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From the editor

Learning to pass the costs on

We have all come to accept that 2008 is the year that the aquaculture industry goes into uncharted waters. This is by no means exclusive to aquaculture but there is no security in numbers in this case. I am talking about high and rising costs of raw materials and commodities which are affecting aquaculture globally and this is not going to retreat anytime soon. The ABARE conference in Canberra in early March is projecting the prices of commodities continue its bull run for several years until about 2013. We can blame biofuels as much as we like but the problem remains. Unlike the 1998 financial crisis in Asia, we cannot export our way out of this problem today. Production costs which used to be cheaper in Asia a decade ago has changed as the Asian currencies appreciate against the US dollar. The Vietnam Association of Seafood Exporters and Producers (VASEP) has recently asked the Ministry of Agriculture and Rural Development (Vietnam) to assist 250 members who are facing difficulties due to the US dollar's devaluation and the shortage of the Vietnamese Dong. At the processor level, they are paid in USD whereas costs of raw materials and production are in Vietnamese Dong. Imagine the impact of this at the farmer level!

At the production stage, rising costs are more tangible. We have passed the denial stage and are using a 2 prong approach to seek a solution. The first and quickest is to look for novel raw materials ranging from DDGS to coconut and palm kernel meal. The term quickest is relative as nutritionists require time to perform trials while procurement specialists seek for logistically viable volumes and economies of scale.

At several discussions with commercial feedmillers during the recent Victam show in Bangkok (March 4-7), I heard ideas of formulating cheaper basic feeds with lower fortification of nutrients. This is beginning to sound like 'a drowning man holding on to anything that floats'. This can work for the short term but we need to look for a long term solution. We have always accepted that aquaculture nutrition is far from being efficient. We do not have concrete data on the nutrient requirements of a major number of commercial species under culture today. The adage 'necessity is the mother of invention' may be the wake-up call that will force us out of the complacent state we have cruised along for the past decade. While research institutions work on this 2nd prong approach, I would like to debate on the 3rd prong – passing on costs.

Feed manufacturing rests at the early stages of the value chain. With the rising costs of commodities, feedmillers will have to increase prices and pass these costs onto the farmers. In theory, the farmers will then have to pass the costs onto the processors and ultimately to the consumers. This is how market forces work but fear of losing sales and market share may prevent us from doing the correct thing. Despite rising production costs (feed, energy and other inputs) over the last year, we see that ex farm prices of marine shrimp and freshwater fish have not been increasing. Instead we have been working at increasing volumes to be competitive. Aquaculture products are commodities and behave in exactly the same way as corn, soy or fishmeal. Demand and supply dictates its price. No one in their right minds will continue an unprofitable business and stopping altogether will reduce supply and automatically increase its price. By not passing on the costs along the value chain would mean bearing the pain and losses and perhaps the business ceasing entirely at a later date. Prices will rise ultimately but helping it along sooner by passing on the costs makes better sense than later.

Zuridah Merican

WRITE TO THE EDITOR

We want to hear from you. Write your comments on the industry to the editor.

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Vannamei shrimp

Vietnam-culture extended to the south

The shrimp can be farmed intensively in the Mekong Delta and Southern Provinces but subject to food safety regulations. Vietnam's Ministry of Agriculture and Rural Development has allowed the culture of the white shrimp *Penaeus vannamei* in the Mekong Delta as well as in the Eastern areas of South of Vietnam. The decision was made as a result of increasing demand to diversify aquaculture species and export products. Officially, this is effective as of 25 January 2008. However, it was noted that the vannamei shrimp can be farmed in intensive cultivation at approved facilities which meet food safety and hygiene conditions. In contrast, there are no restrictions vis-à-vis culture intensity in provinces in the North and Central region. The Ministry has also asked that the local People's Committee introduce and control the farming. Vasep news reported that farms which fail to adhere to the regulations would strictly be dealt with.

India, selective culture

The seafood industry, faced with shortage of shrimp wants a balanced mix of black tiger and vannamei shrimp.

India, the remaining bastion of black tiger shrimp culture in Asia may finally allow the culture of the vannamei shrimp following calls by the seafood industry. At the three-day Indian International Seafood Show in February (see page 46), A T Tharakan, vice-chairman, Marine Products Export Development Authority (MPEDA) asked that selective culture of the vannamei shrimp is allowed to give the country a 'balanced mix of black tiger and vannamei shrimp' and to meet international demand.

The main reason for this call is that the seafood industry is facing a shortage of raw materials. Shrimp contributes 28% to the total seafood exports by volume and 55% by value in 2006-2007. Farmed black tiger shrimp contributed 80% of the total shrimp exports. Production of the black tiger shrimp has stagnated at 150,000 tonnes. Indian seafood exporters also lamented that the market is being taken over by the low-cost vannamei shrimp from China, Thailand, Vietnam and Indonesia.

They added that vannamei shrimp can be produced at 'half' the cost of black tiger shrimp but is equally good looking and tasty as the black tiger shrimp. Importers then quote on low prices for the tiger shrimp which exporters cannot meet and the effect is that the shrinking demand is forcing farmers to reduce farming area or stop culture operations. Vannamei shrimp cost INR 90/kg to produce which is half the cost of the black tiger variety. While farmers can produce 20 tonnes of medium and small vannamei shrimp per ha, they can only produce 2-3 tonnes of black tiger shrimp.

Tra catfish

Low prices threaten output in Vietnam

High exports volumes and opening of new markets such as Mexico are not helping tra catfish farmers who are facing higher costs and low ex-farm prices.

It has been estimated that in the Cuu Long River Delta, the tra farming hub of the country, output will increase to over one million tonnes this year, equivalent to fillet exports of USD 1.2 billion, an increase of USD 200 million over that in 2007. However, in a news report in VietNamNet Bridge, Nguyen Van Hao, the owner of a tra fish pond in Hoa Hung Commune in Cai Be district in Tien Giang Province, said that with the current sale price of VND15,500/kg, profits margins are only VND500/kg.

Furthermore, Le Chi Binh, Deputy Chairman of the An Giang Farming and Seafood Processing Association, said that as more tra processing workshops are being established, more tra ponds are created. He added that in some areas such as in Binh Dai, Ben Tre province, tra catfish culture is taking over ponds previously used for black tiger shrimp. Binh said that while farmers are struggling with high input costs, fish processors are offering lower prices. A director of a basa export company said that the dollar devaluation is insufficient to cover costs and they are forced to ask for lower ex farm prices.

He added that if farmers' profits continue to go down, they will give up farming, leaving tra processing workshops idle with no materials to process. However, analysts expect tra prices to rise to VND17,000/kg in 2008 as output may decline with adverse weather conditions and pollution problems.

Feed

Producers in Thailand seek price increase of 10%

Feed producers have asked for approval to increase feed prices by 10%. This is despite an earlier request by the Ministry of Commerce to freeze and cut prices.

In Thailand, the Commerce Ministry has feed prices on its price control list. In the Bangkok Post, Pornsil Patchrintanakul, President of the Feed Meal Producers Association said that raw material costs have been increasing and that producers have been suffering losses. The price of fish meal rose to THB 25-26/kg compared to THB 21-23/kg in 2006. Corn is now THB 8/kg as compared to THB 5/kg in 2006. Soybean meal is quoted at THB 16.50/kg while it was only THB 12 /kg in 2006. The association has also asked that the government waive import tariffs on 15 types of raw materials. Soybean has a 5-9% import tariff. It has also requested a ban on exports of corn and tapioca. Thailand produces 3.5 million tonnes of corn of which 100,000 tonnes is exported. It produces 200,000 tonnes of soybean whilst the demand is 2.7 million tonnes.

White shrimp at 12.5% of Philippine shrimp production

By Philip Cruz

Finally, the Philippine farmed shrimp industry is back on its feet! Thanks to the white shrimp, *Penaeus vannamei*, farmers, hatchery operators, and feedmillers have renewed confidence and enthusiasm in the shrimp industry.



A 2007 harvest of *vannamei* shrimp from Viveros Farm, Hoc Po Feeds Business Development Unit, Courtesy of William Kramer.

It was not so long ago that the culture of this species was unpopular, because of concerns with diseases, its potential ecological impact and low farm gate prices. As with the documented experiences in much of Asia, the farming of white shrimp offers so many advantages. It is just too good a species to pass. Fortunes have indeed changed and the white shrimp is now the darling of the industry.

