SEPTEMBER/OCTOBER 2010
Volume 6 Number 5

AQUA CULTURE Asia Pacific

Who's Who in Sa Dec's Pangasius Feed Production

Managing Tilapia Health in Complex Systems

Sulphide and Phosphate Problems in Shrimp Ponds

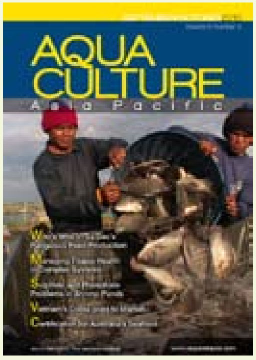
Vietnam's Cobia goes to Market

Certification for Australia's Seafood

MICA (P) 088/10/2010 PPS 1699/08/2010(028228)

Contents

Volume 6, Number 7 September/October 2010 MICA (P) 088/10/2010 ISBN 1793-0561



Tilapia in Thailand. Picture by Soraphat Panakorn

Editor/Publisher
Zuridah Merican, PhD
Tel: +603 2096 2275 Fax: +603 2096 2276
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.wworthmedia.com

AQUA Culture AsiaPacific is published bimonthly by **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

Editorial and advertising enquiries
Request for reprints and articles
Email: zuridah@aquaasiapac.com
Tel: +603 2096 2275 Fax: +603 2096 2276

Subscriptions
Online: www.aquaasiapac.com
Email: subscribe@aquaasiapac.com

Annual Subscription by airmail (6 issues a year)
Asia: SGD70
Other zones: SGD100

WRITE TO THE EDITOR

We want to hear from you. Write your comments on the industry to the editor. Letters may be edited prior to publication.

From the editor

Nutrition – The next bottleneck

In an editorial in 2005, we raised the issue of the paradox in feeding the vannamei shrimp. The debate was on the use of high protein diets (usually above 36-40% crude protein) to a species, proven to need lower protein diets, basically because of high stocking density (100 post larvae/m^2). The practice continues on today. The logic of this creates another problem altogether due to the over fortification and its detriment to the pond environment as well as inefficiency. In comparison, a super intensive raceway (450 post larvae/m^3) culture system for vannamei shrimp in the US uses 35% protein feeds specially designed for this system.

The example above demonstrates the dilemma in aqua nutrition. We have already accepted that aqua nutrition is far from where it should be, namely species-specific formulation of performance feeds. Just like in other areas of aqua farming, nutrition is suffering from a lack of resources and non-sharing of information. At the ASA-IM Aquaculture Technology meeting in Manila, a moratorium on new species was suggested but Dr Victor Suresh, Director of Nutrition and Feeds at Integrated Aquaculture International said that if such was the case, we would not have had the cobia.

To move ahead there is a need to work in two phases. Phase one requires the repair of the current mismatch of specifications to the species and the genetic improvements, very much in the role of 'catch-up'. Phase two requires that we match future requirements of a specific species or range of species to the environment. These are precisely formulated feeds for freshwater and marine fish in ponds, cage culture of marine fish in traditional cages with less desirable water quality parameters or offshore cage culture with a range of intensity. Manipulation of the nutritional profile of culture species to meet consumer needs is another area of focus.

"The economic success of a diet to a large extent depends upon the management of the feed on the farm by the farmer. The conventional aquaculture nutritionist needs to get out into the field and understand the practical world of the farmer and farming system in which the target species is cultured," said Dr Albert G Tacon, Nutrition Consultant.

"The future is with formulated feeds based on digestible nutrient levels rather than just gross dietary nutrient levels, including individual essential amino acids and essential fatty acids. It is also to better understand the nutritional requirements of species reared under zero water exchange floc-based culture systems and the role of gut microflora in the nutrition and health of cultured species,"

Commercial nutrition today is not just the battle against rising raw material costs and to deliver feeds according to specifications to the farmers and be profitable but also meeting requirements on food safety and sustainability. The challenge for the nutritionist is not only rising fish meal prices but also sustainability of fish meal usage in feeds. The opinion of Victor is that industry has responded well to fish meal and fish oil challenges and showed a steady improvement in feed efficiency.

In the last few years, selective breeding of the shrimp, tilapia and other species have been progressing at a fast pace and this poses a huge nutritional challenge. The vannamei shrimp, selected for fast growth can reach 3g/week in ideal conditions but in a farm, only 1.5g/week is achieved because the feed has remained the same. At a discussion during the same meeting in Manila, Dr Morten Rye, Akvaforsk Genetics Centre, noted how genetics increased efficiency in poultry production by 85-90% and 50-100% in pig production. Nutrition kept pace with genetics to give these efficiency data. Aquaculture has the example of the salmon where nutrition played a dynamic role with genetic changes leading to its global success.

Asia may be the largest producer of aquaculture species in the world but nutrition R&D has not kept pace with this growth. The challenge requires a concerted effort of private-public partnership and cooperation within academia. In order to maximise the current situation of limited funds, time and improve on efficiency, the research could be divided out amongst academic institutions to avoid duplication. This would be similar to the multiple public institutions and some private institutions working together in Europe and the US. This should be a wake-up call for academia and the industry.

Zuridah Merican

High shrimp prices

US prices for black tiger and vannamei shrimp increased by 17% and 23% respectively since early 2010.

During the economic downturn following the financial crisis in late 2008, importers and distributors began to reduce shrimp inventories from the usual 4-5 months to one month by end 2009. In January 2009, the lowest US prices, since 2006, were recorded for black tiger shrimp (USD8.25 /kg, size 21-60). Consequently, prices for black tiger shrimp gradually rose as importers and distributors started to rebuild inventories while prices for vannamei shrimp rose from mid-2009. NMFS data for January 15, 2010 showed prices of black tiger at USD 9/kg (size 26-30, origin Indonesia) and USD 5.83/kg for size 41/50 vannamei shrimp originating from Thailand (Shrimp News International).

On the supply side, since 2009, production has been on the downward trend in many parts of Asia. Production for 2010 in Indonesia is predicted to go down by almost 20-30% because of the spread of infectious myonecrosis virus in Lampung and parts of Java Island (Bangkok Post). In Malaysia, production is also expected to fall due to diseases. Production in India was affected by heavy rains in November 2009 (Globefish, February 2010) whilst in Vietnam's Mekong Delta, production is at a cyclical low and is expected to rebound only from September 2010.

The US receives 8% of its shrimp from white shrimp fisheries in the Gulf of Mexico. The oil spill in the Gulf of Mexico in late April has increased demand for imported shrimp. In the EU, the softening of the economic crisis is improving demand in all main markets, according to a Globefish, May 2010 report. US August prices increased 17% to USD10.56/kg for black tiger shrimp, size 26-30, originating from Indonesia and 23% to USD 7.15/kg for size 41/50 vannamei shrimp originating from Thailand. In the Japanese market, Indonesian black tiger shrimp rose by JPY100 on average, and prices ranged from JPY1,400 to 1,300 for headless size 41/60 shrimp (USD 16.37/kg) in April 2010 (Trobos, August 2010). The price of domestically produced US shrimp has leapt more than 40% to USD 6.20/lb (USD 13.64/kg) since the oil spill, according to Urner Barry.

In Vietnam, ex-farm prices for black tiger shrimp are now at their highest, at between VND130,000/kg for 40 pcs/kg (USD7.36/kg) and VND 180,000 for 20pcs/kg (USD 9.47/kg). In Malaysia, prices for 70 pcs/kg vannamei shrimp increased to RM11.40/kg (USD3.45/kg, July 2010) from RM 9.50 (USD 2.87/kg); however, black tiger shrimp (40pcs/kg) prices have remained stable at RM 20/kg (USD 6/kg) since August 2009. In Thailand, the price of 40pcs/kg vannamei shrimp rose to THB150/kg (USD 4.7/kg).

Setbacks

However, amidst these optimistic prices, Asian shrimp exporting countries are also facing various setbacks. In Bangladesh, the absence of proper quality control is causing the returns of some consignments due to inferior quality. This problem is expected to be solved soon, with the establishment of a research body to look into the production of quality shrimp. India, a leading exporter to EU markets is facing new conditions on their exports. There is a mandatory inspection on 20% of consignments and analytical testing is now required, both of which add costs to the exporter and importer.

In Vietnam, the shrimp farming area has been reduced in the last few years when prices went below production costs. However, the recovery is slow as farmers do not have sufficient capital to resume farming and banks are reluctant to provide loans. In addition, the US Department of Commerce recently announced that antidumping duties on frozen shrimp have been increased to 4.27% for 29 companies.

Thailand and Vietnam lead in shrimp markets

Production declines in many countries and the oil spill in the US is benefitting Thailand's shrimp industry as exports are expected to rise 8% in 2010. In the Bangkok Post, Panisuan Jamnarnwej, President of the Thai Frozen Foods Association said that exports rose 34% in the first quarter of 2010 as compared to the same period in 2009. In 2010, Thailand is expected to produce 580,000 tonnes, up from 540,000 tonnes in 2009 and will export 405,541 tonnes, valued at USD 2.79 billion. Thailand is the leading shrimp supplier to the US with 176,870 tonnes in 2009. In February, exports to the US were 12,540 tonnes, up 26% from the same period in 2009.

In 2009, shrimp imports to Japan were led by Vietnam at 56,613 tonnes, Thailand at 37,297 tonnes, and Indonesia at 34,799 tonnes (Vietfish News (26), February 2010). In February 2010, Thailand increased exports mainly of processed products to Japan, overtaking Vietnam as the leading supplier to Japan with 2,976 tonnes as compared to Vietnam's 2,448 tonnes (Vietfish News, (27), April 2010).

Large frozen black tiger shrimp from Minh Phu Seafood Corp during Vietfish 2010 in June.

Improving aquaculture through feeds and technology

In 2006, in Siem Reap, Cambodia, participants came together to discuss issues affecting the aquaculture feed industry in Asia, in a format similar to earlier workshops for the livestock industry. Out of this came a new approach, 'Improving aquaculture through feeds and technology', which served as the basis for a series of workshops on aqua feed technology and nutrition, organised by the American Soybean Association International Marketing Program (ASAIM).

From left, Dr Jacques Gabaudan, Dr Michael C Cremer, Lukas Manomaitis and Dr S. Subasinghe

This year, it became the theme of the ASAIM Southeast Asia Aquaculture Conference 2010. The event, initially planned to be held in Bangkok, Thailand in March was moved to Manila and held on August 2-5, 2010. In planning for this workshop, Lukas Manomaitis, Technical Director for Aquaculture at the ASAIM South East Asia Office, said that it is important that both aqua feed and production sectors look at all areas challenging sustainable aquaculture.

"For some time, the program has focused on increasing soy meal inclusion in feeds through sustainable feed based production," said Manomaitis. "Moving on, we will need to look at aquaculture production holistically, at the ingredients, the technology approaches, and revisiting the basic building blocks. Aside from helping industry understand the value of using soy meal in aqua feeds, we also wish to draw attention to the value of a more efficient and profitable industry."

Providing a global perspective on feed based aquaculture, Dr Michael C Cremer, Global Aquaculture Manager for the US Soybean Export Council said, "Global shrimp production has increased by 18% to 3.43 million tonnes and tilapia by 30% to 2.6 million tonnes. Pangasius production grew 275% between 2005 and 2009 to 1.1 million tonnes. This represents a growth in demand of aqua feeds of 4.45 million tonnes. The effect of these developments is the significant pressure on marine meals and fish oil. This requires a greater effort to move towards alternative and renewable resources."

"In feed based production, China is showing the way. In 2010, 75% of freshwater fish production used aqua feeds which amount to more than 20 million tonnes for the 21 million tonnes of fish. At 30% crude protein in aqua feeds, the protein requirement is more than 10 million tonnes. This means that the feed protein requirement just for China will exceed global fish meal supply by 70%. The industry has moved to feed sustainability with renewal plant protein sources such as soybean meal, wheat and corn. All plant protein fingerling feeds have also been developed for many freshwater species, using a combination of soybean meal and soy protein concentrate to replace fishmeal, "said Cremer.

"Conversely, the concern is also intensive pond systems in freshwater aquaculture. There is the growing competition for use of land resources and concern on waste effluents. The future is in marine fish production but high feed prices are pushing farmers to revert to, or remain with, trash fish as feeds. We can expect that water pollution problems may cause a decline in production in China, unless offshore resources are utilised."

Presentations at the workshop were arranged into three sessions. The session on 'The new basis of seafood' covered growth markets for aquaculture in Asia and producing aqua feeds for target markets. These were presented by Dr S. Subasinghe, Infofish Malaysia and Dr Jacques Gabaudan, DSM Nutritional Products, Thailand, respectively. The second session on 'It's all about the ingredients' examined feed formulation, feed additives and ingredients, nutrition and feed processing. The final session on technology approaches covered production technologies from ASAIM- developed offshore cage technology, vaccination and health management and genetics. A more detailed report on these presentations will be published in the next issue of Aqua Culture Asia Pacific.

The workshop was attended by 100 participants comprising formulators, nutritionists, technical, sales, factory and quality control managers from regional feed mills, feed additive and ingredients suppliers, and production managers in the Philippines, Thailand, Vietnam, China, Hong Kong and Malaysia.

News in Brief

ThaiGap launched

In May, the Food and Agriculture Committee of the Thai Chamber of Commerce (TCC) launched ThaiGap (Good Agricultural Practice), a voluntary private sector standard for safe and sustainable Thai farm products. TCC, National Food Institute, Kasetsart University, National Metrology Institute of Germany and the German Technical Co-operation took three years to develop the standard which is to be equivalent to the GlobalGap standard. ThaiGap standard assures food safety and quality of upstream operations, from hatchery to processed products and encompasses social welfare. The guidelines, in Thai, are easy to understand. ThaiGap was also designed to reduce both implementation and certification costs for farmers. Currently, the ThaiGap committee is in the process of forming a certification body and selecting auditors. It will start with the certification of fruits and vegetables followed by shrimp products.

Live fish transportation project

The 'live fish transportation from southern China to northern China by train' national project has reached a breakthrough after two years of development and testing. Rongfu Aquaculture, Inc. a leading producer of tilapia and snakehead and distributor of freshwater fish is the first company in Guangdong Province authorised to use this technology to deliver fish to the northern and inland regions of China. Under the project, the company has railroad containers that circulate water and control temperature. Testing showed improved survival rate at a lower cost. The company believes that with this project, they will have a competitive edge. The next step is the transport of tilapia and other species. Rongfu operates 13 fish farms, 3 in Hainan Province and the rest in Guangdong Province.

Lower target for shrimp in Indonesia

The government has lowered the 2010 target for shrimp production to 350,000 tonnes as industry is yet to recover from the disease outbreak of 2009 affecting mainly CP Prima farms and intensive farms in Lampung, East Java and South Sulawesi. In 2008, 410,000 tonnes of shrimp were produced and this declined to 350,000 tonnes in 2009. Another reason for the lower production is the lack of incentives, said Iwan Sutanto, President of Shrimp Club Indonesia in Kompas News. To stabilise production, farmers are encouraged to use the locally bred 'vaname Nusantara' shrimp post larvae. Traditional farming with lower stocking density of 80-100 post larvae/m^2 instead of 150-200 post larvae /m^2 is being encouraged. Ex- farm prices have risen by IDR 3,000 to IDR 38,000/kg (USD 4.2 for 70pcs/kg).

UP plans aqua feed plant in India in 2011

Early in 2010, Uni President Enterprises Corp (UP), Taiwan's largest agriculture, food, animal and aquatic feed producer began to export aqua feeds to India from its feed mills in Vietnam. The company plans to set up a feed mill in India if sales reach 10,000 tonnes in 2010. Uni President Vietnam (UPV) has three feed mills, two of which are running at full capacity. It also plans to expand its presence in Southeast Asia and China within the next two years. Taiwan Economic News said that despite volatile aqua feeds prices, UPV expects higher profits in 2010, as compared to the USD7.7 million in 2009.

'Euro leaf' and labelling rules for organic food

The new EU rules on organic food labelling including the requirement to display the new EU organic logo, entered into force on 1 July, 2010. The so-called 'Euro-Leaf' shows the EU stars in the shape of a leaf against a green background. This will now be obligatory on pre-packaged organic food products that have been produced in any of EU member states and meet the necessary standards. Other private, regional or national logos will continue to appear alongside the EU label. The logo is optional for non-packed and imported organic products. The new labelling rules also include the compulsory information on place of farming of the products' ingredients and code number of the body in charge of the controls. Operators have a two-year transition period to comply with these new labelling rules.

Another change is the introduction of EU rules for organic aquaculture for the first time. The new rules also cover organic aquaculture production of fish, shellfish and seaweed. The rules set EU-wide conditions for the aquatic production environment, the separation of organic and non-organic units and specify animal welfare conditions including maximum stocking densities, a measurable indicator for welfare. The rules specify that biodiversity should be respected and do not allow the use of induced spawning by artificial hormones. Organic feeds should be used, supplemented by fish feeds derived from sustainably managed fisheries. In 2008, there were 225 certified organic aquaculture operations worldwide and 123 operations were in Europe mainly in UK, Ireland, Hungary, Greece and France. Europe accounted for almost half world production of 50,000 tonnes in 2008 and the top species was salmon.

BAP standards for pangasius farms

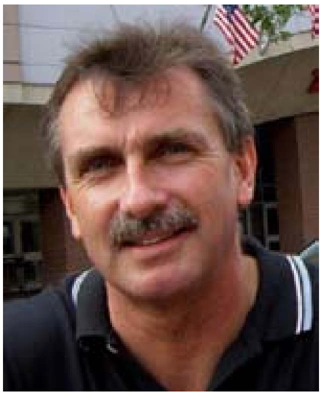
The Global Aquaculture Alliance (GAA) said that the BAP standards for pangasius farms are completed. The pangasius standards are the result of work by a technical committee chaired by Philippe Serene, aquaculture expert and former BAP auditor based in Vietnam. The standards development process benefited from a public review where comments were received from both conservationists and aquaculture professionals, as well as multiple meetings with aquaculture representatives in Vietnam. The standards were finalised following reviews by the BAP Standards Oversight Committee.

The BAP standards and guidelines for pangasius farms, apply only to pond culture, which has emerged as the primary commercial culture system. The high density typical of pangasius pond culture led to BAP requirements for sedimentation ponds to handle effluent and standards that protect the safety of divers who clear sludge from pond bottoms during production (www.aquaculturecertification.org).

Organic SuperBio Tilapia

German and Chinese companies have signed an agreement to produce completely controlled `Organic SuperBio Tilapia'. The objective of the Baader Group, Pourkian Group, Fraunhofer Institute, San'an Technology Group and Maoming Hi-Taste Aquatic Product Technology Co Ltd is to tap the developing markets for high quality fish products in Germany and China. The Fraunhofer Institute will develop the production lines whilst the San'an Technology Group in Beijing will conduct different tests, certificates and audits for the fish farmers. Maoming is one of the largest tilapia farming and processing companies. The Baader Group has a 90 year history as producer and supplier of machinery for processing lines, especially for fish. Initiator of the project, the Pourkian group specialises in the development and organisation of organic markets in Europe. The companies will cooperate to create a closed Organic SuperBio process chain which will meet the EU's organic standards as well as ISO, IF, GMP and GlobalGap standards. However, they aim to exceed EU standards, which permit only 5% chemical additives. The products will be easily recognisable by customers through labelling.


A NEW GENERATION OF ARTEMIA CYSTS
SEP-Art
TECHNOLOGY
Complete separation
Clean biomass
Undamaged nauplii
Increased biomass output
INVE
Advanced Solutions
for animal rearing
www.inve.com
INVE
AQUACULTURE



Industry comments…

Dan Fegan on risks and limiting the introduction of the virus

Article: The proactive way to live with WSSV by Roselyn Usero and Leobert de la Pena, Volume 6 (4) July/August 2010

I would like to make a couple of comments on this excellent article on the proactive way to live with WSSV. The biosecurity efforts being made by the staff and management at Aqua-Cards Victorias are indeed impressive but I believe that their point in the final paragraph about economic justification cannot be emphasised enough. Obviously, if the cost of a biosecurity program exceeds the cost of the disease losses, then it makes business sense to reduce the biosecurity cost and focus on those areas of highest risk.

This, in effect, becomes an "insurance policy" approach where the cost of the 'policy' (the biosecurity program) reflects the potential risk of losses due to the disease. The potential risk itself is a function of the value of potential losses and the likelihood and frequency of the losses.

This brings me to my second point which relates to reducing the risk of disease outbreaks through limiting the introduction of the virus. Although it was not mentioned in the article, I would imagine that the farm uses their PCR lab to also check for WSSV in the post larvae (PL) to reduce the risk of introducing the virus. Despite all of the other risk factors, it is clear that infected PL remain the highest and most common risk for WSSV. The problem with depending on PCR testing for PL and in the routine farm monitoring program is that the greatest risk of obtaining a false negative result lies not with the PCR test but the number of shrimp tested.

If the prevalence of the virus in the source population is low, then the sample size needed to find a single positive individual is high. Conversely, if the prevalence is high, then the number of shrimp needed to test before finding a positive individual is less. It is often recommended that a sample of 150 PL be negative for WSSV before stocking.

Many people erroneously believe that this provides 'evidence of absence' of WSSV in a particular batch of PL. However, from epidemiological statistics, a sample of 150 shrimp testing negative for a disease in a population larger than 10,000 simply tells us that the prevalence of WSSV in the source population is less than 2% and has a 5% (1/20) chance of being wrong due to the number of shrimp in the sample relative to the population. Commonly, a sample of 30 PL is used which raises the limit of detection to 10% prevalence. Therefore it is highly possible that even a good PL screening program cannot provide 100% certainty of freedom due to sample size limitations, no matter how good the testing method.

In the case of the positive PCR results on the farm, no mention is made of the number of animals being tested at any one time. Using the same statistical approach, the fewer shrimp tested before finding a positive individual, the higher the prevalence of infected shrimp in the pond. If, for example, 10 shrimp are tested and a positive result is found, then as much as 30% of the population could be infected. However, as the authors indicate, infection and disease are not the same, and although presence of infected shrimp in the pond increases the risk of disease losses, it does not guarantee that these disease losses will occur.

Display of 2009 harvest at Aqua-Cards Victorias

A view of biosecurity at Aqua-Cards Victorias

Their approach of confirming the increasing severity of disease through more intensive surveillance and relating it to the level of the PCR positive result (single or nested) is a pragmatic and sensible approach to avoid over-reaction which could have as many negative economic consequences as an actual outbreak.

The best way to ensure no risk of introduction of WSSV or other major pathogens into the farm is to work with specific pathogen free shrimp from a reputable program. Given the other routes of entry of viruses into the farm, even this is no guarantee of success if no other biosecurity program is in place. Unfortunately, supplies of SPF *Penaeus monodon* are limited and many farms are unable to benefit greatly from these due to poor biosecurity or environmental conditions. However, the success of Asian farmers in taking advantage of SPF *P. vannamei* using relatively simple biosecurity measures shows that these can be cost-effective and easy to administer.

A plea for better understanding..

Finally, if I can make a plea based on years of working on animal health issues in the aquaculture industry. We have a great need for more involvement of epidemiologists to support a better understanding of how diseases affect fish and shrimp populations and how they spread between ponds, cages, farms, and countries. This knowledge can be used to develop better practical methods and approaches for managing fish and shrimp health and reducing the severity and spread of diseases in our farms.

Update from the authors

According to the authors, Roselyn Usero and Leobert de la Peña, Aqua-Cards Victorias is still awaiting harvest for the 2010 season. The crop performance data for the June 2009 stocking is given below.

