

The afternoon session comprised three presentations. An article based on the presentation by Andy Shinn, Fish Vet Group Asia on 'Economic impact of aquatic pathogens on Asian aquaculture production' is given in the Health and Management section (see pages 16-19). Victoria Alday-Sanz, National Aquaculture Group, Saudi Arabia presented on Shrimp Disease and Avoidance: Approaches and Challenges. Jon Ratcliff, consultant, Food and Agriculture Consultancy Services, Thailand presented on EU food and safety standards: Retailer and Consumer concerns. Reports on these two presentation will follow in the March/April issue of Aqua Culture Asia Pacific.

Dominique Bureau (centre) with Dr Fuci Guo, Regional Technical Manager Aquaculture, DSM (right) and Bunluesak Sorajjakit, Thai Union Feedmill, Thailand

"This year, we concentrate on early life nutrition to bring economic benefits to producers. DSM has been strengthening its position in the regional aquaculture industry with a larger team. Our goal is to see the development of the right type of solutions to meet the needs and objectives of our customers," said Christos Antipatis, regional marketing director, Asia Pacific, DSM Nutritional Products, Singapore in his short welcome to the 200 participants.

Perspectives on early life nutrition

Dr Dominique Bureau, Fish Nutrition Research Laboratory, University of Guelph, Canada, gave his perspectives and opinions as well as suggested areas worth investigating in 'Perspectives on early life nutrition of aquaculture species.' This would be the stages from early life to the starter feed stage, where fish would have attained 50 g.

"The challenge we have is developing nutritional specifications for different species, life stages, weight ranges and feed types. Most of the nutrient requirements are different from one stage to another, at least in terms of nutrient concentration. The task of formulating feeds for the developing stages of fish is not easy. Larvae have to sustain themselves and yet they still cannot be considered fully formed. The gastrointestinal (GI) tract is developing and changing rapidly. There are dramatic differences between species so we cannot always apply broad rules and approaches to all species.

"In Asia, this becomes more complex as there are different feed types with different quality in terms of protein content. The paradox is that the fish is not fully mature and we have to work alongside it as it grows but we lack the information on *in vivo* processing of nutrients.

Evolution of the gut

"We know that the GI tract is changing rapidly but the pancreas is the first to develop in fish. The stomach develops later. There is evidence that digestion starts intracellularly in cells of the GI tract and later moves to outside of cells," said Bureau.

"Tracer studies show the very poor digestibility of intact proteins in larvae but better digestion in the juvenile. A clear difference in digestibility between intact proteins and hydrolysates can be seen in larvae which do not have the enzymes to breakdown intact proteins. This means that digestion is the limiting factor, not absorption. Digestibility of intact protein can be 20-25% at the early stage and reach 80% a few days later. We need to keep a balance, as the animal grows we could reduce the supply of hydrolysates and increase supply of intact proteins. What we need to remember is that as the animal evolves, we want the animal to do the work but we can help with this process.

Bureau added that tissues under development need a balanced supply of nutrients, so that cells can proliferate and organs and tissues grow. Many nutrients also play important roles in cell signalling and regulation of the proliferation and differentiation processes of cells involved in ontogeny.

"We also need to look at the maternal effects that is the influence of feeding and managing the broodstock. Very little is

known about how these maternal factors influence embryonic and larval developmental capacity. Studies have indicated for example that the amount of cortisol that the female deposit in the egg can have an effect on growth of the animal. More cortisol appears to make the animal grow faster giving it an early start. However, Bureau said that studies demonstrated that the effect was only at the early stage.

Why is early-life nutrition important?

"The mass production of high quality, healthy and fast-growing larvae, fry and fingerlings is one of the cornerstones of aquaculture production. As nutritionists, we need to know how to feed the animal, and to define the appropriate diet as we want the animal to grow and be healthy, not only at the immediate stage but also have an impact on productivity and profitability of the farm," said Bureau.

"Nutritional or metabolic insults and environmental problems during this period can be highly detrimental, not only to immediate growth performance, health and welfare of the animal but also to long term performance and health, final product quality and on the overall profitability of the enterprises rearing these animals to market weight. The understanding of the metabolic capabilities of the fish is critical."

Small feeds and weaning

According to Bureau, nutritionists have not been active enough in determining the nutritional requirements of early stage nutrition as most of the work has been at the grower phase.

"I am a strong believer in metabolic flux in the animal to determine what can be done and what to focus on. We need to translate this know-how into practical solutions. We need to connect basic with applied science in our R&D efforts and support aqua feed millers in the translation of this knowledge into practical solutions. Weaning fish to dry feed remains a major challenge, although there has been a lot of progress in this transitional phase.

"In larval nutrition, we have already managed to replace rotifers and *Artemia*, completely or partially with 50 to 200 µm microencapsulated, micro coated or micro bound diets. However, we still have difficulty in obtaining results which are as good as what can be achieved with copepods. There are still unanswered questions in larval nutrition. Producers often face the dichotomy of good growth with poor survival or poor survival with good growth. The aim is to find the middle ground."

Larval feeds are expensive, require complex mix of ingredients and elaborate manufacturing processes. These feeds often have more than 50% protein and 14% lipid which require the use of high quality fish meal and marine meals such as krill meals and hydrolysates and lipid sources of marine origin which are not only expensive but also in short supply. If we know the nutritional requirements, what is required and how much, we can then develop more cost-effective and sustainable feed formulations.

Optimal nutritional specifications

Bureau commented that in early life stages nutrition it is not only important to define optimal nutritional specifications but also to manage cost and quality of ingredients.

"The exact nutritional requirements of early life-stages are still poorly characterised, even for the better-studied species. The use of live food in nutritional studies of fish larvae places serious limitations on experimental design, given the fact that with the exception of some lipid components, it is difficult to manipulate the nutritional composition of live prey. Many variables render the interpretation of results often difficult," said Bureau.

Dr Jacques Gabandan, former Director, DSM Asia Pacific Centre (third from right) is pictured with old colleagues and industry, from left, S K Basha, Sharat Industries Ltd, India, Ruhul Amin, DSM- Bangladesh, Anuj Tyagi and Venkata Raju, Avanti Feeds, India, Vilas Autade, DSM, India, Dr Fuci Guo, DSM, Arphakorn Petthong and Dr Mohan Das, CPF India.

"As nutritional requirements are not perfectly characterised, the commercial nutritionists need to compile whatever information on nutrient requirements is available and have their focus on what works."

Conducting experiments for early life stages is difficult, especially when the animal is evolving faster than the experimental duration and resources to run experiments are limited. Bureau proposed that nutritionists look at cutting edge 'nutritional modelling' approaches whereby it is possible to slice and dice factorial modelling and obtain theoretical estimates of requirements at any stage in the animal's life cycle such as has been done for the digestible phosphorus requirement of Atlantic salmon of increasing weight. The other challenge is that with small feed particles, we have to figure out how to deliver nutrients equally in each particle without too much leaching and wastes. We certainly have work to do on that.

Bureau emphasised that, "In the production costs, the cost of feeds for rearing at the early life stage is generally considered an investment when the operation is integrated. Reducing cost of feeding with these high-end feeds is not always an option given the potentially greater negative impact of using ill-suited feeds. On the contrary, independent hatcheries or nurseries may be pressured to squeeze out maximum profits and may have limited resources to invest in the long-term performance and health of the animal. There may be a need in Asia for different stakeholders to work more cooperatively to ensure better fish quality and long-term profitability."

A modern context on n-3 LC-PUFAs

In 2011, **Professor Douglas Tocher**, Institute of Aquaculture, University of Stirling, Scotland presented his work on "Lipids and long-chain polyunsaturated fatty acids: metabolism, physiological function and requirements in aquaculture species". This year, his presentation focused on the "Requirements and supply of omega-3 long chain polyunsaturated fatty acids (n-3 LC-PUFA) for specific life stages."

"The reason why fish and crustaceans need n-3 LC-PUFAs goes back to the food chain in the marine environment which is dominated by n-3 fatty acids such as eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3). They are essential because most animals cannot biosynthesise these fatty acids. We have focussed on n-3 PUFAs such as EPA and DHA but n-6 fatty acids such as arachidonic acid (ARA, 20:4n-6) also have key metabolic roles. For instance, the n-6 LC-PUFA are very important in promoting key inflammatory responses and the n-3 PUFAs are required to bring acute inflammation to an end and so there should be a balance of n-3 and n-6 fatty acids in the diet."

In the past, aquaculture depended on capture fisheries for its supplies of n-3 LC-PUFA (fish meal and fish oil). According to the IFFO 2013 report, aquaculture used 75% of global fish oil and, of this, salmonid farming used 60%, marine fish 23% and crustaceans 6%.

"Today, supply is, at best, static and both fish oil and fish meal are being spread thinner in aquaculture feeds. With the *El Nino* in 2015 expected to be among the three most severe since the 1950s, we can expect lower levels of fish oil to be available for aquaculture. Supplies also compete with direct human consumption of fish oil, which is rising. How has aquaculture managed with the reducing supplies of fish oil?

"In the salmonid industry in Norway, there has been a steady reduction in fish oil and fish meal usage. Norway began to replace fish oil with rapeseed oil in the mid 2000s and so, from more than 30% marine oil in the feed in 2000, the amount was reduced to less than 11% marine oil in 2013, with plant oils increasing to 19.2%. (Figure 1).

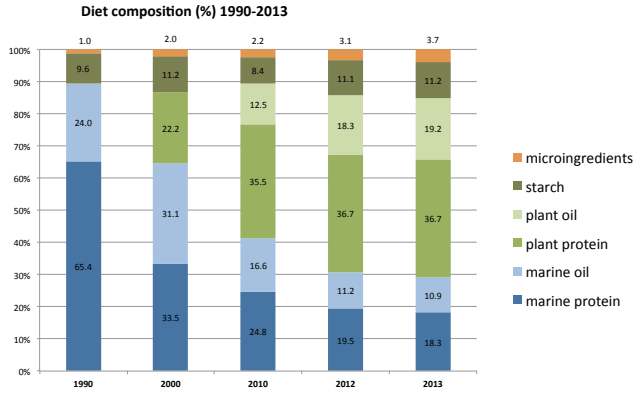


Figure 1. Development of salmon feed composition in Norwegian salmon farming from 1990 to 2013. Source: Ytrestøyl, T., Aas, T.S., Åasgård, T., 2014. Resource utilisation of Norwegian salmon farming in 2012-2013. NOFIMA report no. 36/2014. The Norwegian Institute of Food, Fisheries, and Aquaculture Research, Tromsø, 35 pp).

"The consequence has been decreased EPA and DHA in farmed salmon flesh. In 2015, a 100 g portion of Scottish farmed salmon provided 1.4 g DHA per 100 g, and less for Norwegian salmon. As the recommended intake of DHA and EPA is 500 g per day or 3.5 g/week, the farmed salmon will deliver this in two portions per week compared to one portion in 2006. However, farmed salmon can still deliver the EPA/DHA required and is just lower than sardines."

Speakers, Daniel Merrifield (second left), Douglas Tocher (second left) with DSM participants.

EFA requirements

Surprisingly, little has advanced in terms of information on essential fatty acids (EFA) requirements for fish since 1991. Research on n-3 and n-6 LC-PUFA requirements were largely qualitative and few have been quantitative. In addition, work has been mainly on early life stages and ratios – less costly and more feasible research.

"Methodological problems with classical studies on quantitative EFA requirements have hindered research. An EFA-free basal diet has to be used, which can be tricky with problems of palatability,

DSM's Dr Ei Lin Ooi, Regional Technical and Research manager Aquaculture (right) and Luo Zuoyong, Category manager, China (second left) with Mi Haifeng, Tongwei Feed (left) and Sun Luyu, DBN Aquatic, China.

Suaedi Sunanto, PT DSM Nutritional Products Indonesia (centre) with from left, Teddy Njoto, PT Matahari Sakti, Erwin Soewendi and Suatmini, PT Suri Tani Pemuka, and Stefani, PT Wonokoyo Jaya Corporindo Feeds, Indonesia.

attractability, etc. Ideally, purified individual fatty acids are required; however, these can be costly, even if they are available.

"Qualitatively, we know that for many freshwater/salmonid species, EFA requirements are generally satisfied by 18:3n-3 and 18:2n-6, available from plant oils, but marine species require LC-PUFA, EPA, DHA and ARA. Quantitatively, around 1% dry weight of diet is required by many species, but this can be higher. In species where C18 PUFA satisfy requirements, lower amounts of LC-PUFA is required. The species differences are due to the enzymes available for biosynthetic pathways."

Current information on EFA requirements in NRC (2011) is from work performed on juveniles and sub adults and the information is not necessarily representative of adults or fish on-growing to market size such as 500 g for sea bream or 5 kg for cobia.

"Larvae and early development stages are critical and almost certainly require higher levels of EFA, but obtaining quantitative requirement data has been a challenge. Studies with larval fish have been hampered by methodological issues, including small size, developmental immaturity and dependence on live feeds."

Molecular and biochemical basis of EFA requirements in fish

In this part of the presentation, Tocher looked at the pathways known to exist in fish. "In terms of enzymes, freshwater fish and salmonid species generally have the desaturases and elongases to synthesise EPA and DHA from 18:3n-3. Marine species lack the enzyme(s) to make EPA from 18:3n-3 but perhaps can convert EPA to DHA, particularly in key tissues (e.g. brain). We cannot generalise as Senegalese sole *(Solea senegalensis)* have only a low requirement for n-3 LC-PUFA even as larvae, despite lacking Δ5 desaturase, and Δ4 desaturases have been discovered in some fish species."