In the Philippines, the current high domestic prices are driving white shrimp farming. Since the collapse of the shrimp industry in 1994, domestic supply of marine shrimp has remained stagnant and this has steadily pushed prices up. The spread of WSSV-white spot virus syndrome in wild stocks some 6-7 years ago was believed to have reduced the supply of wild caught shrimp driving market prices higher. At present, farm-gate prices of white shrimp range from USD 4.9 to 5.4/kg for 12-15g shrimp. Larger shrimp (15-18g) fetch USD 5.7-6.2/kg. With a production cost of USD 2.7-3.4/kg, white shrimp farming in the Philippines is turning out to be very profitable. It is not uncommon to see farmers making USD10,000-15,000/ha/crop, especially those located near Metro Manila where buyers queue up at the farm to buy freshly harvested shrimp.

All is well

White shrimp farming is now practiced both in intensive and extensive culture systems. In intensive culture, typical production is between 7 to 12 tonnes/ha/crop, for a culture period of 90-120 days. Survival is around 65-80% and FCR ranges from 1.3-1.5. Many of these farms practice partial harvesting and start with a stocking density of 100-200/m². Contrary to earlier claims that white shrimp farming will not work in large and shallow brackishwater ponds with zero biosecurity, a growing number of extensive farmers are now culturing the species with a production of around 1 tonne/ha and an FCR of 0.7-1.1. Production cost using this system is only around USD 1.7-1.8/kg for 20-25 g shrimp.

However, WSSV is a big problem experienced by *P. vannamei* farmers especially during the cooler months of the year. Hence culture tends to be limited during the warmer months. It is interesting to note that extensive farmers report that they have a much better chance of harvesting something in extensive white shrimp culture and breaking even compared to extensive black tiger shrimp culture. According to some farmers, white shrimp compared to the black tiger may be marketable at 6 grams at USD3.7/kg. The same size of black tiger will sell for only USD2.5/kg.

Back to the hey days

There are no official estimates on the white shrimp production in the Philippines for 2007, but this probably exceeded 5,000 tonnes from an estimated 3,000 tonnes in 2006. This places *P. vannamei* production at around 12.5% of total shrimp production. Most of industry players are aware that the high domestic prices will not last long and probably not beyond 2010. There are studies to suggest that should farmers be able to bring down farm gate prices to USD3.5/kg or less for 12-15g shrimp, the domestic market can expand to as much as 75,000 tonnes based on per capita shrimp consumption figures of the early 90s. While it may be difficult to make a decent profit with this price with intensive culture methods, farmers carrying out extensive culture systems can easily have good profit margins.

As for black tiger shrimp, Philippine production remains stagnant at around 38,000 tonnes. Of this figure, only around 5,000 tonnes are from intensive culture while the rest from extensive farms producing jumbo 40-60g shrimp. At its peak, the Philippines produced 94,000 tonnes of black tiger shrimp, of which around a quarter of the volume came from intensive culture systems. With the entry of the white shrimp, it is very likely that the farms facing difficulty culturing black tiger will shift to white shrimp, similar to the trend in many parts of Asia.

BT still king in the Visayas

Black tiger shrimp is expected to remain king in some intensive farming centres in the Philippines, such as in the islands of Negros, Cebu, and Bohol, where high growth rates and survival rates have been sustained in the last 5 years. Typically, farmers from these areas harvest 4-6 tonnes/ha/crop of 30-35 g shrimp in 120-130 days with a survival of 80% and FCRs of 1.8-2.

However, unlike the intensive black tiger shrimp farmers of the past, the present pool of farmers is highly skilled and experienced. They also have a strong respect for the environment, judicious in their stocking densities, employing proper pond preparation, rigorously screening fry for diseases and totally abandoning the use of antibiotics.



Philip S. Cruz, is a shrimp aquaculture consultant and owner of Cruz Aquaculture Corporation. The company does consulting work and hatchery and grow-out of shrimp, crayfish and some marine fish. In 2006, he received 'The Outstanding Young Men Award' for his valuable

contribution to aquaculture in the Philippines. Philip is the Conference Chairman in the upcoming 6th Philippine Shrimp Congress in Bacolod City.

The shrimp culture industry in the Philippines will meet to discuss developments, technologies, issues affecting the industry and development of new markets from May 28-30, 2008 in Bacolod City. See page 47 for more details on the 6th Philippine Shrimp Congress (PSC 2008).

Brief news

Oral vaccine against TSV in shrimp

Viruses lethal to shrimp have been responsible for large losses to aquaculture worldwide. Among these is the Taura Syndrome virus (TSV). Replikins, Ltd. has announced the development of a chemically synthesized vaccine specific to a Taura Syndrome virus structure based on its patented Replikins™ technology. When the vaccine was administered orally to shrimp, 91% survived a challenge by the lethal Taura virus. The specificity of the protective effect was established in control groups by chemically blocking the active regions in the vaccine. As a result the protective effect was lost in these control groups. The effectiveness of this vaccine, and its rapid production cycle (7 days), represent an important proof of concept for developing vaccines against a range of rapidly replicating high lethality virus outbreaks.

The production of vaccines by other methods took 3 to 12 months. By this time, the epidemic is believed to have gone or the effectiveness of the vaccine is reduced or lost because of mutation of the target virus. In contrast, the replikins vaccine found effective here was manufactured synthetically in 7 days. The company also announced that it was forming a division to focus on these viruses and is pursuing development of synthetic vaccine products for the control of fish hemorrhagic viruses and other lethal aquatic microorganisms.

Closing the cycle of SBT in Australia

Clean Seas Tuna has achieved a world's first when live larvae of the Southern Bluefin Tuna (SBT) were produced at its Arno Bay, South Australia hatchery. With this, Clean Seas will be able to grow out SBT fingerlings produced from its own broodstock and in turn enable year round production and reduce the overall cost of production. This success will also pave the way for an annual production greater than the Australian quota of 5,200 tonnes. Some 80% of the catch goes to Japan for the sashimi market and individual fish can sell for as much as USD 1,000. Chairman Hagen Stehr said in the Port Lincoln Times, that fish can grow at a rate of 7-8 kg/year in sea cages. The company anticipates that it will need to invest heavily in new sea pens and service vessels, and seek pristine sites beyond Australia, to expand its grow-out capacity. Mauritius had been suggested as a site for expansion. The SBT industry is worth USD 215 million annually.

Standards for abalone aquaculture

WWF (World Wildlife Fund) said that the process of developing standards for certifying farmed abalone will begin on April 29 in Melbourne, Australia. Abalone aquaculture is filling the gap in demand as natural stocks are depleting. Although abalone aquaculture has a low impact on the environment, relative to other farmed seafood species, the standards are required to ensure that the growth of the abalone aquaculture industry occurs with little to no impact on the environment or society.

Standards will be measurable and performance-based. They will be developed with input from a diverse group of stakeholders, including producers, academics, retailers, NGOs and government officials. The goal of the two-day meeting in Melbourne is to identify the six to eight key environmental and social impacts of abalone aquaculture, principles (i.e., high-level goals) for addressing each impact and criteria to focus on to reduce each impact. Dialogue participants will develop a research strategy to address any areas of disagreement and gaps in information. To attend the meeting, contact Dialogue coordinator Colin Brannen, email: colin.brannen@wwfus.org; Tel:+1 202 778-9534, by April 1. Web: www.worldwildlife.org/aquadialogues

World seafood market to exceed USD 388.9 billion by 2010

Global Industry Analysts, Inc. (GIA) a publisher of off-the-shelf market research said that although seafood is recommended as a healthy food, based on its lower fat and cholesterol content and high protein levels, people have stayed away because of its smell. The innovations in production and concerns on diets and health have changed this to bring an upward swing in seafood consumption. World seafood (frozen, canned and fresh) market is forecasted to maintain a CAGR in excess of 5.4% over the 2001-2010 period and exceed USD388.9 billion by 2010. Fresh/frozen/chilled fish dominates the global market for seafood, with a share estimated at 56.7% in 2007. In terms of growth, however, shell fish is forecasted to surpass all other segments, with a projected CAGR of 6% over 2001-2010. GIA added that customers are more discerning on their seafood and the seafood marketers have to invest more to compete with other protein foods like meat, poultry, and vegetables. Today the frozen seafood segment is undergoing a change with an increase in both unit and dollar sales. This is due to the improved products being introduced at all levels of markets - major brands, private label and smaller brands. The emphasis on new products and increased category support has resulted in the improved performance of the frozen seafood segment.

New aqua feed mill in Mekong Delta

Japan's Higashimaru Joint Stock Co. inaugurated its fish and shrimp feed mill in the Province of Tien Giang in the Mekong Delta in February. Built at a cost of USD 4 million, the mill has an annual capacity of between 10,000 and 15,000 tonnes of products under the Sakura trademark. This will be raised to 50,000 tonnes after the second phase which will require an additional USD 6 million.