Modules stocking in June 2009	No of ponds	Total area (ha)	Average stocking (PL/m^2)	Average Biomass (tonnes/ha)	Average A.B.W (g)	Average Survival
1	14	84.40	26.81	9.215	35.22	97.00%
2	16	87.60	22.15	7.795	38.62	90.97%
3	10	57.36	21.36	7.461	36.40	96.02%

Dan Fegan is currently Regional Technical Manager at Cargill, based in Bangkok, Thailand. Dan has spent almost 25 years in commercial shrimp aquaculture with wide experiences in most aspects of the industry in Asia and Latin America. He has also managed the shrimp biotechnology business unit of Thailand's National Center for Genetic Engineering and Biotechnology (BIOTEC).

Sa Dec - Vietnam's pangasius feed capital

By Zuridah Merican and Nguyen Thi Minh Huong

A significant expansion in Vietnam's pangasius catfish feed production has been seen in Sa Dec in the Mekong Delta. Several new feed mills are attached to top integrators completing the supply chain.

View of the feed mills along the Tien River. Picture courtesy of Philippe Serene.

Since 2000, pangasius catfish production has continued on its upward trend. It reached 400,000 tonnes in 2004, 825,000 tonnes in 2006 and 1.5 million tonnes in 2008 with demand in European, US and other markets. However, production decreased to 1.4 million tonnes in 2009 because of several factors: global economic slowdown, low fish prices which led farmers to take a wait and see position, limited cash flow and risks of bankruptcy. Meanwhile, cost of inputs continues to rise. Feeds account for 70-80% of production cost and prices currently range from VND 7,000 to 8,000/kg (US 36-42 cents/kg). Nevertheless, pangasius catfish is a strategic product for the country. The production projections are 1.8 million tonnes by 2015 and 2 million tonnes in 2020.

According to official figures, Vietnam has 106 aqua feed mills. Domestic aqua feed production was 1.92 million tonnes in 2009 which accounted for 77.3% of total feed requirement. On-farm feeds accounted for 10.1% and imported feeds, 12.6% of requirement. The current annual capacity has been estimated by the feed industry at 5.9 million tonnes from 56 aqua feeds mills. In 2009, the volume of extruded feeds for pangasius catfish totalled 1.37 million tonnes per year (tpy). In 2010, fish production has been estimated at 1.25 million tonnes and the feed demand is 2 million tonnes.

Commercial fish feed production began in 1998 with the first aqua feed mill of Cargill, USA. In 1999, Proconco started to produce extruded feeds in Can Tho, specifically for the extensive pangasius farming in cages in the Mekong Delta. By the end of 2003, 15 large and 20-30 small and medium size mills were established. These feed mills are spread out in several locations all over the Mekong Delta (Can Tho, Ben Tre, Long An, Dong Thap, Tien Giang and Vinh Long) and around Ho Chi Minh City (Dong Nai and Binh Duong). During 2007 to 2009, more fish feed mills were set up to produce extruded feeds for pangasius catfish such as Uni President Vietnam in Tien Giang and CP Vietnam in Ben Tre. The top three producers of pangasius catfish feed are Viet Thang, Proconco and Hung Vuong Tay Nam.

Sa Dec

Since 2008, Sa Dec in the Mekong Delta has been leading in the production of pangasius catfish feeds. The eight feed mills here have a total estimated production capacity of almost 1.2 million tpy. In 2009, they supplied 660,000 tonnes which was half of the country's annual production. Feed is extruded using high capacity extruders from the US, Europe, Taiwan and China. Sa Dec has the advantage of a new road and good infrastructure as well as easy access to the Tien and Hau rivers. This reduces transportation costs for raw materials and enables fast delivery of feeds to farms in Vinh Long, An Giang and Dong Thap provinces.

Several feed mills in Sa Dec are attached to top pangasius catfish integrators. Hung Vuong Tay Nam and Sonfish are the feed producing business of Hung Vuong and Cuulong, respectively. Domyfeed opened in April 2010 with a capacity 90,000 tpy. It is a joint investment of Docimexco, Hoan My JSC and Vinh Long Foods Co. One of the pioneers in pangasius feed production, Viet Thang has two plants in Sa Dec. Cargill set up its new aqua feed mill here in 2009. Others are Vina Aquafeed Co, May, Minh Quan and New Hope.

This development in Sa Dec is also linked to the changing profile of Vietnam's pangasius fish production which used to be dominated by small farms with feed supply from the merchant market. From 2000, farming intensified in ponds with stocking at 40-50 fish/m^2. The total farming area has remained unchanged at 9,000ha. Since 2008, a consolidation of the industry saw large processing companies taking control of farming with full scale vertical integration absorbing farms and adding hatcheries and feed milling. Many small farms continue to produce as contract suppliers to processing plants. With rising input costs and lower margins, many small farms depend on processing companies for feed supply, in particular during the last two months of production when feed consumption is highest.

A link with integrators

This recent development is helping feed mills secure a ready market. Currently, Viet Thang supplies 86.2% of its feed production to a major pangasius fish integrator and to large farms of more than 10ha. The balance of 13.8% is sold through dealers to medium size farms of 5-10ha (12.6%) and small farms of less than 5ha (1.2%).

"It was the export potential of pangasius catfish which attracted me to the feed business. In comparison to the channel catfish with 5-10

tonnes/ha, production of pangasius is very high at 300-400 tonnes/ha. However, since then, the industry has seen drastic changes. In 2008 to 2009, the fish market almost collapsed when ex-farm prices were lower than cost of production and farmers refused to harvest, waiting for better prices," said, Nguyen Quang Hien, General Director who started Viet Thang with a group of friends.

In 2003, Viet Thang started to produce catfish feed with one extrusion line with a capacity of 30,000 tpy. Since 2008, capacity has increased to 360,000 tpy with 7 lines of new extruders of US, European and Taiwanese origin.

"The good times were in 2004 to 2007, when profit margins for feed averaged 12% and farmers got 40% profits on their harvests. However, now we are constantly threatened by rising raw material costs and the farmer by low ex-farm prices.

"In the last two years, farms have consolidated. We can expect better profit margins from small farms but payment is slow. We cannot increase the price of the feed and so we work together with farmers to get them to have better feed management and reduce input costs. In general, at current ex-farm prices, the farmer can expect 10% profit margins.

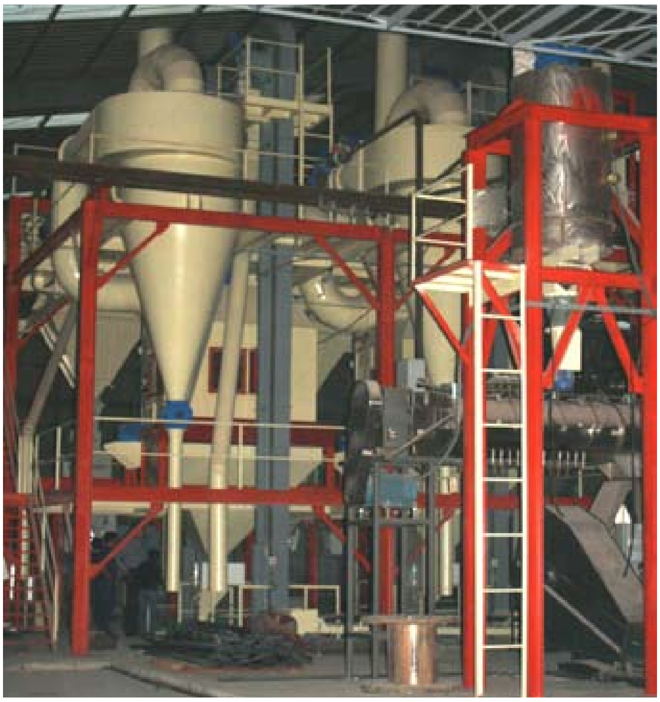
"Certification is also important and we have worked with Bureau Veritas for the ISO 22000. We are one of the few feed mills with this certificate. This may not help in sales but I see this as helping farmers using my feeds to produce better quality fish," said Hien.

Nguyen Quang Hien

Completing the supply chain

The feed milling arm of the 7-year old Hung Vuong Corporation, Hung Vuong Tay Nam began production in September 2009. Hung Vuong is the market leader in the processing, cold storage and export of pangasius. The main markets are Russia, Ukraine, Mexico and East Asia. It is one of the largest integrators in Vietnam with 250ha of farming area in Tien Giang, Ben Tre, Vinh Long, Dong Thap, Can Tho and An Giang. These produce 100,000 tonnes of raw material for processing. Raw material is also sourced from qualified contract farms in the delta. The company has 7 processing plants along the Tien and Hau rivers with a total annual capacity of 130,000 tonnes.

The mill initially started with 2 extrusion lines of 80,000 tpy. Since July 2010, it has two new lines using new processing equipment from the US and France. This increased capacity to 160,000 tpy. All of the feeds produced here are for Hung Vuong's farms. Additional supplies of feed are bought from three other feeds mills. The total consumption by farms belonging to Hung Vuong was 127,000 tonnes in 2009 and in 2010, it is estimated that these will require 200,000 tonnes of feeds. Hung Vuong will continue to buy fingerling feeds from the merchant market for fish smaller than 30g.



Hung Vuong Tay Nam's feed mill

Changing pangasius feeds to meet market demands

Vo Phu Duc

Vinh Hoan, the third largest pangasius exporter has eight farms totalling 126 ha located around the Mekong Delta. These supply 70,000 tonnes or 70% of the raw material for its three processing plants. The rest are supplied by contract growers. Fish exports are mainly to the US and Europe (90%) and the rest to Mexico, Singapore and Hong Kong. In 2007, the company completed its vertical integration with a feed mill, Vinh Hoan Feed, located in Cao Lanh, Dong Thap Province. It started with two extrusion lines producing 72,000 tpy. Recently, it increased capacity to 144,000 tpy with four lines.

"As our buyers in Europe audit the whole supply chain, it is better if we are fully integrated. We demand higher prices for our quality fillet as we do value adding. The company is AquaGap certified by IMO, and we are now implementing GlobalGap for our processing plants, farms and feed mill," said Vo Phu Duc, General Director of Vinh Hoan Feed.

The fish production sector is constantly challenged with price fluctuations. Duc said that ex-farm prices have been too low. In January 2010, prices went up to VND 18,000/kg but for only three weeks. In the last two months to June, ex farm prices were good at VND 16,700 to 17,000/kg but unfortunately since then they have gone down to VND 15,000/kg. The average cost of production is VND 15,000/kg. At these prices, times are difficult all along the supply chain.

"This is the reason Vinh Hoan has opted for the high value segment. As an integrated company, it pays to invest into high quality feed, both for the processing company and the farmer."

"While we have to supply to our farming system at market price and thus need to control production cost, quality feeds ultimately result in better performance and a higher income to the farmer. From the beginning, we had expert advice on post extrusion application systems. We invested in vacuum coating technology and apply enzymes to all our feeds. Liquid enzymes allow us to get the most from the ingredients that we use. The advantages are many fold. With increased bioavailability of phosphorus and better protein utilisation, catfish can make more efficient use of their diet. Farmers notice a better FCR of their fish, but for us it is equally important that this minimises wastage and reduces the amount of nutrients discharged into the environment," said Duc.

Under the Green Farm program, Vinh Hoan an official member of GlobalGap will have 5 farms certified by mid 2010. Feed factories, hatcheries and nurseries will follow at the beginning of 2011. The target is to have these certified before the second farms audit.

"We were always at the forefront of sustainable farming practices and decided early to go green. We supervise feeding management at the farms and actively monitor fish health and growth performance until harvest. We also invite our EU partners to visit our farms. The GlobalGaP certification is just the next step on our way to be recognised as a sustainable producer of pangasius in Vietnam," he added.

Huynh Duc Duy Linh

"Before we became a joint stock company, we were already producing feeds here in Sa Dec. Hung Vuong is a large exporter of pangasius catfish and has specific requirements for its feeds. Feed prices follow market prices and we benchmark against those from some feed mills such as Viet Thang, the leader in catfish feeds. We were required to have HACCP and ISO9000 certification and have worked to obtain ISO 22000. Since Hung Vuong is applying for GlobalGap in 12 months, the feed mill has to apply for this too. These two certifications are not easy to achieve but it is a necessity. This is our target in 2011," said Huynh Duc Duy Linh, Vice Director.

"The feed plant produces a range of feeds for the various sizes of fish. Some 20% of production comprise feed for 30g to 230g fish with 28% crude protein; 20% of 26% CP for 230g-400g fish and 60% of 22% crude protein feed for the larger 400-950g fish. Feeds (2.2mm) for fingerlings are bought. Feed performance is monitored easily at the Hung Vuong farms in Ben Tre and FCR is good at 1.43- 1.54," said Nguyen Van Lam, Director.

"Although prices are guaranteed, similar to other feed producers, we have to continuously seek ways to reduce processing costs. Unlike the independent feed producers, we are required to maintain a specific feed quality and we cannot adjust costs with reformulation. Thus, now we are producing steam using rice husks instead of coal. We constantly look for ways to save costs such as maximizing use of water, fuel and labour. At the same time, we would like to maintain and increase the quality of feed by research and improve the FCR and fillet quality of fish."

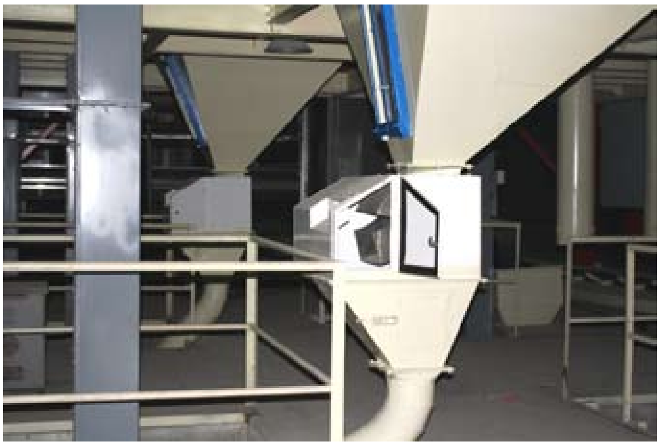
Relatively higher FCRs

According to Viet Thang's Nguyen Quang Hien, reports from the field show that feed performance has been declining.

"In 2008, farmers were confronted with the global economic slowdown and pangasius catfish also lost some markets. Ex-farm prices came down. Normally, farmers produce a one kg fish in 6-7 months but during that time it took almost one year to reach the same weight as farmers waited for prices to improve. Farmers reduced feeding rate as they merely wanted to keep the fish in the ponds. With this extended culture, feed conversion ratio (FCR) was higher."

"I benchmark feed performance with data in the field. Farmers are happy with a range of 1.45 to 1.5. In one survey of 100 ponds, it was reported that only 15% achieved a FCR of less than 1.5, 42.2% obtained 1.5 to 1.55 and 6.3% 1.56 to 1.59. The average is now 1.54

Nguyen Van Lam (centre) with Nguyen Quang Vinh, Behn Meyer Vietnam and Dirk Lorenz-Meyer, Behn Meyer Animal Nutrition



Post pellet addition equipment at a feed mill

Nutrition and feed quality

Dr Le Thanh Hung

Dr Le Thanh Hung, Nong Lam University has been monitoring the changes in feed usage in the industry. He said that competition and rising raw material costs are forcing feed millers to use lower quality raw materials. In the early years of the industry, the crude protein of pangasius feed averaged 26 to 28%. At present, the crude protein levels are 22%, 26%, 28% and 30%. There is also a 'economy' feed with 18% crude protein. The nutrient density of starter feeds has remained steady at 40% crude protein. However, only a very small number of feed producers are marketing these feeds.

Raw materials used in pangasius catfish feed production comprise rice bran, cassava, broken rice, defatted rice bran, wheat bran, fish oil, meat and bone meal and poultry blood meal. Several of these are available locally but rising prices are limiting their use. Depending on quality, locally produced fish meal can be used, but often the quality is too variable. Soybean meal is still imported with no value added tax.

Lower protein levels impacts fish fillet quality and increases FCR. Stress is also related to protein levels. Some ad hoc solutions include increasing vitamin C in the feed and use of immunostimulants. The use of n-3 fatty acids also affects flesh quality. Yellow fillet is attributed to oxidation of rice bran.

"The problems in the industry are also linked to high stocking density, although some farmers are beginning to recognise this and are reducing stocking density. My message is for the processors to demand higher protein levels in the feeds." said Hung.

"Despite the volume of production, there are still gaps in our knowledge in the nutrition of pangasius. The feed formulation is still based on a modification of the formula for channel catfish which is a sub tropical species, and the tilapia. The requirements for lysine and methionine are still not known, as well as that for some minerals. Unfortunately, there is still a lack of emphasis on this at government research centres and research has been left to the private sector."

Bagging at Hung Vuong Tay Nam's feed mill

for 8 months of culture. Better FCR is due to good feed and pond management," said Hien.

In general, survival of fingerling average 60% and this is also lower in the first quarter of the year. Hien also attributed poorer growth performance to poor fingerling quality. His next step is to build a hatchery to nurture better quality fry from the research centres. The 14g fingerlings will be sold to customers.

Nevertheless, despite the challenges in the catfish industry of over capacity, low prices, seed quality and disease issues, industry is optimistic that Sa Dec will emerge as the centre of fish feed production for the area of Dong Thap and the Northwestern part of the Mekong Delta. With the latest technologies employed by the new mills, there is a good probability that these companies will likewise persist.

Ms. Nguyen Thi Minh Huong is aquaculture manager of Behn Meyer Vietnam. She has 10 years of experience in aquaculture nutrition and health and is responsible for Behn Meyer's Freshwater Aquaculture R&D Centre in Binh Duong. The current focus of the team is on feed efficiency and antibiotic free ways to combat and prevent disease in catfish and tilapia. Email: minhhuong@behnmeyer-vietnam.com

Making a change in feeds

By Ron Hardy

Escalating fish meal prices require fish farmers to be ahead and position themselves with reformulations of feeds with plant protein concentrates.

Severe market disruptions beginning in 2007 with a doubling of fishmeal and fish oil prices followed in 2008 by an unprecedented rise in commodity prices for oil, grains and oilseed proteins gave aquaculture producers a double dose of financial stress as costs of production rose much faster than selling prices of products. This difficult period was followed by an unexpected and rapid drop to pre-2006 commodity prices (except for fishmeal and oil) over a period of just a few months at the end of 2008, but unfortunately, the drop was accompanied by a near total retreat of the value of many investments (stocks, bonds, real estate prices) to 2000 prices.

Associated with the rapid decline in prices were a worldwide credit freeze and a rapid fall in economic growth. The Chilean earthquake of February 27, 2010 caused a tsunami that destroyed much of the fishmeal manufacturing capacity of the country. The Gulf of Mexico oil spill that began on April 20, 2010 is expected to greatly affect fishmeal production in the USA for years to come. Together, these events are expected to have a long-term effect on global fish meal supplies.

The effect of all of these troubles on fish farmers has been brutal. Fish farmers have gone from being forward looking to operating on a defensive basis to stay financially solvent until economies recover. However, now may be the time for fish farmers to think ahead and position themselves for recovery of the global economy. The long-term outlook is in their favour. FAO's annual report "The State of World Fisheries and Aquaculture 2008" was released in March 2009 and contained some promising facts. World population continues to grow, per capita fish consumption continues to increase (16.7 kg in 2006) and the percentage of fish consumption supplied by aquaculture is set to equal that supplied by wild harvests.

Changing formulations

One way for fish farmers to move forward is to make permanent change in their feeds. Fish feed formulations are undergoing major shifts, primarily away from fishmeal and toward plant protein concentrates. Fishmeal prices, which reached USD1,400/tonne in June 2006, retreated to USD1,050 but then climbed again to USD1,200 by June 2008 and to even higher numbers in 2010. It appears that the 30-year price range, which had been between USD400/tonne and USD 800/tonne prior to 2007, has shifted upward, with a new bottom price above the old top price.

FAO reports that fishmeal prices are expected to remain high, along with fish oil prices, which followed a similar pricing pattern since 2006 to that of fishmeal, except higher. One of the drivers of higher prices for fishmeal and fish oil is demand. FAO estimates that over 60% of annual global fishmeal production is now used in aquaculture feeds. The percentage is about 85% for fish oil, with salmon feeds consuming 55% of the fish oil used in aquaculture feeds. These values are not expected to decrease.

Plant protein concentrates

Clearly the future for aquaculture is that the bulk of dietary protein in grow-out feeds will be supplied from plant protein concentrates, saving fishmeal for special uses, such as starter feeds for fry and fingerlings and for fish species that cannot, as yet, be reared successfully without it. Feeds for omnivorous species, such as carp, catfish and tilapia, can easily be formulated to contain very low or even no fishmeal and meet the dietary amino acid requirements of the fish. However, optimum fish performance when plant-based feeds are used requires more than simply balancing essential amino acid levels.

Adding phytase is crucial to ensure mineral bioavailability.

Micro and macro minerals and bioavailability

Fishmeal is an excellent source of amino acids, but it also supplies other essential nutrients to aquaculture feeds. One group of essential nutrients that requires careful formulation when fishmeal is reduced or eliminated from aquaculture feeds is the minerals. Fish meal is a rich source of minerals, both macro minerals such as calcium, phosphorus, magnesium, sodium and potassium, and trace minerals such as zinc, manganese, iron, selenium and iodine.

These minerals are present in much higher levels in fishmeal than in plant protein ingredients, mainly due to the presence of fish bones and other hard tissues in fishmeal. Furthermore, they are easily digested by fish, at least those with a gastric stomach, leading to higher apparent digestibility coefficients than those measured for minerals in plant proteins. Acid conditions in the stomach dissolve fish bones, making the minerals they contain more easily absorbed in the intestines.

However, just adjusting mineral supplements in plant-based fish feeds is not enough to support maximum fish growth and health. Plants contain phytate, also known as phytic acid or myo-inositol hexakis dihydrogen phosphate. Each molecule of phytate contains six molecules of phosphorus. Phytate is the storage form of phosphorus in seeds, such as grains and oilseeds, and phytate-phosphorus is indigestible to monogastric animals, such as fish, birds and man. Ruminant animals have bacterial in their stomachs that digest phytate by producing an enzyme called phytase. Phytase catalyzes the release of phosphorus for absorption in the intestine.

Some species of fish also contain small amounts of phytase from bacterial in their gut, but generally the activity of phytase is too low to release sufficient phosphorus from phytate. Phytate is a natural chelate, meaning that in addition to having a high affinity for phosphorus, it also can bind to other minerals, specifically divalent cations such as zinc, calcium, magnesium, manganese and iron. As a result, plant-based feeds must be formulated carefully to ensure adequate levels of available minerals, both macro minerals and trace minerals. This is an example of an antagonistic interaction in feeds between dietary ingredients.

To overcome this problem, feeds can be over-fortified with minerals and microbial phytase can be added to facilitate the release of phosphorus and prevent antagonistic interactions. Adding phytase is crucial to ensure that mineral bioavailability is not reduced by phytate. Microbial phytase is now a common and reliable feed additive, available from several sources.

Many research and field studies with tilapia, catfish, and carp have been conducted showing that addition of 1000 FYT per kg feed increases apparent digestibility coefficients of dietary phosphorus in plant protein-based fish feeds, and increases the concentrations of ash, calcium, phosphorus, magnesium and zinc in fish bones. Fish also experience higher weight gain. The effects of phytase are magnified when diets are supplemented with citric acid.