On the effects of high-energy (fat) diets on EFA requirements, Tocher explained that the quoted EFA requirements are probably a good estimate of minimum requirement to prevent deficiency pathologies, but higher levels are likely required to sustain optimal/maximal growth in fish fed diets with high lipid/fat contents, supported by data obtained in marine fish that showed growth reduction when fed high-energy feeds despite being formulated to more than satisfy EFA requirements.

In broodstock, dietary fatty acids affect reproductive performance such as fecundity, egg production, etc., and dietary transfer has been shown from broodstock to eggs. "It is all about relationships. DHA:EPA ratio has been shown to be positively correlated with egg quality criteria. In the sea bream, sea bass, cod, etc., hatching, fertilisation rate and early survival have been positively correlated with levels of n-3 LC-PUFA and ARA in eggs."

During larval and early development stages, Tocher said that newly hatched freshwater fish and salmonids are generally large and well developed enough to feed on formulated diets with adequate EFA from first feeding. In contrast, marine fish larvae are small in size with poorly developed digestive systems. Live feeds such as rotifers and Artemia are convenient and practical but not nutritionally ideal, and require to be enriched in LC-PUFA prior to feeding.

"During stressful stages, such as metamorphosis in marine fish, the requirement changes. In flat fish, pigmentation or eye migration has been positively correlated with n-3 LC-PUFA and negatively with ARA and ARA:EPA. During smoltification and seawater transfer of Atlantic salmon, feeding C18 PUFA may be beneficial for LC-PUFA synthesis. With diseases or infections, functional feeds enriched with n-3 LC-PUFA can be beneficial."

Future supplies of essential n-3 LC-PUFA

In this final part, Tocher discussed the pros and cons of *de novo* production of marine microalgae and genetically modified (GM) crops as alternative sources of EPA and DHA. The primary producers, marine microalgae, are potentially the most sustainable options with the heterotrophic species such as thraustochytrids *(Schizochytrium sp.)* and dinoflagellates *(Crypthecodinium cohnii)* showing greatest potential. Their disadvantage is the currently limited production and high cost.

"Initially algae products were mainly sources of DHA without or with only low levels of EPA such as DHASCO® (DSM Nutritional Products). However since 2012/2013, DSM produced *Schizochytrium* oil with >22% DHA and >10% EPA. Transgenic oilseed crops modified to produce oils rich in EPA and DHA can be produced in large volumes and at affordable prices. The yeast *Yarrowii lipolytica* from Dupont has 15% dry weight of EPA from 55% lipid and the CSIRO/Nuseed canola is enriched in DHA and DHA+EPA. Research by Rothamsted Research and the University of Stirling in the UK with transgenic Camelina has yielded lines with 20% EPA and 6% each of EPA and DHA. The disadvantage is that these oils are from GM plants and there will be issues of legislation and acceptance at the political, retailer and consumer levels to overcome."

> **"The supply of n-3 LC-PUFA for the human population is a global issue and aquaculture is simply a very good delivery system for 'new' n-3 LC-PUFA into the human food chain. However, there are exciting options on the horizon that can potentially provide long-term solutions." - Tocher**

The DSM team, from left, Karim Kurmaly, Dina Joardar, Ei Lin Ooi, Jennifer Tan, Christos Antipatis, Robert Redman and Fidelis Fru

Importance of gut health

Dr Daniel Merrifield, Aquatic Animal Nutrition and Health Research Group, Centre for Agriculture and Rural Sustainability, Plymouth University, UK discussed current understanding on gut health, role of gut microbiota and dietary modulation of the gut microbiota. He highlighted some findings on probiotics and prebiotics. Merrifield recently published Aquaculture Nutrition: Gut Health, Probiotics and Prebiotics, the only book dedicated to gut health and microbiota in aquaculture.

"Most of our research on gut microbiota have focused on bacteria but there is also a rich community of archaea, viruses, protozoa and yeasts present in the gut of fishes. Bacteria are the most abundant component of the microbiota community. In the digestive tract of a finfish; we can find 10^{10}-10^{12} bacteria/g, which is several orders of magnitudes higher than the levels in rearing water.

Current knowledge on microbiota in the gut has been derived from a compilation of information from hundreds of reports and most studies have focused on farmed fishes.

Merrifield said, "However, with the use of high-throughput sequencing studies, we are identifying more bacterial species than ever before and gaining an understanding of the "rare biosphere". Despite this diversity, and a wide array of abiotic and biotic factors which affect the microbial composition, there appears to be a group of core microbiota present in all members of the fish species irrespective of environmental conditions. The microbiota composition also vary in species between freshwater and marine fish. For example, Vibrios are commonly present in marine fish species but less frequently present in the gut of freshwater fish species. The types of relationship with each other and the relationship between bacteria and their host can change. It can be either commensalistic, mutualistic or parasitic (i.e pathogenic)."

Importance of gut microbes

The gastrointestinal (GI) tract is a port of entry for many fish pathogens and it is also where opportunistic microbes can multiply. Under normal circumstances the microbial abundance and level of interaction with the host is constrained by immunological and competitive exclusion. When the host is subject to stressors or when the microbiome is exposed to adverse environmental conditions, a microbial imbalance, known as dysbiosis, can occur.

"A healthy intestinal epithelium combined with a viscous mucus layer provides an effective defensive barrier against infections. However, these barriers can easily be breached by opportunistic pathogens if the structural integrity of the epithelium is compromised by stress and poor nutrition. In order to maintain epithelial integrity it is vital to maintain a healthy microbiota, which before the epithelium, is the first line of defence against infection through competition and antagonism," said Merrifield.

"Resident commensal microbes help maintain efficient functioning of the gut; as they influence gastric activity, produce vitamins and extracellular enzymes, are responsible for fermentation and short chain fatty acids - SCFA production, stimulate epithelial turnover and defend against pathogens. For example *Cerobacterium somerae*, frequently isolated from the GI tract of freshwater fish such as tilapia, grass carp, common carp and ayu produces Vitamin B12 which, interestingly is not required by all fish. Fish with a high abundance of *C. somerae* have no dietary requirement of B12."

Feed additives to manipulate microbiota

Merrifield said, "Why rely on random colonisation and development of bacterial populations? The protective role of gut microbiota combined with its nutritional role has generated great interest in novel feed additives collectively known as eubiotics. Current information available on phytobiotics, acidifiers, prebiotics and probiotics was elaborated in this presentation. In the latter group, he highlighted the following.

"We can manipulate the microbiota to induce host benefits including elevated growth performance, immunity and disease resistance. In our studies on effect of ingredients with anti-nutritional factors (such as soybean meal), we observed that microbiota modulating feed additives could reduce the extent of enteritis in the intestine."

However, he stressed that the continued provision of probiotics is required since probiotic presence in the GI tract is only temporal, with persistence lasting from days to weeks after probiotic provision has ceased.

His take home message was, "We can modulate the gut microbiota and intestinal health status through nutritional strategies, but in order to gain the greatest benefits, we must know not only what microorganisms live in the gut, but what they are doing. Metagenomics analysis can help to provide the information we require in order to provide tailor made solutions that are species/farm specific."

Marine shrimp in Asia in 2015: Production trends

By Zuridah Merican

Lower production led by low prices delaying stocking, adverse weather, poor post larvae quality and disease outbreaks.

During the early part of 2015, it did seem that production volumes in 2015 would be similar to that of 2014. Asian farmed shrimp production in 2014 was estimated at 2.9 million tonnes. However, at the end of 2015, with more crop failures and stocking delays, post larvae quality issues, climatic and export woes, including low ex-farm prices in some countries, our calculation of production showed a decline of 20% over the 2014 figures to only 2.3 million tonnes (Table 1). For the first time since the early mortality syndrome (EMS) was reported, industry reported a large decline in production in China. Due to the early release of this report, we add the caveat that we can expect some revisions on the numbers presented here. However, the trends presented in this report remains valid.

Year 2015 started with a push to increase production fuelled by higher prices which started in 2013. In 2014, Vietnamese producers recorded good production results as they recovered from EMS or acute hepatopancreatic necrosis disease (EMS/AHPND). However in 2015, production was constrained by low ex-farm prices inked to lower demand in the US. Vietnam also imported shrimp from Ecuador and India due to lack of local supply for processing. In India, the increase in processing capacity eliminated the bottleneck during the peak season and there seemed to be no end to the breakneck frenzy in production. During Seafood Expo Global 2015 in Brussels, there were news of Indian processors and exporters seeking markets for their shrimp and undercutting and dropping prices. With news of floods reducing the supply of shrimp from India, processors offer prices rose at year end. This was coupled with demand in the US. Unfortunately, the second crop in India is usually risky with a higher disease threat during the colder months. Shrimp growers in the Philippines continued to increase production (see pages 4-5).

China

A drop in production volume of the vannamei shrimp is expected, with estimates ranging from a high of 800,000 tonnes to a low of 500,000 tonnes. The failure rate for crops was particularly serious in south and eastern China. May and June stocking results were poor because of adverse weather and environmental conditions, inferior post larvae quality, and poor water quality and management. In Hainan, the winter crop was not successful leading to a 33% decline in annual production. Mortality was from an unknown bacterial disease occurring at 60 days of culture. Farmers then shifted to farming the freshwater prawn. Since the disease situation with the vannamei shrimp is very serious, shrimp associations advise farmers to do crop rotation to improve yields (fishfirst.cn).

A survey conducted by the magazine Fisheries Advance covering several hatchery and farming companies and shrimp associations in south China indicated that aside from disease which industry acknowledged is a major problem, two main factors for poor production were: slow-growing shrimp and variable quality of imported broodstock. Collectively, EMS, white faeces disease (WFD) and shrimp with empty gut, seemed to be more problematic than in previous years.

The problem of slow-growing shrimp was so serious in 2015 that some hatchery operators asked farmers to cap feeding at 500 g per 120,000 post larvae in order to maintain good water quality. Chinese hatcheries import vannamei shrimp broodstock mainly from SIS, followed by CP and several others such as Kona Bay, Molokai and SyAqua. With more than 50% of the market share in south China, SIS is the target of blame for the poor quality broodstock in the market. However, poor fry quality is not solely dependent on broodstock brand; key factors influencing fry quality are also dependent on good broodstock management and control of post larvae production process, said a hatchery owner.

In the first half of 2015, the hatchery sector suffered lower output because of poor hatching rates due to poor water quality as well as lower demand by farms facing repeated crop failures. In preparation for the 2016 season, some hatcheries have pledged to raise post larvae quality and make improvements to their facilities such as adopting advanced water circulation and treatment systems.

Thailand

The total production in 2015 was 230, 338 tonnes (Table 1). This was contrary to earlier expectations of an increased production to 300,000 tonnes. The main reason for this lower production was the low ex-farm prices which according to industry in Thailand, was lower than in 2014 as well as lower than ex-farm prices in other countries. Farmers delayed stocking as they battled increases in production costs with disease outbreaks and unstable post larvae quality.

"The average feed conversion ratio (FCR) in shrimp farms (which includes unsuccessful crops where shrimp die after 1-2 months of stocking) rose to 1.7 If we just consider the successful crops, the FCRs ranged from 1.1- 1.4, and this was better than the previous years (2011-2013)," said Dr Supis Thongrod, Thai Union Feedmill.

"EMS and white spot syndrome virus (WSSV) are still found everywhere but with lower impact in comparison to previous years. This is mainly because farmers are now more knowledgeable and know how to handle an outbreak better. Farmers keep an alert on outbreaks of the microsporidian *Enterocytozoon hepatopenaei* or EHP and followup with culture management," said Soraphat Panakorn, Novozymes Biologicals.

"The strong point for the industry in Thailand is the sharing of ideas and information on disease and culture management. Together they investigate problems, share solutions and develop new standard operating procedures. The focus is not only on how to deal with diseases but also on how to avoid them. If shrimp prices improve in 2016, it is possible to increase production even by 50% over the 2015 figures."

Shrimp farm in Calatagan, Batangas, Luzon. Picture by Jake Vergara.

Vietnam

The 2015 production is likely to be 20-30% lower than that in 2014, said industry sources. In 2014, based on feed and post larvae sales, industry gave a lower production figure of 300 tonnes, which is contrary to official statistics. In a presentation on the industry in Vietnam at the PhilShrimp Congress in 2015, Dr Thomas Raynaud, Invivo Vietnam showed data from the Ministry of Agriculture and Rural Development (MARD). The 2014 production comprised almost equal proportions of vannamei and monodon shrimp at 290,000 tonnes and 270,000 tonnes, respectively and that 20% of production came from large integrators such as Minh Phu.

The low production throughout 2015 was attributed to a combination of factors. Low ex-farm prices falling below the cost of production was one reason. If all was well, the cost of production would be VND 80,000/kg (USD 3.55/g) at FCR of 1.0-1.3 but ex-farm prices in July for size 80/kg shrimp was only VND 82,000/kg (Vasep.com). However, costs are expected to increase with diseases resulting in low survivals, as well as with extra inputs such as probiotics and feed additives. By deferring stocking, farmers brought down the demand for post larvae and feeds.

"The disease situation was rather depressing too due to bad weather during the first half of the year. The low temperature was ideal for manifestation of WSSV. This was followed by high temperatures for the rest of the culture period that led to the outbreak of bacterial diseases such as EMS and white faeces disease as well as others," said Dr Dang Thi Hoang Oanh, Can Tho University. "The situation lasted for the whole year, but EMS seems to be less serious than WSSV."

In the first 7 months of 2015, the crop losses affected 22,300 ha of ponds, due to disease, weather and environmental factors, according to a MARD report. Reports of losses from WSSV in 2015 was marginally higher. Disease surveillance showed that broodstock may be infected with *Vibrio haemolyticus*. Serious occurrences were during week 23-28 of the year and were linked to the weather.