Vaccines against fish viruses

In an agreement with Taiwan Cobia Inc. (TCI), Texas-based biopharmaceutical company CytoGenix, Inc. will develop DNA vaccines against selected fish viruses. TCI will vaccinate the fish and test immunological responses. Founded in 2004, TCI said that it was the first company to introduce the concept of organic aqua farming in Taiwan. The company is currently adding production sites in China and Southeastern Asia. Additionally, TCI has collaborative agreements with a number of research institutes and universities.

Barramundi in Malaysia

Protech Yu Asia Sdn Bhd, a subsidiary of Goldis Bhd is looking to further expand its export markets for its aquaculture produce on completion of its new USD3 million integrated fish farm in Tanjung Malim, Perak, in July 2008. In the Edge Financial, Colin Ng, said that the company is currently exporting barramundi to Canada and Singapore. It produces pollutant and antibiotic-free fish under a master license in Asia for Fish Protech Technology developed by Australian company Fish Protech Pty Ltd. Protech Yu is hoping to introduce the jade perch to the Malaysian market under the OM3 fish brand. This will be exported to other Asian countries, US and Europe. China is also an attractive market where it may build a farm via a strategic alliance.

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Time to move on in India Says Ravi Kumar Yellanki

Current culture regimes and dependence on gravid brood stock are drawbacks to the progress of industry in India. While it awaits commercial SPF broodstock, the industry must seek intermediate solutions.



Ravi Kumar Yellanki, is Managing Director of Vaisakhi Bio-Resources and Vaisakhi Bio-Marine. With management expertise and practical insights on challenges in shrimp fry production, Ravi brings conviction and understanding to the marketing process. He has a BSc in

Engineering and an MBA from the Xavier Institute of Management.

WSSV and Industry

White spot syndrome virus became a major obstacle to the growth of the farmed shrimp industry as early as 1994. Prior to this, there were no reports of outbreaks and farmers used to stock ponds throughout the year. Harvests were good. Apparently the disease made its way into the shrimp culture in India through trans-boundary movement of live shrimp post larvae. Since then, reports on WSSV infections have been increasing. Now it is a major contributor to crop failures. This is despite the fact that caution is being taken at the hatchery stage where all post larvae are tested using PCR (polymerase chain reaction) at the 100 or so laboratories.

The conventional theory is that if the parent (brood stock) is infected, the result should also be positive in the offspring (post larvae) through vertical transmission. However, it is only a few hatcheries in the country that are stringently screening the brood stock for all the known viruses.

The rate of infection is highest in the months of December, January and February and this is also the stocking season. During the 50 day period from January 20 to March 30, about 4 billion post larvae are stocked in ponds. February to July is also most conducive for culture and most of the farmers still manage to go through with a successful crop although most of the seed is being produced from virus-positive brood stock.

In India, the problem is aggravated as most farms culture shrimp using the open water system. Viruses play havoc with these farms and neighbouring farms. Reports on horizontal contaminations are very high.

The small window in the demand also means that hatcheries can be operated viably only for two months. For the rest of the year, barring few hatcheries, others stop operations or end up with losses. PL prices fluctuate from INR 350/1000 post larvae (USD 8.5 USD/1000) during the peak demand to INR 50/1000 post larvae (USD 1.2/1000) during the low season. This situation neither helps the farmers nor hatchery operators.

As all the farms are harvesting at the same time, there is pressure on the processors. Processing plants are also running at capacity for only two months of the year. Some are idle for the rest of the year. Incidentally, our harvesting time also coincides with peak harvesting times of many other shrimp growing countries, resulting in an inevitable fall in price of

harvested shrimp. It is the farmers who are most affected.

It is obvious that the whole industry is playing a zero sum game. To get the industry on its feet, it has to be sustainable. To achieve further growth, the farmers have to stock their ponds throughout the year. This is the only way out. Simply said, this is achievable if farmers are offered seed produced from virus-free brood stock enabling their farms to avoid transmission of virus vertically as well as horizontally.

Ultimate goal is with SPF stocks

A sustainable industry will need to depend on shrimp that will grow faster, resist diseases and help farmers to increase their productivity and profitability. Selective breeding program forms the basis for this. While there has been tremendous progress in this field with *Penaeus vannamei*, progress on specific pathogen free (SPF) for *P.monodon* has been limited.

Two main underlying factors are the difficulty in maturation of the pond-reared broodstock and lack of understanding of diet requirements for the mature stock. Moana Technologies, Hawaii has apparently made some headway in this field, but their stocks are not commercially available in India today. Their project on an SPF multiplication centre started recently in India. MPEDA has a SPF project in the Andamans. The gestation period of an SPF project with nucleus breeding centre is at least six years. However, this is the ultimate solution for combating shrimp disease problems and the goal for a sustainable shrimp industry.

Intermediate solutions

Our immediate and plausible solution is to produce seed from wild brood stock free from all known viruses in all hatcheries. This is not possible if the industry depends on wild gravid shrimp because we know that we cannot get sufficient numbers of virus free stocks. Our dependence on this less robust operational practice of producing nauplii from wild gravid shrimp also means that we have lost our competence over the years in using ablation to induce maturation in adult shrimp and then on produce nauplii. An outcome of this is that most hatcheries have converted their maturation areas to larval rearing.

I would suggest that the way forward would be for hatcheries to form clusters or lease idle hatcheries to operate maturation programs. Furthermore, we do not have sufficient competence in this area and we may need to bring in international experts. As we are blessed with a long coastline on the east and west coasts, I presume that it would not be too difficult to source virus free shrimp as brood stock year round.

The other variables

With respect to stress, while it is impossible to control weather, we do

have the ability to control many important variables, such as pond and creek carrying capacities, feed inputs and water exchange. At present dry feeds appear to be adequate, although there is obviously room for improvement in their quality. The biggest problem that farmers currently face is lack of bio-security of the pond environment to prevent entry of pathogens and their carriers. However, this is controllable.

Alternate species

Apart from the issue of *P. monodon* brood stock, the industry has to come up with an alternative species. Serious work on domestication of *P. indicus* and *P. merguensis* has to be done, as maturation in captivity is easier in both these species as compared to *P. monodon*. This would

increase the productivity of the country with less number of failures in the crop and increased utilization of the available farming area. Perhaps, *P. vannamei* should also be looked at considering the relatively better crop assurance with time tested SPF stocks and higher market price for 50 count vannamei as compared to that for black tiger shrimp.

If this status quo persists, no amount of hard work by farmers will get the industry back on track. While we wait in anticipation of the domestication and selective breeding programs on P. monodon, all the hatcheries should start screening brood stock. We will be ahead if industry comes with fast growing strains of P.indicus and P. merguensis. It is getting pretty late in the game, but as baseball immortal Yogi Berra once put it "It ain't over till it is over."

WSSV incidence levels during different months of the year, along the east coast of India in 2005 to 2007.

1. South of Machilipatanam up to Pazhaiyar from Padmanaba Labs, Chennai.

Month	2005			2006			2007		
	Total	Positive	%	Total	Positive	%	Total	Positive	%
January	10	4	40	223	81	36.32	481	190	39.5
February	123	47	38.2	98	16	16.32	654	262	40
March	0	0		120	6	5	653	85	13
April	0	0		116	4	3.4	155	9	5.8
May	30	4	13.3	161	0	0	223	9	4
June	90	3	3.33	7	2	2.1	383	83	21.7
July	17	0	0	185	24	12.9	408	61	14.9
August	80	7	8.7	158	3	1.8	208	23	11
September	22	0	0	197	6	3			
October	0	0		1	0				
November	5	0	0	218	40	18.3			
December	19	4	21	219	78	35.6			
	396	69	17.4	1793	260	14.5	3165	722	22.8

2. North of Machilipatanam up to Paradeep from Vaisakhi Bio-Resources (P) Ltd.

Month	2006			2007		
	Total	Positive	%	Total	Positive	%
January				293	78	26
February	97	23	23.70	159	55	34.59
March	217	74	34.10	119	19	15.96
April	244	57	23.36	221	33	14.93
May	156	29	18.58	221	34	15.38
June	141	25	17.73	202	52	25.74
July	114	27	23.68	185	55	29.72
August	68	06	8.82	144	48	33.33
September	74	17	22.97			
October	72	20	27.77			
November						
December	221	45	20.36			
	1404	323	23.00	1544	374	24.22

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The impact of shrimp and fish larval physiology and digestion processes on larval feed processing techniques

By Bernard Devresse

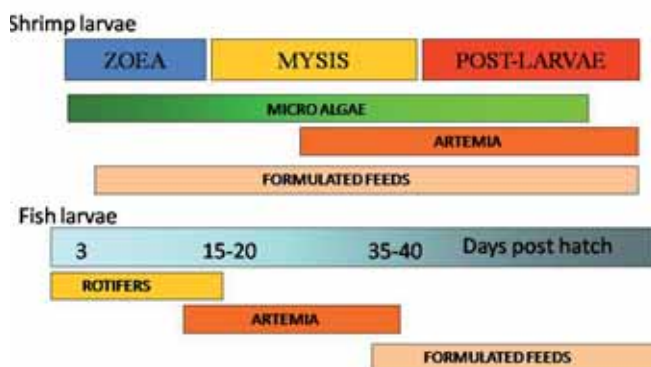
It is the feed processing techniques, not the formulation which has the bigger impact on the quality of larval diets. This impact is on the digestion and there are differences in feeding fish and shrimp larvae.