Need for bone mineralisation in farmed fish

Why is it important to ensure adequate bone mineralisation in farmed fish, especially grow-out fish that will be harvested? First, bone mineralisation is simply a marker for adequate phosphorus status in fish. In fact, phosphorus is a critical nutrient not simply for bone formation, but for cellular energy metabolism (ATP, ADP), phospholipids (cell membranes), buffering blood, and many other essential cellular functions. This is an important point.

Although the primary tissues monitored for adequate phosphorus status in fish are bone or scales, phosphorus, like all essential nutrients, is needed by all cells in the body. Even partial deficiencies in essential nutrients, including phosphorus, reduce fish performance without being clinically detected in farmed fish. Thus, it is essential for economic fish growth to ensure adequate phosphorus status in fish.

Secondly, adding phytase allows phytate phosphorus to become available to fish. If it were not made available, it would be excreted in the faeces, contributing to eutrophication in the pond, thereby lowering pond water quality and reducing fish yields. Releasing phosphorus from phytate makes it unnecessary to add inorganic phosphorus supplements to plant-based feeds, thereby reducing feed costs and lowering phosphorus levels in pond water or farm discharge water.

Finally, adding phytase is economically advantageous because it reduces the cost per kg gain in fish by preventing sub-clinical phosphorus deficiency and also sub-clinical deficiencies of other essential minerals. Such sub-clinical deficiencies often go undetected, but reduce fish performance, lowering production and the profitability of pond aquaculture, especially in carp, catfish and tilapia that are fed soybean meal-based feeds.

Ron Hardy, is Director of the Aquaculture Research Institute and the Hagerman Fish Culture Experiment Station, University of Idaho, and a Professor in the Department of Animal and Veterinary Sciences, University of Idaho. He is an expert on aquaculture, fish nutrition and feed production technology, authoring over 250 scientific publications, book chapters and popular articles on these topics. His research interests include developing sustainable feed sources for the global aquaculture industry and expanding the use of genomics in fisheries research. Email: rhardy@uidaho.edu

Botanical extracts enhance disease resistance and reduce parasitic **infestation in pangasius catfish**

By Peter Coutteau, Nguyen Huu Thinh, Simon Eskinazi and Huyen Dieu Nguyen

Pangasius catfish production in Vietnam has increased significantly over the past years with production reaching well over 1 million tonnes since 2007. The rapid development of *P. hypophthalmus* culture has lead to intensive culture practices where stressors such as crowding and poor water quality are common. As a result, farmed catfish become more susceptible to disease agents. Bacillary necrosis and red spot disease caused by *Edwardsiella ictaluri* and *Aeromonas hydrophila*, respectively, are wide spread bacterial diseases in intensive farming of the pangasius.

High stocking densities can quickly lead to heavy infestations by monogenean ectoparasites on the gills of fish. The use of antibiotics and chemicals to treat bacterial and parasitic diseases has the risk of resistant bacteria, bioaccumulation and environmental pollution. Commercial vaccines are not available for the pangasius catfish. One of the most promising methods of controlling diseases is improvement of the resistance of fish through prophylactic administration of natural products derived from herbal extracts.

The present experiment evaluated the effects of dietary administration of a synergistic blend of botanical extracts with anti-bacterial and anti-parasitic activities (APEX AQUA, Nutriad, Belgium) on disease resistance of Pangasius catfish against *E. ictaluri*, *A. hydrophila* and monogenean gill parasites.

Feed preparation and dosage levels tested

Three isonitrogenous and isoenergetic, floating feeds were extruded in a commercial feed mill. A basal commercial feed formulation was used, including fishmeal, soybean meal, rice bran, meat bone meal, cassava meal, vitamin and mineral premix. A non-supplemented control feed (referred to as 'control') and two dosage levels of the blend of botanical extracts were evaluated ('Apex 0.5' and 'Apex 1', supplemented with 0.5 and 1 kg/tonne of feed, respectively). Analytical values were very similar for all test feeds (crude protein 29.6-30.2%; crude fat 3.9-4.1%; calcium 1.1-1.3%; phosphorous 1.2-1.3%).

Experiment 1: Effects of a blend of botanical extracts on growth performance and incidence of gill monogenean parasites

This was carried out in a nursery pond located in Thotnot District, Cantho Province. The pond was in a nursing cycle of fingerling pangasius catfish and fish were cultured at the density of 60 fish/m^2. Healthy fingerlings of 9-11g in weight from the pond were used in the experiment.

Fish were fed a commercial diet twice daily to apparent satiation before the start of the experiment, conducted in 9 hapas (2x4x1.5 m) in the nursery pond. Each hapa contained 640 fish (at a density of 80 fish/m^2). The fish were fed experimental diets for 8 weeks. Physicochemical parameters, temperature, dissolved oxygen, ammonia and pH of water in pond were checked weekly. These were within acceptable ranges for pangasius catfish culture. The fish were fed twice daily to satiation. Feed intake was registered daily. Parameters measured included the specific growth rate (SGR), daily weight gain (DWG), survival (SR), and feed conversion ratio (FCR).

Five fish from each hapa were examined weekly for monogenean infection in the gills. Gill filaments were excised and placed in a wet mount then compressed by applying pressure using a cover slip. The entire wet mount was scanned from left to right and from top to bottom using a compound microscope at low magnification. The monogenean numbers were recorded for the calculation of infection rate and mean intensity of infection.

Hapas used in the experiments

Experiment 2: Effects of a blend of botanical extracts on disease resistance in pangasius catfish

Fish were challenged with two strains of pathogenic bacteria *E. ictaluri* and *A. hydrophila*, respectively, to evaluate the effect of the botanical complex on disease resistance.

Healthy and non-infected fingerlings (8-10g), were acclimated to confined conditions in tanks for 2 weeks. Fish were fed a commercial diet twice daily to apparent satiation before starting the experiment. The experiment was conducted in 9 hapas (1x1x1 m) submerged in concrete tanks. Each hapa contained 100 fish.

The bacterial strains, *E. ictaluri* VL33 and *A. hydrophila* VL01, were isolated from diseased pangasius catfish from Vinh Long Province in June 2007. Strains were cultured in brain heart infusion (BHI) broth for 18 h at 25-30°C. Bacterial growth on BHI agar for 24-48 h at 30°C was used for bacterial identification. Bacterial counts were done by spread plate on BHI agar.

Challenge tests

After 2 weeks of feeding on the experimental diets, fish from each hapa were transferred to tanks (0.4x0.6x0.6m) containing 70 litres of water.

50 fish in each tank were used for the challenge with *E. ictaluri* and the remaining fish were subjected to *A. hydrophila* infection. A bacterial analysis was performed before the start of the challenge test to ensure that fish were not infected by the challenge bacteria.

A bath challenge was applied with *E. ictaluri* (exposure during 1h at 1.44 x 10^6CFU/ml). Intraperitoneal injection was applied for the challenge with *A. hydrophila* (0.1 ml of a bacterial dilution containing 1.47 x 10^8 CFU/ml per fish). After the challenge, the fish were monitored for 14 days in the tanks. Relative Percent Survival (RPS) was calculated using the following formula,

$$RPS\ (\%) = \left\{ 1 - \frac{\text{Percent mortality in treated group}}{\text{Percent mortality in control group}} \right\} \times 100$$

Effects on fish performance

The supplementation of the botanical complex improved the fish performance in terms of growth and feed conversion with significant effects obtained only for the highest dosage (Table 1). Although not significant, there was a trend for improved survival with increasing dosage of the botanical extracts. Feed intake was not affected by the feed supplementation in this trial.

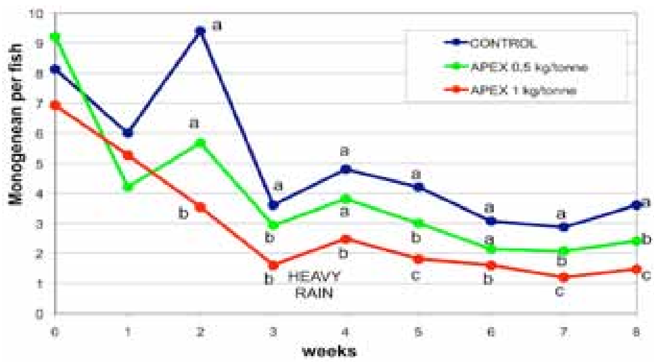
Effects on incidence of gill monogenean parasites

The intensity of monogenean infection usually becomes worse during a fingerling nursing cycle. On the contrary, the monogenean intensity in the control treatment of this experiment decreased gradually from the beginning to the end of the experiment. This might be due to the

Table 1. Survival, feed conversion ratio and growth performance after 8 weeks of feeding. Different letters denote significant difference P<0.05.

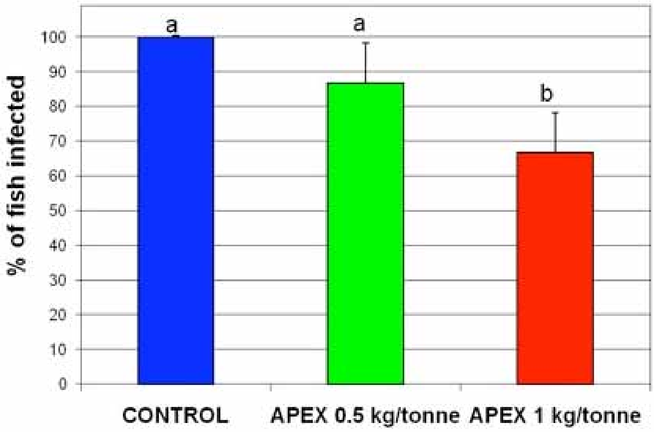
Parameter	Treatment		
	Control	Apex 0.5 kg/tonne	Apex 1 kg/tonne
Initial weight (g)	9.95 a	9.90 a	10.26 a
Final weight (g)	67.55 a	69.92 ab	71.36 bc
Specific growth rate (%/day)	3.01 a	3.05 a	3.13 b
Feed intake (g/fish/day)	1.46 a	1.49 a	1.44 a
Feed conversion ratio	1.42 a	1.41 a	1.34 b
Survival rate (%)	83 a	85 a	90 a

Figure 1. Intensities of monogenean infection in fish fed different levels of a blend of botanical extracts during 8 weeks. Different letters denote significant difference P<0.05.



better water quality resulting from reducing feeding rate for fish in the pond. The intensity of monogenean infestation was significantly reduced from week 2 onwards for treatment Apex 1 kg/tonne and from week 3 for treatment Apex 0.5 kg/tonne (Fig. 1). The highest dosage of the botanical extracts gave the best results in reducing monogenean count per fish. At the end of the trial, the number of fish infected with monogenean was significantly lower for the group supplemented with the highest dosage of the phytobiotic compared to the other treatments (Fig. 2)

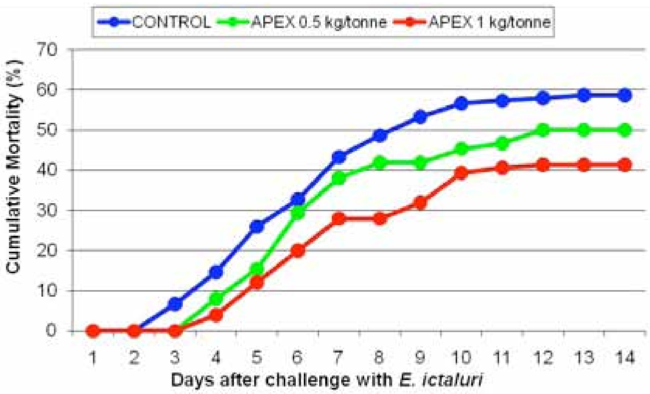
Figure. 2. Prevalence of monogenean infection of fish fed different levels of a blend of botanical extracts during 8 weeks. Different letters denote significant difference P<0.05.



Effects on resistance to an experimental infection

The efficacy of the experimental infections was confirmed by isolating *E. ictaluri* and *A. hydrophila* from the liver, kidney and spleen of moribund and recently dead fish; and observing their respective disease symptoms (*E. ictaluri*: white spot necrosis in the liver, kidney and spleen; *A. hydrophila*: hemorrhagic infections on the mouth, abdomen skin, fins and internal organs).

Figure 3. Cumulative mortality of *E. ictaluri* challenged fish fed different levels of a blend of botanical extracts during 2 weeks prior to infection.



There was no significant difference in mortality of control fish compared to fish fed the treatment feed with 0.5 kg/tonne of botanicals after challenge with *E. ictaluri* (Fig. 3). However, mortality in fish fed 1 kg/tonne of the botanical complex was lower than in fish fed the lower dosage and even significantly lower compared to the control group (relative percentage survival 30%; Table 2). The botanical extracts showed even more significant protective effects during the challenge experiment with *A. hydrophila*, where mortalities of fish receiving

Figure. 4. Cumulative mortality of *A. hydrophila* challenged fish fed different levels of a blend of botanical extracts during 2 weeks prior to infection.

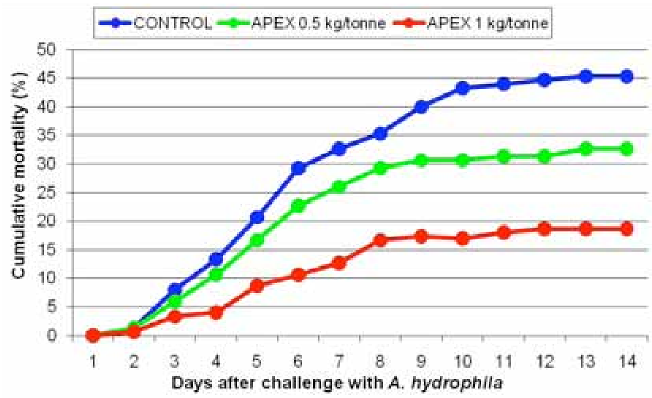


Table 2. Cumulative mortality and relative percent survival compared to control (RPS) of fish in a bacterial challenge test. Different letters denote significant difference P<0.05.

	Challenge with *E. ictaluri*			Challenge with *A. hydrophila*		
Treatment	Control	Apex 0.5 kg/ tonne	Apex 1 kg/ tonne	Control	Apex 0.5 kg/ tonne	Apex 1 kg/ tonne
Mortality (%)	58.7a	50.0ab	41.3b	45.3a	32.7b	18.7c
RPS (%)		14.8	29.6		27.9	58.8

both dosages of the botanical extracts gave significant differences compared to the control treatment (Fig. 4; Table 2).

Conclusion

Synergistic blends of botanical extracts offer an interesting potential to increase production efficiency and reduce the effects of bacterial diseases and monogenean gill parasites on productivity of pangasius catfish farming using natural ingredients. The reported trial results showed a clear dose-response relationship for a specific phytobiotic complex added to the feed of the fish, resulting in improved performance in terms of growth and feed conversion, reduced incidence of gill parasites and improved disease resistance against two important bacterial pathogens. Further work is required to understand the mechanisms of synergistic botanical products on productivity and health of fish.


Peter Coutteau


Nguyen Huu Thinh

Dr. Peter Coutteau is Business Development Manager Aquaculture for Nutriad (p.coutteau@nutriad.net).

Dr. Nguyen Huu Thinh is head of the Fish Pathology Department at the Faculty of Fishery, Nong Lam University, Ho Chi Minh City, Vietnam.

Simon Eskinazi is Technical Marketing Manager for Nutriad Ltd., Chester, United Kingdom.

Huyen Dieu Nguyen is Country Manager for Nutriad Asia in Vietnam.

Effect of essential oils on the growth performance and intestinal bacterial **populations of the channel catfish**

by Zonglin Zheng and Matt Pearce

Channel catfish *Ictalurus punctatus* is an important aquaculture species originally from USA but introduced into China in the mid 1980s and now widely cultured in China. In 2009, Chinese channel catfish production was estimated at over 500,000 tonnes in both small scale and larger commercial monoculture and polyculture systems.

Optimisation of feed intake and nutritional composition of the diet helps to ensure that channel catfish show the maximum growth from feed consumed. Ingestion of aquatic feed inevitably causes drinking of the localised aquatic environment putting the gut interface of catfish into direct challenge with the indigenous pathogenic microbial community. The gastrointestinal tract is responsive and sensitive to a wide range of stressors.

Phytogenic ingredients in aquaculture

Various phytogenic ingredients have been shown to facilitate beneficial effects on gut environment and microflora, though some plant species have a stronger impact than others. The antimicrobial effects of phenolic compounds which are the active ingredient of phytogenic feed additives, target pathogenic bacterial cell walls by interaction with the cytoplasmic membrane and changing its permeability for cations, like H^+ and K^+.

Orego-Stim® (Meriden Animal Health Ltd., UK) a 100% natural feed additive contains essential oils which include precise natural compositions of a-terpinene, p-cymene, carvacrol and thymol. These components are found to have inhibitory effects on microorganisms especially in spore forming organisms.

It has been clearly demonstrated that chronic stress measured by prolonged elevated blood plasma cortisol concentration in trout results in dose dependent increased mortality from common aquatic bacterial and fungal diseases. This finding is not just confined to salmonid species but is a normal physiological response in all fish species. The hypothalamic-pituitary-interrenal axis in fish which can be stimulated by both environmental and stress events affects the production of lymphocytes and antibody response as well as the reproductive capacity. Gut Associated Lymphoid Tissue (GALT) is the interface between the diet, host physiology and gut microflora. GALT activity can be modified through the diet by three principles – competitive bacterial exclusion, bacterial antagonism and immune modulation which in turn affect the health and commercial productive status of fish.

This latest experimental trial in channel catfish was to investigate the response of bacterial populations when exposed to this feed additive. Both aerobic and anaerobic beneficial and pathogenic populations of bacteria were isolated and quantified from different regions of the intestine of channel catfish. Various other growth parameters, weight gain, feed conversion ratio, specific growth rate, protein efficiency ratio and survival were also quantified.

Fish and culture conditions

Channel catfish propagated and reared by the Research Institute for Fisheries in Chongqing, China were used for the experiment. Trials were conducted in a recirculation aquaculture system at Southwest University in Chongqing. Fish with an average initial weight of 50g were held in 200 litre fibreglass tanks. Fish in randomly assigned duplicate aquaria (40 fish per aquaria) were fed one of the two experimental diets to apparent satiation six times a day. Water temperature was constant at 23-24°C and pH was kept at 8.5 throughout the experimental period. Water flow was maintained at 4.5 l/minute.

Experimental design and diets

The diets tested were a control with no feed additive and treatment diet (OS) contained Orego-Stim®, 50g/kg of feed. The formulation and proximate composition is given in table 1. Both diets were formulated to be isocaloric (12.51 kJ/ kg diet) and isonitrogenous (345g/kg of crude protein). All ingredients were finely ground, mixed in a Hobart mixer and pelleted through a 2.4 mm diameter die in a Hobart meat grinder. The pellets were air-dried at room temperature, fragmented and stored in a freezer until use. Ingredients and proximate composition of the experimental diets are presented in Table 1.

The feeding trial lasted 8 weeks. At each feeding, an excess amount of feed was fed to the fish and uneaten feed was collected an hour after feeding, dried at 70°C and reweighed. Leaching of uneaten feed was estimated by placing weighed samples of each diet into a tank without fish for an hour and then recovered, dried and reweighed. The average leaching value was used to correct the amount of uneaten feed.

Intestine bacteriological sampling

Six channel catfish were sampled from each diet group after one day starvation. The fish were killed and the number of incidental organisms was reduced by washing the fish skin with 700ml/litre ethanol before opening the ventral surface with sterile scissors. The spleen, gallbladder and liver were removed. The intestinal sections were emptied and thoroughly rinsed three times in 2ml sterile 9g/kg saline to remove non-adherent bacteria. Anterior intestine (AI), mid intestine (MI), and posterior intestine (PI) of the corresponding sections were treated separately, and were then transferred to sterile plastic bags and homogenised in a Stomacher (Seward Laboratory, London, UK).

Table 1. Formulation (g/kg) and proximate composition of the diet.

Ingredients		Chemical composition	
Soybean meal	300.00	Digestible Energy (kJ/ kg)	12.51
Rapeseed meal	260.00	Crude protein (%)	34.50
Corn gluten meal	50.00	Crude lipid (%)	3.85
Fish meal	100.00	Ash (%)	6.24
Wheat shorts	220.00	Ca (%)	0.85
Rapeseed oil	20.00	Total Phosphorus (%)	1.22
$Ca(H_2PO_4)_2$	16.00	Available Phosphorus (%)	0.80
Vitamin premix [a]	1.70	Lysine (%)	1.75
Choline chloride	2.00	Methionine + Cystine (%)	1.32
Sodium chloride	1.00		
Mineral premix [b]	5.00		
Bentonite	24.30		

Note: Crude protein, crude lipid, ash, crude fibre are expressed on a dry matter basis and given as means. Lysine, Methionine & Cystine expressed as percentage of the diet.
[a] Vitamin mix provided the following vitamins (mg kg^{-1} diet unless otherwise stated): vitamin A, 4000 IU; vitamin D3, 2000 IU; vitamin K, 10; vitamin E, 50; thiamine, 10; riboflavin, 12; pyridoxine, 10; panthothenic acid, 32; nicotinic acid, 80; folic acid, 2; biotin, 0.2; vitamin B12, 0.01; L-ascorbyl-2-polyphosphate (250 g kg^{-1} vitamin C activity), 60.
[b] Trace mineral mix provided the following minerals (mg kg^{-1} diet): zinc (as $ZnSO_4{\cdot}7H_2O$), 150; iron (as $FeSO_4{\cdot}7H_2O$), 40; manganese (as $MnSO_4{\cdot}H_2O$), 25; copper (as $CuCl_2$), 3; iodine (as KI), 5; cobalt (as $CoCl_2{\cdot}6H_2O$), 0.05; selenium (as Na_2SeO_3), 0.09.

Bacterial plates spreading and count

Homogenates of the intestinal sections were diluted in sterile 9 g/kg saline and appropriate dilutions were spread on the surface of fresh water agar (FWA) plates. The formulating method of FWA was as follows: $MgSO_4$ (0.05 g), beef extract (2.5g), NaCl (500g), K_2HPO_4 (0.2g), glucose (1g), peptone (5.0g), yeast extract (2.5g), agar powder (15.0g), add water to 1000 ml, pH 7.2-7.4, and sterilised for 30 min at 121°C.

Eighteen FWA plates were spread with homogenates of the intestinal sections in each group. Nine plates were incubated at 30°C for 24 to 48h in an incubator, and 9 plates were incubated at 30°C for 48 to 72h in an anaerobic incubator. Plates with 20-200 bacterial colonies were counted and bacterial numbers in plates were converted to the number per unit weight of intestine.

Identification of bacteria

Approximately 10 colonies were randomly picked from plates containing 20 to 200 bacteria. A total of 100 isolates were inoculated with a method of slope culture, respectively. Sixty tubes were incubated at 30°C for 8 to 12h in an incubator, and placed at 4°C after incubation. Another 40 tubes were incubated at 30°C for 24 to 36h in an anaerobic incubator, and were identified after 4h.

Bacterial identification was in accordance with Bergey's Manual of Determinative Bacteriology. Anaerobic bacteria were identified with an automatic microorganism identification instrument (VITEK-2) by BioMerieux Company and identification plate (VITEK-ANA) for anaerobic bacteria.