According to the Uni President Vietnam team at the PhilShrimp Congress in November 2015, big and small farms have lowered their stocking density to stabilise production. In the south and west, the stocking density is now 40 PL/m^2 down from 80 PL/m^2. Some farmers would like to increase stocking density

Mardal Corp Farm, Negros Occidental was the winner of the " most efficient farm" by Bayer Philippines. Here the production cost dropped from the industry standard of PHP 170-180/ kg (USD 3.6- 3.8/kg to PHP 140-150/g (USD 3-3.2/kg) only. The farm also posted no disease outbreaks since early 2014 when it started P. vannamei farming. Picture by Chris Mitchum Ganancial, Bayer Philippines.

but fear disease will affect their stock. Farmers prefer to stock lower and increase survival rate.

"Overall, in Vietnam, we have better control of the EMS, but EHP is a major problem. Almost all farms are facing this disease. Shrimp are still at 10 g after 90 days of culture. The general advice is to dry out ponds after every cycle and to use post larvae from credible sources," said Ma Chin Tien, Uni President Vietnam.

The demand for post larvae has decreased drastically and many small hatcheries have closed down. Despite this, some hatcheries need to continue spawning and produce post larvae with broodstock they purchased earlier. As such, they often provide double the amount of post larvae required by the farmers. Uni President has stopped post larvae production at its hatchery in Quang Tri in central Vietnam.

Indonesia

Based on feed sales, production estimates by industry range from 240,000 to 260,000 tonnes for vannamei shrimp and up to 21,000 tonnes for monodon shrimp. These figures differ significantly from published figures of 406,582 tonnes for the vannamei shrimp and 124,332 tonnes of monodon shrimp in 2014 (DJBP, 2015). In 2015, Indonesian farms enjoyed the best ex-farm prices and high demand from Japan and Taiwan fuelled high prices and encouraged farming. The ex-farm price in 2015 for vannamei shrimp size 100/kg rose 16% to IDR 50,000/kg (USD 3.6/kg) from IDR 43,000/kg (USD 3.1/kg) in 2014. Prices for larger shrimp (size 90/kg) rose 36% to IDR 75,000/kg (USD 5.39/kg) from IDR 55,000/kg (USD 3.95/kg).

Feed companies lamented on lower feed sales because of the latest threat, ie WFD. "With disease outbreaks and lower survival, FCR increases from 1.7 to as high as 2.3," said Haris Muhtadi, CJ Feeds. Post larvae prices have increased by 6% following production increases by 15-18% with higher costs for energy, *Artemia* and broodstock costs, the latter two being affected by the devaluation of the Indonesian rupiah by 10%.

An industry source said, "The very good shrimp prices are still attracting new pond construction, concentrating in areas with good quality sea water such as in the south western coast of Java, the eastern coast of Sumatra and in Sulawesi. An extended and bad drought in most parts of Indonesia raised salinity to as high as 60 ppt which disrupted production up to November.

WFD outbreaks occurred in the second half of 2014 in Lampung, Sumatra, which has an annual production of 64,000 tonnes. The disease is widespread in Lampung (Trobos, 2015). However, within industry, there are differing opinions on the gravity of WFD outbreaks. "When some farmers indicated problems with shrimp growth, probably only 30% could be due to the microsporidian," said an industry source. WFD occurred in areas with high salinity and where the stocking density is high from 200 PL/m^2 to 400 PL/m^2. In Lampung, farms also reported slow growth with increasing FCR.

India

The 2015 production estimates from industry ranged from 300,000 to 340,000 tonnes, almost 20% down from the industry estimate of 420,000 tonnes in 2014. This was because of lower outputs in both first and second crops. Farmers delayed stocking after low prices in the first crop. Another issue was poor quality post larvae. "In November, floods hit farms in Nellore and Gundur, major shrimp producing districts," said Venkata Raju, Avanti Feeds at the DSM Conference in November, in Bangkok. He estimated a loss of almost 40% of stock. "The threat in 2014 was EMS and running mortality syndrome (RMS). The causative pathogen is still unknown for RMS but this is no longer a major threat. The threat dominating the industry is EHP and WFD."

Alec Lustre, Sta Clara Estate Inc in Negros Occidental (left) and Adrian Anglo with their awards at the CP Philippines industry dinner alongside the 10th National Congress in General Santos City.

THE
AQUACULTURE ROUNDTABLESERIES® 2016

TARS 2016
The Aquaculture Roundtable Series
August 17-18 2016

A shared vision for aquaculture in Asia

SHRIMP AQUACULTURE & THE NEW NORMAL

August 17-18 2016, JW Marriott Phuket Resort & Spa, Thailand

Asia's premier aquaculture conference returns for the 6th successive year!

Limited to 200 participants
Early bird rate ends on 17 June 2016

Don't Miss This Premier Aquaculture Industry Exchange & Networking Opportunity!

Shrimp Aquaculture & The New Normal

The presence of ongoing and emerging diseases in Asia's shrimp aquaculture industry comes with adverse multiplier effects. From loss in production efficiency and rising production costs, to profitability and emotional stress for farmers. Shrimp farming is viewed as risky business today.

TARS 2016 will facilitate the exchange of insights and experiences to explore how Asia, as a unified group, can reconcile to increase its sphere of control in disease prevention and management. It will bring to focus, new management tools and production techniques, research and development, as well as new business models. The objective is to take the industry to a ***New Normal*** to better manage and control the variables in shrimp farming; build on industrialisation; and develop technical, operational and production efficiency.

INTRODUCING HARD TALK WITH SHRIMP FARMERS!
Hard-hitting questions on farming models, challenges and success with disease mitigation.

16 PLENARY SESSIONS AND 3 BREAKOUT SESSIONS

TARS 2016 *promises a comprehensive agenda of state-of-the-science and industry presentations by leading international experts that will set the tone for highly informative and interactive breakout sessions.*

STATE-OF-THE-INDUSTRY AND CHALLENGES

- State-of-Industry in Asia
- Marketing Asian Shrimp
- Challenges in India's Second Wave
- Post IMNV in Indonesia: Lessons Learnt

WEAK LINKS IN THE SUPPLY CHAIN

- Genetics for productivity: SPF versus SPT
- An Early Start for Stronger Shrimp
- Production Planning and Maximising Efficiency

LIVING WITH DISEASE

- Counting Costs of Disease Outbreaks
- Current Disease Threats and What Next?
- Disease Mitigation: Management and Production Innovations
- Disease Mitigation: Management and Feed Innovations
- Future of Extruded Shrimp Feeds in Asia?
- Living with Disease: Experiences from Thailand

TOWARDS A SUSTAINABLE SHRIMP FARMING BUSINESS

- Public-Private Partnership in Disease Mitigation
- Success with SPR Shrimp in Semi-Intensive Models in South America
- Intensive Farming under Controlled Conditions

ABOUT TARS

The Aquaculture Roundtable Series (TARS) is designed as a series of roundtable sessions to focus on specific sectors of the industry. TARS is a stakeholder driven platform where the industry, academia, government and non-government organizations convene to share new knowledge, deliberate on critical issues, and identify key strategies to ensure the sustainable development of Asia's aquaculture industry.

Organised by:

AQUA CULTURE Asia Pacific

corporatemedia
The Total Communications Company

For more information;
email: **conference@tarsaquaculture.com**
or visit **www.tarsaquaculture.com**

At the 10th National Philippines Shrimp Congress in General Santos City. Uni President Vietnam is marketing feeds into the emerging shrimp industry in the Philippines. From right, James Hung, Ma Chin Tien, Jimmy Wang and Ryan Alegre, hatchery operator in Cebu.

At the InVivo booth during the 10th National Philippines Shrimp Congress in General Santos City. Mathieu Laissus, InVivo Vietnam (second right), Thomas Raynaud (third right) who presented on feeding management and farming systems in Vietnam, Jena Victoria G. Baril,, InVivo Philippines (centre), Florian Renault, InVivo NSA Asia (third left) and Carlos Massad, Blue Genetics, Canada (second left) who presented on future technology in shrimp hatchery production.

Durai Balasubramanian, secretary of the Pattukottai Shrimp Farmers Association, which has 4,000 members in the state of Tamil Nadu, told undercurrentnews that the cold season and EHP are causing very limited growth. Some farmers are harvesting early at 8 g, and most are reporting reduced survival rates due to white faeces, a disease that generally does not appear during the winter months.

In early 2015, the main grouse among vannamei shrimp farmers was the lower farm-gate prices during the first crop (January to June). Industry said that the cost of production was INR 320-330/kg but the offer price was only INR 290/kg for 33 g shrimp. The cost of production for 40-50/kg size shrimp at INR 270/kg was still higher than the offer prices. The high production cost was attributed to lower survival rates, disease and cost of feeds at INR 76/kg (USD 1.13/kg).

With a supply shortage and the need to fulfill orders, processors raised prices in the last quarter of 2015 for harvests of the second crop. The supply shortage is expected to continue to February 2016, according to a news report by undercurrentnews.com. A buyer based out of Visakhapatnam said that prices have now increased; INR 480/kg for size 40/kg; INR 420/kg for size 50/kg; INR 390 for size 60/kg and INR 330/kg for size 70/kg.

Raju compared the farming practices between farms in the west coast (namely Gujarat) and on the east coast. "In the east coast, Tamil Nadu, Orissa and West Bengal, the culture period is usually 136 days with ADG (average daily growth) of 0.16 g and FCR of 1.27 to produce size 33/kg when survival is 95%. The FCR goes down to 1.8 if survival is 50-60%. The stocking density is usually 32-40 PL/m^2 for the first crop and 40 PL/m^2 for the second crop. Of course we have some farms trying 100-200 PL/m^2. Andhra Pradesh is lucky as it has been selected among the 4 states for the 24 hours electricity program by Prime Minister Modi."

In Gujarat on the west coast, Dr Manoj Sharma, Mayank Aquaculture said, "For production of large 30/kg sizes, we stock at only 20-25 PL/m^2. The culture period is 140 days without any partial harvests. The best FCR is 1.5 and the worst is 1.8. The major threat is still WSSV but as we import post larvae from the east coast hatcheries, slowly, EHP is becoming a threat.

Philippines

"In 2015, according to industry leaders, there was an increase of 10% from that achieved in 2014 because of low farm gate prices for most of 2015 as well as the extended culture period to grow the shrimp to bigger sizes (30 g up) to compensate for low prices," said Chris Mitchum Ganancial, Bayer Philippines, Inc. Based on feed usage at 30,000 tonnes per year, Industry has estimated production to 23,000 tonnes at an average FCR of 1.3. In 2014, the official production figures showed an annual production of 47,800 tonnes of monodon shrimp (PSA, 2014) and only 1,826 tonnes of vannamei shrimp. These figures do not reflect the actual production of the vannamei shrimp if the imports of brood stock and post larvae production are considered. In 2015, there were reports of outbreaks of EMS (see page 12).

"A majority of *P. monodon* production came from the extensive or traditional farms. A major shift in *P. monodon* production is from the intensive sector in Bohol, Caraga region and Cebu which produced an estimated 2,000-2,500 tonnes in 2014. In comparison intensive *P. vannamei* farms produced 15,000-20,000 tonnes.

"In general, the Philippines shrimp growers use health products conservatively as compared to Vietnamese farmers. In Vietnam, the budget for probiotics, mineral supplements, disinfectants and feed additives are estimated at a total of USD 0.25-0.30/kg whereas here in the Philippines, it is only PHP 2-3/kg (USD 0.04-0.06/kg or less if only probiotics are used."

Malaysia

The country's shrimp production continued on its downward trend after succumbing to EMS in 2011. Industry said that it is likely to achieve only 27,000 tonnes in 2015. In addition to WSSV and EMS, EHP was also prevalent. The Strait of Malacca seaboard has not been able to recover to previous production levels while the large and newer farms on the east coast of the Peninsular have not been able to ramp-up production. Sabah state shows potential with new farms but this has not been translated to numbers. Malaysia's strength is its local market in the peninsular and Singapore but the weakening of the MYR against the USD provides potential for an export industry. In December 2015, the local price for size 70/kg rose to MYR 22.50/kg (USD 5.1/kg), from a low of MYR 20.60 (USD 4.65/kg) in August 2015 (GCSSB, Malaysia, 2015).

However, this export potential is hampered by the lack of a processing industry which was decimated by the self imposed ban on exports to the EU in 2008. This is still a 'chicken & egg' situation as independent processing plants complained that they are unable to source for suitable raw materials with high local prices.The biggest negative media report in 2015 was the high rejection of shrimp by the US FDA due to antibiotic residues. However, with the small volume of Malaysian production and large local demand, the Shrimp Aquaculture Alliance has claimed that these shrimp in question were transhipped from China and Vietnam and cannot be of Malaysian origin.

A monodon shrimp wave

In 2015, monodon shrimp prices in Vietnam rose to a record high in 10 years to VND 260,000 /kg (size 20/kg, USD 11.6/kg), VND 190,000/kg (size 30/kg, USD 8.5/kg) and VND 155,000/kg (size 40/kg, USD 6.9/kg). These high prices have encouraged farmers in Camau Province to invest in traditional extensive systems. This contrasted with Bangladesh, where exporters depend on the markets in Russia and Europe. Prices dropped 42% to USD 5.25/lb (USD 11.55/kg) for size 16-20/kg (undercurrentnews.com). In Indonesia prices also went down to IDR 75,000/kg (USD 5.43/kg) for size 40/kg in May 2015.