In the market, there are several kinds of formulated larval feeds for shrimp and fish, varying in composition and processing technology. These are not always well adapted to the biology of the animal at the various larval stages. Shrimp larval feeds range from pelleted crumbled feed, extruded crumbled feed, flaked (crumbled or whole), spray dried beads, agglomerated, encapsulated, milled meals (mixed) and liquid beads.

Shrimp hatchery operators seem to experience no problems with their use. However, when you look into the differences in shrimp and fish, you will see in that in feeding larval shrimp, hatcheries operators mix several feed types and everything seems to work. This is because there is a large (total) overlap between live food and formulated feed at many stages. It is evident that the biggest contributor is still live food mainly micro algae and artemia.

In feeding fish larvae, this overlap between live food and formulated feed is short. Larval fish pass from one stage to another and feeding starts with enriched live food followed by agglomerated or encapsulated feed before weaning and extruded crumbled feed after weaning. The feeding regime is rather similar everywhere. In contrast, most shrimp hatcheries have their own recipe for feeding shrimp larvae. They use microalgae at zoea, mysis and post larval stages and artemia at mysis and post larval stages (Figure 1). This also explains the high demand for artemia.

Figure 1 Feeding Chart of shrimp and fish larvae



Statistics on Artemia

The worldwide production of artemia totaled more than 2,000 tonnes annually. Marine fish hatcheries use 200-250 tonnes artemia/year equivalent to 10 % of the global production. Some 90% is used in shrimp hatcheries. Some 70% of the feed needs of shrimp hatcheries are covered by artemia. The global requirements to produce 2 million tonnes of shrimp in 2007 indicated an *L. vannamei* equivalent of approximately 500 billion post larvae/year. Each million of PL 15 shrimp will require 5.0 kg of feed. However, it is economics and market demand that sets the trend in the use of artemia and dry diets as sale prices of 1,000 postlarvae can range from USD8.00 to less than USD1.00

Co feeding

However, live food is a poor supplier of essential fatty acids (EFA) such as docosahexanoic acid and eicosapentaenoic acid (DHA & EPA). The hatchery operator is co-feeding with dry diets richer in essential fatty acids (EFA). Analysis has shown that for most commercial hatchery feeds, protein is largely indigestible. Thus, these feeds contribute mainly the fat component and more precisely that of the highly unsaturated essential fatty acids DHA and EPA. The supply of these from the hatchery feed is a good match to the live artemia instar 1 nauplii which is almost devoid of these fatty acids (Table 1).

Table 1 The essential fatty acid profile of live food

mg/g DW	Marine microalgae	Copepods	artemia	wild shrimp
20:4n-6 AA	0.2-1.5	<1.00	0.1	2.25
20:5n-3 EPA	1.0-14.0	22.50	0.0	14.25
22:6n-3 DHA	0.5-15.0	45.00	0.0	23.25
Total HUFA	5.0-15.0	76.50	5.0	39.75
Shrimp eggs contain approx. 15-20% lipid dry weight				

Physiology and digestion

In the wild, the natural food sources of shrimp and fish are the copepods, rotifers and diatoms. Actually during the first stages in development, the only nutrient of extreme important are the soluble proteins which it gets from the plankton. This is demonstrated in Figure 2, where in the halibut larvae, an ingested artemia is still recognizable when excreted. This showed that the fish barely digested the artemia. The fish ingested the artemia and drew out the solubles, leaving the solid particles to be excreted. The action is similar to extracting juice from an orange. This also demonstrates that the artemia is a living capsule of soluble proteins. Digestion is intracelullular as the small peptides enter directly into the enterocytes.

Figure 2 Physiology of digestion





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In the case of marine shrimp, the enzyme profile during the zoea larval stages showed high levels of trypsin which drops at the mysis stage. This occurs as the shrimp larvae passes from a phytoplankton diet with indigestible cellulose walls to the zooplankton diets with easy to digest soluble proteins. Evolution wise, the shrimp has been adapting. It does not require trypsin during these stages because the food is readily digestible.

The case for a requirement for lipid is explained in Table 2. During culture from egg to zoea III stage, a cumulative survival was higher in shrimp from eggs with higher total lipid levels. The composition in terms of quantity has an impact on survival too. Those higher in triglycerides, free cholesterol and phospholipids had higher survival. Within the polar and neutral lipids, the requirement for survival is for

can produce diets that meet the biological requirements of the animal is compared in Figure 3.

Unique production techniques

It is clear that shrimp and fish larvae demand small water soluble protein for optimal digestion. The poor digestibility of most hatchery feed is related to the insolubility of the protein. The production techniques should aim for feed quality and has to consider the digestion process in the respective species. These require different processing techniques. It has to be a combination of processes comprising micro-encapsulation, agglomeration and micro-extrusion marumerisation. In developing the feeds, we worked with frozen fish and squid because we want to use uncooked protein.

Table 2 General biochemical composition of individual spawns of *P. vannamei* grouped according to their cumulative survival through culture to zoea III stage. (N.S.=not significant).

Wet weight basis	High	Low	
Cholesterol ester (mg/g)	1.2 ± 0.2	2.1 ± 1.1	N.S
Triglycerides (mg/g)	30 ± 2.8	23.3 ± 3.9	P<0.05
Free Cholesterol (mg/g)	0.9 ± 0.4	0.7 ± 0.3	N.S
Phospholipids (mg/g)	21.7 ± 2.6	18.7 ± 4.1	N.S
Total Lipids (mg/g)	53.9 ± 3.6	46.1 ± 8.4	N.S
Total carotenoids (µb5g/g)	61.5 ± 13.4	40.6 ± 9.8	P<0.05
Total proteins (mg/g)	153 ± 138	137 ± 16	N.S
Fatty acids (mol %)	Polarlipids	Neutral Lipids	
20:4n-6	2.0 ± 0.2	1.8 ± 0.3	1.3 ± 0.2
20:5n-3	11.0 ± 0.6	10.1 ± 1.7	8.5 ± 0.8
22:6n-3	15.5 ± 3.0	15.6 ± 2.5	15.9 ± 2.3

EPA and DHA. Wild eggs have a total HUFA composition of approximately 40 mg/g. However, it would be impossible to even get a third of this value in eggs produced in a hatchery. Artemia does not contain any DHA and micro algae only contains a third of the required DHA and EPA. This is the reason for the use of artificial diets. In several cases, salmon starter diets high in these HUFAs are being used to feed shrimp.

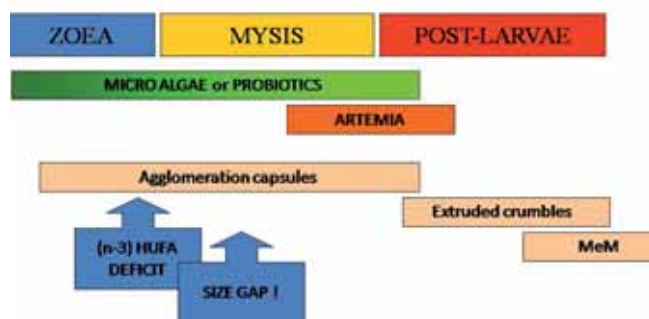
In summary, the shrimp digestive system is adapted to the food found in nature and the trophic level of the larval stage. These are naturally buoyant and perfectly encapsulated. It contains large fractions of highly digestible soluble protein and small peptides. The role of exogenous enzymes is negligible. However, live food is not always nutritionally balanced (HUFA, protein/energy) and is not always of the right size.