Growth performance

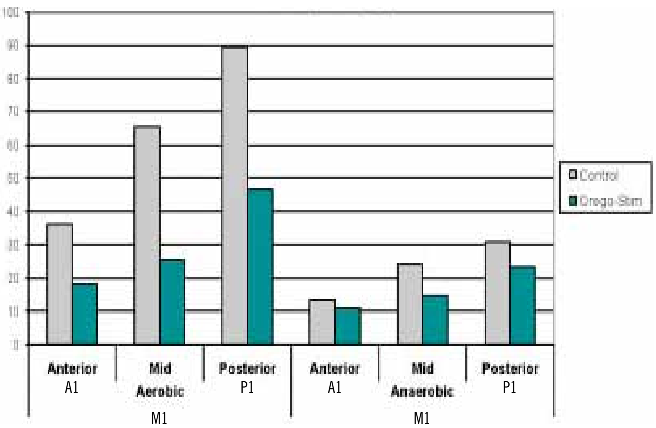
The overall survival rate of the catfish in both treatments was high (>95%) and appeared to be unrelated to dietary treatment (Table 2). Weight gain and specific growth rate of fish fed the OS diet was significantly higher than those of fish fed the control diet (P<0.05). Better FCR and highest PER values were observed for catfish fed the OS diet compared to catfish fed the control diet (P<0.05).

Table 2. WG, SGR, FCR, PER and survival of channel catfish fed different diets with feed additives.

Diets	WG[1] (g)	SGR[2] (%/d)	FCR[3]	PER[4]	Survival
Control	102.63±2.22^{a}	1.95±0.04^{a}	1.94±0.092^{a}	1.49±0.08^{a}	95.83±2.89^{a}
OS	127.53±6.40^{c}	2.24±0.12^{b}	1.64±0.04^{b}	1.77±0.07^{b}	98.33±1.44^{a}

Data were presented as mean±SD (n=2). Value in the same column having different superscripts is significant (P<0.05).
[1] WG (Weight gain, g) = final body weight – initial bodyweight
[2] SGR (Specific growth ratio, %/d) = (log_e average final weight - log_e average initial weight) / no days) x 100
[3] FCR (Feed conversion ratio) = feed consumed (g, dry weight) / weight gain (g)
[4] PER (Protein efficiency ratio) = weight gain (g) / protein intake (g)

Figure 1. Distribution of numbers of aerobic and anaerobic bacteria species in the anterior, mid and posterior intestine of channel catfish.



Aerobic bacteria

Intestinal aerobic bacteria of 4 families (genera) of channel catfish were identified. The intestinal predominant aerobic bacteria were *Enterobacteriaceae Ent.), Aeromonas (Aer.), Bacillus (Bac.)* and *Vibrio (Vib.)* (Figures 1-2).

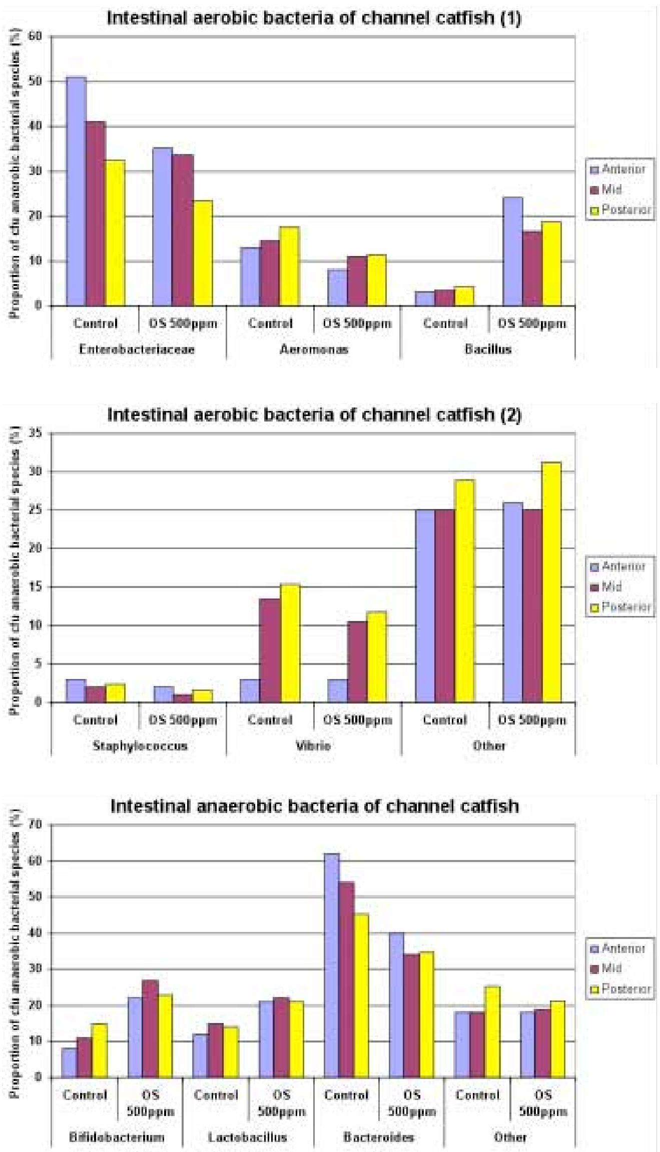
In AI, the numbers of *Enterobacteriaceae* in fish fed the additive decreased significantly compared to control (P<0.05). Numbers of *Aer.* also declined in fish fed the additive diet and this result was significantly different from the control (P<0.05). Conversely, *Bac.* numbers increased significantly upon addition of the additive (P<0.05). Addition of the additive had no effect on the numbers of *Staphylococcus (Stap).*

In MI, the numbers of *Ent.* significantly decreased upon addition of the additive (P<0.05). The feed additives had no effect on the numbers of *Aer.*, *Stap.* and *Vib.* The numbers of *Bac.* also increased significantly in fish fed the additive diets compared to control (P<0.05). In PI, the numbers of *Ent., Aer., Stap.* and *Vib.* decreased with the additive diet.

Anaerobic bacteria

The three intestinal anaerobic bacteria identified with the identification plate (VITEK-ANA) of anaerobic bacteria were *Bifidobacterium (Bif.)*, *Lactobacillus (Lac.)* and *Bacteroides (Bact.)*, respectively. The

Figures 2-4. Composition of aerobic and anaerobic bacteria species in the anterior, mid and posterior intestine of channel catfish.



predominant intestinal anaerobic bacteria were *Bact. Bif.* and *Lac.*

In the AI, MI and PI numbers of *Bif.* and Lac in the additive group significantly increased compared to that of the control (P<0.05). Numbers of Bact. significantly decreased in the additive group compared to that of control (P<0.05).

Discussions and conclusion

In this trial, Orego-Stim® demonstrated its ability to selectively reduce or increase different species of bacteria. Numbers of key pathogenic bacteria such as *Ent. Aer.* and *Vib* were reduced in the treatment group of catfish, whereas beneficial bacteria which help to promote gut health such as *Lac.* and *Bif* had higher numbers of bacteria. It also shows that the additive acts in a similar way as probiotics using competitive exclusion, but unlike probiotics, this feed additive has much more potent antimicrobial properties.

However, this specific discipline of aquaculture feed science is still an innovative and pioneering technology. At the time of writing the exact biochemical mechanism by which beneficial bacteria are allowed to grow in the intestines and pathogenic bacteria are killed, is still not fully understood. The theory is that there must be a structural difference in the cell wall of the two classes of bacteria possibly relating to epitopes and virulence factors which selectively promotes or prevents cell lysis upon exposure to the phytogenic additive, but this needs further research

What is clear is that both the holistic and generic effects of Orego-Stim® work in a way that alters intestinal bacterial populations and benefits the host fish by increasing aquaculture productivity, both experimentally and commercially.

References are available on request.

Zonglin Zheng

Matt Pearce

Zonglin Zheng, PhD is with the School of Veterinary Medicine of Sichuan Agriculture University, Sichuan and Fisheries Breeding and Healthy Cultivation Research Centre, South-west University, Chongqing,P. R. China. Email: zhengzonglin@126.com

Matt Pearce is International Technical Support Specialist, Meriden Animal Health Limited. Email: mattpearce@meriden-ah.com

Thailand's tilapia in 2009

Higher production, higher prices and more frozen fillet to the US in 2009, says Dhanapong Sangsue.

The global tilapia production was recorded at 2.27 million tonnes in 2009 and it was expected to reach 3 million tonnes in 2010. China stands out with the largest tilapia production of half of global production. China, together with production from other parts of Asia, accounted for 70% of the global production.

Market analysis showed that imports of frozen fillet increased by 16.35% in volume in the first 9 months of 2009. This indicated that US consumers switched more to frozen fillet than chilled fillet, due to the economic slowdown. Imports of whole frozen fish and chilled fillet reduced by 16% and 9.75%, respectively. The main share of fresh tilapia fillet imported into the US came from Ecuador and Honduras. China and Indonesia were the top two in the list of main tilapia fillet frozen suppliers to the US.

Thailand's tilapia

In 2008, the Thai Department of Fisheries said that there was a disease outbreak which spread to all of the tilapia farming areas. This resulted in a lower production as compared to that in 2006 and 2007. However, production in 2009 increased slightly.

Table 1. Tilapia production in Thailand.

Year	Number of farms	Area (rai)[1]	Production (tonnes)
2005	233,122	394,742	203,737
2006	247,281	409,546	190,075
2007	240,815	362,475	190,075
2008	235,931	360,074	195,900
2009	238,420	360,488	197,021

1 One rai equals 1,600m²
Source: adapted from Pongmaneerat (2010)

Higher local prices

The short supply following disease outbreaks resulted in increases in local market prices during 2007 and 2008. According to an estimation by the Thai Feed Mill Association, fish feed use increased from 504,000 tonnes in 2008 to 581,800 tonnes in 2009. However, in February 2010, the wholesale price of fish feed increased by 3-4%. This followed the trend of increases in prices of feed raw materials such as dry crops and fish meal, in particular. In March 2010, there was a report that local tapioca production was hit by mealbugs while corn was at the late phase of its production season.

Table 2. Trends in average Bangkok market prices (THB/kg) for the tilapia in comparison with hybrid catfish and vannamei shrimp.

Products	2007	2008	2009
Medium-sized nile tilapia (3-4 tilapia/kg)	33.22	39.27	43.83
Large-sized nile tilapia (1-2 tilapia/kg)	44.48	49.20	55.56
Medium-sized hybrid catfish (3-4 fish/kg)	48.66	50.82	53.57
Large-sized hybrid catfish (1-2 fish/kg)	47.91	50.47	53.07
Vannamei shrimp (mixed sizes)	168.41	165.60	160.98

Source: Thai Ministry of Commerce
One THB equals 32.21 THB (July 27, 2010)

Exports

Reports from the Thai Department of Fisheries showed that in the first three quarters of 2009, exports totaled 11,255 tonnes which was 25% down in volume from the same period in 2008 but up in value by 15%. The breakdown of exports was whole frozen fish 60.66%, frozen fillet 26.35%, and chilled fillet 10%. Exports went to the following markets; US, 21%, France, 12.75%, Saudi Arabia, 12.71%, U.K., 10.26% and Arab Emirates, 9.46%.

US imports of tilapia

During 2008-2009, US imports of tilapia fillet fresh and tilapia frozen from Thailand showed a decreasing trend while tilapia fillet frozen increased (Table 3). Additionally, in the tilapia fillet frozen category, product of Thailand ranked the fourth among Asian exporters after China, Indonesia, and China-Taipei.

Table 3. Summary of imports of tilapia and tilapia product into the US market in 2008/2009.

	2008(kg)	2008 (USD)	2009 (kg)	2009 (USD)
Fillet fresh				
China	0	0	20,769	109,200
China Taipei	561,646	2,700,140	207,949	1,348,949
China Hongkong	52,552	201,852	0	0
Thailand	34,274	198,857	17,654	84,472
Indonesia	0	0	0	0
Fillet frozen				
China	90,285,571	384,025,557	100,691,098	363,266,149
China Taipei	2,088,544	10,803,134	2,332,494	12,483,161
China Hongkong	87,584	323, 276	0	0
Thailand	440,059	1,846,514	678,831	3,792,956
Indonesia	9,628,825	56,275,597	8,757,932	56,464,317
Malaysia	6,800	11,138	0	0
Philippines	17,368	139,105	1,701	10,500
Vietnam	10,606	37,400	156,028	555,401
Tilapia frozen				
China	29,028,940	51,975,407	29,671,564,	44,175,802
China Taipei	15,863,239	29,881,795	13,179,606	23,915,366
China Hongkong	215,489	381,184	0	0
Thailand	3,315,237	5,534,289	904,663	1,676,321
Indonesia	163,869	824,915	11,026,431	
Japan	12,375	22, 501	0	0
Malaysia	49,497	61, 958	18,144	27,550
Philippines	190,210	377, 186	23, 871	55,079
Singapore	1,060	3,176	0	0
South Korea	36,200	75,466	0	0
Vietnam	212,656	472,650	132,266	330,770

Source: U.S. National Marine Fisheries Service, Fisheries Statistics and Economics Division (data through May 2010, access on July 28, 2010)

2010 outlook in Thailand

In the first quarter of 2010, drought was expected to have a significant impact on the main areas of tilapia farming in Thailand. Therefore, farmers had no choice but wait for an adequate water supply before they could begin stocking fish. At the same time, the disease outbreak was still a concern to the farmers. Due to the above situation, it is expected that the production of Thai tilapia in 2010 will not be very different from the previous year.

Dhanapong Sangsue is Technical Sales Manager -Aqua at Evonik Degussa (SEA) Pte. Ltd, Singapore. Email: dhanapong.sangsue@evonik.com

Managing tilapia health in complex commercial systems

By Neil Wendover

Key components of integrated health management are proactive strategies focusing on prevention of disease and on the responsible use of therapeutic agents when disease outbreaks occur.

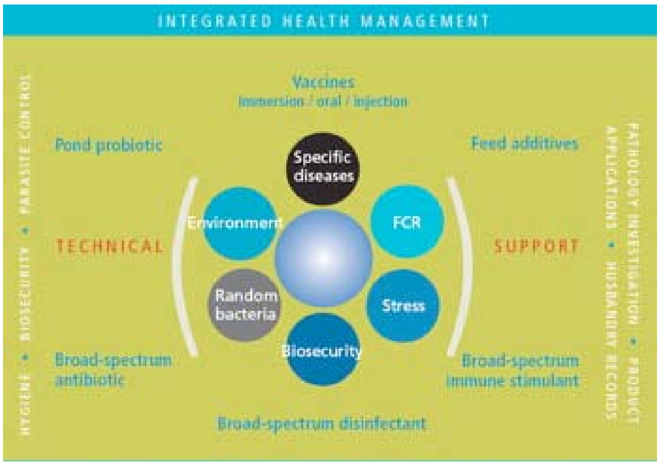
The tilapia is currently the second-most-produced fish in the world and production of this species is increasing. In fact, the popularity of tilapia is skyrocketing. By 2010, Intrafish (2005) predicts that the global value of tilapia will be USD 4 billion.

There are several reasons for the increase in production. Tilapia can be produced in various locations, water systems, temperatures and salinities. They have good performance characteristics such as fast growth, high fillet yield and low feed-conversion ratio as well as firm, white fillet that makes them easy to market.

In many areas, tilapia production is in extensive system and likely to intensify. Intensified production, however, will undoubtedly lead to challenges, including sourcing quality seed, maintaining fish quality, controlling disease, ensuring food safety and effective marketing.

When adhered to, good sanitation can control or even eliminate disease outbreaks, but implementation is often a limiting factor.

Figure 1. Integrated health management takes into account all factors on the farm that affect fish health and is required for effective prevention and control of disease.



Intensive tilapia production in Malaysia

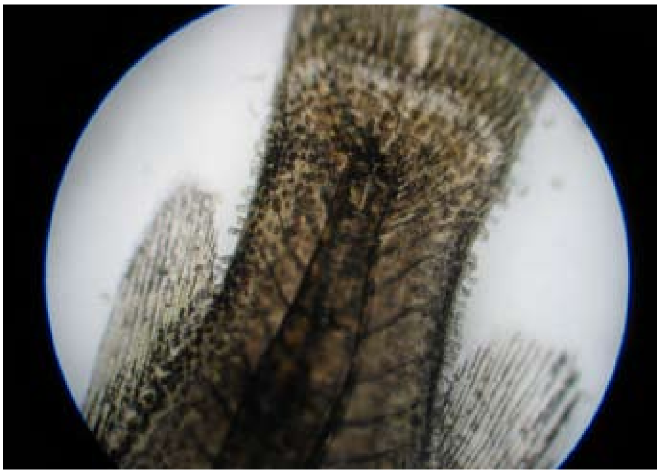
Each of these subjects is huge and demand attention but this paper will focus on control of disease. When the farming of any animal is intensified, disease is virtually inevitable, in part because the farming environment is artificial and stressful compared to the natural habitat. In general, there are six to 10 specific diseases for each animal species. In new farming systems, we have found that infections usually require 2 to 5 years to become fully established.

Effective prevention and control of disease requires an integrated approach to health management, which takes into account all aspects of fish farming that impact the health of the fish population (Figure 1).

Factors affecting disease expression

The expression of disease on any fish farm involves four controllable factors: the species, farm management, the environment and the pathogens present. No one factor dominates, but the type and severity of the disease will depend on the complex relationship among them all.

Poor farm management, suboptimal environment and/or the presence of pathogens result in fish stress. Stress is a product of trauma that fish suffer and the length of time that fish are exposed to the trauma. Disease develops when a combination of stressful factors meet and the stress level of the fish population has reached a point that is detrimental to the immune system.



Ectoparasitic protozoans in a hatchery in China

As mentioned before, there is a large diversity in the husbandry systems used by tilapia farms around the globe. There is also a correspondingly large variation in tilapia strains and hybrids, allowing farmers to select for different traits to suit local conditions. This ensures good growth in systems ranging from clear, open-water cages or green-water ponds to closed, recirculated raceways and tanks. However, whichever system is used, there are important issues to address in the farm before its full production potential can be realised.

Farm management

A primary concern is identifying a consistent source of good quality seed stock. Hatchery produced fish are recommended because they are often genetically selected or improved, monitored for diseases and given an optimal diet that results in a more uniform starting point for the farmer, and more reliable and reproducible results.

Suboptimal feeding or other environmental stressors, such as poor water quality, will result in poor quality, weak fish and increased susceptibility to opportunistic pathogens. The smaller the fish, the lower the reserves they have and stress will put more strain on their tolerance limit.

With consistent, disease-free quality seed stock, emphasis should be placed on biosecurity to prevent or limit the transfer of pathogens onto the site and between locations. This requires minimising the transfer of vectors, which include humans, animals, equipment, water and machinery. Defined or physical barriers established to minimise the spread of disease will play an increasingly important role in aquaculture. These restrictions should encompass everything from the impact of regional trade on live production to inter-production-unit movements in the farm. The faster the biosecurity process evolves, the more sustainable the industry will be.

To some extent, vector movement between production units within a farm is unavoidable, but correct sanitary measures are necessary. Indeed, overlooking general hygiene measures is a common problem in farms and is often found to be the root cause of disease.

There are always three important steps involved in the sanitary process for any situation. The first is 'cleaning,' which entails the

Flavobacterium columnare in tilapia in China

Francisella-infected tilapia in Thailand

removal of unwanted substrate. Next is 'disinfection,' designed to eliminate the organism with the appropriate choice of products and methodology and finally 'rinsing' to remove remnants of potentially toxic disinfectant chemicals. To control the transmission of fish pathogens, it is vital that this sequence be followed for any surfaces that may have been directly or indirectly in contact with fish. Techniques applied must ensure the safety of fish, humans, equipment and the environment (Khars 1995).

When adhered to, good sanitation can control or even eliminate disease outbreaks, but implementation is often a limiting factor. To carry out important routine sanitary measures, employees must be productive, proactive, experienced and, above all, take pride in their work. Clear goals and well-defined protocols are necessary. The aim is to ensure that fish welfare is a top priority and that any adverse or unusual event is reported swiftly and dealt with quickly. Employees can be encouraged to cooperate with sanitation procedures if incentives are given for reporting events that may be detrimental to fish health.

Another factor that correlates farm management to disease outbreaks is production recording. If recorded data is relevant, clear and precise, it can help in the early recognition of disease. Disease triggers are multi-factorial and often complex; however, time-data records enable comparisons of historical situations and will often reveal patterns or trends pertaining to the same disease outbreak. Typical patterns may include fluctuations in environmental parameters, changing characteristics in fish behaviour and/or the severity and onset of mortality within population. Recognising these triggers through good production-data records can go a long way in improving disease management.

Tilapias are susceptible to both infectious and noninfectious diseases.

The environment

The environment plays a crucial role in the expression of disease. Production recording and pathogen surveillance demonstrate that most diseases in tilapia thrive in certain temperature and salinity ranges. These findings add to the complexity of tilapia farming but may prove to be a useful tool in disease control since, in many cases, temperature and salinity manipulation is possible.

Greenhouses, for example, are now common phenomenon throughout aquaculture in China and help prevent suboptimal growth and coldwater diseases. In addition, saltwater use, if readily available, can help to control parasitic or saline-dependent bacterial outbreaks

Pathogens

The tilapia is susceptible to both infectious and noninfectious diseases. An infectious disease occurs when a pathogen is present. Simply identifying pathogen is a good start but does not prove that the pathogen identified is the cause of reduced performance, morbidity or mortality. To accurately diagnose the cause of disease, field sampling and diagnostic techniques must be performed. It is crucial that the correct samples be sent for analysis. Moribund fish should be sampled since common environmental bacteria will contaminate dead fish quickly and mask identification of the pathogens that cause the disease. Furthermore, it is of no value to investigate fish with clinical signs that do not represent those of the greater diseased population.

To really understand the cause of disease, it is essential to implement long-term, routine field sampling and disease epidemiology. Correct sampling techniques will identify the specific pathogens present and screen for new pathogens entering the system. Once established in the farm management system, this information, combined with knowledge about disease triggers, will allow for effective identification and resolution of the problem.

For the last 8 years, Intervet/Schering-Plough Animal Health has conducted extensive sampling and epidemiological investigations throughout Asia-Pacific, Africa and Latin America. Four major bacterial diseases have been found; *Streptococcus agalactiae, S. iniae, Flavobacterium columnare* and RLO, or 'rickettsia-like-organism' and recently identified as *Francisella* spp. We also found one viral disease (iridovirus) and several important external protozoal and monogenetic parasitic infections including *Trichodina* spp. and *Gyrodactylus* spp.

Noninfectious diseases generally result from nonliving causes; the most common are water toxicity and feed toxicity, although biological factors such as genetics, age, diet and stress may also contribute to noninfectious disease.

In short, disease epidemiology and health monitoring are crucial to the development of worthwhile integrated health management plans. Prerequisites for disease prevention are the identification of the etiological agents and understanding the epidemiological factors that trigger and aggravate diseases in an aquaculture farm.

Treatment and prevention

An integrated health management plan encompasses all factors that may affect fish health, as shown in Figure 1. The key components of the plan are two complementary strategies aimed at dealing with infectious diseases. One is reactive pathogen exclusion strategy and the other is proactive pathogen prevention strategy. Given time and understanding, the reactive strategy may indeed develop into an optimised metaphilactic treatment given just before the fish becomes sick.

Therapeutic medicine, particularly antibiotics, have resulted in a lot of controversial discussions in the press recently. Aquaculture and the tilapia industry are also included. Environmentalists want assurance that natural ecosystems will not suffer damage and consumers want to know that any antibiotic treatment used will not contribute to antibiotic resistance in humans and that the food they eat do not contain antibiotic residues. There are also discussions about the presence of prohibited antibiotics in food animals.

In light of these pressures and to ensure the sustainability of the aquaculture industry, it is imperative that reactive, therapeutic disease management be conducted responsibly. The first step is correct identification of the etiological agent causing a disease outbreak so that appropriate treatment can be determined. For instance, an antibiotic may be indicated for an outbreak of bacterial infection but cannot be used to treat a parasitic outbreak.