In the Philippines, Malaysia and Thailand, there are groups of farmers dedicated to monodon shrimp farming and mainly using post larvae from either SPF or high health brood stocks. Indonesia's Directorate of Aquaculture began to promote monodon shrimp farming in early 2015. There was a plan for a 70,000 tonnes increase. However, it asked farms to use only domesticated and selected brood stock from its breeding centres (industri.bisnis.com). In China, Hainan Hai Yi Aquaculture Seedling Pte Ltd Co, has plans to introduce monodon shrimp broodstock because it expects more farmers to start crop rotation to improve yields. It said that with current genetic selection, shrimp can reach size 60/kg in 90 days.

In Gujarat, India, Sharma, who started producing large size vannamei shrimp in 2010, said, "Vannamei shrimp has really taken over farms, even here in Gujarat. For my next crop in 2016, I will be farming monodon shrimp again. In India, monodon shrimp prices are high at INR 590/kg for size 25/kg. Farms reported survival rate of 99% and FCR of 1.58 over a culture period of 170 days."

In Thailand, Panakorn said, "Monodon shrimp is slowly coming back as premium quality shrimp, farmed at low density, natural and eco-friendly, at larger sizes, better taste and most important, free from residual chemicals. The volume will be small at about 20,000-30,000 tonnes/year. The good thing is that all farmers are coming together as a club or cluster for better cooperation."

Acknowledgements: The author would like to thank those mentioned in this article and as well as many in the industry who have willingly assisted in this article but would like to remain anonymous. Special thanks goes to Soraphat Panakorn and Chris Mitchum Ganancial for their assistance.

Table 1. Production of vannamei and monodon shrimp (tonnes) in 2013 to 2015

	Published and estimates of production in 2013 a		**Published and Estimates of production in 2014 bd**		**Estimates of production in 2015 cd**	
Country	*P. vannamei*	*P. monodon*	*P. vannamei*	*P. monodon*	*P. vannamei*	*P. monodon*
China	1,429,929	72,008	850,000	60,000	800,000	60,000
Thailand	311,879	16,193	230,000	13,000	222,510	7,828
Viet Nam	256,197	276,309	290,000	270,000	206,000	241,000
Indonesia	376,189	175,318	406,582	124,332	240,000	21,000
Malaysia	45,474	4,483	57,161	4,205	27,000	2,400
India	211,200	78,500	420,000	45,000	300,000	45,000
Philippines	7,597	49,467	20,000	47,843	23,000	48,000
Myanmar		57,785		15,000		15,000
Bangladesh		68,948		60,000		60,000
Total Asia	**2,638,465**	**730,063**	**2,273,743**	**639,380**	**1,818,510**	**500,228**
Ecuador	304,000		277,749		321,000	
Mexico	60,292		68,000		75,000	
Brazil	64,669		90,000		85,000	
Honduras	49427		32,072		24,000	
Others	73,808		105,347		99,000	
Total Americas d	501,181		573,168		604,000	

a Published production figures for 2013 (Fishstat Plus, 2015).

b Published and estimates. Vietnam, data from MARD (Raynaud, 2015); Indonesia, official data from Ministry of Marine Affairs and Fisheries, Indonesia (KPPI, 2015); Malaysia, DOF 2015; Myanmar -used industry estimates, adjusted (email from Willem der Pijt, 2015). - Philippines Statistical Authority (PSA, 2015) data for monodon shrimp, industry data for vannamei shrimp.

c All data are estimates from shrimp and feed industry in the respective country. Thailand, data from Ministry of Agriculture and Cooperatives.

d Data and estimates for Americas provided by Fernando Garcia, Epicore, USA

CFSE 2015: Marketing into and from China

Global shrimp producers aggressively selling shrimp to China while Chinese tilapia producers pursue international market access with sustainable products.

China's appetite for more seafood, mainly imported and premium seafood was demonstrated at the China Fisheries and Seafood 2015 (CFSE), held from November 4-6 at the new Qingdao International Expo Centre. The show moved to a new location some 55 km away from downtown Qingdao which allowed the organisers, Sea Fare Expositions to expand the exhibition area to almost 31,000 m^2. More than 25,000 visitors attended the event, a 9% jump from the 2014 figure with 1,396 companies exhibiting from 46 countries.

"The China seafood market keeps flourishing", said Peter Redmayne, president of Sea Fare. In 2013, China's imports of seafood reached USD 8.4 billion and Redmayne added that in 2014, China's reported seafood passed the USD 9 billion mark. "This year the value could reach USD 10 billion. This makes China the fastest growing market when the seafood markets elsewhere are either flat or declining."

These imports also included fish meal and flours (USD 1.6 billion), and fish such as Alaskan pollock for reprocessing (USD 0.9 billion, Global Trade Atlas, 2014). Frozen fish imports were valued at USD 465 million and frozen shrimp and prawns, USD 199 million in 2013. The consumption of fresh seafood reached USD 36.6 million in 2013. In its 2015 report on world seafood, Rabobank expects China to become a key consumer of high-value seafood as its population grows increasingly affluent. China will increasingly import high-end seafood products in the future, while its seafood production industry will focus more on domestic demand, gradually stabilising its enormous positive net trade position.

Demand for shrimp

China's position as a major exporter of the marine shrimp has changed. In 2010, production volumes went down with the early mortality syndrome while domestic demand was rising with higher domestic incomes. According to Rabobank (2012), the highest 10% income groups consume more than seven times the volume of shrimp compared to the lowest income groups. Currently, local supermarkets sell shrimp of size 70/kg (14 g) at USD 10/kg whereas in wet markets in Qingdao, the same price was for smaller live shrimp of size 90-100/kg (10 g; Chen Jiaxin, pers. comm).

Up to July 2015, China's imports of shrimp reached USD 323 million. Average import price was USD 7.1/kg, up 15%, in comparison with the same period in 2014. Shrimp imports, by value were from Thailand (USD 72 million), Ecuador (USD 42 million), Indonesia (USD 33 million) and India (USD 26 million). At CFSE 2015, there were large groups of shrimp producers, namely from Ecuador and India building brand or country presence. Indian producers were under the umbrella of the Marine Producers and Exporter Development Authority (MPEDA). CP Prima, the fully integrated shrimp producer in Indonesia was a first time exhibitor at the show.

Imports of shrimp from Ecuador to Asia, mainly to China, rose sharply in 2015. As of November, the amount was 278 million pounds (128,000 tonnes), a 65% increase as compared to 2014, according to Seafoodnews.com. The report added that Asia is now its main market followed by EU and US. Chinese and EU buyers generally import head-on shrimp and such shrimp is also used for reprocessing in China. Ecuador producers have shifted to exporting size 41/kg or smaller counts which Chinese buyers pay higher market prices than US buyers.

A first time exhibitor at CFSE, Swiss based Selva Shrimp is introducing its brand into China. Selva Shrimp markets Penaeus monodon, naturally farmed without any feeding in mangrove enclosures at low stocking densities.

Vietnam' exporters are also looking to expand into China's market; as in 2014, Vietnam exported only USD 12 million frozen shrimp to China. At Vietfish 2015 held in August, Vietnam Association of Seafood Exporter and Producers (VASEP) suggested expansion into China for its shrimp and pangasius products, amid declines in its main markets, such as the US, Japan and the EU. VASEP (2015) reported that since September 2015, 35 exporters have started selling shrimp to China.

According to the Rabobank's report "The Dragon's Changing Appetite", growing domestic incomes are driving demand for high value species, changing what China produces, exports and imports. China has the potential to become a USD 20 billion seafood import market within this decade.

In 2016, CFSE will be held at the Qingdao International Expo Centre from November 2-4.

References

Rabobank, 2012. The Dragon's Changing Appetite. Rabobank Industry Note #341 - October 2012

Vasep, 2015. http://seafood.vasep.com.vn/seafood/50_10910/china-tends-to-raise-shrimp-imports.htm

Chris Chang (left) and Mike Dai, Tongwei (Hainan) Aquatic Products Co Ltd (TWAP). The company is the second largest producer and processor of tilapia in Hainan Province. TWAP is a 2-star BAP certified company and has the brand Tongwei Fish® registered in the US. It also has 500 farmers committed to its 365 farming technique. Zhang said that tilapia prices are lower in November but producers expect better prices in December. Online tilapia is sold through alibaba.com.

Sustainable tilapia from Hainan, China

Qionghai Zhongpingzi Grobest tilapia farm, part of Hainan Sky-Blue Ocean Foods Co Ltd and Chengmai Xingyuan Development Co Ltd, part of Hainan Xiangtai Fisheries Co Ltd, have become the first Chinese farms to achieve Aquaculture Stewardship Council (ASC) certification in October 2015. Both are on Hainan Island. Qionghai Zhongpingzi Grobest has 20 years experience in tilapia farming and produces 3,000 tonnes of tilapia annually in 133 ha of farming area. Chengmai Xingyuan Development Co., Ltd, started 15 years ago and produces 2,800 tonnes in its 15 ponds covering 100 ha.

The award ceremony for these two farms was held alongside the sustainable seafood forum 2015, held on November 3, 2015 prior to CFSE in Qingdao. This landmark achievement reflects the pioneering initiative and efforts of a few farms in China to tackle some of the major challenges facing its tilapia farming. This achievement towards a more environmentally sustainable and socially responsible tilapia sector in the Chinese aquaculture industry was achieved through a partnership between ASC, the China Aquatic Products Processing and Marketing Alliance (CAPPMA) and WWF China.

Dr Cui He, executive president of CAPPMA said, "This is a milestone event in Chinese aquaculture and a major step in this important market. Since 2012, CAPPMA has been diligently working with ASC and WWF China with EU funding to promote responsible aquaculture in China. These two Hainan companies are taking the lead and we expect more to follow. This shows that the industry has begun to make real strides in improving the transparency of Chinese tilapia aquaculture."

Chris Ninnes, CEO, ASC said that an important development with this certification is that it benefits the environment. The bottom line is not necessarily market premium but reductions in costs of production with higher survival rates and lower costs of inputs such as for feeds. This achievement is important not only for ASC in China but also for the rest of the industry in China.

Qionghai Zhongpingzi Grobest tilapia farm and Chengmai Xingyuan Development Co. Ltd are the first among a number of farms that undertook pre-assessments with the help from WWF China to see if they operated in a way that meets the ASC Tilapia Standard. A third tilapia farm, Wenchang Zhou Qinfu, has been assessed against the ASC standard and hopes to be certified soon.

Yang Huaying, deputy executive director Hainan Sky-Blue Ocean Foods Co. Ltd said: "We are pleased that Qionghai Zhongpingzi Grobest has passed the assessment of the ASC Tilapia Standard. ASC certification allows us to prove to our customers that we are committed to responsible aquaculture." Hainan Sky-Blue is vertically integrated from feed, aquaculture to processing sector and produces and markets 24,000 tonnes of tilapia annually.

Xiangtai Fisheries Co. Ltd, is the largest tilapia producer and processor on Hainan Island. Liu Rongjie, president Xiangtai Fisheries Co. Ltd, said: "For us it is important to be able to show through a third party that our ambitions towards responsible tilapia farming have been achieved. We started the ASC certification process in 2013. With this certification, we can now assure our customers that our production is sustainable. This is the first step for us and we still have a long way to go. We hope that this will open doors to the international market for our tilapia."

For more information: www.asc-aqua.org; www.cappma.org; www.wwfchina.org

At the award ceremony, from left, JinZhonghao, director of Market Transformation of WWF China, Chris Ninnes, Liu Rongjie, Liang Lidong, technical director for food certification at Intertek, Cui He and Yang Huaying.

Aquaculture, Nature and Society

Louise Fresco giving her fascinating and passionate insight into aquaculture developments.

Aquaculture Europe 2015 (AE 2015), organised by the European Aquaculture Society (EAS) in partnership with Wageningen University and Research Centre, was held from October 20 to 23 in Rotterdam. It attracted a total participation of 1,057 from 65 countries. "The theme, **Aquaculture, Nature and Society** focussed on the role and contribution of aquaculture to the management of natural resources and its importance in society through the provision of high quality and nutritious and healthy food. This theme was addressed by three plenary on each day of the three day conference programme," said EAS resident, Dr Sachi Kaushik.

Chris Ninnes, CEO, Aquaculture Stewardship (ASC) shared with delegates the ASC strategy and criteria. Huw Thomas, Fisheries & Aquaculture Manager at Wm Morrisons, famous for its in-store fishmongers, discussed the retail policies of the UK supermarket chain. The focus of the group is fresh seafood and it retails 68 aquatic species, of which 13 are farmed. Salmon is the leading seafood. "Seafood is important as the customer recognises that seafood as brain food and a source of good protein. But in contrast to Asia; where seafood is sold as is, the average UK consumer do not like to see bones and skin. This makes the pangasius popular."

In addition, the average UK homemaker knows one seafood recipe, compared to three or four for pork and five or six for chicken and beef. It is therefore a challenge to get people to eat seafood twice a week. Seafood competes with meat and poultry and in terms of pounds/kg, seafood is an expensive food item. In targeting the young customer, Morrisons introduced 'funky fish' and for gastronomy dining at home, there is the pangasius sold as premium seafood.

The sourcing challenge faced by Morrisons with farmed seafood is antibiotic use, genetically modified (GM) ingredients, fish health and welfare, use of land animal and processed animal proteins in feeds and social impacts. On marine ingredients in fish feeds, Morrisons' position is that fish eat fish, so marine ingredients should be a part of fish feeds, as long as they are responsibly produced or sourced. This was the first time that a retailer had addressed an EAS conference and his presentation was very well received.