Larval feed process technology

When the requirements of the shrimp are well understood, we can then work towards the best processing technology. When pelleting or extrusion processing is used, the ingredients are cooked, protein is denatured and texturised. Protein becomes insoluble and indigestible. Starch is also required as a binder. This is usually used for large batches of more than 25 tonnes and the production cost range from USD 150-250/tonne. Although large volumes of such feeds are sold, the protein fraction in them is not suitable for shrimp and fish during early feeding stages.

In drum drying or flaking, feed is also cooked and protein denatured. The production cost is higher at USD 500 - 1500/tonne. It is usually used for small production batches of 500kg or more. Feed have good buoyancy. The better method is spray drying where the feed ingredients are kept reasonably intact and particles are small at 20 to 100 microns. Production batches depend on machine size and range from 500 kg to 5,000 kg. Feed have good buoyancy. However, production costs are highest at USD 1500 - 3500/tonne. How these production techniques

Figure 3 Production technique & shrimp biology



The classic encapsulation method which uses organic solvents is difficult, has environmental constraints and is expensive. A new method for microencapsulation developed avoids the use of solvents. This method use two phases of different viscosity and electrical charges. These two phases behave like two incompatible solvents (complex coacervation). However, the products from this micro encapsulation are capsules which are too small to be used directly. These are agglomerated with a binder. After drying, the result is a cluster of capsules as a feed particle (Figure 4). Each particle contains 2,000 capsules. Thus in one intake, the shrimp will ingest 2,000 capsules.

In micro extrusion marumerisation (MEM), the temperature used is less than 60°C. This keeps protein quality intact as opposed to high temperatures with the extrusion process. The protein in low temperature (LT) fish meal will remain intact with no further denaturation of protein and reduction in digestibility. There is no racemisation of amino acids and no heat damage on vitamins and other delicate nutrients. Perfect water stability is achievable without a need for starch and particles do not swell in water.

These three processing techniques conserves the best characteristics

Figure 4 Agglomerated capsule



of the ingredients. In the feeding regime, it is advisable to use microencapsulation and agglomeration for feeds for first feeding stages (zoea, mysis and PL1-6) followed by agglomeration and perhaps MEM to PL 15. This allows for a limited use of artemia until PL6 as after this stage, the digestive gland is preparing for dry diets. Larval feed is used for its fat as well as protein content, making these nutritional complete diets. In this optimal feeding regime (Figure 3), microcapsules can fill the size gap before artemia can be used at the early mysis stage. This optimal feeding regime is cost effective and also takes into account the physiology of larval stages.

The article was based on a presentation with the same title at Aquaculture Indonesia, July 30- August 2, Bali, Indonesia

Figure 5 MeM machine with strings coming out of the machine.



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Rendered animal protein blend in practical diets for the Siberian sturgeon

Acipenser baeri

By Xue Min, Wu Xiufeng, Guo Liya, Wang Junhua, Liu Haiyan, Zhu Hua, Niu Cuijuan, Zhao Weixiang and Yu Yu

In these growth trials conducted at the Feed Research Institute (Chinese Academy of Agricultural Sciences), Beijing with juvenile sturgeon, it was shown that substitution of fish meal with an animal protein blend (APB) up to 50% with or without supplementation of lysine and threonine had no effect on feed intake, weight gain, feed utilization and carcass composition. Feed cost per unit of weight gain was reduced by 21% with this replacement of fish meal. The value of APB when diets are formulated on digestible EAA basis meets the ideal protein requirement of the fish.

In carnivorous fish diets, fish meal (FM) is typically included at relatively high levels (30–50%), mainly for its palatability and protein quality. However, the future availability of FM for aquafeed production could be a challenge due to the fast the expansion of aquaculture. Sustainability of carnivorous fish farming depends not only on the consumer's demand of the fish but also the optimum utilization of protein ingredients which accounts for about 50–60% production cost. Among all possible FM replacements, rendered non-marine animal protein meals such as PBM, MBM, FeM, RBC (Table 1) are prime candidates because of the high protein content and quality. These ingredients are also free from anti-nutritional factors and are of animal origin.

Table 1. Nutrient composition (%) of poultry by-product meal (PBM), meat and bone meal (MBM), hydrolyzed feather meal (FeM) and red blood cells (RBC) used in digestion and growth trials

	PBM	MBM	FeM	RBC
Dry matter	96.3	94.8	93.9	93.8
Crude protein	60.1	51.9	80.7	94.9
Lipid	13.6	11.7	9.9	0.1
Ash	16.6	26.9	2.9	3.5
Essential amino acids				
Arginine	4.2	3.8	5.0	3.6
Histamine	1.4	1.3	1.0	7.0
Isoleucine	2.3	1.9	3.5	0.41
Leucine	4.3	3.9	6.5	12.7
Lysine	3.8	3.2	2.2	8.3
Methionine+ Cystine	1.08	1.16	4.1	1.6
Phenylalanine + Tryptophan	4.0	3.6	5.8	8.4
Threonine	2.3	2.0	3.2	2.6
Valine	2.5	2.4	5.1	7.4

The objectives of the present study were to evaluate the acceptability and cost effectiveness of an APB comprising PBM, MBM and FeM as a partial FM replacement in practical diets for a high value carnivorous fish such as the Siberian sturgeon.

Digestibility trials

A FM based reference diet (Table 2) was formulated according to the nutrients requirement of the white sturgeon *Acipenser transmontanus* (Ng and Hung, 1991). Nutrient digestibility of ingredients was measured indirectly by mixing the reference diet in test diets (70:30). Chromic oxide (as Cr₂O₃) was added as the inert marker. Diets were extruded under conditions of feeding section (90°C/5s), compression section (150°C/5s), and metering section (60°C /4s) using a single-screw extruder (EXT 50A, Yanggong Machine, Beijing, China). Feed pellets

Table 2. Formulation (%) of reference and test diets of digestion studies

Ingredient	Reference diets	Test diets
Fish meal	48.0	33.6
Soybean meal	20.0	14.0
Red blood cells	3.5	2.5
Fish oil	3.0	2.1
Soybean oil	3.0	2.1
Wheat flour	19.5	13.7
Vitamin/mineral ² premix	2.5	2.1
Cr ₂ O ₃	0.5	0.5
Test ingredient	-	29.5
Total	100	100

¹ Vitamin premix (mg kg⁻¹ diet): thiamine-HCl, 10.0; riboflavin, 10.0; niacin mix, 60; pyridoxine-HCl, 15.0; cyanocobalamin (1%), 5; pantothenate, 40; biotin, 2.0; inositol, 180; folic acid, 8.0; choline chloride, 2000.0; ascorbic acid, 500.0; Vitamin A, 15.0; Vitamin D, 8.0; Vitamin E, 18.0; Vitamin K, 12.0; BHT, 200; rice hull meal, 150.

² Mineral premix (mg kg⁻¹ diet): Ca(H₂PO₄)₂ • H₂O, 15000; MgSO₄ • 7H₂O, 2000; 2 FeSO₄ • 1H₂O, 392; ZnSO₄ • 1H₂O, 350; MnSO₄ • 1H₂O, 100; KI (10%), 13.25; Na₂SeO₃ (10%), 22.38; CoCl (10%) • H₂O (10%), 20.62; CuSO₄ • 5H₂O, 20; zeolite, 3488.

were force-air dried at 70°C and stored at 4°C until feeding.

Juvenile sturgeon with an average weight of 8.4g were obtained from the Beijing Fisheries Institute. Fish were acclimated to the recirculating system and fed the reference diet for two weeks. Fish were then randomly distributed into 256 litre flat bottom cylindrical fiberglass tanks. Four tanks were randomly assigned for each diet group in the six weeks experiment. At the start of the experiment, fish were deprived of feed for 24 hrs, and then 20 fish were batch weighed and stocked into each tank. Fish were fed the assigned experimental diets to apparent satiation five times a day at 06:30, 10:30, 14:30, 18:30 and 22:30. Faeces were collected by a siphoning system with modification to fit the bottom feeding behavior of sturgeon. Water temperature was 20 - 22°C, pH 7.5, and NH₄-N was less than 0.5 mg. Aeration was supplied to each tank 24hr per day and photoperiod was 12D:12L using eight 40W fluorescent lights.

Chemical analysis

Samples were dried to a constant weight at 105°C and nitrogen was determined by combustion using the Kjeldahl method (AOAC, 1997). Crude protein content was estimated by multiplying nitrogen by 6.25. Analysis of crude lipid was by acid hydrolysis with a Sotex System HT 1047 Hydrolyzing unit (Tecator Application Note 92/87), followed by Soxhlet extraction using a Sotex system 1043. Ash was determined by

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Sturgeon

combustion in a muffle furnace at 550°C for 16 hrs. The amino acid content of ingredients, diets, faeces and muscle was determined by HPLC (Agilent 1100). Chromic oxide content of diets and faeces were determined by ICP atomic emission spectrophotometry (JY38 S, Jobin Yvon, France). Duplicate analyses were conducted for each sample.