It is of fundamental importance that any chemical or antibiotic administered has regulatory approval for use in fish in the local country. Malachite green, for example, is a banned substance and cannot be used.

To achieve effective disease control, the agent causing disease must be sensitive to the chosen therapeutic treatment. In addition, the therapeutic drug must be administered in strict compliance with the manufacturer's label recommendation, i.e. the correct dosage must be administered as directed for the recommended treatment duration and withdrawn at the proper time.

Following the manufacturer's directions in many cases can help ensure food safety as well as effective disease control. It also helps prevent the development of resistance to therapeutic drugs.

Treatment of disease outbreak should be supervised by fish health professionals to ensure that fish receive appropriate and correctly administered therapy but it is also the fish farmer's responsibility to adhere to the specified withdrawal periods for antibiotics.

Antibiotics should be purchased from trustworthy sources that provide products from plants that practice Good Manufacturing Practices and that ensure quality, purity and the desired concentration of the active ingredient.

History has taught us that there will always be new diseases. Responsible therapeutic management is an important tool that can minimise the short-term impact of disease and help allay fears among environmentalists and consumers. However, drug treatment should never be considered as a long-term solution since the root of the disease problem must be identified and proactive and preventive strategy devised as part of an integrated health management plan.

The preventive disease strategy should be aimed at reducing stress in fish through good husbandry practices, the use of immunomodulators to boost the immune system and the use of vaccines. It must be remembered that vaccines target specific disease and cross-protection rarely occurs. For instance, the vaccine to protect fish against *S. iniae* protects only against *S. iniae* infection and not against *S. agalactiae*. In addition, if the environment is suboptimal, the vaccine may still perform, but the fish may die of another cause.

Conclusion

Diversity in production techniques and environment means each aquaculture operation is different. A universal trend, however, is culture intensification, which will undoubtedly lead to disease challenges.

The prevention and control of disease in any fish farm depends on an integrated health management plan that is balanced and takes into account all factors that may affect fish health, including the fish species, the environment, farm management and the pathogens challenging the fish.

S. agalactiae in adult fish in Indonesia

Integrated health management incorporates preventive techniques such as the use of immunomodulators and vaccines, which are likely to gain emphasis in the future, as well as the responsible use of antibiotics when bacterial disease outbreaks occur.

Health monitoring and data management systems are integral components of integrated health management. They can serve as the basis for the development of basic guidelines, enable the recognition of disease triggers and, when outbreaks occur, make it easier to devise tailored solutions that foster speedy diagnosis and rapid, appropriate treatment.

Integrated health management will not only help tilapia farmers ensure food safety, it will also improve survival rates, production forecasting and consistency.

The article was extracted from the proceedings 'Managing Streptococcus in Warm Water Fish' and is reprinted with permission from Intervet/ Schering-Plough Animal Health.

Neil Wendover is Technical Services Manager, Asia, Intervet/ Schering-Plough Animal Health, Singapore. He has worked for the Aquatic Animal Health branch for the past 4 years and is responsible for the investigation and epidemiological study of fish diseases throughout Asia. He provides regular training and technical support to the aquaculture industry in the areas of disease diagnosis and health management. Prior to this, he worked in China with GenoMar, a world-renowned tilapia selective-breeding company. He has extensive experience in tilapia production on both the Asian and African continents. Email: neil.wendover@sp.intervet.com

Leading in genetic improvement of the vannamei shrimp

The 12-year old provider of SPF shrimp broodstock is ahead with faster growth rates and higher fecundity in its genetic program and supplies from three locations worldwide.

Shrimp Improvement Systems (SIS) is the world's leading provider of specific pathogen free (SPF) stocks of Pacific white shrimp, *Penaeus vannamei* broodstock. Dr. Edward Scura and partners founded the company in 1998 in Islamorada, Florida, USA to conduct a commercial genetic improvement program for shrimp aquaculture using established techniques of selective breeding already used widely in other agribusinesses. The mission is to provide the best-performing, genetically improved and SPF broodstock to the global shrimp farming industry.

"The use of domesticated stocks brings shrimp farming closer to modern production practices similar to those of the livestock industry," said Joe Tabrah, President, SIS Florida.

SIS began exporting SPF broodstocks to Asia from the broodstock multiplication centre in Florida in 2003 and since 2005 has supplied broodstocks from a multiplication centre in Singapore. Selective breeding of the black tiger shrimp, *P. monodon* was started in 2006 at the nucleus breeding centre in Hawaii (see box).

In 2006, SIS was acquired by Central Proteina Prima (CPP), a large vertically-integrated shrimp aquaculture group in Indonesia.

"SIS fits well into CPP's model of large, wholly integrated shrimp production operations which include shrimp feed mills, hatcheries, farms, processing plants and a diverse product line of shrimp. SIS supplies CPP farms in Indonesia with broodstock as well as the merchant market in Asia and the Americas with same quality stocks. Our vision is that of a global animal breeding company dedicated to improving performance of aquaculture stocks worldwide," said Tabrah.

A leading genetic program

The genetic program of SIS is based on proprietary-developed pure lines, selected for specific economic characteristics over 16 generations. This is based on the use of individual and family selection for growth, disease resistance, reproductive capacity and general hardiness. Hundreds of full-pedigree families belonging to several genetically-distinct lines are created and evaluated each year.

Advanced statistical models are used to calculate genetic advantage from the results of field and laboratory performance tests and pedigree information. Performance tests in the field include results from several different test systems. The best performing individuals from the top families from each breeding session are used to generate the families for the next generation. Figure 1 shows the different phases of the breeding program.

Raceway test system

Figure 1.

Similar to the advanced genetic improvement programs in poultry, swine, and livestock, the shrimp program is based on animals certified free of a list of pathogens. This SPF status is a requirement to manage an effective program of genetic selection. Based on this status SIS is an authorised importer of live shrimp into many countries including: Indonesia, Malaysia, Philippines, China, India, Vietnam, South Africa, Brazil, Ecuador, Venezuela, Belize, Panama, Surinam, Jamaica, Puerto Rico, Guatemala and Cuba. It is also authorised to supply SPF postlarvae and broodstock to shrimp operations in the US.

Disease resistance

Selection for disease resistance is guided by the results of challenge tests run on siblings, but never on the animals that enter the commercial stream. These tests are run in a completely separate laboratory located in the city of Miami, 120 km away from the genetic nucleus centre, and at overseas facilities under commercial pond conditions.

Results of disease challenge tests provide crucial information on the relative genetic disease resistance of specific families in a line. The most resistant families are identified and their siblings in the genetic nucleus are used to produce the next generation. In this way animals free of diseases (SPF) can slowly be specific pathogen resistant (SPR). Freedom from pathogens (SPF) and resistance to pathogens (SPR) are not mutually exclusive strategies. In fact, they should be combined so as to obtain high survivals under 'real world' farming conditions.

Fast growth and high fecundity

The main competitive advantages of SIS shrimp are fast growth, high fecundity, Taura Syndrome Virus (TSV) resistance and free from specific pathogens. Its commercial lines have the genetic potential to grow more than 2g/week, to produce more than 800,000 nauplii per female per month and to resist TSV with higher than 85% survival. However, expression of these genetic traits is heavily dependent on specific environmental and culture conditions.

Performance monitoring

Performance testing at test platforms with varying degrees of complexity help to guide the genetic program. The results of these and all tests performed at the genetic nucleus centre and the disease challenge laboratory are then combined in a weighted index for selection of the overall best families to produce the next generation.

- Raceway tests are run at company facilities to ascertain the growth potential and hardiness of the different lines.
- Cage tests are run at corporate farms in Indonesia to assess growth, survival and disease tolerance of the different lines and crosses. The company has invested substantial resources on building and operating cage-based testing platforms located in production ponds.
- Microcosm trials are run at customer farms. In these tests, groups of tagged shrimp representing several families or crosses are stocked in pond-side tanks which receive continuous water exchange of pond water. Shrimp in the tanks are subject to pond water of different quality and can be easily harvested and evaluated for growth, survival and in some cases disease resistance.
- Pond tests are run at corporate farms in Indonesia where the availability of thousands of ponds and consistent management allow for growth and survival testing under 'real world' culture conditions.

"SIS plans to continue its improvement program with emphasis on developing specific product lines for Asia. We will strengthen and expand our technical and customer service to our major clients in different countries," said Kenneth Tay, Managing Director, SIS Singapore.

More information: Web: www.shrimpimprovement.com; Email: sales@shrimpimprovement.com

Kenneth Tay

Three locations worldwide and *Penaeus monodon*

Florida

SIS Florida in Islamorada is the original company facility. Located in Florida Keys, the area was chosen for its pristine waters and natural protected areas. Devoid of any other shrimp aquaculture activities, the biosecurity level is high. The water supply comes from an underground salt-water aquifer via wells drilled in a fossil coral reef. Although remote, it is only 1½ hours away by road from Miami which has an international airport that is a major hub for air cargo, especially to Latin America.

This area of 3 ha contains the genetic nucleus for *P. vannamei* and all stocks for SIS originate here. It also has a broodstock multiplication centre with a capacity to produce and ship about 100,000 commercial broodstocks annually. SIS Florida has a 12-year history of SPF stocks, documented by results of a quarterly sampling program of stocks submitted for PCR analysis to the Aquaculture Pathology Laboratory of the University of Arizona. The facility is certified annually by the State of Florida as compliant to Best Management Practices and maintains a yearly certification for SPF status with the US Federal Animal and Plant Health Inspection Service (APHIS).

Singapore

SIS Singapore is a broodstock multiplication facility, started in 2005. It can produce and ship about 60,000 commercial broodstocks/year and is in the process of doubling this. Expansion, planned to be operational by 2011, is being done in anticipation of increased demand from China, Vietnam and India. All shrimp stocks at this facility originate as juveniles in SIS Florida. The facility occupies a 1.8 ha of land at one of the Agrotechnology Parks in Singapore developed by the Agri-Food and Veterinary Authority of Singapore (AVA). AVA is the national authority for food safety (including aquatic animal health) as well as the agency designated by the World Organisation of Animal Health (OIE) to monitor and regulate the health status of animal stocks in Singapore. Since the start of operations in 2005, the AVA has supported the farm's health monitoring program through periodic PCR and histopathology testing of shrimp stocks.

Tay said, "This is an ideal biosecure and strategic location to serve Asian markets and to provide comprehensive support and technical expertise to Asian customers."

SIS Singapore

Hawaii

Previously known as Pacific Aquaculture and Biotechnology (PAB), SIS Hawaii started in 2006 at temporary facilities in Kapolei, with a selective breeding program to develop improved SPF stocks of the black tiger shrimp. Permanent production facilities were acquired in 2008 at the Natural Energy Laboratory of Hawaii Authority (NELHA) located in Kailua-Kona, Hawaii.

NELHA is located in a barren lava flow area with only an average rainfall of 20 cm annually. Surface seawater (25ºC) and deep ocean seawater drawn from a depth of 1,000 metres (8ºC), supplied through pressurised mains, provide consistent water quality and flexibility in temperature control. Biosecurity is high as there are no native penaeid shrimp species in Hawaiian waters. Consequently, the combination of pristine sea water, dry climate and no soil or foliage, effectively reduces the possibility of disease vectors.

The new 2.6ha site houses the genetic nucleus centre for *P. monodon* and a separate broodstock multiplication facility for *P. vannamei* with capacity to produce and ship an estimated 100,000 commercial broodstocks/year. All shrimp at the facility are subject to the disease surveillance program of the State of Hawaii which involves periodic testing by PCR for OIE listed pathogens. Sampling and testing are performed by the State's Aquatic Veterinarian according to OIE protocols, as mandated by State law. Close proximity to the Keahole International Airport provides for efficient air-freight connections, especially to Asia.

Vietnam's cobia marches to ESE 2010

The growth opportunity in farming the unique and versatile cobia in cages off Central Vietnam culminates with a launch at the European Seafood Exposition in April.

Since 2005, Marine Farms asa has applied the company's pioneering experience and expertise in marine cage farming, to the farming of another species, the cobia, *Rachycentron canadum*. Marine Farms Vietnam has 10 production sites allocated for the farming of the cobia around Hon Lon Island in Van Phong Bay, off Nha Trang in central Vietnam. Production was 500 tonnes in 2009 and it is expected to increase to 1,500 tonnes in 2010 and 2,000 tonnes in 2011.

Bjørn Myrseth CEO of Marine Farms asa, said, "Vietnam was chosen for our first venture in Asia because of the ideal temperature profile and the hard working population. It is the only place where 100% foreign ownership is allowed. We have 89 local staff out of the 90 currently working with us. However, I must add that it took us longer than expected to start operations. We began the groundwork in 2003 and obtained permits in 2004, conducted trials in 2005 based on the success of our operations in Belize and had our first production in 2006."

Marine Farms has a 38-year history in aquaculture. It was established in Norway in 1976 and listed in the Oslo Stock Exchange in 2006. The company also farms cobia in cages in Belize where the first harvest was reported in 2007. Other global aquaculture operations are in the farming of the sea bass and sea bream in Spain and salmon egg, fry, smolt and grow out operations in UK.

European standards

In Vietnam, the company sees itself carrying out ethical and responsible operations. It applies Norwegian farm management techniques in its operations in Van Phong Bay. At present, there are 54 Norwegian Polarcirkel cages, 50m, 60m and 100m in circumference. The sites were chosen because of the strong currents, which disperse farm residues and prevent them from affecting the local ecosystem.

Out of the ten sites, only five are used on a rotation basis to protect the environment. This helps to keep diseases away. At one site, only one generation of fish is cultured to prevent diseases spreading to the next generation. At the other sites, culture is rotated to have cobia available throughout the year.

"Taking care of the environment is important and thus there is no usage of antibiotics and no antifouling agents," said Myrseth. "Density is low at 10kg/m^3. I believe this is a good way to have a sustainable aquaculture of any marine fish."

Cobia juveniles for stocking the cages are now produced specially for the farm at the Research Institute of Aquaculture 1 (RIA1) although in the long term, the company plans to have its own hatchery. After larval rearing in tanks, 0.2g fry are cultured in nursery to juveniles of 2-5g. These are stocked in the cages and are cultured for one year to reach a marketable size of 5-6 kg. Feeds are from Ewos (Canada) and Biomar (Chile). These are special feeds with 46% crude protein and low fat content, free of genetically modified organisms (GMO), without any terrestrial animal proteins and using only fishmeal as protein source. The cost of feed is USD 1.70/kg

Carlos Massad (right) at the booth in ESE with the tag line 'Cobia-First Fish of the Century'.

The projected annual capacity is 5,000 to 6,000 tonnes. Carlos Massad, Managing Director of Marine Farms Vietnam said, "In five years, we can produce 6,000 tonnes in the sites. We are also looking for more grow out sites in Central Vietnam. However, our challenge is to reduce the cost of production further by reducing mortality and improving on the feed conversion ratio which is currently at 2:1. Research is ongoing to do this as well as to develop lower-cost feeds, perhaps with vegetable proteins."

Marketing cobia

Cobia from this farm in Vietnam is targeted for the value-added markets in the US and Europe and the fresh fish market in Asia. Fish is already being sold in Taiwan and Japan. The company markets frozen sashimi grade vacuum packed long loins in sizes of 200-300g, 300-400g and 500g and upwards and skinless and boneless fillet of 680-1000g. Marketing and distribution to the US is via the Nordic Group

Slices of cobia prepared by Norwegian chef from the culinary Institute of Norway

Frozen loins ready for slicing into sashimi

Modern sushi with cobia, picture courtesy of Marine Farms Vietnam

Feeding cobia

Harvesting

Cages (All pictures courtesy of Marine Farms Vietnam)

whereas Sea Products of Scotland handles the European markets. The facility in Belize produces 100-200 tonnes and production is geared for the American fresh fish market.

"Cobia has so much to offer. Although technically a white fish, it has a high oil content of 16g in 100g of flesh (16%) and within which there is 2.24g of long chain omega 3 fatty acids (HUFAs). It has excellent eating qualities, including a mild flavour and firm texture. Cobia can be cooked in many ways from poaching to baking and frying. It is also particularly good as sushi or sashimi, as the firm flesh can be accurately sliced. At the ESE, the chef at our booth prepared the frozen fillet into sashimi or quick-fry slices. My favourite is to quick fry slices, served with a squeeze of fresh lime and freshly ground white pepper," said Massad.

"If the market can hold at good prices, we will be considering expansion," said Myrseth.

Cage technology and the environment

A containment system and waste management system will minimize impacts on the environment. The aim is a sustainable production of tilapia in lake environments.

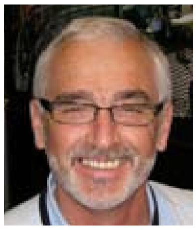
In 2007,Trapia Malaysia Sdn Bhd acquired the rights to develop cage culture of tilapia in the pristine, rain forest fed freshwater in Lake Temenggor in Perak State, Malaysia. The company is a joint venture between Genomar, Norway and local partners. Genomar is well known as a major supplier of tilapia seed stock selected for fillet yield, improved FCR and hardiness from hatcheries in China and Singapore. This is the first tilapia grow-out production facility for this company.

The challenge is to set up a safe and sustainable production facility in this pristine water body. The project must develop eco friendly production technology to produce fish of the highest quality that exceeds current global standards. Using unique genetic technology and tagging process developed by Genomar, the tilapia is traceable and genetically verifiable. The most crucial aspect is that there should also be minimal impact of cage culture activities on the water body in order to demonstrate a sustainable production of tilapia.

Complete containment

Trapia Malaysia required advanced equipment to fit into the specifications for a complete containment system. The cage environment must be secure to prevent escapes and the netting longer lasting and more resistant to bio-fouling.

Don Bishop, Global Market Manager and Technical Advisor, Ten Cate™ Aquagrid® said, "The increased strength of the Aquagrid® containment system met and exceeded the objectives set out by Trapia management for the operations. Aquagrid® cages are completely different to those constructed of



Don Bishop

nylon or polyester and the unique PVC coating makes it difficult for bio-fouling to attach. This eliminated the use of anti fouling agents which usually have an impact on the environment. Water flow is increased leading to better fish health. The netting material is a semi rigid, PVC coated polyester material.

"Trapia also understood in order to sustain their business model, the pristine waters they operate in would have to remain unspoiled. They now use the Aquagrid® containment system which includes the LiftUP® Mortality Retrieval System. With one in each cage, this system collects dead fish, waste feed and faeces which are then pumped to the surface."

In November 2008, Trapia began installing the first of the 20m diameter cages at their new grow out site. In all, there will be 20 Aquagrid® Containment Systems, each module capable of producing 2,500 tonnes of fish/year.

Cost savings

Trapia Malaysia COO Alejandro Tola said, "Ten-Cate™ were very involved in cage design and construction to suit our needs. They also arranged for a specialized technical consultant to install and train our people in cage operations and were on site to ensure proper deployment.

"Although tilapia grazing behaviour is definitely contributing to the lack of biofouling in the inner side of the net, I trust the smooth surfaces of the material and its plastic nature contributes to the reduction of organic matter build up and the presence of parasite forms in the system. The nets are very easy to clean by simple brushing."

Tola added, "The strength of the material is definitely keeping away and avoiding break-ins from carnivorous species in the lake. The logistics consequences of this are huge. Divers' man-hours are reduced to a minimum because we do not need to carry out net inspection often, just once between cycles.

"Our goal is that it will be possible to produce fish here in a hundred years' time without our activities having an impact on the environment," said Morten Hoyum, CEO of Genomar during an aquaculture seminar in March, 2010 (Intrafish, 2010).

With these cages in place, the company in Malaysia is ready to fulfil monthly targets of 1,000 tonnes in 2010, 2,000 tonnes in 2011 and 3,000 tonnes in 2012.

BAP certification standards goes to Australia

Standards for responsible aquaculture in the global seafood market are not new to GAA. They have made their mark in seafood retailing and production in Europe, America and Asia, and are now making an impact on Australia's consumer market. The ability to adapt to requirements of producers is critical to success and Peter Redmond, Vice President explains how the BAP standards are adapted to small producers in Asia and their application for the industry in Australia.

In 1997, several aquaculture-related groups from retailers and producers to feed manufacturers and suppliers co-founded the non profit Global Aquaculture Alliance (GAA) to answer an urgent need to counterbalance the bad publicity in aquaculture, mainly on shrimp farming in mangrove areas. The mission is to further environmentally responsible aquaculture to meet world food needs. The goals are to improve production and marketing efficiencies, and to promote effective, coordinated regulatory and trade policies in aquaculture. Continuing doubts on the sustainability of aquaculture also required an organised grouping of stakeholders to resolve problems and maintain public confidence in farmed seafood whilst ensuring that aquaculture remains as a reliable source of food and employment.

A key program of GAA is the development of the Best Aquaculture Practices (BAP) certification standards. Today this business to consumer program is available for shrimp, tilapia and channel catfish. Standards for feed mill certification have recently been completed and standards for the pangasius species, salmon and mussels are due to be completed by end 2010. These BAP certification standards are well established in Europe, America and Asia among retailers and producers.

"We see the BAP logo in supermarkets today because it is a business to consumer logo. Our point of difference is that we do not look just at the species but the production chain. We have different sets of standards for hatcheries, farms, processing plants and feed mills. In our star rating, one is for processing plant, 2 for processing plant and farm and 3 for processing plant, farm and hatchery and 4 for all. We have 20 producers with 3 stars and none with 4 stars as the feed mill standards are newly completed.

"The most difficult challenge in encouraging certification for farms is approaching them, especially in countries where farms can be small with 2-3 ponds and the understanding of certification is lacking. Usually we approach farms through processing plants. We have a group in the organisation doing outreach work. Our model for small farms is the cluster approach where we target 8-9 farms such as in Thailand, China and Indonesia. Outside of these, we have larger farms where we approach directly in Central America, Malaysia and Vietnam. When a retailer such as Wal-Mart requests for a producer to be certified, we then work with them on what needs to be done."

Redmond explained some recent changes in the role of the Aquaculture Certification Council. Now part of GAA and no longer a standalone body, it manages the certification program but does not undertake any auditing. It has selected ISO 65 complaint auditing firms, NSF and Global Trust. The selection for an organisation in Thailand is in progress. Auditors submit reports to the council for the issuance of the certification. In cases where further action is required, the auditors make repeat visits until the corrections are satisfactorily done. There are cases where the corrections are never completed, possibly due to language barriers or poor understanding of the requirement.

Peter Redmond

The value of management based standards

The BAP certification standards are focussed on four distinct areas: environment, social, food safety and traceability. Standards development undergoes a transparent process with stakeholder groups and a standards oversight committee comprising 5 NGOs, 4 academics and 2 seafood retailers in 2010.

"There is an old adage which says certification is good for one day. If you measure everything in one day, it is good for that day. We examine both measureable criteria and management principles which will lead into a habitual process. In my opinion, if the standard is for 0.4 and I give you a process to manage this, this is more sustainable than just obtaining the measured level. Thus we have a lot of management based programs. About 75% of the standards are critical pass or fail and the balance of 25% are scores which can be either subjective or cut and dry. The idea is that you need to have 100% of the critical pass or fail to be certified. There is no deviation from this and once an establishment has a fail for the critical pass or fail, auditing will be terminated," said Redmond.

"The BAP certification standards are often compared to the GlobalGap standards. The latter is very strong in the food safety aspect and is regarded as the panacea. However, we believe that BAP standards are stronger when it comes to the environment, as we look at the environment as a management process. In the case of effluents, we have set a measurable goal. I also believe that following local laws is not an answer. If these are already robust enough, then we really do not need to have any standards in the first place."