On day three, without any supporting presentation or notes, Wageningen CEO Louise Fresco gave a fascinating and passionate insight into aquaculture developments and how they compare to those in agriculture, with specific reference to selective breeding and resource use. According to the AE2015 report, her 'new approaches to production' inspired delegates to consider the contribution of aquaculture to maintain and enhance our natural capital and the need to balance the 'precision farming' concept with the provision of eco-services and being a key element of conservation in local areas. She also gave the audience 'food for thought' with the concept of 'urban production' and how it may be integrated in, for example, combined fish/aquaponics systems.

The Europe paradox, according to Fresco, is that EU countries will need to be importers but what % of food will be European. What will be the conditions for Europe to import and should the supply chain of food imported be at the same standard as food produced in Europe? As Europe depends on food imports from Asia, it is important to have dialogues with Asia to bring production standards to the same level as in Europe. Aquaculture can learn on sustainable intensification from the horticulture industry such as how to optimise systems and design systems. Horticulture have made enormous mistakes with overuse of chemicals and herbicides. Aquaculture is under pressure to produce enough fish to supply the 9 billion population. Although aquaculture is seen as a 'problem', it can be an integrated part of the ecosystem. "We need to realise that any type of food production system will have an impact on the environment and we need to actually do something and measure," said Fresco.

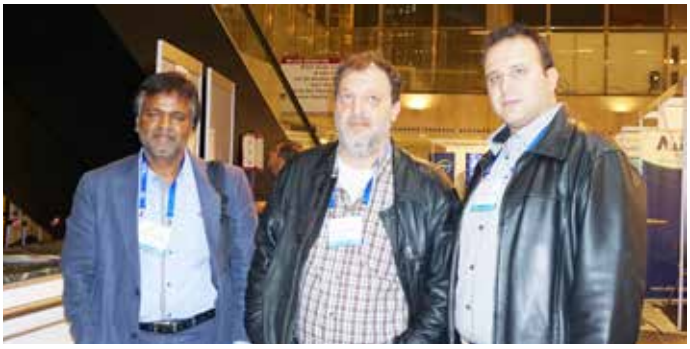
The technical sessions that made up the AE2015 programme; 357 oral and 205 posters gave an update of the latest research in almost all aquaculture domains. The trade event was also well attended, with 66 exhibitors showing their latest products and services. Many other meetings, workshops, panels and other events were organised in and around AE2015, confirming its status as THE European aquaculture event, said the organisers.

Investing in RAS

The discussion at this half day workshop, organised by feed company, Biomar was on various aspects of recirculating

Henrik Aarestrup, Biomar (left) and David Bal. Biomar was gold sponsor of AE2015.

Dr Manuela Parini (right), marketing director at the SILO Spa booth



Dr Kantham K Papanna, pathologist and fish health manager (left) with colleagues from Nireus Aquaculture, a leading producer of European sea bass and gilthead sea bream with production facilities in Greece & Spain

Sri Lankan students studying in Korea presented poster presentations at AE2015

aquaculture systems (RAS). The environmental benefits of RAS include low discharge of nitrogen, phosphorus, organic matter, sludge, less spread of parasites etc. The management related benefits are lower labour costs, land cost and increase in market perception of products. RAS started in Holland with eel farming to maintain warmer rearing temperatures in colder climates. Almost all smolt production in Norway uses land based RAS with considerable automation of cleaning, feeding and vaccination. The system for grow-out farming was started in Denmark to produce 4-5 kg salmon. RAS technology is well developed for freshwater culture whereas culture in seawater needs to be established.

In Europe, there is strong interest in sustainable methods of fish production in land based systems. The newer countries adopting RAS are France, China and countries in Asia. The constraint with RAS is the investments costs which can run into €5-10 million. On top of these investments are the operational costs such as specialised feed and farm management. The idea is to have the maximum benefits to bring down investment costs said Henrik Aarestrup, Biomar in his presentation on optimising return on investment in RAS.

According to Christina Frisk, Biomar, feeds specifically formulated and designed for RAS systems firstly take into account the biofilter. Pellets must be stable and do not break up easily. Faecal structure and digestibility are important to reduce stress on filters and high density pellets results in lower feed intake. Feed costs can be higher but is compensated with higher production.

In Spain, aquaculture is regarded as a strategic sector by the Basque Government, said Maddi Badiola. She discussed plans to develop land based Atlantic salmon production in the region. Her studies on the feasibility of RAS covered biological aspects (i.e., growth, survival), product quality, sustainability and economic profitability of the business. A Life Cycle Assessment (LCA) was carried out including the rearing system and connected industries.

RAS for the pangasius

In the session on new issues in aquaculture, MCJ Verdegem looked at the sustainability of pangasius *Pangasianodon hypophthalmus* production in flow-through and recirculation as compared to pond farming. He concluded that the 15-25 % better feed conversion ratio realised in RAS compared to ponds, combined with faster growth and better survival creates opportunities to invest in recirculation technology for pangasius farming. With the RAS, a higher density at 200kg/m^3 will be possible.

Monoglycerides of short and medium chain fatty acids

Monoglycerides of short and medium chain fatty acids inhibit in vitro pathogenic bacteria such as *Vibrio parahaemolyticus, Aeromonas hydrophila* and *salmonicida, Streptococcus uberis, Flavobacterium columnare, Yersinia ruckeri, Pseudomonas dermoalba, P. anguilliseptica* and *Bacillus Cereus* at pH 7-8. Dr Manuela Parini, SILO S.p.A, Italy described the trials with SILOhealth 108. This is a blend of monoglycerides of short and medium chain fatty acids. The growth of beneficial bacteria *Lactobacillus* was not affected. In the case of EMS prevention, Parini said that trials in the presence of EMS challenged post larvae were conducted in China and they showed that at 0.5% inclusion prevented mortality. Trials in India showed that running mortality syndrome was prevented in ponds at inclusion rates of 1% of the feed additive. In fish, trials were carried out with the yellowtail in Japan.

Insect meals

A nutrition session was dedicated to insect meals as an alternative raw material in fish feeds. Marleen Vrij said when fish meal is replaced by insects, important considerations are amino acid composition and fat level which is dependent on the substrate serving as food for the insects. In using *Hermetia illucens* prepupae meal as a protein source in the diet of gilthead seabream (*Sparus aurata*), Ioannis Karapanagiotidis suggested that up to 30% replacement of fish meal by *H. illucens* can be achieved without causing a significantly negative effect on fish growth and feed utilisation by fish. In his work on fly larvae as a sustainable protein source for animal feed, David Hermans, showed that substitution of up to 50% of fish meal was possible for the salmon. Ongoing trials are being carried out with the shrimp in China and tilapia in Africa. Irene Biancarosa looked at changes in nutrient and heavy metal composition of *H. illucens* fed on marine macroalgae. She demonstrated that macroalgae could be used as a feedstuff in diets for black soldier fly larvae. However, lower growth was observed with increasing percentage of macroalgae in the feeding media. However, using macroalgae in the insect diet not only introduces valuable nutrients, such as eicosapentaenoic acid (EPA) and minerals into the insects but it also transfers heavy metals and arsenic from the media containing macroalgae to the larvae.

Minh Anh Phan, InVivo Vietnam (left) and Kim Tran, Nong Lam University who is now attached to Wageningen University.

MSc in Aquatic Production and Veterinary Health in Hong Kong

City University of Hong Kong's School of Veterinary Medicine, in collaboration with the University of Stirling, Scotland, will be introducing an **Msc in Aquatic Production and Veterinary Health** in September 2016.

Most aquatic-related master's programs in the region approach aquatic production from marine biology, ecology, or environmental perspectives. This MSc program is differentiated by its focus on aquatic production with a veterinary element, and will attract industry professionals who are seeking to deepen their knowledge in order to advance their careers moving on from production roles into specialist roles.

The main objective of the program is to give students training in the wide range of disciplines and skills necessary for the investigation, prevention and control of aquatic animal diseases. Students will gain an understanding of the biology, husbandry and environment of farmed aquatic species, in addition to specialist expertise in aquatic animal diseases. The graduates will be able to appraise aquaculture operations and contribute to management decision making. It is also intended to prepare students who later plan to pursue a PhD in the area of aquaculture.

Program structure

Students will be required to complete the program in one academic year of full-time study or two years of part-time study. There is no elective course in the program. The Ist cohort will commence in September 2016. Students who have successfully completed 24 credit untis of taught courses and elected not to pursue for the Master's degree are eligible for applying the intermediate award of Postgraduate Diploma in Aquatic Production and Veterinary Health.

Subjects covered will include the following: Aquatic Animal Biology & Health • Aquatic Animals in the Environment • Aquatic Animal Nutrition & Food Safety • Aquatic Animal Reproduction • Systemic Pathology • Parasitic Diseases • Bacterial Diseases • Viral Diseases • Immunology • Ecotoxicology • Epidemiology and Health Control • Research Projects

More information: http://www.cityu.edu.hk/svm/en/Programmes/MSAPVH/Curriculum/index.html

Australian aquaculture chalks up another 'world's first' in sustainability

Brisbane based Ridley Aquafeed has launched the world's first commercial shrimp feed containing zero traditional wild caught fish meal. This is the new NoCatch™ feed which contains no wild caught fish meal. NoCatch™ diets for barramundi and salmon have also been successfully developed and tested by Ridley.

Group Technical and R&D manager at Ridley Aquafeed, Dr Richard Smullen said "It is critical that we feed shrimp a balanced and nutritious diet that helps bring out the best qualities of this Australian favourite seafood, while maintaining quality, sustainability and affordability". Ridley's new NoCatch™ diet has been made available to prawn farmers for the first time this year at no extra cost relative to its other premium shrimp diets, and is designed to avoid the price volatility to which other diets are subjected, relying as they do on wild caught fish meal which has seasonal availability and variable catches.

The 2015 launch of Ridley's Perform Plus NoCatch™ diet for shrimp is the culmination of over a decade of research by Smullen and his team, who have also developed similar diets for barramundi and salmon. These have been successfully tested and shown that for these species too, it is possible to provide a diet free of capture fish meal and achieve the same performance and quality as that achieved with standard diets.

"Using a broad range of high quality, responsibly sourced ingredients, we have learnt how to optimise our feeds to help deliver the biggest, healthiest and tastiest prawns and fish, and done it without relying on fish meal. No one else in the world has been able to deliver this commercially" said Smullen.

2012 marked two major milestones for aquaculture, when the world for the first time ate more farmed seafood than farmed beef globally, and also ate more farmed seafood than wild seafood for the first time (FAO). As aquaculture continues to grow faster than any other food sector, responsible, sustainable approaches are key to realising that growth potential.

Australian monodon shrimp fed on the Ridley Performance Plus NoCatch™ diet

Huw Thomas, Fisheries and Aquaculture manager for UK retail giant Morrisons, who was among a group of several international speakers recently visited Australia to attend the inaugural Ridley Salmon Seminar, commented that "we're moving away from calling foods sustainable or not, but rather focussing on whether their production is responsible". He added that "sustainability is typically thought of as the environmental footprint of food production only, but we need to really focus on the triple bottom line of environmental, social and economic responsibility".

Nutriad at FENACAM

A number of aquaculture events joined forces at this year's FENACAM event in Brazil; the Latin American & Caribbean Aquaculture 2015 (LACQUA), the South American Regional Aquaculture conference 2015, the XII International Shrimp Farming symposium and the 3rd IX International Aquaculture Symposium. The meeting was held in Fortaleza, November 16-19, with the central theme "Science & Industry Join Forces to Meet Seafood Demands".

Nutriad was present with a booth at the trade show, to exhibit Nutriad's portfolio in aquaculture specialty additives. The focus was on improved feed efficiency and health in shrimp and tilapia farming. Dr Peter Coutteau, Nutriad's Business Unit manager Aquaculture, presented a talk at the International Shrimp Farming Symposium entitled "Reduce the impact of shrimp diseases on productivity: anti-bacterial warfare in the feed" .

His paper documented the different types of natural antimicrobial compounds and their possible mode of action to reduce the impact of bacterial diseases on shrimp production. It proved to be a very relevant topic in Brazil, where white spot virus (WSSV) and different bacterial pathogens are increasingly affecting shrimp production.

At the International Aquaculture Symposium, Dr Coutteau explained in his talk "Reducing feed cost in tilapia farming through digestive and metabolic enhancement", how digestibility enhancing additives can improve nutrient utilisation from cheap ingredients and stimulate the conversion of nutrients into meat gain. Results from feeding trials with tilapia *Oreochromis niloticus* under laboratory as well as field conditions were discussed. The optimal application of novel feed additives for Tilapia under field conditions in Brazil improved farm revenues by 17% compared to the unsupplemented control group and showed a return on investment (ROI) of 3.8:1.

Nutriad delivers products and services to over 80 countries through a network of its own sales offices and distributors. It is supported by 4 application laboratories and 5 manufacturing facilities on 3 continents. More at http://nutriad.com/nutriad-species/aqua/

Mr. Itamar Rocha, president of the Brazilian Shrimp Farming Association (ABCC) hands out the speaker's certificate to Dr Peter Coutteau

Eco-trap waste solids removal system from Pentair

Eco-Trap from Pentair Aquatic Eco-Systems is an exclusive highly-optimised dual drain waste collection system that effectively and efficiently removes settleable waste solids (uneaten feed and faeces) in Recirculating Aquaculture Systems (RAS). The Eco-Trap system's centre main drain handles the primary water exchange for a RAS tank; while a smaller integrated solids drain provides an in-tank means for fast and efficient waste removal. Up to 50% of the waste solids can be removed from the tank within minutes of their generation.

The Eco-trap system makes RAS tanks self-cleaning by pulling solids to the middle of the tank where they are automatically removed. Once collected, the Eco-Trap system moves these waste materials through a side-stream solids drain to a polyethylene waste collector that is mounted on the side of each tank. Solids are collected and concentrated in a side-stream flow consisting of approximately 5% of the total flow from the tank.