Apparent digestibility coefficients of nutrients were calculated as $ADC = [1 - (F/D \times DCr / FCr)] \times 100$; where F is % nutrients and energy in faeces, D is % of nutrient or energy in the diet, DCr is % of Cr₂O₃ in diet and FCr is % of Cr₂O₃ in feces. All data were subjected to one-way analysis of variance (ANOVA) to test the effect of experimental diets at statistica 6.0 environment. Duncan's multiple range test and critical ranges were used to test the differences among individual means. Differences were significant at P<0.05.

Growth trials

PBM, MBM and FeM (Table 1) of US origin were supplied by National Renderers Association, Hong Kong. Fish meal (Peruvian) and spray-dried RBC (origin, China) and Chinese soybean meal (SBM) were purchased from local suppliers. PBM, MBM and FeM were pre-blended in a 4:4:2 ratio to simulate the essential amino acid (EAA) profile of FM. The control diet contained 48% FM, which was replaced on a crude protein basis by APB at 25 and 50% (Table 3). At each replacement level, three test diets were formulated with the only difference in supplementation of lysine and threonine (none, from RBC or crystalline amino acids). The supplementation of lysine and threonine was based on the EAA profile of ABP and that of requirements of white sturgeon. All diets contained SBM (20%), RBC (3.5 or above), fish oil (3.1 to 3.3%) and soy oil (3.1 to 3.3%)(Table 3). Diets were extruded under conditions similar to that described earlier.

Juvenile sturgeon from the Beijing Fishery Institute were acclimated to laboratory tanks and control diet for two weeks prior to the experiments. The fish were maintained in conical fiberglass tanks (water depth 80cm, volume 0.25m³) in a recirculation system during the acclimation and experimental periods. Water temperature, pH, NH₄-N and other rearing conditions were as described earlier.

The average initial body weight (IBW) of fish was 29g. Four tanks were randomly assigned to each diet in the eight week feeding trial. At the start of the trial, fish were deprived of feed for one day, and then 20 fish were batch weighed and stocked into each tank. Fish were fed to apparent satiation five times a day at 06:30, 10:30, 14:30, 18:30 and 22:30. One hour after feeding, uneaten feed was removed, dried to constant weights at 70°C and weighed. Leaching of uneaten diets was estimated by leaving five samples of each diet in tanks without fish for one hour and then recovered, dried and weighed.

Fish of each tank were batch weighed fortnightly to adjust feeding rate. Mortality was recorded daily. At the completion of the trial, random samples of five fish per tank were analysed for carcass composition. One-way and two-way ANOVA was used to test the effects of diets. Tukey's procedure was used for multiple comparisons. Differences were regarded as significant at p<0.05.

Nutrient composition

The analyzed nutrient composition of all diets was similar except for the extra RBC supplemented diets (25 and 50% FM replacement rate) which had slightly increased levels of protein, and was the direct result of high protein content of RBC (Table 4). This may have some effect on protein utilization efficiency by the fish, but may not have significant effect on weight gain should the actual nutrients intake closely meet the requirements for normal growth of the sturgeon.

Feed digestibility

All animal proteins tested (including FM) had similar digestibility of dry matter (70-78%) and crude protein (84-88%) except for RBC (95%) (Table 5). Peruvian FM had a higher energy digestibility than other protein tested possibly due to its desirable fatty acids profile (i.e. highly unsaturated) and low ash content. EAAs of all tested ingredients were well digested (average 89%) by the sturgeon, with a descending order of FM (96%), PBM (90%), FeM (90%), RBC (88%) and MBM (81%). The high digestibility of FeM was somewhat unexpected and could be related to the processing conditions (e.g. pressure, temperature, and time).

Digestible EAA and ideal protein

Limiting EAA observed from digestibility coefficients for PBM, MBM and FeM was histidine (61-76%), but for RBC, isoleucine (52%) was also low. These EAA digestibility data indicate a complementary effect for FeM and RBC, and therefore should be used together in the formulation. (Table 2 and 5).

Table 6 lists the digestible protein and EAA contents of all diets and also the requirement of ideal protein (IP) for growing sturgeon. The digestible EAA content of all diets met the requirement of IP, which implied that additional supplementations of lysine and threonine either from RBC or crystalline AA was of limited value. The higher than

Table 3. Formulation of control and experimental diets used in growth trial

	Control	FM ² protein replacement rate %					
		25			50		
		- ²	+RBC ³	+AA ⁴	- ²	+RBC ³	+AA ⁴
Fish meal	48	36	30	36	24	24	24
APB ⁵	-	12.5	12.5	12.5	25	25	25
Red blood cells (RBC)	3.5	3.5	7.3	3.5	3.5	10	3.5
Lysine.HCl	-	-	-	0.52	-	-	0.89
Threonine	-	-	-	0.08	-	-	0.07
Soybean meal	20	20	20	20	20	20	20
Fish oil	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Soy oil	3.2	3.2	3.2	3.2	3.1	3.2	3.1

¹ Fish meal, ² Replacement diet without supplementation of red blood cells or crystalline amino acids, ³ Replacement diet with supplementation of red blood cells (RBC), ⁴ Replacement diet with supplementation of crystalline lysine and threonine, ⁵ pre blended PBM:MBM; FeM (4:4:2)

Table 4. Nutrient composition (%) of control and experimental diets used in growth trials

	Control	FM ³ protein replacement rate %					
		25			50		
		- ²	+RBC ⁵	+AA ⁶	- ²	+RBC ³	+AA ⁴
Crude protein	43.7	44.0	46.1	45.5	43.3	48.6	43.9
Lipids	10.1	10.6	10.4	10.9	11.1	11.2	11.2
Essential amino acids							
Arginine	2.32	2.42	2.46	2.48	2.41	2.65	2.42
Histamine	1.34	1.14	1.31	1.16	1.06	1.50	1.09
Isoleucine	1.59	1.61	1.58	1.61	1.48	1.54	1.52
Leucine	3.34	3.32	3.67	3.40	3.16	4.06	3.22
Lysine	2.94	2.78	2.94	3.08	2.47	3.08	2.98
Methionine+Cystine	1.54	1.70	1.69	1.66	1.55	1.77	1.54
Phenylalanine+Tryptophan	3.31	3.07	3.18	3.02	2.78	3.48	2.94
Threonine	1.6	1.62	1.66	1.74	1.54	1.80	1.66
Valine	2.12	2.10	2.26	2.12	1.94	2.52	2.08
^{1 2 3 4} See Table 3							

expected EAA digestibility of tested protein meals was most likely the cause for lack of deficiency in EAA for the replacement diets. Indeed, weight gain data in table 7 was in agreement with the analysis of dietary EAA and IP requirement of the fish. Satisfactory feed intake of test diets (Table 7) could also have minimize the impact of deficiency in supply of digestible EAA if there were differences in digestible EAA content between diets.

Table 5. Apparent digestibility (%) of nutrients and energy of poultry by-product meal, meat and bone meal, hydrolyzed feather meal and red blood cells in juvenile sturgeon

	FM ¹	PBM ²	MBM ³	FeM ⁴	RBC ⁵
Dry matter	77	75	74	78	70
Crude protein	85	84	84	88	95
Energy	86	76	73	71	73
Essential amino acids					
Arginine	98	94	86	96	92
Histamine	88	76	61	73	98
Isoleucine	98	94	84	96	52
Leucine	99	95	86	95	97
Lysine	97	91	82	86	98
Methionine+Cystine	94	81	75	82	82
Phenylalanine+Tryptophan	99	96	86	94	95
Threonine	96	91	83	91	95
Valine	99	94	84	95	84
Avg.	96	90	81	90	88

¹ Fish meal (Peruvian), ² Poultry by-product meal, ³ Meat and bone meal, ⁴ Hydrolyzed feather meal, ⁵ For RBC, digestibility was measured in a separate trial using common carp.

Growth from good feed intake

Fish fed the test diet (50% FM replacement and supplemented with EAA had the best weight gain (Table 7). This possibly resulted from good feed intake and feed conversion efficiency. These data may also support the value of crystalline amino acids in enhancing feed palatability and utilization for weights gain. Feed intake data suggests that RBC had the lower feed intake at relatively high inclusion rates (22%) as compared with all other animal protein sources tested (Table 7) although it did not affect (p<0.5) the feed conversion ratio. All diets were well utilized (F/G.1.0 to 1.11, Table 7) by the sturgeon for normal growth. Nitrogen retention efficiency averaged 24% and was unaffected by the protein sources.