GAA and Australia

GAA is less well known in Australia. Redmond is set to change this during the Australasian Aquaculture 2010 in Hobart, Tasmania. This is the target for Britain and US based Redmond, who has spent 17 years in the retail industry. He was VP of seafood at Wal-Mart for 7 years, controlling some USD 7 billion in sales, leaving in 2001 to pursue an environmental and business solution consultancy. Redmond joined GAA in May 2009 as VP of Development and Communications.

"This is a market we have not looked at previously. This is my first trip to Australia and from the GAA point of view, we have had no interactions with retailers and suppliers. Australia has a high seafood consumption rate and almost 75% of the seafood is imported. In Tasmania, the large production of salmon is clean.

"Listening to speeches during the conference, I get the perception that they are already doing things the right way but the issue is that retailers want an independent body to tell them rather than the government or producers themselves. I am sure that the internal programs are very good. However, if I am a UK retailer, I would not want certifications from several countries but one or two from a program which cover many countries. A third party logo will give status to the product. At the moment, Australian retailers do not demand any certifications although we are sure that some of the seafood imported into the country already has BAP certification which retailers in Australia are not aware of."

Redmond said that the scenario will be different in the next two years as Australia catches up with what is happening in Europe and the US.

"Two years from now, the landscape will be different from today. They will be in a better position tomorrow if they are certified today."

Targeting internal markets

On GAA's radar are China, India, Brazil and Argentina. According to Redmond, there is a large volume of product coming out from its certified facilities in China. "China has a large internal market and we need to get the strategy to target this market. What is important is to create awareness and demands from retailers in order to succeed here. In China, interest is high from large retailers, such as Wal-Mart and Carrefour whereas in India, the job will be more difficult with a fragmented retail industry.

"We usually have to work through retailers and I do not think there is any country where the demand for certification is from consumers. Consumers depend on retailers to do this. The driving force in purchasing is price, such as in the UK, although awareness of certification is high in the EU countries.

"In the US, retailers are doing this because of corporate social responsibility (CSR). It is not because consumers are asking for this, but because they know that this is the right thing to do and they can make the change. In Wal-Mart, we made the commitment to BAP and MSC to do this. Only retailers have the power to demand that suppliers are certified because their reputation is at risk as their name is on the bag.

"In each country, the key to keeping all products of a certain standard, whether for export or local consumption is to work with governments and retailers in the country to demand this."

New standards drive interest in fish used for fish meal

By Duncan Leadbitter

With the increasing focus on sustainability of aquaculture, attention is on the provenance of fish for fish meal.

Sustainable aquaculture production is a common goal for industry and community groups alike. Over the past few years, defining what is sustainability in the context of various aquaculture production systems has been the focus of several groups globally. In the case of some farmed species, the issue of the sustainability of the feed materials also requires attention and considerable effort is being devoted to understanding what species are used in fish meal production and whether the fisheries involved are sustainable.

From wild fish to fish meal

Fish from capture fisheries are used as feed by a variety of farmed products such as salmon, shrimp, groupers, cobia, spiny lobsters and some species of shellfish. In some circumstances, feed fish are supplied unprocessed, particularly the case in South East Asia, to feed marine fish such as groupers, spiny lobsters and carnivorous shellfish. Otherwise, as with feeding salmon and shrimp, the feed fish is processed and incorporated into formulated feeds to a greater or lesser degree, depending on nutritional and quality requirements.

The demand for feed fish has grown enormously in recent years in tandem with the growth in aquaculture production. In some situations, this is putting stress on the populations of wild fish. Moreover, given the fact that many of the species of interest provide some functional role in the overall marine ecosystem there are also concerns about the consequences of fishing of those aquatic species that depend on these fish for their long term survival.

The most well known feed fish species comprise pelagic species such as anchovies, sardines, sprats, mackerels, herrings and sardinellas. There are well managed fisheries for these species in some countries that can track the status of the stock and control catches. However, in other countries, the level of knowledge about the stocks and the effectiveness of management controls are lacking, and it is thus difficult to assure sustainable use. This in turn puts fish dependent communities, farmers, as well as the wider environment at risk.

A second source of fish for feed production is a wide range of species generally caught whilst trawling for shrimp or benthic fish. In Africa, this by- catch is food for local communities whereas in many western countries, it is simply discarded. In Asia, it is a major source of feed for animals (pigs, ducks, etc.) and fish.

In addition, trawl fisheries are well known for having significant impacts on the seabed itself and for harvesting a wide variety of species, especially in tropical areas where species diversity is high. If management is good then these impacts can be kept to an acceptable level.

The key concerns in these fisheries include:

- the uncontrolled fishing of species of conservation concern such as turtles and sharks/rays;
- the removal of species which cannot tolerate heavy fishing pressure, i.e. loss of species diversity; and
- removal of juveniles which if not caught can provide a good income for other fishermen, e.g. snappers and groupers.

Inadequate management in many countries has resulted in overfishing and major changes in marine ecosystems. The growing demand for fish meal has created a situation where efforts to control overfishing will result in lost catches of so called trash fish. Such controls are resisted by fishermen and the situation continues to decline.

Can standards help?

Most governments and industries recognise the need for good management. The rapid growth in demand for fish meal has created a situation where the right balance between meeting this demand and creating benefits for others has not yet been found.

Channelling demand for fish in favour of sustainable production has proven to be a valuable mechanism for assisting the development of good management in capture fisheries. Existing standards for sustainable aquaculture as well as those in development, use the same logic. The two systems interact when the issue of sustainable fish meal is being considered.

Fish meal standards are in the aquaculture standards developed by the Global Aquaculture Alliance, GlobalGap and the Aquaculture Dialogues. In addition, the International Fishmeal and Fish Oil Organisation (IFFO) has released its Responsible Sourcing Scheme certification program which has requirements for the management performance of fisheries used to supply fish for meal production. Already, there is considerable diversity in the stringency of these standards and, thus, their ability to be a force for good when it comes to the improved management of fisheries.

At the weakest level there are systems which simply ask whether the species being used for fish meal is listed in the so called RED LIST of the IUCN (International Union for the Conservation of Nature). This body considers submissions from members (governments and non government bodies) regarding the status of species and allocates the species to a range of categories depending on how threatened the populations are. Very few marine fish are included as there is no regular evaluation of fish species and those that are listed are not subject to regular review. This is a very low bar in terms of standards.

Other standards seek independently verifiable information that, the stock of fish being used is not in an overfished state; the impacts of fishing have been acted upon and that there is a working management regime in place. Such standards are far more in keeping with modern expectations about standards for fisheries management as set out by the FAO Guidelines for the Ecolabelling of Fish and Fishery Products from Marine Capture Fisheries.

However, some systems are more transparent than others. Given that one purpose of a standard is to educate and inform, a lack of transparency as to how decisions are made undermines credibility and is at odds with the FAO guidelines.

Does the supply chain have a role in promoting sustainable use?

One of the major changes in the fisheries industry in the last ten years has been the involvement of entities outside the traditional management mix of mainly government and the capture fisheries sector. Companies involved in fish processing, wholesaling and retailing have increasingly become involved in fisheries management (to a greater or lesser degree) for a mix of business and ethical reasons.

These companies have accepted that, as purchasers of fish, not only do they need to meet the expectations of their customers in terms of product attributes (sustainability is now an attribute like quality) but that corporate social responsibility is as relevant to the seafood industry as it is to others. In this regard, the fact that a company does not have a consumer presence does not mean it is not a target of public criticism, if it handles a product that is risky in some way.

Agreed and transparent standards that genuinely require sustainability (or are progressing towards it) are an important tool for seafood companies operating in markets that scrutinise their impacts (direct or indirect) on the environment. Companies should ensure that the standards they seek to be involved with have good stakeholder support. ***More importantly, given the growing pressure on feed sources, there has to be more than a small amount of self interest in ensuring that supplies are in good shape for years to come.***

Transparency – good for markets

One of the current challenges in providing factual advice on the status of species used in fish meal production is the difficulty in finding out what species are used. Some companies freely divulge information when available, especially when the source fisheries are known to be well managed and a considerable amount of information is available on www.fishsource.org, a site operated by Sustainable Fisheries Partnership (SFP). However, when information is lacking or the status of the supply fishery is in question, obtaining information is difficult. Whilst this may be understandable, the market is evolving to expect such information to be made available and, in the future, lack of transparency may equal a lack of contracts.

A key objective of SFP involvement in aquaculture feed issues and related standards development is to ensure a much greater transparency in the supply chain. Sellers of seafood are increasingly being asked questions about ***where does the seafood come from and what is 'in' the product.***

In the vast majority of cases the availability of a clear answer is more than sufficient and prevents speculation. Transparency works for all parties and is a key element in ensuring that the capture fisheries that fuel the growth of the aquaculture industry are well managed.

League Table of Fisheries used for Fishmeal and Fish Oil

The Sustainable Fisheries Partnership (SFP) works as a business to business catalyst, encouraging businesses to ask their suppliers to provide technical information. In March, it published a sustainability league table of the principal fisheries used for the production of fishmeal and fish oil. The 22 fisheries have been assessed using the FishSource (www.fishsource.org) methodology devised by SFP. In the top five scorers are herring (Norwegian spring spawner), herring (Canada autumn spawner), sprat (Baltic Sea), herring (Icelandic summer spawner) and horse mackerel (West stock, NE Atlantic).

The results of the table will prove invaluable to fishmeal and oil buyers seeking guidance on sustainable sourcing as well as manufacturers of aquaculture and farm animal feeds. Buyers of aquaculture products and organisations developing aquaculture standards will also find the data useful in helping to shape policies.

The analysis excludes fish taken from so-called 'trash fish' fisheries. These mixed species fisheries utilise fish not suitable for human consumption (whether because of size or palatability) and are frequently found in East and South-East Asia. These fisheries can be deliberately targeting a mixed species catch for the purpose of creating feeds or they may be targeting other species (e.g. shrimp) with relatively indiscriminate gear types and generating a high 'by-catch' which has a marketable value. These fisheries are generally poorly characterised with little data in the public domain but the total catch may be as high as 5 million tonnes (similar to Peruvian anchovy) (Asian Fisheries Today: the production and use of low value/trash fish from marine fisheries in the Asia Pacific region, FAO, 2005)

Duncan Leadbitter is consulting for Sustainable Fisheries Partnerships as Technical Director and one of his roles focuses on feed fish fisheries. He is a Director of Australia-based Fish Matter which provides practical advice to industry, government and NGOs regarding the sustainable use of fish and other aquatic natural resources. Prior to this, in 2000, Duncan was International Fisheries Director for the Marine Stewardship Council (MSC), and was responsible for developing and managing the MSC's Asia Pacific region. Email: duncan.leadbitter@sustainablefish.org

Sulphide and Phosphate Problems in Shrimp Ponds

By David J.W. Moriarty

Soil and sediment chemistry influence water quality and therefore health of the shrimp. This two part article deals with the chain of events in hydrogen sulphide production in ponds, sulphide-phosphate interactions and interactions of phosphate, calcium and iron. The appropriate management strategies are proposed.

A. Sulphide, Iron and Phosphate Interactions

Aspects of sulphide biogeochemistry and its interactions with phosphate

When organic matter concentration is high and the rate of aerobic bacterial activity is greater than the rate of oxygen diffusion, there is insufficient oxygen in the pond sediment to support the complete oxidation of organic wastes. Hydrogen sulphide is produced when sulphates in seawater are reduced by anaerobic bacteria in the sediment in the final stages of oxidation of organic wastes under anoxic conditions. Sulphide anions react with ferric oxyhydroxide phosphate complexes to reduce them and form pyrites with concomitant release of phosphate to the interstitial water. The mobilised phosphate diffuses to the soil surface where it becomes available to cyanobacteria and algae.

Furthermore, if the amounts of sulphide produced by the anaerobic bacteria are greater than the amounts that can be trapped by iron, then free hydrogen sulphide, will be released into the interstitial water of the sediment or soil and then into the water column. An important management strategy for altering the phosphate, iron and sulphur cycles is to minimise the amount of organic matter accumulating on the pond bottom and to keep the surface sediment in an oxic state.

Source of sulphide in marine ponds

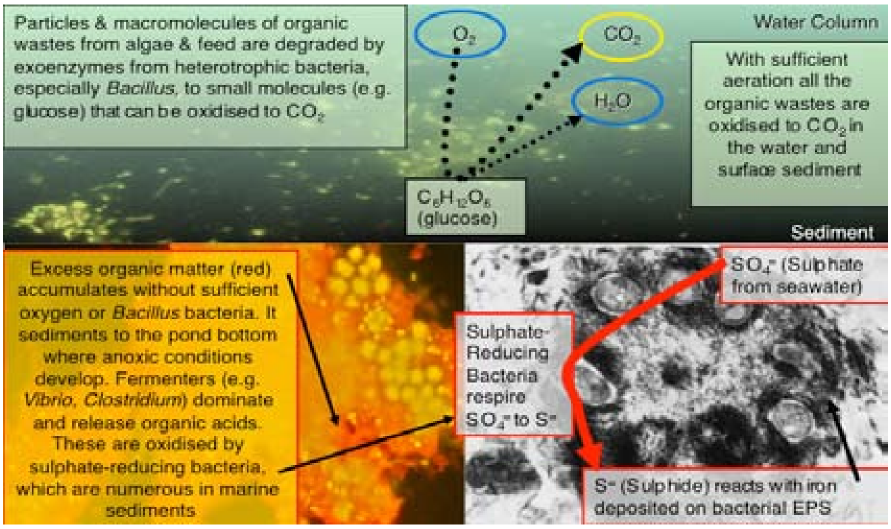
Sulphide is one of the end products of organic matter decomposition by bacteria in an environment with a low redox potential and sulphate ions present (Figure 1).

Oxygen supply

Heterotrophic bacteria obtain their energy for growth by oxidising organic carbon compounds i.e. their food. Oxidation processes and the release of energy require electrons to be transferred from the organic matter to another compound or chemical element. Oxygen is the primary electron acceptor. It is used by aerobic heterotrophic bacteria in the water column and sediment surface to degrade organic matter to carbon dioxide, ammonium and water.

However, if the supply of oxygen is not sufficient for complete oxidation of wastes from feed and dead algae in aquaculture ponds, then the remaining organic matter is broken down in the anoxic zone of the sediment or in flocs of organic matter in the water. After oxygen is used up, some bacteria will respire nitrate and reduce it to nitrite and nitrogen gases or ammonium; some bacteria respire by reducing metals such as iron (the oxidised ferric form). The cycle of organic carbon and its effect on oxygen dynamics in shrimp ponds were discussed in more detail by Moriarty and Decamp in the proceedings of the 2009 meeting of the World Aquaculture Society at Veracruz, Mexico.

Figure1. Carbon cycling in a shrimp or fish pond. Under ideal conditions, i.e. sufficient aeration to ensure no anaerobic activity occurs, all waste organic matter from feed and dead algae is degraded by bacteria in the water column and sediment surface. The upper few mm of the sediment remain in an oxic state, thus preventing iron and phosphate from entering the water column (see Figure 3). However, when the rate of organic waste input is greater than the rate of aeration, many microorganisms ferment the waste organic matter in order to produce energy for growth and they release a range of reduced compounds, especially organic acids, and hydrogen. These acids and hydrogen are the fuel for sulphate-reducing microbes, which oxidise the organic matter to carbon dioxide and produce sulphide.



Fermentation

This is another anaerobic process used by many organisms to obtain energy from organic matter. Fermentative microbes such as yeast and many bacteria, e.g. vibrios and clostridia transfer electrons to organic compounds that are in an intermediate state of oxidation. Carboxylic acids, e.g. formic, acetic, propionic, butyric, lactic and other small organic compounds including ethanol, as well as CO_2 and H_2, are the final products of fermentation by these bacteria.

In the anoxic zones of marine pond sediments, where sulphate is abundant, the reduced organic compounds, especially the short chain fatty acids, are used as nutrients by the sulphate-reducing bacteria, which respire with sulphate as their electron acceptor. Thus organic matter entering the sediment that is not oxidised in prior processes will finally be converted to carbon dioxide by these bacteria. Sulphide is the end product of their respiration, and large amounts are produced in aquaculture ponds when aeration is not sufficient for the complete oxidation of all wastes. Therefore, it is important that fermentation be minimised in a shrimp pond. The strategies that can be used to achieve this are discussed below.

Interactions of sulphur, iron, aluminium and phosphate in soil and water

The sulphide produced by sulphate-reducing bacteria reduces ferric oxyhydroxide-phosphate complexes and ferric phosphate to form various iron sulphides and polysulphides, including pyrite; phosphate is released during this process (Figure 2).

Sulphide also displaces phosphate from the surface of calcium phosphate complexes. With continued input of organic matter to sediment under anoxic conditions, sulphate reduction will result in sulphide concentrations in excess of the ability of iron, aluminium and calcium phosphate minerals to react with sulphide. The excess is liberated from the sediment as free hydrogen sulphide, resulting in fish and shrimp mortality (Figure 3).

Pond management strategies

There are several ways in which ponds may be managed to minimise the problems of sulphide production and excessive phosphate concentrations resulting from the inputs of fish or shrimp feed during the crop cycle. At all stocking densities, the effects of wastes and pond effluents on the downstream environments from ponds must be considered and eliminated or minimised. Intensive aquaculture as an industry for individual farmers or for countries cannot be sustained where wastes are removed in the short term of a crop cycle by pumping out water or sediment and disposing of it downstream. Water exchange has to include treatment and this in turn allows the water to be reused safely, either on the same farm in a recycling system, or by downstream farms.

High stocking density

At high stocking densities, it is cost effective to eliminate the above problems arising from interactions of the soil, feed wastes and microbial processes, by lining ponds with concrete or other materials. Concurrently, water treatment procedures that include aeration and addition of bacteria selected for their waste decomposition capacities should be applied.

For operators of earthen ponds, a question raised by the discussion on the downward movement of iron phosphate complexes and sulphide production by anaerobic bacteria is: should tilling of the soil be discontinued as a standard management practice? Strategies for altering the phosphate and iron cycles and to prevent fermentative bacteria from dominating include minimising the amount of organic matter accumulating on the pond bottom and to keep the surface sediment in an oxic state. This can be achieved by

- mechanical aeration or water exchange,
- applying sodium nitrate to anoxic sediment,
- adding appropriate *Bacillus* species to feed and water at a high enough population density to speed up the decomposition of organic matter,
- avoiding the use of phosphate fertilisers.

Aerobic heterotrophic bacteria are the major consumers of oxygen in ponds and are needed to break wastes down completely to carbon dioxide. However, the rate limiting step is the initial hydrolysis of macromolecules and particulate organic matter. If that does not happen, then fermentative bacteria dominate and provide the nutrients for sulphate-reducing bacteria, which results in the accumulation of toxic sulphides.

A clean pond environment

The *Bacillus* group is much better at breaking down large molecules and organic particles than vibrios and pseudomonads. The *Bacillus* produce a large range of extra-cellular digestive enzymes, which are secreted into their environment. The Sanolife® PRO-W *Bacillus* have been selected especially to speed up the digestion of organic matter. Oxygen is the most important electron acceptor for the *Bacillus*, however, one of the species in Sanolife® PRO-W can also use nitrate. So in some circumstances, sodium nitrate may be applied to anoxic sediment surfaces to assist in waste decomposition.

Lactobacillus and related Gram positive bacteria do not produce a large range of exoenzymes and thus would not be effective in sediment. At intensive feeding rates, the bacteria present naturally in the pond cannot keep up with the rate of waste accumulation, so we have to assist the balance of the food web in the ponds by adding *Bacillus* to maintain a population density sufficient to break down wastes. This is why we recommend larger rates of Sanolife® PRO-W addition at high stocking and feeding rates; the result is a clean pond bottom at harvest (Figure. 3d).

Figure 2. Phosphate, iron and sulphide interactions in pond sediment and soil. Phosphate is trapped as an insoluble complex with iron oxyhydroxides in the oxic surface zone of the sediment and then is mixed downwards e.g. by bioturbation or mechanical disturbance, tilling etc. In the anoxic zone, sulphate reducing bacteria release sulphide, which reacts with metallic minerals in the soil, especially with ferric compounds that are reduced to pyrite.

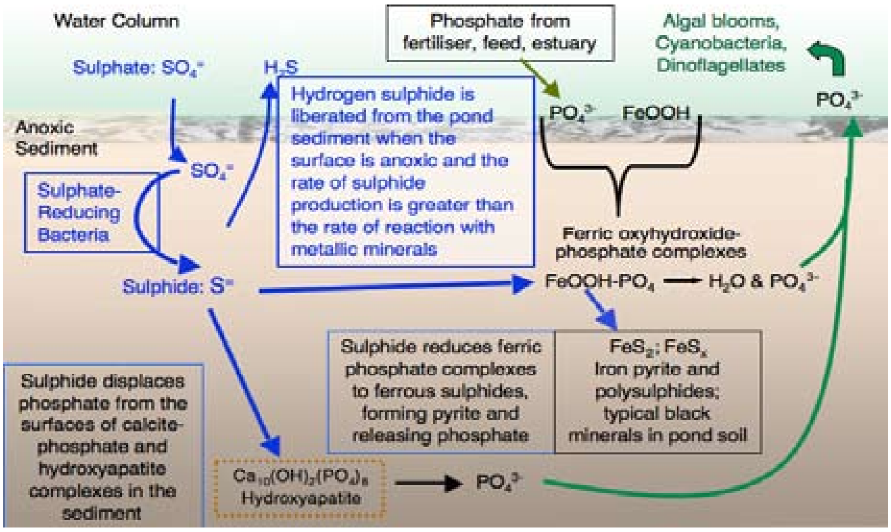
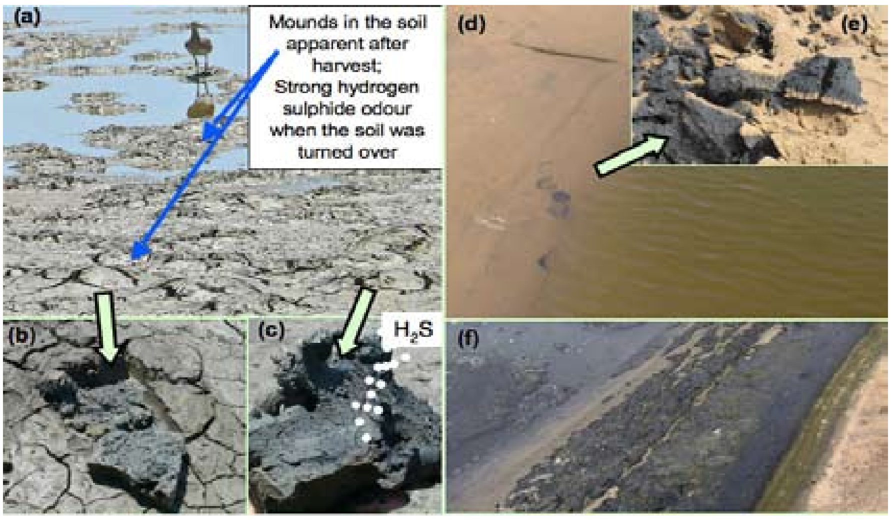


Figure 3. (a): An example of a pond in which the rate of organic matter oxidation by sulphate-reducing bacteria in the anoxic sediment was greater than the rate at which sulphide was trapped by iron and other minerals in the sediment. Hydrogen sulphide gas was released, which caused the sediment to expand; shrimp mortality was apparent. (b, c): The clay soil was black at the surface with the odour of hydrogen sulphide. (d): a pond on sandy soil with adequate aeration and treatment of the water and feed with appropriate *Bacillus* probiotics and no phosphate fertiliser used. (e) sediment from pond (d) showing the upper 1 cm in and oxic state (light colour) and the lower sediment black due to iron sulphide minerals. (f) a pond next to pond (d) with the same sandy soil type, but not treated with appropriate probiotics and with superphosphate applied at a high rate. Note the benthic mats of cyanobacteria (blue-green algae).