Easy observation of the waste collector by the farm operator allows for reductions in feed waste to individual tanks, thus controlling one of the single largest economic inputs to RAS aquaculture. From an investment point of view, using Eco-Trap technology reduces the size and complexity of other associated waste solids removal technologies such as drum-screen filters and bead filters.

Additionally, Eco-Trap technology can reduce the size of the bio filter required to control ammonia nitrogen in culture water. The Eco-Trap system contains no moving parts and nothing to wear out; and it has been proven in many commercial RAS installations worldwide.

The benefits are summarised as:

- Provides a self-cleaning action by automatically removing solids by pulling them to the middle of the tank
- Observation window in the waste collector makes it easy to identify feed waste
- Nothing to wear out as there are no moving parts
- Reduces the size and complexity of other associated waste solids removal technologies
- Adaptors are available for applications that utilise metric plumbing.

(More information: pentairaes.com/eco-trap)

Silica+ to replace part of fish meal in shrimp diet

Dr Wutiporn Phromkunthong

Ceresco Nutrition, a research company that is behind the new technology based on the transfer of vibratory information through an aqueous medium, says their product Silica+® will change the diet formulation in aquaculture feed industry. The study, conducted at the Prince of Songkla University (Thailand) and published in *AQUA CULTURE Asia Pacific*, revealed that the Silica+ feed supplement allows the reduction of fish meal from 15% to 7.5% in shrimp diet.

"The elevation of the protein utilisation ratio and the protease activity in the gut of the shrimp receiving diets supplemented with Silica+ suggest that this product enhances protein digestion", explained Dr Wutiporn Phromkunthong who supervised this study, "Thus, adding Silica+ to feed will contribute to better growth performance and feed utilisation." As a result, a significant difference was observed between the experiment and control groups in terms of average body weight, final weight gain and feed conversion ratio.

"No ordinary silicon dioxide is capable of delivering this effect," says Dr Raj Kasula, veterinarian and Business Development director, "We use a high purity grade natural silicon dioxide from the quartz family, and inform it with a specific electromagnetic signal. This information is capable of exciting the water molecules in the intestine thus providing free electrons necessary to enhance the rate of all kinds of biochemical reactions."

Silica+ works on the concept that all matter (physical, chemical, biological/organic) vibrates at a specific frequency and this vibration can be affected by external factors (bacteria, virus, toxins). When added to feed, the supplement acts like a catalyst by imparting its electromagnetic information on all forms of matter to normalise their vibrations, restoring faster homeostasis of the digestive system. The animal becomes more efficient to digest, absorb and assimilate the nutrients, thus offering better growth and performance. In addition, Silica+ increases dissolved oxygen in water and helps reduce ammonia in litter and manure.

Ceresco Nutrition is a research and development company in the field of animal nutrition. It is a division of SG Ceresco, a global leader in producing, processing and exporting of non-GMO soybean. Ceresco Nutrition specialises in animal nutrition for poultry, swine and aquaculture. More information: Email: cdecaux@ceresconutrition.com (Caroline Decaux, R&D Manager); www. ceresconutrition.com

Innovation and urgency

(From left to right) Wang Lianzeng, Huayu CEO, Tao Yishan, chairman of Tangrenshen, Cai Huiyi, CAAS researcher and Fu Wenge, China Agriculture University professor, formed a panel discussion about opportunities and challenges in Chinese food production.

China agriculture leaders focus on growth opportunities at Alltech conference.

Challenging the audience to "do what makes your heart sing," Alltech founder and president Dr Pearse Lyons concluded the China REBELation Day in Beijing, where more than 100 industry leaders gathered to explore innovation, inspiration and opportunities for growth in China.

Alltech REBELation, an international conference that celebrated entrepreneurship, business and marketing, and the roles of science and technology in agriculture, was held last May in Lexington, Kentucky. Highlights of the event was shared with Chinese industry leaders in Beijing, allowing them to explore and discuss the global concepts on a local level.

Lyons shared that the company is focused on two things: innovation and urgency. As the company moves towards becoming a 10 billion dollar company, it is consistently seeking new products and ways to innovate, such as the algae platform. And while there is urgency, one cannot do it alone. "It is never about you; it is about your team and your customer," he said.

Four industry leaders took to the stage: Tao Yishan, chairman of Tangrenshen; Wang Lianzen, Huayu CEO; Cai Huiyi, CAAS researcher; and Fu Wenge, China Agriculture University professor; to talk about changes in the industry and the importance of conducting business with high integrity. The panel agreed that as more and more agricultural companies develop new technologies, the internet will be an integral part of business in the future. This should improve the flow of information in agriculture and improve overall efficiency.

Patrick Yu, president of COFCO, China's largest food processing manufacturer and trader, opened the meeting with a discussion on the outlook of the food and feed industry in China. He stressed that the industry must upgrade animal protein consumption and that there is plenty of room for further development of China's food and feed industry. "Moderate scale management is the main way to improve the cost competitiveness of agricultural products in China," he said. Yu shared three key challenges that food and feed companies must resolve: cost, food safety and sustainable development. He emphasized the importance of using innovation to overcome these challenges. "Companies who lead in the innovation of manufacturing and technology will become the future leaders of the food and feed industry," he said.

Dr Mark Lyons, vice president and general manager of Alltech China, highlighted the tremendous opportunities in China, as "400 million people have been lifted out of poverty". He emphasised that technology cooperation and speed are key to development in China. "Big data analysis can provide the agricultural industry with strategic advice," said Lyons, adding that speed in decision making allows companies to seize opportunities as they arise.

He stressed the importance of cooperation, highlighting its collaboration with Nestlé at the Dairy Farming Institute in Shuangcheng in Heilongjiang province. The institute, launched in October 2014, is helping to modernise Chinese dairy farming practices.

Aidan Connolly, Alltech chief innovation officer and vice-president of corporate accounts, talked about future proofing the food industry. Traditional concerns with costs, quality and yields are now combined with new challenges that were inconceivable 50 years ago. Hence, food safety is a must for China. "As a supplier of staple foods, it is of paramount importance that the food we provide is safe, tasty and offers good value for money," he stressed. Connolly also discussed Red Tractor, a leading farm and quality food assurance initiative in the U.K, launched to promote clearer labelling and ensure food originates from a trustworthy source.

Rob Koepp, director of the Economist Corporate Network, shared an analysis of China's economy. He said that China is the second largest economy after the US, generating $901 billion in GDP, but it is growing slower than India which is seventh in size. Agricultural growth in China is lagging in terms of GDP output and Koepp highlighted key areas for improvement, including improving productivity efficiencies, marketing healthy, natural products and investing in automation and online marketing.

Malcolm Nerva, founder and managing director, Genowledge Corporation, talked about building a high performance team, with emphasis on who is leading the team and the size and quality of the team. "Trust is important," he shared. "Responsibilities must be noted and accountability should not be avoided."

Dr Neil Xue, research director of Alltech China, spoke about using research to address the problems of tomorrow. Xue shared that the company has developed 23 research alliances globally, ten of which are in China.

The 2016 international conference, ONE: The Alltech Ideas Conference, will be held in Lexington, Kentucky, May 22-25, 2016. Registration is open at one.alltech.com.

SFT awards diplomas to 17 feed technologists

The 21 students of the 33rd Specialist Course in Feed Manufacturing Technology with their instructors and the Board of the Swiss Institute of Feed Technology (SFT).

Seventeen students from 13 countries were recently awarded the coveted diploma of the prestigious Swiss Institute of Feed Technology (SFT) in Uzwil, Switzerland. The 17, from a total of 21 participants, qualified as Feed Production Engineers after successfully completing the 33rd specialist course in feed manufacturing technology which was conducted in English and which began in the spring of 2015. The year's top graduate came from Brazil.

The road to diploma success was not easy. It led the students "up a steep and arduous path", as the institute's Director Ernst Nef said at the diploma awarding ceremony. Nef was very happy to see the ninth woman in the SFT's history successfully complete the course, Norwegian Aina-Elin Karlsen from Ewos AS. "This proves that animal feed production is no longer a pure men's domain".

Reaching the summit

Following an intensive ten-month training, the graduates of the course received the diploma award from Nef in the Hotel Uzwil. In his speech, which as usual was full of humor, Nef stressed the significance of lifelong continuing education and praised the graduates for their decision to go back to school once more: "With this decision, you took up a big challenge, which you have now successfully mastered. Today you have reached the summit. With the acquired knowledge and your great dedication, you are now equipped with the tools you need to meet the high requirements for a safe and economical production of formulated feeds."

He said that on the one hand, the goal is to satisfy consumer's needs for hygienic feeds that are safe for humans and animals alike. On the other hand, he continued, feed manufacturers are increasingly being forced by regulations and legislation to produce and market animal feeds more efficiently and, especially, more responsibly.

A Brazilian as best in class

In line with a long-standing diploma ceremony tradition, the SFT always distinguishes the student who has achieved the best final score. This year's distinction went to the Brazilian Leonardo Miyata, employee at Bühler AG in Joinville, Brazil. Peter Hofer, Vice President of the SFT Board, congratulated him for his outstanding average grade of 5.53 out of 6, by handing over the traditional commemorative plate. Miyata outperformed second ranked Canadian John Smillie by a hundredth point and third ranked Aina-Elin Karlsen by four hundredth points.

Ernst Nef honored

SFT Director Ernst Nef retires at the end of 2015 to hand over the SFT responsibilities to Daniel Müller. Marcel Scherrer, the new President of the SFT Board, and his deputy Peter Hofer took advantage of the 33rd diploma ceremony to acknowledge Nef's accomplishments and to thank him for his immense dedication and efforts.

New concept

The 2015 "Feed Production Engineer" Diploma course was based for the third time on a new concept. The course starts in spring with a 15-week preparatory correspondence course. This is followed by a four-week intensive course in Uzwil. In autumn, the second block is then held with a preparatory correspondence course of the same length and the final intensive training in Uzwil. In the two preparatory courses, students had to work through 21 subject areas. During the two intensive courses, they must pass a total of 14 written examinations. The highlight and finale of each block are the two oral examinations in the core subjects in front of a panel of experts. The new concept reduces the students' absence from their jobs.

The 34th Specialist Course in Feed Manufacturing Technology will start in January 2016 and will be held in German.

Focus on practice

The SFT is a non- profit association that is recognised by the Association of Swiss Feed Manufacturers (VSF) as an institution of training and continuing education. The SFT imparts practice-oriented specialist knowledge of feed production processes to professionals from the feed manufacturing industry and related industries. A successful completion of the specialist course provides the basis for graduates to understand state-of-the-art process technologies and to apply this expertise to practice. The international Technology Group Bühler AG is the partner of the SFT. To date, over 520 men and women from 69 countries have successfully completed the Specialist Course in Feed Manufacturing Technology. More information, Ernst Nef, School Director SFT, e-mail sft.uzwil@buhlergroup.com

亚太水产养殖展
APA Expo
www.apaexpo.com.cn

福建厦门渔博会
Seafood Expo
www.fishexpo.cn

May 26-28, 2016
Xiamen International Conference & Exhibition Center

ASIA-PACIFIC AQUACULTURE EXPO 2016

The 11th China International (Xiamen) Seafood Expo

Asia-Pacific--the center of world aquaculture industry.

APA Expo--the sole aquaculture event in Asia-Pacific.

China--The World's Largest Seafood Potential Consuming Market.

Xiamen Int'l Seafood Expo--The Global Charming Seafood Exchange Platform.

Organizers

China Aquatic Products Processing and Marketing Alliance (CAPPMA)

Fujian Aquatic Products Processing and Marketing Association (FAPPMA)

China Great Wall International Exhibition Co. Ltd. (GIE)

Xiamen Sinoshow-Centery Commercial Exhibition Co.,Ltd

WeChat: APAExpo

WeChat: SeafoodExpo

Contacts

CAPPMA
Ms. Yaling Sun; Di Lu
Phone:86-10-65076331
Email:cappmaexpo@126.com

GIE
Mrs. Ping Yang; Dr. Lisa Pang
Phone:86-10-88102348;88102346
Email:apaexpo@chgie.com

XiamenSinoshow-Centery
Mr. Richard;Mr. Damon
Phone:86-592-5078295; 3984166
Email:Sinoshow@vip.163.com

Growth & Innovation

There is much to see and learn from Asia's foremost showpiece event for the feed and grain sectors.

The points brought up at the recently held Press Conference in Bangkok for FIAAP, VICTAM & GRAPAS ASIA 2016 were the "sustained growth of the size and influence of the event, innovations within the event, and the continued introduction of new products and services at the showpiece event by the exhibitors".

These themes were echoed by the principal speakers at the press conference: Pornsil Patchrintanakul, chairman, Federation of ASEAN Feed Associations and president of the Thai Feed Mill Association; Manat Kitprasert, president of the Thai Rice Millers Association; Henk van de Bunt, general manager, Victam International BV; and Catelijne van Gooijer, Visitor Promotion and PR manager, Victam International BV.

Both Pornsil and Manat congratulated Victam International for organising events for the animal feed and grain processing industries in Asia. The year 2016 marks 25 years since the first Victam show was held in a hotel's car park in Bangkok. Both said that the Victam exhibitions and conferences have had significant beneficial influences on their industries in Thailand and throughout Asia/Pacific and Southern Asia.

The FIAAP, VICTAM & GRAPAS events have now become the region's showpiece events where industry gathers to see the latest innovations in products and services that are being staged by the exhibitors at the shows and learn from the speakers at the many conferences that are held during the event. It has now become Asia's foremost event for the feed and grain industries within the region.