Reducing costs

Diet formulate cost was progressively reduced as FM was replaced by APB from 25 to 50% (Table 7). The same trend was observed for feed cost per unit of weight gain since F/G was generally unaffected by dietary treatment. The greatest reduction (21%) in weight gain cost was noted for 50% FM replacement and supplemented with RBC. Data in Table 7 clearly demonstrates the value of ABP as FM replacement in carnivorous fish diets, namely the reduction in the dependence on FM and the cost of weight gain. This should be highly significant for the aqua feed industry since feed typically accounts for 70-80% of the total production cost.

Fillet taste

Carcass composition showed that the replacement of FM with APB had no effect on body protein and lipid and liver lipid content, which maybe expected since all diets supported as normal growth rate and feed



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Table 6. Digestible protein and amino acid content of control and experimental diets in comparison with the ideal protein requirement for growing of Siberian sturgeon

	Control	FM ¹ protein replacement rate %						
		25			50			
		- ²	+RBC ³	+AA ⁴	- ²	+RBC ³	+AA ⁴	IP ⁵ Range
Digestible protein	40	40	43	40	39	45	40	40
Digestible EAA								
Arginine	2.34	2.42	2.55	2.42	2.51	2.72	2.51	1.92
Histamine	1.09	1.04	1.29	1.04	0.98	1.41	0.98	0.92
Isoleucine	1.55	1.52	1.53	1.52	1.49	1.51	1.49	1.2
Leucine	3.29	3.25	3.71	3.25	3.22	3.99	3.22	1.72
Lysine	2.83	2.66	2.94	2.92	2.49	2.97	2.93	2.16
Methionine +Cystine	1.32	1.27	1.33	1.27	1.23	1.32	1.23	0.88
Phenylalanine+Tryptophan	3.00	2.98	3.28	2.98	2.96	3.47	2.96	2.12
Threonine	1.49	1.47	1.57	1.55	1.46	1.62	1.53	1.32
Valine	1.99	1.98	2.25	1.98	1.97	2.43	1.97	1.32

^{1 2 3 4} See Table 3. ⁵ Ideal Protein requirement

efficiency. Both body protein and total lipid in fish fed the treatment diets (range 12.0 to 12.7% and 7.4 to 8.8%, respectively) did not vary significantly from that fish fed control diets (11.6 and 7.7% respectively). Liver lipids were 34.1 to 35.0 in fish fed treatment diets as compared to 33.3% in fish fed control diet.

A single taste evaluation of the fish fillet was conducted by several laboratory technicians at the research section. Result indicated that fillet taste was not affected by the dietary protein source. This further supports the feasibility of replacing FM with APB in sturgeon diets.

Bottom line

Growth and carcass data from the present study clearly demonstrates that 50% of FM protein in this sturgeon diet can be replaced with a combination of rendered non-marine animal proteins without any deleterious effect, and the cost of weight gain was lowered by 21%. The reduced dependence on FM would be positive for the sustainability of this sturgeon industry.

Diets for carnivorous fish should be formulated on a digestible nutrients basis and meeting the need of ideal protein for growth. However, further studies are warranted for determining the maximum FM replacement rate with APB in the sturgeon diet.

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Table 7. Feed intake and conversion, weight gain and cost of gain comparison of sturgeon juveniles fed control and experimental diets

	Control	FM ¹ protein replacement rate %					
		25			50		
		- ²	+RBC ³	+AA ⁴	- ²	+RBC ³	+AA ⁴
Feed intake (% body weight/d) = 100 x feed consumption / ((IBW+FBW)/2)/feeding days	2.75	2.78	2.60	2.69	2.87	2.63	2.82
Specific growth rate % = 100 x [ln(FBW) - ln(IBW)] /days	3.1	3.2	3.2	3.2	3.2	3.2	3.3
Feed/gain (F/G) =Feed consumption/fish weight gain	1.1	1.11	1.0	1.0	1.1	1.0	1.1
Net protein retention (NPR) = 100 x (protein gain/protein consumption)	23.0	25.5	25.3	23.8	26.6	21.7	24.7
Formulation ingredient cost (US\$/kg)	0.71	0.65	0.67	0.66	0.57	0.61	0.59
Feed cost USD/kg weight gain	0.78	0.71	0.67	0.66	0.63	0.62	0.65
% Reduction in feed cost/weight gain	-	-	-	-	19	21	17

^{1 2 3 4} See Table 3.



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A mycotoxin survey in 2007

This survey showed that although average contaminations are not high, maximum levels are quite disturbing. Contaminations vary among geographical regions and between commodities.

The mycotoxin-producing fungi generally fall into two different groups: those that invade the plants in the field before harvest – the field fungi – and those that occur after harvest – the storage fungi. Despite the prevention methods, 95% of the mycotoxins existing in the feed are already produced in the field. Legislation on mycotoxin contamination limits for feedstuffs and feed is getting stricter worldwide. Therefore monitoring needs is increasing. According to FAO estimations, up to 25% of the world's food crops are significantly contaminated with mycotoxins.

This is a continuation of previous surveys conducted by Biomin GmbH in collaboration with Romer Labs Singapore Pte Ltd. The aim was to look at the contamination of feedstuffs and feed both qualitatively and quantitatively. From October 2006 until September 2007, a total of 4,649 analyses of 960 samples were carried out covering the important mycotoxins in terms of agriculture and animal production – aflatoxin B1 (Afb1), zearalenone (ZON), deoxynivalenol (DON), T-2 toxin (T-2), fumonisin B1 (FUM) and ochratoxin A (OTA). Samples were diverse, ranging from cereals such as corn, wheat and rice to processing by-products, namely soybean meal, corn gluten meal, dried distillers grains with solubles (DDGS), other fodder such as straw, silage and finished feed.

High Performance Liquid Chromatography (HPLC) was used for the analysis of all mycotoxins, except for T-2 toxin, where Thin Layer Chromatography (TLC) was applied. For the purpose of data analysis, non-detection levels are based on the detection limits of the test method for each mycotoxin: Total aflatoxins < 4µg/kg (ppb); zearalenone < 32µg/kg (ppb); deoxynivalenol < 50µg/kg (ppb); fumonisin B1 < 100µg/kg (ppb); T-2 toxin < 125µg/kg (ppb); ochratoxin A < 2µg/kg (ppb). Data was compiled and categorised based on origin of the samples. In the full report, detailed data regarding mycotoxin prevalence in the different regions was given and only information for Asia is discussed below.

North Asia

More than 50% of the samples analyzed in this survey were from this region, in particular China. Results showed that the occurrence was very high in this region. The most highly contaminated samples for DON was in with corn and for FUM, finished feed, both from China.

South-East Asia

The contamination was lower for all mycotoxins, except for aflatoxins. T-2 toxin was not found in any of the 236 tested samples. The highest level of Afb1 contamination in the whole survey (1,023 ppb) was found in a corn sample from Vietnam and for FUM, it was in a corn gluten meal sample from Vietnam. A finished feed sample from Malaysia had the highest contamination level of OTA (10 ppb).

South Asia

The smallest number of samples was received from South Asia. Interestingly, there was a higher incidence of Afb1 in this region. A corn gluten meal sample from India was highly contaminated at 872 ppb) and the highest contamination of FUM for the region (1,455 ppb) was in a corn sample from India.

Commodities

The prevalence of the mycotoxins is showed in Table 1. In corn, the average contamination of FUM was 1,526 ppb. The highest contamination with DON in corn as well as in all commodities (27,852 ppb) was found in a

Table 1. Prevalence (%) of mycotoxins in different commodities

	1st	2nd	3rd	4th	5th	6th
Corn	FUM	DON	ZON	Afb1	OTA	T-2
	78	65	35	32	18	1
Soybean meal	OTA	ZON	DON	FUM		
	33	20	18	8		
Wheat/bran	DON	OTA	FUM	Afb1	ZON	
	87	33	29	14	13	
Corn gluten meal	DON	FUM	ZON	Afb1	OTA	
	94	94	81	63	50	
Rice/bran	ZON	FUM	Afb1	DON		
	34	34	19	6		
DDGS	FUM	DON	ZON	Afb1		
	88	80	77	14		
Other feed ingredients	ZON	DON	OTA	Afb1	FUM	
	36	33	33	25	12	
Finished feed	FUM	DON	OTA	ZON	Afb1	T-2
	70	63	55	44	42	2

sample from China. In comparison, soybean meal samples not only showed a lower prevalence of mycotoxins but also lower contamination levels. The average contaminations of FUM, DON and ZON present were 2,554, 379 and 66 ppb, respectively. Afb1 and T-2 were not found in any of the samples tested.