B: Calcium, Iron and Phosphate Cycling

Interactions in the sediment are linked to soil types

Excessive phosphate concentrations that result in undesirable or toxic cyanobacterial or dinoflagellate blooms are interrelated with the biogeochemistry of iron and calcium in soils. In sediment with a high redox potential at or near the surface, iron is in the oxidised ferric state; ferric oxyhydroxide-phosphate complexes are very insoluble and therefore phosphate is trapped and immobilised.

However, when the sediment is anoxic at the surface the organic acids produced by anaerobic fermentative bacteria release phosphate from iron, aluminium and calcium minerals; many microorganisms reduce ferric compounds to ferrous forms and release phosphate that was bound on them into the interstitial water. The mobilised phosphate diffuses to the sediment surface where it becomes available to cyanobacteria and algae. When the pH is high and light penetrates to the pond bottom, the release of phosphate provides ideal conditions for benthic cyanobacteria.

Phosphate accumulation and cycling with iron in pond soil

Phosphate enters ponds mostly from feed and fertiliser, and in some regions from estuarine water that has a high load of phosphate leached from agricultural soils. It accumulates in the pond soil over time, usually bound into calcium, iron and aluminium compounds and adsorbed onto organic matter, especially extracellular polysaccharides (EPS) produced by microbes (Figure 4).

Microbial activities and chemical interactions

In the sediment, these have a profound influence on water chemistry, especially with respect to iron, calcium and phosphate; soil type, e.g. the sand or clay content and types of clay modify the interactions. Ferric oxide, ferric phosphate and other oxidised iron compounds are very insoluble compared to the reduced ferrous compounds, so phosphate in pond water becomes trapped and bound at the soil surface, especially when the soil is dried between crops and in the first month or so when oxygen concentration is high at the pond bottom (Figure 5).

Figure 4. In seawater, calcium binds phosphate strongly, and especially in aquaculture ponds where liming is applied, it plays a major role in trapping phosphate; a typical insoluble mineral is hydroxyapatite. Calcite crystals (calcium carbonate) attract Ca^{2+} & PO_4^{3-} ions and thus form phosphate complexes; microlayers of apatite form on calcite, displacing hydroxyl ions, and then calcite deposits on the apatite, resulting in a build up of complexes of both minerals, which precipitate to the pond sediment. Downward movement is increased by burrowing animals and by any mechanical disturbance, such tilling between crops, so phosphate accumulates in pond soil over many crop cycles, especially when superphosphate or calcium phosphates are applied.

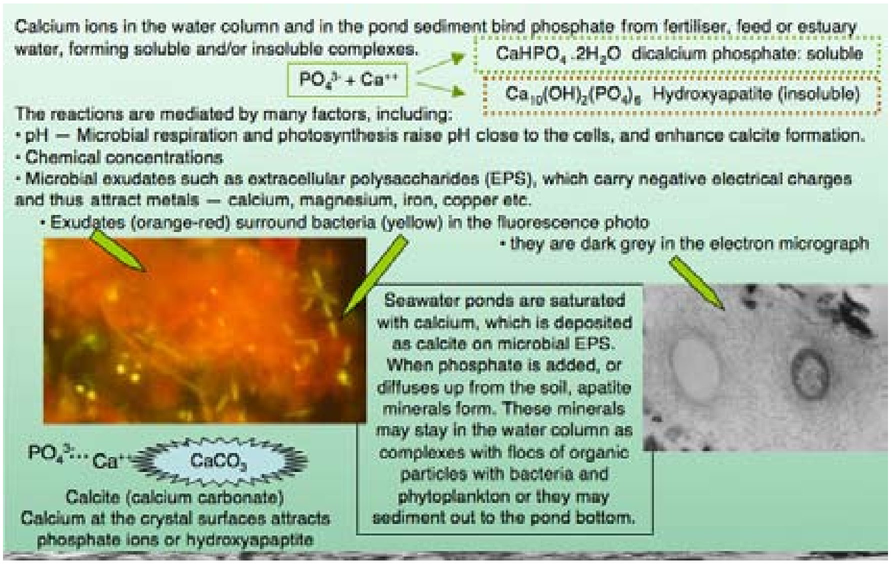
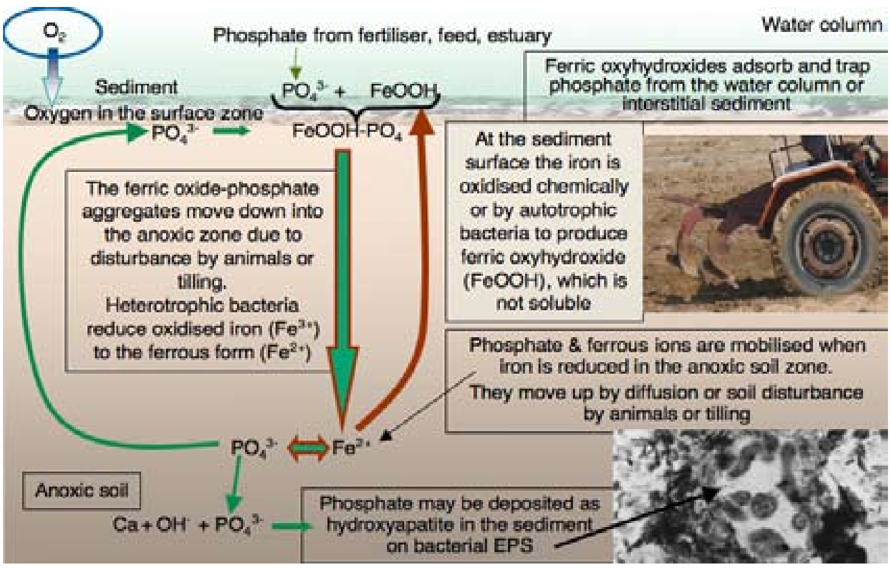


Figure 5. Phosphate and iron interactions in aerated pond sediment, i.e. with oxygen diffusion into the upper few mm or cm of the sediment. Phosphate is trapped as an insoluble complex with iron oxyhydroxides in the oxic surface zone of the sediment, often bound to organic material such as microbial EPS, and then is mixed downwards e.g. by bioturbation or mechanical disturbance, e.g. tilling or aerator turbulence. In the anoxic zone, ferric compounds, both dissolved and the very insoluble ferric oxyhydroxides are reduced by bacterial and archaeal respiratory processes or chemically by sulphide. Ferrous ions and compounds are more mobile than ferric ions and compounds and diffuse upwards, where these may be oxidised by bacteria or chemically by oxygen. Phosphate is released by the reductive processes and diffuses upwards, where it is then scavenged again by the oxidised iron. Thus there is a cycle of iron and phosphate movement and redox processes in the soil. Phosphate may also be precipitated in the sediment by reaction with calcium to form hydroxyapatite.



Aerobic bacterial activity

When there is a high concentration of organic matter on the pond bottom, the rate of aerobic bacterial activity can increase to the point where the rate of oxygen diffusion into the pond sediment is insufficient to support the complete oxidation of organic wastes, resulting in sediment with an anoxic surface layer and reducing conditions in the sediment (Figure 6). After oxygen and then nitrate are depleted by microbial respiration, a wide variety of bacteria and archaea respire by reducing ferric iron to the ferrous form and manganic compounds to manganous forms. They reduce not only soluble, but also the very insoluble compounds, such as ferric oxyhydroxides. Archaea were discovered in 1977. They comprise a group of organisms that look like bacteria, but in fact are more closely related to eukaryotes (see Nitrifiers and Denitrifiers-Myths and Facts, Aqua Culture Asia Pacific Volume 5 (6) November/December 2009, p32-35)

The reduced iron compounds are more mobile and bound phosphate is released; these compounds and ions will diffuse out into the water column if the surface is anoxic. Ferrous oxide is less mobile than the phosphate released by reduction of ferric oxyhydroxide-phosphate complexes, but it also diffuses into the water column under extended anoxic conditions. High concentrations of free iron, manganese and aluminium, which are mobilised under anoxic conditions, can be toxic to animals.

Fermentative microbes

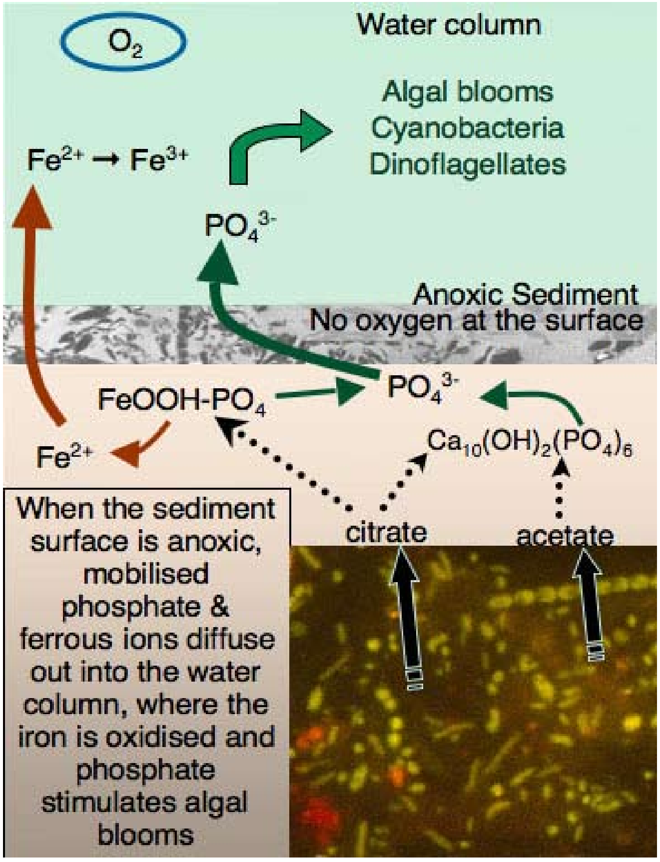
Yeast and many bacteria, e.g. vibrios and clostridia, transfer electrons to organic compounds that are in an intermediate state of oxidation. Carboxylic acids, e.g. formic, acetic, propionic, butyric, lactic and other small organic compounds including ethanol, as well as carbon dioxide and hydrogen, are the final products of fermentation by these bacteria. They interact with calcium phosphates to displace phosphate, which then diffuses into the water column. Polycarboxylic anions, e.g. citrate, are also produced by bacteria and will displace phosphate from ferric and aluminium complexes by chelation of the metals (Figure 6).

Pond management strategies

These have been discussed in detail in Part A. In general, ponds have to be managed to minimise the problems of excessive phosphate concentrations that promote algal blooms during the crop cycle, or downstream from the farm. At very low stocking densities, with biomass at a maximum of about 500 kg/ha, the waste organic matter per unit volume of water may be low enough to be dealt with by the microbial communities in the ponds themselves and in adjacent wet lands, e.g. mangroves. Typical values for gross primary production in aquatic tropical ecosystems such as seagrass beds, mangroves are around 5-10g C/m^2/day, which is approximately equivalent to adding about 100 – 200 kg feed per hectare per day.

However, respiration by the primary producers usually accounts for 80 - 90% of the gross production, so we should consider net production values of around 1g C/m^2/day as being normal for natural tropical communities to process without unbalancing the ecosystems. In other words, we could expect that mangrove communities could process about 10 - 20 kg of feed wastes/ha/day from aquaculture ponds. As that is about the same as feeding rates in low density ponds, the mangrove area for processing wastes would need to be equivalent to the pond area or greater.

Figure 6. Phosphate, iron and calcium interactions in pond sediment and soil where oxygen is depleted by microbial processes at the sediment surface and thus does not diffuse into the sediment. Short chain fatty acid anions, e.g. acetate, lactate and butyrate, which are produced by microorganisms during fermentation in anoxic sediment, interact with calcium phosphate minerals to displace phosphate, which then diffuses into the water column. Polycarboxylic anions, e.g. citrate, are also produced by bacteria and will displace phosphate from ferric and aluminium complexes by chelation of the metals.



Stocking density and biomass harvested, pond size, soil type and aeration are the most important factors influencing management. At high stocking densities, it is cost effective to eliminate the problems of iron and phosphate cycling in anoxic soils by lining ponds with concrete or other materials and applying water treatment procedures that include sufficient aeration and addition of appropriate bacteria selected for their waste decomposition capacities.

David J.W. Moriarty, is Consultant with INVE Aquaculture, Health Division, Bangkok, Thailand and Honorary Professor in the School of Biological Sciences, The University of Queensland, Brisbane, Australia. Email: djwmoriarty@bigpond.com

Technology, standards and marketing

Communicating to the world the standardisation of production in Vietnam at Vietfish 2010.

Prior to this annual event, the Vietnam Association of Seafood Exporters and Producers (VASEP) identified key areas to help members maintain their competitiveness, especially in exports of the pangasius catfish. The first was to attain international standards required by global markets and second to apply advanced production technologies to standardise production and quality.

Vietnam Fisheries International Exhibition (Vietfish) brought 170 local and regional companies to present their products in 283 booths from 12-14 June. Some 70% of these were seafood processing and export businesses focussing on value added products. The post economic downturn was reflected at this year's show. Vietfish International (July/August) reported that European visitors declined, possibly due the low value of the Euro against the USD. Raw material shortage was another factor. Nevertheless, the value of seafood exports for the first half of 2010 rose to USD 2.05 billion, 17% more than in the same period in 2009 with the EU and Japan, as the biggest importers of the pangasius and marine shrimp, respectively.

The processing conditions and production methods for the pangasius catfish are at centre of the buyers' concerns. The top pangasius catfish producers clearly want buyers to be familiar with their progress in attaining certifications such as GlobalGap for their integrated operations. In August, Sai Gon-Mekong Co. Ltd was granted the Global Good Agricultural Practice (GlobalGap) accreditation for farmed aquaculture products and the International Food Standard (IFS) certificates. It was Vietnam's eighth enterprise to receive these accreditations (www.vietnambusiness.asia).

In a seminar to an audience of mainly Vietnamese producers, Bureau Veritas and Casino group in Vietnam discussed compliance to requirements and consumer preferences for seafood in European markets, respectively. Pharmaq and the Akva group jointly conducted a seminar on new technologies to help producers comply with international standards. This covered the progress in vaccine development for the pangasius catfish (see box) and on how to achieve better control and traceability in sales, processing and farming.

Uplifting production standards

In her presentation on how the Casino group does its sourcing Vietnam, Caroline Poppe, Sourcing and Export Director in Vietnam, said, "It is very important to implement control checks before shipment. A rejection is complicated as the supplier is then subjected to more scrutiny. This can also impact all producers in Vietnam and black list of country. Producers must 'want this' as well as understand the need for this."

From Left, Pauline Roca, Viet Au, Caroline Poppe and Do Thanh Muon, Bureau Veritas, Vietnam.

Laurent Galloux (left) with Ning Samudra Widjaja (centre) and Nguyen Vu Thanh Nguyen, CJ Vina Agri, Vietnam

In Vietnam, the Casino Group is known as Big C. It exports Vietnamese products all over the world. It is the first retailing group to have private label branding and this is at the heart of Casino's strategy and expertise. It has the house brand which is a major asset in times of economic downturns and central to product selling. The Casino brand is the leading house brand in France.

Their sourcing principles in Vietnam are linked to consumer requirements in terms of quality, health, food safety, nutritive value, sustainable development and social ethics. These need to follow EU regulations and it only selects products certified with international labels such as BRC. The ethical audit of the Casino group follows that

Launch of fingerling feed for pangasius and tilapia

This is a result of a process called Nanoaqualogie by Ocialis which can produce nutritionally homogenous 500 microns micro pellets. The advantage over crumbles- the most common way to produce starter feeds, is the prevention of leaching. Ocialis named the feed Nanolis. The feeds also contain immunostimulants (β 1.6 and 1.3 glucans) to enhance fish health. Using disgestible raw materials, the feeds have high palatability and good feed conversion ratio.

These starter feeds are designed for intensive culture conditions where both nutrition and water quality should complement each other. The hatchery feeds presented at the launch contains 40% crude protein and 5% crude fat. Feeds sizes are 0.4, 0.6, 1.0 and 1.5mm and they are recommended for fish of less than 0.5g to 8-20g fish.


Phan Minh Tuan, An Xuyen Joint Stock was marketing tilapia produced in cages in An Giang Province

of the ICS. The sourced products in Vietnam comprise 65% shrimp, 12% pangasius, 12% marine fish and 11% cephalopods.

"The control at the farm level includes laboratory checks. In turn laboratories are also audited. We know that the consumers want this and we are taking the responsibility working with suppliers and we hope that the number of good quality suppliers will increase."

On requirements in European markets, Laurent Galloux, Seafood Manager, Bureau Veritas said the consumer demands in Europe have to be understood in the context of the mad cow scare in 1998. Doubts then arose on the farmed salmon followed by antibiotics contamination in aquaculture products and later the pollution and mangrove destruction in coastal areas. The consumer now questions the safety, origin, traceability of food and on sustainability of production.

Vaccine development


Kjersti Gravningen

In the pangasius project, Norwegian veterinary pharmaceutical company PHARMAQ is developing an efficacious vaccine against *Edwardsiella ictaluri*. The groundwork started in 2006. In 2008 and 2009 documentation studies were carried out in the Mekong Delta in cooperation with Bayer Vietnam and Can Tho University. By the end of 2010, the company hopes to have the ideal vaccine available for the industry. **Dr. Kjersti Gravningen**, Director Pharmaq Asia, **Vo Thanh Tung**, Clinical scientist both from the representative office in Vietnam and **Dr. Tu Thanh Dung**, Senior Scientist, Fish Disease, Can Tho University discussed the general concept of vaccination in disease prevention, laboratory results and field trials during the development process for the oil based injection vaccine ALPHA JECT Panga 1.

According to Gravningen, fish vaccination is expected to reduce the use of antibiotics, increase survival, improve the environment, increase the predictability and sustainability of production and help farmers comply with international standards. In a comparison on the different application models of vaccines, she said oral vaccines give the least stress on the fish and is a dream for vaccination of small fish. Immersion gives moderate stress but requires large volumes of vaccine. However, although the application by oral and immersion route is easy, neither oral nor immersion vaccination give a high level and long duration of protection. Injection vaccination is the most laborious administration method but gives the highest level and longest duration of protection.

The project started in 2006 in collaboration with a hatchery in Dong Thap Province and Bayer Vietnam. The documentation trial presented was conducted in 2009. Tung said that the fish (14±1g) received intraperitoneal injections (0.05 ml/fish) of the vaccine.


Vo Thanh Tung (left) and Dr. Tu Thanh Dung (second right) with participants from VASEP, AKVA and Pharmaq


Vaccinating fish (picture from Pharmaq Vietnam)

Control fish were injected with sterile saline. Fish were challenged with lethal doses of the virulent *E. ictaluri*, isolated from a clinical outbreak in pangasius in The Mekong Delta. Fish were challenged from 2 up to 20 weeks post vaccination. The efficacy trials demonstrated that the vaccine protected the fish against *E. ictaluri* for 20 weeks. The mortality in vaccinated fish was always significantly lower than in the control groups. The safety trial showed that the vaccine was safe to use for the fish. The length and weight relationship also showed no significant difference between control and vaccinated fish.

In her presentation on the field trials, Dung reported results from commercial ponds in 3 areas (Ben Tre, Dong Thap and An Giang) in the Mekong Delta over a 170 day period. In each area, one person was appointed to carry out daily recording and oversee the investigations. Both vaccinated and control fish were kept in one pond but separated by netting dividers, to ensure equal water environment. In 3 farms, a total of 360,000 fish were vaccinated and an equal number were kept as non vaccinated controls for comparison.

"We selected juveniles of good quality in the range of 28-58g. The health status was documented prior to vaccination. Antibody, weight and length in the fish were measured at different time-points during the study. The following was observed. In all farms, there was a significant increase in antibodies against *E. ictaluri* in all vaccinated groups. The antibodies remained high for 170 days. We observed outbreaks of *E. ictaluri*, in 2 farms. In Dong Thap, the post vaccination outbreak occurred at 48 days when the vaccinated fish were exposed to an infection and in An Giang, this occurred after 65 days. In both farms the vaccinated groups were protected, the mortality was significantly lower in vaccinated group than in control groups. The vaccine was safe, as there were no post vaccination mortality and the growth in vaccinated and control group within each farm was not different. However, differences between farms were observed." said Dung.

Keeping pace with change for Australia's industry

Australasian Aquaculture 2010 Conference and trade show brought industry together to learn from experts on keeping pace with changes in trade and markets, climate and production.

This theme 'keeping pace with change' was highlighted at this joint conference of the National Aquaculture Council, Australia and the Asian Pacific Chapter of the World Aquaculture Society held in Hobart, Tasmania from 23 to 26 May. According to conference chairman, Roy Palmer, this theme relates both to industry and government.

Production and environment

Changes in trade and markets, climate and production and how industry can adapt were addressed by six plenary speakers throughout the 3 day conference. **Mark Ryan**, Managing Director of Tasmania's Tassal Group Limited said that the protection of environment has been critical for the success of its salmon farming business. At the forefront of its success are risk and impact mitigation. The focus of impact mitigation has to be ahead of current regulations so that Tassal is well positioned to move forward.

Tassal is fully integrated, with economies of scale, high survival rates and low feed conversion ratios in its production cycles. It is a major player in the industry in Australia and New Zealand, contributing 65% to Australia's salmon production. Together, Australia and New Zealand markets 38,000 tonnes of salmon annually. Australia has four main players in its salmon farming industry and all of them are in Tasmania.

The leader, Tassal is now well positioned globally with a rate of growth of 15% per annum in the last 15 years and it expects to produce 19,000 tonnes in 2010. Tassal was set up in 1984 under a JV between Norwegian companies and the government. Ryan also added that the changing landscape in seafood consumption meant that consumers are more knowledgeable on issues such as food miles and carbon units. They are more critical on food choices and on quality, safety and health benefits and feel connected with the right seafood.

Production and environment

Aquaculture consultant in Chile, **Adolfo Alvial** said that during the boom period, Chile was the second largest producer of Atlantic salmon after Norway and was exporting to 62 countries with 85% of these to the US and Japan. It was exemplary in production and marketing, even producing value-added products at an early stage in its development. The bust after 20 years of impressive growth brought production down by half and was attributed to environmental and health management issues. Sea lice *Caligus* populations increased at the end of 2006 probably due to a combination of factors such as fish farms concentration.

The missing factors in the industry were weak local monitoring of the ecosystem and lack of regulation and enforcement. An integrated management system was in place but there was a lack of conviction and commitment of stakeholders to face the common interest problems which demanded concerted efforts. However, the industry is on its way to recovery with the new Salmon2.0 production model introducing

Roy Palmer (right) with Graham Mair, Seafood CRC

From left, Drs C Mohanakumaran Nair, Dean (Fisheries), K.R. Viswambharan, Vice Chancellor, and K.R. Salin, Asst. Professor, Kerala Agricultural University were in Hobart to promote Asian Pacific Aquaculture 2011 in Kochi, India

Aquaculture and seafood in Australia

In the next 20 years, the Fisheries and Research Development Corporation sees aquaculture expanding in a clean and green manner to produce 100,00 tonnes of finfish. Aquaculture produced 57,800 tonnes of the total annual production of 240,000 tonnes of finfish. The leading aquaculture products by value are salmonids, yellowtail kingfish and southern blue fin tuna. The Tasmanian salmon industry is expected to drive this contribution higher. It plans to increase production levels by 14,000 tonnes of marketable fish (head on gutted) to 48,000 tonnes. It has to do this in a sustainable way.