Van der Bunt explained how the feed ingredient and additive show, FIAAP, works well in Bangkok as it relates to the senior industry executives who visit VICTAM, their feed processing exhibition. How VICTAM relates to the rice and flour milling and grain processing show GRAPAS was also covered. With these two shows it is the auxiliary equipment such as conveyors, elevators, silos, cooler/dryers, programmes and more that are used within feed, flour, rice mills, grain processing plants and biomass plants. Some of the multi-nationals that exhibit at FIAAP also produce additives for flour, etc. so there is a relationship between FIAAP and GRAPAS.

He went on to say that over 200 of the world's leading suppliers to the feed and grain industries will be present at the exhibitions that will be held at BITEC, Bangkok for 29– 31 March in 2016. There will be a number of conferences during the event, including a number of technical conferences which will assist specialists with applications and developments in their industry sectors.

March 29	FIAAP Animal Nutrition Conference Asia 2016
March 29	Aquafeed Horizons Asia 2016
March 30	GMP+ Feed Safety Assurance
March 30	Petfood Forum Asia 2016
March 30	Global Milling Conference with GRAPAS ASIA Conference 2016
March 30	2nd ASEAN Feed & Rice Symposium 2016
March 31	Biomass Pellets Asia Conference 2016

"During a previous meeting with the Thai Department of Livestock, the subject of GMP was discussed in detail and the department was especially pleased that there would be a free seminar devoted to this subject. The other conferences were also discussed and were met with approval," said van der Brunt.

With regards to the 25th anniversary of Victam, van der Bunt said, "The first show was in a hotel car park and now it is in the magnificent halls at BITEC. The shows have grown from a few hundred m^2 to 1000's of m^2. From about 80 small exhibition stands to well over 200 exhibitors from all over the world, and many with very large stands full of equipment and staff. It's an amazing change. But this was to be expected as it reflected the incredible growth of the feed and grain industries throughout Asia over this period. The growth of both the shows and the industries in Asia would continue," said van de Bunt.

On the ASEAN Feed Summit and the ASEAN Feed & Rice Symposium, both of which will take place during the 2016 event, van Gooijer, said, "The Summit will be held in closed session for all the presidents and secretary generals of the ASEAN Feed Associations under the chairmanship of Pornsil Patchrintanakul. The ASEAN Feed & Rice Symposium is open to all registered visitors and respected authoritative speakers from the FAO, ADM, International Feed Industry Federation and more will address the audience on a wide range of topics."

Wide range of additives & technology

Tyson Animal Nutrition Group is a supplier of protein feed ingredients serving aquaculture, agriculture, and companion animal food manufacturers. The group understands the importance of superior nutritional quality and track & traceability for feed ingredients. They also understand the value to a nutritionist/feed formulator of working with a supplier with more than 80 years' experience in feeding people and their animals. Tyson Animal Nutrition Group is exhibiting at the FIAAP Asia 2016.

Exhibiting once again at FIAAP Asia 2016 is **Special Nutrients, Inc.** It is a worldwide leading supplier of scientifically proven anti-mycotoxins additives produced in two production sites in the USA. It also has over 50 distributors located around the globe. For more than 25 years the company has offered reliable products supported by an excellent quality control and technical support team. Mycoad and Mycoad AZ are the two main products manufactured and marketed by the company, with both having

the capacity to adsorb and retain the most important mycotoxins affecting poultry. This absorption from the gastrointestinal tract avoids the deleterious effects caused by these toxins in the body, without interfering with the absorption of critical nutrients present in the ration.

At VICTAM Asia 2016, which specialises in feed production technology, companies such as **Buhler** will be there. The Bühler Feed & Biomass business unit said that it has been continuously adapting its product portfolio, manufacturing and logistics services specifically to the needs of customers in Southeast Asia. Bühler Changzhou, a highly successful affiliate of the Feed & Biomass business unit, has been setting new benchmarks for feed mill quality and standards in Southeast Asia since its launch in 2008. The unit has has expanded over the past few years into a continental base for China and Southeast Asia. On the basis of a shared technological Bühler platform, a range of products has been developed and produced in China that matched regional requirements. A technological development center and China Institute of Feed Technology (CFT) for customer staff have been set up. A wide range of machines and technology will be displayed on its stand at VICTAM Asia 2016.

Stolz, a French company, has developed various technical solutions of high efficiency thanks to its commitment to the feed and grain industry. Numerous regulatory constraints have helped in completing its know-how and knowledge. With its wide range of equipment such as automated flat storage, heat treatment, pellet mills, mixers, fat-coaters, vacuum-coaters, crumblers, sifters and the well-known hammer mill, the goal of Stolz is to offer machines that will help its customers to produce the best possible quality of semi-finished or finished products, with the highest productivity, according to regulations and budgets. Its job as expert and constructor is to ensure good project management, from preliminary stages to commissioning.

California Pellet Mill, is a world-renowned pelleting specialist, equipped with a wide range of machinery for crushing, grinding, densifying, cooling, drying, sifting, computerized process controls, ingredient scaling systems and extrusion. Constantly introducing new developments over the years, it is proud to introduce tools and technology on its pellet mill and showcase its products in Victam Asia 2016. Its innovative developments such as wired shear pin, remote knife adjustment, automatic remote roll speed measurement and electronic oil indicator, allow its customers to enhance their productivity and have a safe working environment.

A number of companies which are exhibiting, are also marketing their products to a number of different industry sectors and so will be in both Victam and Grapas Asia 2016. One of these is **Cimbria** which is one of the world's leading producers in the processing, handling and storage of grain, seed, and feed and food products. It offers projecting and process control – as well as the development, manufacture and installation of individual machines, customised systems and complete turnkey plants. The product range includes technologies within drying, seed processing, conveying, storage and electronic sorting as well as advanced control and automation systems. Cimbria's solid market position is a result of new thinking deeply rooted in special knowledge and experience achieved through decades of intense research and development.

With such a wide and varied number of exhibits -- there are almost 200 exhibitors from all over the world -- that are used within the animal feed, dry petfood, aquafeed, rice and flour milling, grain processing and biomass industry sectors, a visitor should be able to find what he is looking for over the three days of the event.

FIAAP, VICTAM & GRAPAS Asia 2016 will take place at BITEC, Bangkok, Thailand from 29 – 31 March 2016. Entry to the shows is free of charge and online registration is now open at the websites: www.fiaap.com, www.victam.com or www.grapas.eu

Henk van de Bunt (centre left) with from left; Manat Kitprasert, Jaruwan Suwannasat director, Exhibition and Event Thailand Convention & Exhibition Bureau, Thailand, Catelijne van Gooijer, Pornsil Patchrintanakuland Phusit Sasitaranondha, managing director Expolink Global Network Ltd, Thailand.

Appointments

Aqua health expert for Nutriad

Maria Mercè

Global producer of feed additive solutions Nutriad is further strengthening its aqua division, by appointing **Maria Mercè Isern i Subich**, DVM, as Business Development Manager Aquaculture Health. Subich holds a degree in Veterinary Medicine and has occupied various positions with fish farms and feed manufacturers.

"This recent incorporation of an aquaculture veterinarian with over 10 years of farm experience complements our existing scientific and technical capabilities to support our customers in the key aquaculture markets in Asia, Europe and America", says Dr Peter Coutteau, Business Unit Manager Aquaculture for Nutriad.

"The aquafeed industry is expanding extremely fast and maturing from a young, pioneering industry into a more professional feed industry. The degree of technical development is extremely different among the distinct species and regions. Salmon is surely the most industrialised aquaculture species, whereas production of shrimp, tilapia, carp and catfish is still under full development and consolidation. However, health prevention has become a key issue for all aquaculture species, increasingly plagued by a diversity of diseases and parasites.

Subich will work on further strengthening the product portfolio and services that the company offers to both feedmills and integrated farmers.

Nutriad International delivers products and services to over 80 countries through a network of own sales offices and distributors supported by 4 application laboratories and 5 manufacturing facilities in 3 continents.

Olmix strengthens Asian team

Marine Josso

Si-Trung Tran

Maarten Jay Van Schoonhoven

Olmix Group, global provider of algae-based solutions for farm and feed from France, is strengthening its Asia team through acquiring three new technical staff specialised in livestock and aquaculture.

Marine Josso joins as Technical Supervisor. Based at Olmix's Asia Pacific headquarters in Ho Chi Minh City, Vietnam, Dr Josso obtained a Veterinary Degree from the National Veterinary School of Nantes in France in 2015. In her new role, she will provide technical support in animal health for Olmix's operations across the Asia Pacific region and promote Olmix's products to existing and new customers.

Si-Trung Tran joins Olmix as Asia Technical Manager. Dr Tran obtained a Veterinary Degree from the University of Agriculture and Forestry in Ho Chi Minh City, Vietnam in 2000. He pursued an advance education at the National Polytechnic Institute in Toulouse, France and earned a doctorate degree in food quality and safety in 2005.

During 2005-2006, Tran worked as a postdoctoral researcher at the School of Veterinary Medicine (ENVT), also in Toulouse, France. Then, he moved to Canada and continued his postdoctoral research at the University of Guelph during 2008-2015. Over there, he carried out a wide range of research on the development of analytical methodology for determining mycotoxins and masked mycotoxins in food and feed ingredients.

As a specialist in mycotoxins, Tran will assist the Omix Asia team to analyse mycotoxins and provide solutions for their prevention and control, in addition to supporting the team in livestock production. He is also based at Olmix's Asia Pacific headquarters in Ho Chi Minh City.

In aquaculture, Olmix appointed **Maarten Jay Van Schoonhoven** as the Aqua Business Unit Manager. He will look after the aquaculture business of Olmix globally, particularly in Asia.

Schoonhoven earned a Masters Degree in Biology from the Wageningen University in the Netherlands in 2000 and subsequently in Aquaculture at the University College Cork in Ireland in 2003. After that, he entered into the aquaculture business working with various suppliers of larval feeds in Europe. During 2007-2009, he joined Inve as Sales Manager for Southeast Asia and was based in Bangkok, Thailand.

ALL IN FOR AQUACULTURE

AQUACULTURE 2016

Paris Hotel and Convention Center
Las Vegas, Nevada USA
February 22-26, 2016

WORLD AQUACULTURE Society

National Shellfisheries Association

NATIONAL Aquaculture ASSOCIATION

CO-SPONSORS

Aquaculture Suppliers Association

ASSOCIATE SPONSORS

American Veterinary Medical Association
America's Tilapia Alliance
Aquacultural Engineering Society
Aquaculture Association of Canada
Aquaculture Feed Industry Association
California Aquaculture Association
Catfish Farmers of America
Global Aquaculture Alliance
International Association of Aquaculture Economics and Management
Latin America & Caribbean Chapter WAS
Striped Bass Growers Association
US Shrimp Farming Association
US Trout Farmers Association
World Aquatic Veterinary Medical Association
Zebrafish Husbandry Association

In Cooperation with California Aquaculture Association

For More Information Contact:

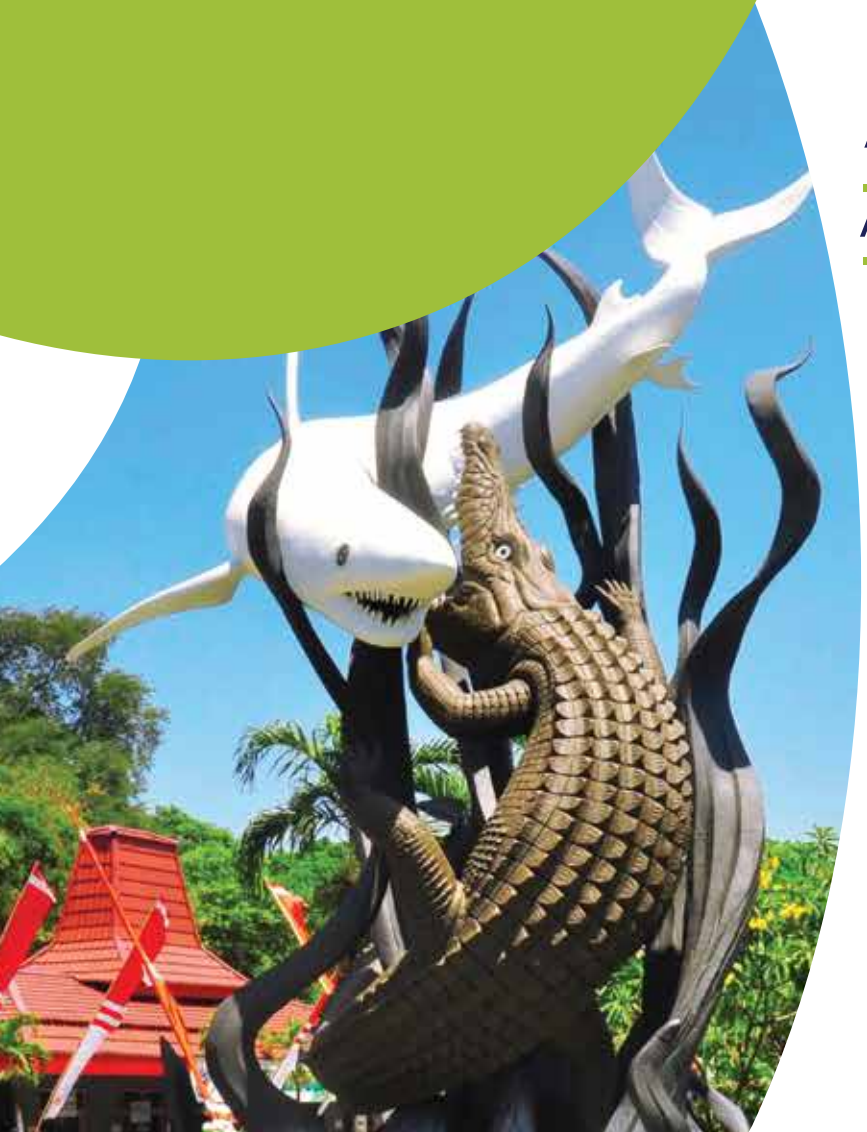
Conference Manager
P.O. Box 2302 | Valley Center, CA 92082 USA
Tel: +1.760.751.5005 | Fax: +1.760.751.5003
Email: worldaqua@aol.com | www.was.org

Asia Pacific Aquaculture 2016

Surabaya
Indonesia
April 26-29
2016

APA16

ASIA PACIFIC AQUACULTURE 2016



WORLD AQUACULTURE Society

For more info
on the TRADESHOW
mario@marevent.com

For more info
on the CONFERENCE
www.was.com

Asian-Pacific Aquaculture 2016

Profitability, Sustainability, and Responsibility for the Future
April 26-29, Surabaya Indonesia

Asian-Pacific Aquaculture 2016 (APA 2016) will be from April 26 to 29 at the Grand City Convention Centre in Surabaya. After the first successful meeting in 2005 in Bali, Asian Pacific Aquaculture 2016 (APA 2016), hosted by the Ministry of Marine Affairs & Fisheries (MMAF) will be another chance for the international aquaculture community to visit Indonesia and observe its rapidly expanding aquaculture industry. Attendees will be able to see the growth in Indonesian aquaculture as well as aquaculture developments in the rest of Southeast Asia. This year, the International Symposium on Tilapia in Aquaculture (ISTA) will be part of the program.

The theme for APA 2016 is 'Profitability, Sustainability, and Responsibility for the Future.' The technical sessions will be intensive with poster and oral presentations covering several areas of interest to Asian aquaculture. There will be an Indonesian Aquaculture session. There will be opportunities for many farm tours and these will be organised by Indonesian Associations. Details will be provided later.

At the 232- booth trade show, visitors and participants can learn the latest in aquaculture and the technological advances from around the region and elsewhere. This year's APA trade show will be unique with displays by local and regional feed companies such as PT CJ CheilJedang, PT Matahari Sakti, PT Grobest Indomakmur, Uni President Vietnam and Invivo. Indonesian cage manufacturer PT Star Gold as well as several international feed additives and aquaculture solutions companies will be there as well. Provincial aquaculture centres will be displaying developments and activities in their regions.

Special producer program

As is usual with Asia Pacific Aquaculture events, there will be several special industry sessions with the latest in practical knowledge for Indonesian aquaculture producers. IndoAqua, FITA and 12th All Indonesian Young Koi Show are included in this event. More information: www.was.org; trade show: Mario Stael (mario@marevent.com).

What to look forward to in Aqua Culture Asia Pacific in 2016

Our editorial calendar for 2016 reflects the new trends and technologies in aquaculture in Asia Pacific. These are most relevant to the industry and will help you reach your target audience.

Volume 12 2016					
Number	2 – **March/April**	3 – **May/June**	4 – **July/August**	5 – **September/October**	6 – **November/ December**
Issue focus *Recent developments and challenges for the next step*	Hatchery & Nursery Technology	R&D & Genetics in Fish/ Shrimp	Industrialisation & Automation	Biosecurity & Disease Management	Probiotics
Industry Review *Trends and outlook, demand & supply*	Tilapia	Aqua Feed Production	Catfish	Marine fish	Freshwater Fish/Prawn
Feeds & Processing Technology *Technical contributions from feed industry*	Micro Feeds/Lipid and Fatty acids	Additives/Probiotics	Extrusion & Processing Technology	Feed Safety/Feed Enzymes	Nutrition & Formulation
Production Technology *Technical information and ideas*	Cage Culture	Recirculation Aquaculture Systems	Sustainable & Responsible Aquaculture	Biofloc & Biotechnology	Aeration Technology
Aqua business Feature articles	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc				
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)				
Company/Product news	News from industry including local and regional trade shows				
Deadlines for Technical articles	**January 15**	**March 15**	**May 15**	**July 15**	**September 15**
Deadlines Advert bookings	**January 22**	**March 22**	**May 22**	**July 22**	**September 22**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**Victam Asia 2016** March 29-31 Bangkok, Thailand **Asia Pacific Aquaculture 2016** April 26-29 Surabaya, Indonesia	**Asia-Pacific Aquaculture Expo** May 26-28 Xiamen, China	**11th Asian Fisheries & Aquaculture Forum** August 3-7, Bangkok, Thailand **Vietfish 2016,** August 3-5 Ho Chi Minh City, Vietnam **The Aquaculture RoundTable Series, (TARS 2016)** August 17-18, Phuket, Thailand	**China Seafood & Fisheries Exposition 2016** November 2-4 China	

Indoaqua & FITA 2016 with APA 2016

April 26, Surabaya, Indonesia

Preceding APA 2016 will be INDOAQUA AND FITA 2016 on April 26

INDOAQUA (Indonesian Aquaculture) and FITA (Forum of Aquaculture Technology Information) is a prestigious national conference. Held annually, it provides information on the latest technology on aquaculture through a conference and trade exhibition attended by public and private sectors, ranging from government, academia to practitioners and other relevant stakeholders from the regions in Indonesia.

In 2016, INDOAQUA and FITA 2016 will collaborate with Asian Pacific Aquaculture 2016. It will be on April 26 from 8:30 am to 4:00 pm at the ballroom of Grand City Convention. The organizing committee will invite respected national and international speakers to discuss the development of sustainable aquaculture businesses to prepare for national, regional and international markets, in accordance with international practices. Experts will address strategic issues including:

- strategies in line with global trends in aquaculture development towards the year 2030;
- opportunities and challenges for a sustainable shrimp industry in the future;
- utilisation of local ingredients for eco-friendly and environmental aqua feed
- fish health management to increase sustainable aquaculture production;

More information: www.djpb.kkp.go.id or email: apa_2016_indonesia@yahoo.com.

Indonesia has a tremendous aquaculture potential to develop for local and international enterprises. The potential for aquaculture development cover freshwater, brackish water and mariculture areas for seafood production to meet demand in domestic and foreign markets. The Indonesia government is supporting investments in aquaculture businesses.

2016

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**

January 29-30
Aqua India 2016
Visakhapatnam, India
Email: contact@aquaprofessional.org
Web: www.aquaprofessional.org

February 22-26
Aquaculture 2016
Las Vegas, USA
Email: worldaqua@aol.com
Web: www.was.org

March 29 – 31
FIAAP Asia, VICTAM Asia, GRAPAS Asia 2016
Bangkok, Thailand
Web: www.victam.com

March 29
Aquafeed Horizons Asia 2016
Bangkok, Thailand
Web: www.feedconferences.com

April 26-28
Seafood Expo Global
Brussels, Belgium
Web: www.seafoodexpo.com/global/

April 26-29
Asia Pacific Aquaculture 2016
Surabaya, Indonesia
Email: worldaqua@aol.com
Web: www.was.org

May 26-28
Asia-Pacific Aquaculture Expo
Xiamen, China
Web: www.apaexpo.com.cn

June 2-4
Middle East Aquaculture Forum (MEAF-16)
Izmir, Turkey
Email: meaf16@meaf.ae
Web: www.meaf.ae/meaf16/

August 3-5
Vietfish 2016
Ho Chi Minh City, Vietnam
Web: www.en.vietfish.com.vn

August 3-7
11th Asian Fisheries and Aquaculture Forum 2016
Bangkok, Thailand
Web: www.afsconferences.net

August 4-6
Asean Fisheries and Aquaculture Conference and Exposition 2016
Bangkok, Thailand
Web: www.aseanfishexpo2016.com

August 8-9
Aqua Fisheries Cambodia
Email: sabrina.hoang@veas.com.vn
Web: www.veas.com.vn

August 17-18
The Aquaculture RoundTable Series (TARS 2016) - Shrimp Aquaculture & The New Normal
Phuket, Thailand
Email: conference@tarsaquaculture.com
Web: www.tarsaquaculture.com

September 20-23
Aquaculture Europe 2016
Edinburgh, Scotland
Web:www.easonline.org

September 28-30
Aqua Fisheries Myanmar
Yangon, Burma
Email: sabrina.hoang@veas.com.vn
Web: www.veas.com.vn

1991 VICTAM 25TH Anniversary 2016

FIAAP Asia 2016

Exhibition and conferences for feed ingredients, additives and formulation

VICTAM Asia 2016

Exhibition and conferences for feed processing technology

29 – 31 MARCH 2016 · BITEC EXHIBITION HALLS, BANGKOK, THAILAND

Asia's premier aquafeed event

Symposium and Summit

- **The second ASEAN Feed and Rice Symposium**
- **The second ASEAN Feed Summit**

ASEAN Feed Summit

Specialist conferences

The exhibitions will be supported by their own specialist conferences. They will include:

- **FIAAP Asia Animal Nutrition Conference 2016**
- **Aquafeed Horizons Asia 2016**

Contact details

For visitor, exhibition stand space and conference information please visit:
www.fiaap.com or **www.victam.com**

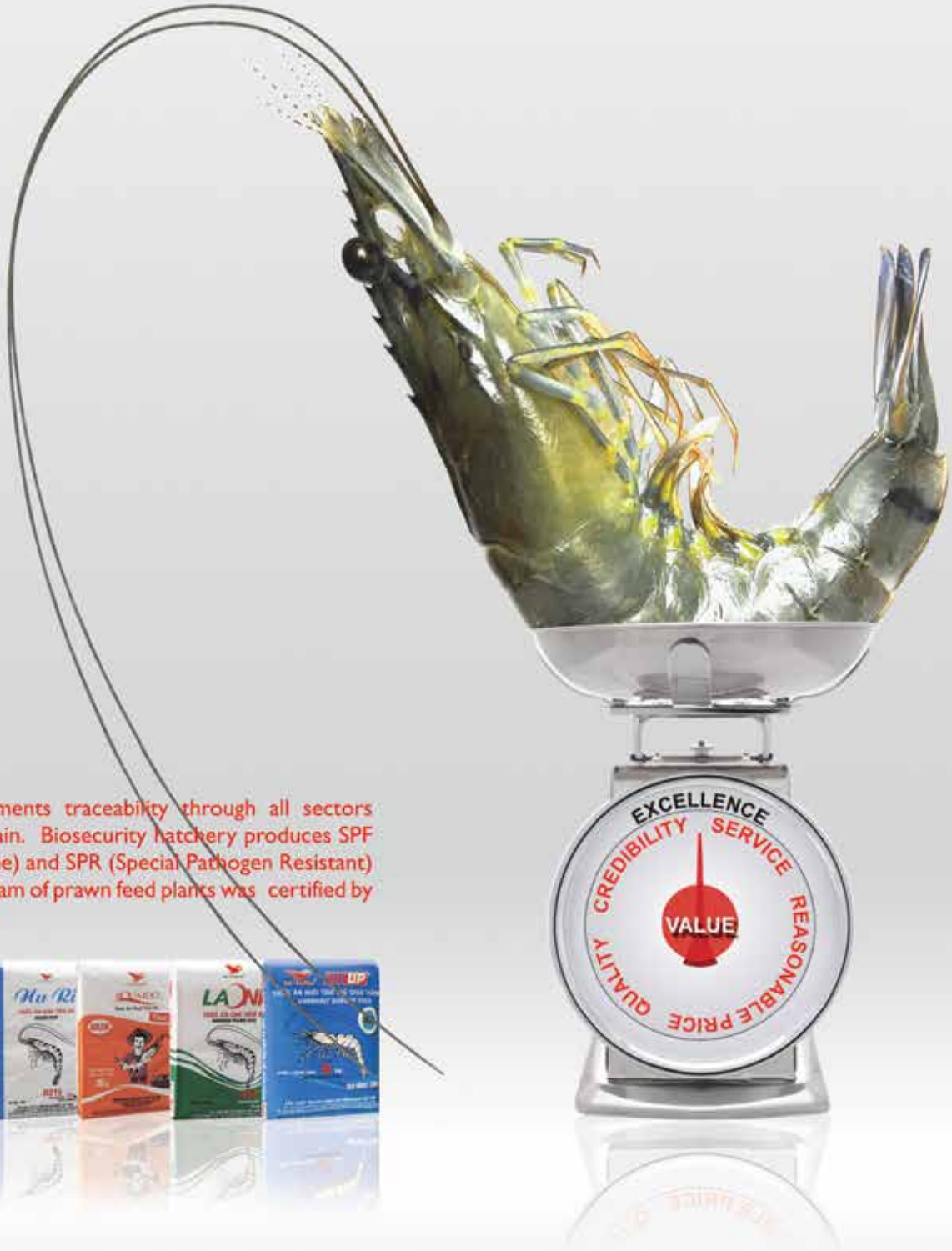
Co-located with
GRAPAS Asia 2016 **www.grapas.eu**

Supported by
The Thailand Convention and Exhibition Bureau

TCEB
THAILAND CONVENTION & EXHIBITION BUREAU

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.

- No.16-18-20, DT743 Road, Song Than II Industrial Zone, Di An Ward, Di An Town, Binh Duong Province, Vietnam
- Tel: +84-650-3737626 - Fax: +84-650-3790819
- Email: aquafeed@upvn.com.vn

CTY TNHH UNI-PRESIDENT VIỆTNAM
UNI-PRESIDENT VIETNAM CO., LTD.

Establishing a Healthy and Happy Tomorrow