Seafood exports totalled AUD 1.5 billion in 2008 led by rock lobster, pearls, abalone, tuna and shrimp, mainly to Hong Kong. Seafood imports totalled AUD 1.7 billion, mainly from Thailand and New Zealand followed by China, Vietnam and Malaysia. Products are fresh, chilled fish and shrimp. In New South Wales, the shift towards low cost imported shrimp from Asia was due to the strong Australian dollar which made imports more attractive, said Jeff Guy. The impact of cheaper imports was to scale back local production of the shrimp and focus on larger size shrimp.

Sources: FRDC, 2008. Snapshot 2008; DAFF, 2010. Australia's Agriculture, Fisheries and Seafood at a glance; Jeff Guy, 2010. The economic impact of low cost imported Asian prawns on the NSW aquaculture industry.

new changes such as strict reporting, freshwater cycle in tanks, and mandatory use of vaccines and species segmentation in farms.

Climate change

The impact on climate change on aquaculture and fisheries is uncertain. CSIRO scientist **Alastair Hobday** said that observed and predicted warming of waters over 5 years, particularly around the Tasman Sea, means that aquaculture practices have to be adapted to these climatic changes. Planning has begun by some sectors. As an example, the Tasmanian salmon industry which is planning on expansion is already responding to variability in climate. Hobday described a proposed integration data collection and management system developed in partnership between industry and government researchers that will enhance the capacity of the salmon industry to adapt and respond to climate change.

The project will allow industry to experimentally test farm management practices to temperature extremes, with comprehensive real time information of near field and in cage environment and the fishes' physiological and genetic response using highly instrumental and large scale in situ experimental facilities. The goal is for industry to develop new practices.

The sessions at the conference covered current topics such as feed for future development, understanding the interaction between health and nutrition, reducing red tape on aquaculture regulations, nets for fishing and open ocean aquaculture, genetics and genomics, aquatic animal health, marine fish and aquaculture in Vietnam.

The trade show had 58 companies exhibiting and 15 companies presenting commercial information on products at the newly introduced trade show soap box, located at the end of the exhibition area. A gala dinner brought the Australian aquaculture industry and participants together over a culinary feast of Australia's premium products such as abalone, prawns, oysters, mussels and salmon. The Tasmanian Salmonid Growers Association was the major sponsor.

Branding and differentiating Australian seafood

Surveys showed that Australians have a strong preference for seafood produced in Australia but cannot readily identify the provenance of the product. An instantly recognisable brand and logo for local Australian seafood is needed. SSA Manager Ted Loveday and Seafood Experience Australia (SEA) CEO Roy Palmer have obtained funding from DAFF for a marketing platform that will use the trusted 'Australian Made, Australian Grown' (AMAG) logo.

The branding of Australian seafood booklet is precise on what constitutes 'Australian grown' for a particular fresh or frozen product such as seafood. For example, a fish harvested or grown and packed in Australia qualifies as 'Australian grown' but shrimp grown in Australia and packed outside Australia will not qualify. In the example of Australian grown' with descriptor, the example of barramundi was also given where a specific percentage of the manufacturing cost, weight of the goods or ingredients must have occurred or grown in Australia.

The value of this effort was highlighted in a recent survey by Seafood CRC. The survey found that consumers value and would like to purchase Australian seafood and are under the impression that they are consuming largely Australian seafood, whereas they may be consuming imported products. However, the price premium that consumers are willing to pay for Australia grown seafood is unknown.

Source: Branding Australian Seafood, Seafood Services Australia.

Aquatrees for a sustainable marine forestry

Inspired by the unique structure of the Norfolk pine tree, Aquabuild, based in Victoria, Australia, has developed the Aquatree. This provides fishermen and researchers an opportunity to sustainably grow multiple species alongside each other in a healthy environment.

The concept of an artifical reef is not new, but the Aqua Tree creates specifically shaped reef environments that can systematically harvest every type of aquaculture species on the market. Supporting a large variety of species, including crayfish, mussels, abalone, scallops, fish, prawns, as well as marine plants, Aquatrees are the ultimate foundation for marine growth all year round.

Multicultural life is possible in the Aquatree due to the use of different sized 'habitat pockets'. Each habitat pocket links to a central hollow core, which allows water and food to pass freely through and within the unique sandstone structure. With 100 naturally shaped habitat pockets in a medium size 2400mm tree, the Aqua Tree's vast surface area creates a density of sealife that exceeds most natural and artificial reef forms.

Aquatrees have been designed to be a valuable addition to existing artificial reefs systems, such as the artificial ball reef. When used in conjunction with existing farming methodologies, the Aquatree can also provide increased micro-organism density. Research has shown that the reef system can increase biomass within 1 -2 months, and within two years a complete marine eco-system will exist.

Farmers are able to create high-density multicultural reefs that provide year-round harvesting opportunities and varied sustainable food sources.

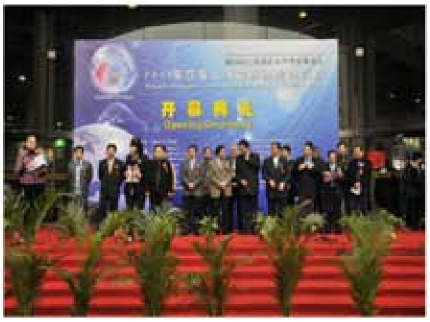
Aquabuild is excited about the impact that Aquatrees will have on future fish markets. Creating disease-free high-density aquaculture areas ensures fresher fish for the consumer and greater market flexibility for fishermen. These multicultural reef systems will also enable farmers to project fish production, making pre-ordered fish an exciting possibility.

For more information: www.aquabuild.com.au.

http://www.sifse.com/en/

SIFSE

The 5th Shanghai International Fishery & Seafood Expo 2010



Dec 10–13, 2010

Shanghai Everbright Convention & Exhibition Center

Sponsors： Shanghai Fishery Industry Association
China Tongyuan Co., Ltd

Organizer： Shanghai Gehua Exhibition Service Co., Ltd

Bosco Wang
Tel：+86-21-34141312
E-mail : boscoseaexpo@163. com

歌华展览
Gehua Expo

Alltech®
Nutrition, health, performance ...naturally

Value Proposition

A highlight at the 2010 Asia-Pacific Lecture Tour in June

"The Value Proposition illustrates how Alltech's research-based technologies and value-added tools can help identify opportunities and respond to the issues that exist in the food chain such as raw material shortages, performance and profitability, environmental legislation, food safety problems and reputation management," said Vice President for Asia-Pacific, Steve Bourne.

"There are answers and practical methods to address these issues, namely through Alltech's core competence of Primacy of Science. Bourne went further to say that "The future is all about 'Personalised Nutrition', whether this be the way we feed animals or people, it is not just about nutrition, but is the interaction between nutrients and gene expression, for health and wellbeing."

Under the umbrella theme of 'People, Profit and Planets', the two week tour focused on new technologies that can help the feed industry solve current issues. Over 1,300 animal feed industry professionals joined the 23rd Asia-Pacific Lecture tour which began in New Zealand and travelled to ten countries including Australia, Japan, China, Korea, Vietnam, Taiwan, Philippines, Thailand, Indonesia and Malaysia. The second leg of the Lecture Tour took place from August 1-6, 2010 visiting India, Sri Lanka, Pakistan and Bangladesh.

Representing the company's R&D team, Dr. Richard Murphy, Research Laboratory Manager, Alltech Ireland and Dr. Alexandros Yiannikouris, Senior Research Scientist and Coordinator of Glycomics Research, outlined some of the fundamental research which has been used to develop these technologies. "Alltech has the tools to move nutrition to a whole new level," said Murphy as he described the pioneering Animal Nutrigenomics Centre which provides an understanding of how nutrition affects health and performance through altering gene expression patterns and the company's work in the area of selenium enriched products and functional foods. Yiannikouris told delegates how the understanding of the structure of yeast and yeast cell wall components has led to the development of more effective natural solutions to mycotoxin problems and the control of pathogens.

For other reports: www.alltech.com/aplt.

From left to right: Dr. Richard Murphy, Dr. Juan Tricarico, Dr. Alexandros Yiannikouris, Dr. Alison Leary, Steve Bourne, Dr. Philip Chew Hong

New lighting system

This is a brand new technology for the market introduced by Shining Sea Marine & Industrial Light Co., Phuket, Thailand. The unit can save energy, the environment and cut operating costs for aquaculture farms and hatcheries.

This WAP Marinetech ESL 150 light is a 150W Energy Saving Light with a difference. An electronic ballast gives a performance of 99.9% efficiency and keeps the running temperature low (touchable by hand) for longer life, together with a specially coated reflector, this unit offers several advantages over traditional fluorescent strip lights and mercury bulbs.

The brightness of this light is equivalent to that of a 600W mercury light measured with a light meter at 3m distance. A bonus for hatchery applications is in the artemia and plankton production which require high light intensity.

The running cost is that of a 150W bulb. This gives considerable savings in electricity bills in farms and hatcheries. This combined with the 1 year warranty provided and an average working life of 10,000 hours makes this product a breakthrough for those interested in environmentally sound aquaculture practices. The unit comes complete with weatherproofing suitable for external applications and humid internal environments such as in a hatchery. More information: Email: ssmileco@gmail.com

Asian Pacific Aquaculture and Giant Prawn 2011, Kochi

'aquaculture: the future is here'

ASIAN PACIFIC AQUACULTURE 2011 is all set to become a major aquaculture and fisheries industry event in India with confirmed participation from academicians, researchers, officials, and industry leaders from India and elsewhere.

In June, Dr. B. Meenakumari, Deputy Director General, ICAR, and former Director, CIFT, Kochi inaugurated the website of Asian Pacific Aquaculture 2011 (APA 2011) and Giant Prawn 2011 (GP 2011), the twin conferences, to be held in Kochi, Kerala from 17 to 20 January 2011.

At the meeting chaired by Mr. K.R. Viswambharan, IAS, Vice Chancellor, Kerala Agricultural University. Dr. C. Mohanakumaran Nair, Dean, College of Fisheries and Convener APA 2011 welcomed the gathering and presented an overview of the conferences. Dr. Meenakumari also unveiled the conference logo by handing over the plaque to Mr. K.R. Viswambharan.

Asian Pacific Aquaculture 2011 is the annual conference of the World Aquaculture Society, Asia Pacific Chapter. It is the first conference held in India in the 40 years history of the World Aquaculture Society. Giant Prawn 2011 will be coordinated by Michael New OBE who had earlier visited India during the Freshwater Prawn 2003 Conference organised by College of Fisheries in Kochi.

The theme for APA 2011 is **aquaculture: the future is here**. It signifies the important role aquaculture must play in meeting the food security challenges in the immediate future. Giant Prawn 2011 will be the most significant global event on the farming of freshwater prawns since the first international Giant Prawn conference was held in Bangkok 30 years ago. APA 2011 and GP 2011 will provide the best place for all stakeholders in Asian Pacific region to meet and discuss the opportunities in aquaculture, from emerging challenges to global food security.

The conference website (www.apa2011.org) provides up-to-date information on the conference program and has options for online abstract submission, online/offline registration etc. Delegates could also opt for pre and post conference tours to visit aquaculture farms and scenic places in Kerala from beaches, backwaters, hill stations to wildlife sanctuaries. Daily tours will be arranged for spouses.

Farm tours options

- **Pokkali rice – shrimp fields in Ernakulam District**
  Participants will see rotational cropping of shrimp and a saline resistant, tall variety of paddy, locally known as Pokkali in the low lying coastal belt of Central Kerala. Supplementary stocking of black tiger shrimp (*Penaeus monodon*) and Indian white shrimp (*Fenneropenaeus indicus*) has recently transformed this into a modified-traditional system of farming.
- **Modified-traditional shrimp farms and shrimp hatchery in Thrissur District**
  In this district, eco-friendly farming uses traditional and improved traditional methods for farming. This trip will include a visit to a modified-traditional shrimp farm, and a modern black tiger shrimp hatchery in Kerala.
- **Integrated brackishwater farm and multi-species shrimp hatchery in Ernakulam**
  This farm follows an integrated approach in brackishwater farming including shrimp, mullets, and crab (*Scylla serrata*). The shrimp hatchery at Cherai Beach produces both black tiger shrimp and giant freshwater prawn seed stock on demand.
- **Multi-species hatchery in Thiruvananthapuram District**
  The Kerala government owned hatchery at Odayam in Thiruvananthapuram (Trivandrum) District is one of the best shrimp hatcheries in Kerala producing seed stock of the giant freshwater prawn.

CALL FOR PAPERS - DEADLINE: September 30, 2010

Asian-Pacific Aquaculture 2011 and Giant Prawn 2011 encourage the submission of high quality oral and poster presentations. All abstracts must be in English, the official language of the conference and should be submitted online at www.was.org

More information:

Asian-Pacific Aquaculture 2011, 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 Web: www.was.org; www.apa2011.org

Dr. C. Mohanakumar Nair, Dean (Fisheries), Conference Secretariat: College of Fisheries, Kerala Agricultural University, Panangad PO, Kochi 682 506, Kerala, India. Tel: +91 484 2700596 Fax: +91 484 2700337 Mobile: +91 984 6047741 Email : apa2011kochi@hotmail.com; naircm@hotmail.com; deanfisheries@kau.in

Giant Prawn 2011 updates

Michael New, coordinator of this concurrent meeting said that plans for the event are going well. This will be a landmark event in freshwater prawn farming. Presentations at the thee day conference, GP2011 will cover many important species, particularly *Macrobrachium nipponense* and *M. amazonicum*, in addition to its primary focus on *M. rosenbergii*, the giant freshwater prawn, which is the prawn with a global significance. At press time, more than 35 abstracts on this topic have been submitted to the World Aquaculture Society (WAS). Details are available at http://www.apa2011.org/program_gp2011.php

GP 2011 is a component of APA 2011 and there is a common registration fee. All participants, including invited speakers, will need to register through WAS for the APA 2011 conference and exhibition. GP 2011 will be held in one of the session rooms of the APA 2011 meeting and will be a full three-day event from January 18-20.

Dedicated animal feed show moves to Germany

In May 2011, Victam International and its co-located sister feed ingredient trade show FIAAP International will open for the very first time in Cologne, Germany.

Victam, the world's largest event for animal feed processing technology, has always been held in The Netherlands but the organisers, with the support of the majority of the industry, have decided that Cologne would be a more suitable venue for such a prestigious international event. Over 80% of the much larger space has been reserved.

What will visitors see when they visit Cologne? Visitors will find a very modern state of the art venue. The exhibition halls are fully air conditioned and they have excellent facilities for visitors, exhibitors and conference delegates. An impressive autobahn system links directly to Cologne and the exhibition centre where there are large parking facilities. The international airport is served by many direct flights from all over the world and the Koln Messe (Cologne Exhibition Centre) has its own railway station on the direct railway line from the airport to the impressive city centre and downtown hotels.

In 2011, there will be three shows co located in one event. Victam will focus on animal feed processing and biomass pelleting; GRAPAS on flour milling, grain processing and pasta production and FIAAP on animal feed ingredients, additives and formulation.

At the Victam stands, there will be a large range of animal feed processing equipment and technology. This will be suitable for the very largest feed mill to a small mill. The technology will vary from the very latest to simpler re-furbished machines. New for the Cologne show will be the inclusion of Biomass Pelleting Technology. Visitors will find what is probably the largest ever assembly of biomass pelleting technology on the show floor. This is already a large and expanding industry sector within Germany, Austria, Scandinavia, Russia and other Eastern European countries.

A survey conducted during a Victam International exhibition concluded that 64% of all the industry executives that attended the show "were interested in animal feed ingredients, additives & formulation". Accordingly, a new show and conference called FIAAP, was launched at Victam Asia 2006. The show and conferences was successfully repeated in Bangkok in 2010.

FIAAP International 2011 will therefore be co-located alongside Victam International 2011. It will be the showcase event for specialist ingredients, additives and their formulation within feeds for animals, dry petfood and aqua feed.

Industry executives and experts will also be able to attend a series of technical conferences and workshops. These include:

- IFF Feed Processing Conference is organised by IFF, (International Research Association of Feed Technology) Germany.
- Biomass Conference-organised by AEBIOM (European Biomass Association)
- FIAAP and GRAPAS Conference organised by Linx Conferences
- Petfood Forum Europe 2011-organised by Watt Publishing
- Aquafeed Horizons-oganised by Linx Conferences
- Feed Safety Assurance in a Globalising Industry organised by GMP+International

More information: Web: www.victam.com with links on this site for the conference secretariats.

What can you expect from Aqua Culture Asia Pacific in 2011

To date in 2010, we have brought to you an extensive coverage on issues affecting the Asian-Pacific industry. Some of our lead articles meant to catalyse a paradigm shift for Asia's industry were on vaccination of tilapia against the *Streptococcus*; optimisation of feed ingredients; diseases of the barramundi; pangasius seed quality; feed sustainability with marine meals and selective breeding of the marine shrimp. As we aim to move the aquaculture industry to the next phase of growth, we see that there will always be new opportunities to use the magazine for your marketing needs. During this 7th year of our publication, we invite you to join us to look at current issues, trends, latest developments and technology and be updated.

Volume 7 2011						
Number	1 - January/February	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	Aqua Feed Production	Cage Culture	Sustainable & Responsible Aquaculture	Health Management	Hatchery	Food Safety & Traceability
Industry Review Trends and outlook	Marine Shrimp	Groupers	Catfish	Tilapia	Freshwater Fish/Prawn	Marine fish (Cobia/Sea bass)
Feeds & Processing Technology Technical contributions influencing the final value of aqua feeds	Additives/ Protein meals Processing Technology	Micro-nutrients /Vitamins & Minerals Extrusion	Feed Enzymes/Lipids Post Pellet Additions	Nutritional Health Feed Management	Feed Probiotics Drying Technology	Novel Feed Ingredients/ Nutrition
Production Technology Technical information and ideas	Biofloc Technology	Breeding and Genetic Improvement	BMP, Standards and Certification	Recirculation Aquaculture Systems	Hygiene & Food Safety	Health Management & Biosecurity
Aqua business Feature articles	Experiences from industry, including role models, benchmarking and opinion articles in shrimp/fish culture					
Markets	Market trends, product development and promotions at ESE 2011,Vietfish 2011 and regional trade shows					
Show Issue Distribution at these events *Show preview in prior issues	VIV Asia 2011/Aquatic Asia 2011, Bangkok, Thailand 9-11 March*	9th Asian Fisheries and Aquaculture Forum & ISTA 2011, Shanghai, China, 21-25 April*	Vietfish 2011, Ho Chi Minh City, Vietnam 12-14 June World Aquaculture 2011, Natal, Brazil 6-10 June*		Aquaculture Europe 2011, Rhodes, Greece 18-21 October 16th China Seafood & Fisheries Exposition 2011 & Aquaculture China 2011, November*	Shanghai International Fisheries & Seafood Exposition, Shanghai, China, December

9th ASIAN FISHERIES AND AQUACULTURE FORUM (9AFAF)

This is the triennial forum of the Asian Fisheries Society. It will be organised together with the Shanghai Ocean University, in collaboration with few other government and non-government agencies. 9AFAF with the theme, '**Better Science, Better Fish, Better Life**' will be held from April 21-25, 2011 at the Shanghai Ocean University, Shanghai, China.

There will also be two key international symposia during the 9AFAF,

- 4th International Symposium on Stock Enhancement and Sea Ranching (4ISSESR); and
- 9th International Symposium on Tilapia Aquaculture (9ISTA).

The three day conference and trade show will bring together leading aquaculture and fisheries scientists and key commercial stakeholders from all over the world to discuss important issues pertaining to sustainable aquatic resource production, utilisation and management in the Asia-Pacific. It is expected to be attended by government administrators, scientists, industry partners, students, and experts in aquaculture and fisheries. Presentations and working language will be English.

Tentatively the program will include:

Plenary sessions

- Better Science, covering genetics, aquaculture, fish feeds or production systems
- Better Fish covering fish health, breeding cycles or SPF broodstock
- Better Life covering markets, consumers or economics of production

Seventeen technical sessions covering aquaculture and fisheries covering:

- Aquatic animal nutrition & feeding
- Fishing gear & technology
- Integrated aquaculture & aquatic resource management
- Fish, human nutrition & health
- Marketing & globalization
- Fisheries policy & governance
- Freshwater fisheries & culture
- Harvest & post-harvest technology
- Fisheries assessment & management
- Aquaculture, environment & impacts
- Fishwatch Asia-Pacific
- Cage aquaculture
- Social-economics & fisheries
- Aquatic biotechnology & breeding
- Biodiversity & conservation
- Aquatic animal health & management
- Gender & fisheries

Scientists and researchers are encouraged to submit their recent findings to the 9AFAF for either oral or poster presentations. Due date for all abstracts is November 20, 2010. More information: Web: www.9afaf.org

October 5-8
Aquaculture Europe 2010
Porto, Portugal
Web: www.easonline.org
Web for exhibition: www.marevent.com

October 3-6
GlobalGap Workshop for Version 4- Aquaculture

October 7-8
Summit 2010,10th GlobalGap Conference
London, UK
Email: conference@globalgap.org
Web: www.globalgap.org

October 25-28
International Conference of Aquaculture Indonesia 2010

October 27-30
International Conference on Shrimp Aquaculture 2010
Surabaya, Indonesia
Email: aquacultureindonesia@gmail.com
Web: www.aquaculture-mai.org

October 27-29
Tilapia 2010
Kuala Lumpur, Malaysia
Email: infish@po.jaring.my/ infish@tm.net.my
Web: www.tilapia2010.com

October 29-30
Aqua India 2010
Chennai, India
Web: www.aquaprofessional.org
Email : aquaindia2010@gmail.com

November 2-4
Aquaculture China 2010
15th China Seafood and Fisheries Expo 2010
Dalian, China PRC
Web: www.Seafare.com

November 8-10
X International Symposium on Aquaculture Nutrition
Monterrey, Nuevo Leon, México
Email: sina2010@uanl.mx (Dr. L. Elizabeth Cruz Suarez)
Web: www.fcb.uanl.mx/xsina/index.html

November 25-28
Aquafair Malaysia 2010
Kuala Lumpur
Email: enquiry@aquafairmalaysia.com.my
Web: www.aquafairmalaysia.com.my

December 10-13
5th Shanghai International Fisheries & Seafood Exposition
Shanghai, China
Email: sifse@yahoo.cn (Wei zi qiang)
Web: www.sifse.com

January 17-20
Asian-Pacific Aquaculture 2011 and Giant Prawn 2011
Kochi, India
Email: worldaqua@aol.com
Web: www.was.org

March 9-11
VIV Asia & Aquatic Asia 2011
Bangkok, Thailand
Web: www.vivasia.nl; www.aquatic-asia.net

March 31-April 1
12th Aquaculture Insurance & Risk Management Conference
Kinsale, Co Cork, Ireland
Email: info@aums.com
Web: www.aquacultureinsurance.com

April 21-25
9th Asian Fisheries and Aquaculture Forum & 9ISTA-International Symposium of Tilapia Aquaculture
Shanghai, China
Web:www.9afaf.org
Web: http://ag.arizona.edu/azaqua/ista/ISTA9/ISTA9.htm

May 3-5
Victam International 2011
Cologne Germany
Web:www.victam.com

June 6-10
World Aquaculture 2011
Natal, Brazil
Email: worldaqua@aol.com
Web: www.was.org