Samples of wheat and bran showed a high prevalence of DON with an average of 337 ppb. Only one of the samples tested for OTA was found contaminated (20 ppb). However, as only three samples were analysed, this result was not representative. Although only about 17 corn gluten meal samples were analysed (depending on the mycotoxin tested), the results showed that the average DON and FUM contamination was 1,222 ppb and 5,687 ppb, respectively. A corn gluten meal sample presented a FUM contamination of 21,132 ppb, one of the highest in the whole survey.

Almost 20% of the rice/bran samples were contaminated with Afb1 at an average of 13 ppb. DON was found in only 6% of the tested samples at an average level of 138 ppb. ZON and FUM, on the other hand, were found in 34% of the 32 tested samples with an average contamination of 81 and 241 ppb, correspondingly, although at least one sample has showed a contamination of 253 and 358 ppb, respectively.

In the case of DDGS, the golden rule generally accepted for the industry is that if incoming cereal contains 1 ppm of a mycotoxin, the resultant DDGS will contain approximately 3 ppm. Therefore, mycotoxin screening in DDGS is of concern. In the samples tested, FUM, DON, ZON and Afb1 were present and in some cases, at high levels with averages of 1,017 ppb, 2,738 ppb and 362 ppb respectively.

Other feed ingredients tested include commodities such as copra meal and cake, palm meal and oil, cassava, fish meal and full fat soy, amongst others. The most prevalent mycotoxin in these samples was ZON with an average of 413 ppb. A level as high as 19,371 ppb of DON was also found.

Overall the survey showed that sometimes average contamination data are not high but maximum contamination levels are quite disturbing and that one should always consider their potential effects on the animals. This report confirmed not only the results of previous ones, but also data from literature. It showed that analysing commodities and feed is crucial to monitor mycotoxin presence, as these substances are invisible, odourless and tasteless. The use of mycotoxin deactivating products to counteract the hazardous impacts of these toxins on animal health and performance should be considered as a preventive measure.

Culturing marine finfish in China

By Jianxin Chen

As early as the 1970s, Drs CK Tseng and ZX Fang, emphasised that 'mariculture and sea ranching' has great potential. This was testified with the rapid development in the past three decades as China leads in marine finfish production.



Traditional cages in Fujian Province, culturing large yellow croaker.

In 2003, production of marine finfish was 519,157 tonnes. This increased to 582,500 tonnes in 2004 and then on to 658,700 tonnes in 2005. Culture area expanded to 1.6 million ha in 2005. In comparison, production was a mere 150,000 tonnes from 60,000 ha of area in 1995. By 2010, the target production will be one million tonnes.

About 40 species of finfish are cultured comprising several local species such as the large yellow croaker, *Pseudosciaena crocea*. Imported species include southern flounder *Paralichthys lethp stigma*, summer flounder *Paralichthys dentatus*, European turbot *Scophthalmus maximus* introduced from UK and red drum *Sciaenaps ocellatus*. Culture systems include brackishwater ponds, floating rafts, pens, cages (inshore, offshore and submerged), indoor tanks with water recirculation, sea bottom culture and sea ranching.

Cage culture of marine finfish began in traditional cages in 1981, initially to hold live fish for export to markets in Hong Kong and Macau. By 1993, there were 57,000 cages, mainly in Guangdong, Fujian and Zhejiang provinces. This increased to 200,000 cages in 1998. In 2000, there were 700,000 cages with 450,000 in Fujian province alone. By 2004, the number had increased to one million cages with 540,000 in Fujian Province and the rest in Guangdong, Zhejiang, Shandong and Hainan provinces. Farmers usually construct the cages on site to cut costs, generally below USD 250 each for cages of 3x3x3m or 5x5x5m. R&D in modern cage systems began from the 1990s, primarily in line with the development of techniques for the culture of marine fish such as red seabream *Pagrus major*, Japanese sea perch *Lateolabrax japonicus*, cobia *Rachycentron canadum* and croceine croaker *Larimichthys crocea*.

R&D in off shore cage technology

The history of offshore cages is less than 10 years old. In the 1990s, the government introduced offshore cages to move farming to waters more than 20m deep. However, the imported cages, mainly from Norway, Japan, US and Denmark were too expensive for local farmers. This then spurred R&D by local entrepreneurs for cheaper and more affordable cages. This was also to study the suitability of cages for local conditions as the coastal provinces of China suffer from at least one typhoon per year.

By 2006, there were 3,293 cages larger than 500m³. Currently there are six models of offshore cages, comprising mainly HDPE circular, floating rope and bi-cone submersibles cages. Some 80% of these are located in Zhejiang, Shandong and Fujian Provinces. The local version of the HDPE cage based on the Norwegian design is 60% of the cost. Metal cages based on a design from Japan are available. Floating rope cages, popular in Japan and Taiwan have been adopted extensively in Hainan, Guangdong and Zhejiang Provinces. A PDW submersible cage design, usually used for flatfish culture has been awarded intellectual property rights.

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Cobia in offshore cages. China produced 18,882 tonnes of cobia in 2005.

Constraints

Some of these were identified as feeding and nutrition, environmental impact and supply of larvae and fry. Some 90% of production use trash fish as feed. As trash fish cannot meet the different nutritional requirements of several species, unbalanced nutrition has led to poor growth, health problems and mortality. Disease transmission with trash fish is a huge problem. The stocking density used during the grow out stage is 500–600 fish per cage. Farmers believe the cost is lower than that of pelleted feed. In 2005, in Fujian Province, the cost of feeding with trash fish was USD 1.5/kg whereas farm gate prices were USD 2.0–2.5/kg for the croceine croaker, USD 3.0–3.5/kg for red seabream, USD 1.6–2.0/kg for red drum *Sciaenops ocellatus*, USD 3.0–4.0/kg for Japanese sea perch and US\$30–40/kg for grouper. The use of too many species in cage culture is a constraint in the development and production of species specific feeds.

Hatchery production of fry and fingerlings are mostly from land-based hatcheries. Hence, the seed supply can meet the demand of cage culture. In 2004, one billion fingerlings of large yellow croaker (*Pseudoscisena crocea*) were produced in Fujian and Zhejiang province. Fujian Province alone accounted for 70% of production. However, seed stock for only 27 of the 40 species under cultured are being produced in hatcheries. Fry or juveniles of some species, such as the yellow tail *Seriola lalandei* and estuary grouper *Epinephelus tauvina* are imported from other countries. The large yellow croaker is the only marine fish species which has been genetically improved.

For decades, the focus was purely on production with no consideration of the negative effects that cage culture may have on coastal waters. In China different levels of government had adopted various policies to encourage fish farming. These include waving of rents for the use of open waters, providing interest-free or low-interest loans and dispatching experts to extend aquaculture techniques and experimental demonstration. A result was an overload of cages and consequent disease problems. Direct losses caused by disease amount to USD10 million or more annually. Current fishery policies of the Chinese Government and local authorities are to limit the number of cage operations to a reasonable level in order to maintain an ecological balance and a harmonious environment.

A new deal

The general strategy for mariculture is the use of sea resources for fish, mollusc and seaweed production and creating employment. In China, the 13 million ha within 20m from the shore and coastal flat areas of 2.1 million ha are ideal for developing mariculture. A rational utilisation of these resources is also to establish a food security system. More than 70% of coastal flats areas have been exploited with 3,000 to

4,000 ha created annually and by 2010, this will reach 300,000 ha. By 2010, mariculture will contribute 9 million tonnes of marine products, including seaweeds and annual economic return will be RMB 25,000/ha, 2.93 times that from land resources.

An integrated fish farming concept is being developed. This requires a 100% feed input into the system and 14.5% of feed is utilized by shellfish such as cockles, 22.4% for seaweed production and 26% goes into fish production and 37% is waste. In China, fish production is integrated with brown algae (*Laminaria* and *Undaria*). This follows similar concepts in Japan where culturing *Ulva* increases fish production by 1.5% and dissolved oxygen is increased by 9%.



PDW submersible cages. Locally developed, these are used for the culture of the cobia, pompano, croaker and yellowtail

Bottom line

Today, it is clear that the capacity for inner bays and sheltered waters to accommodate traditional cages has been met and there is no space available for further expansion. Coastal lands are too valuable to be used for land based farms. Offshore cage-fish culture is now an indispensable measure for production of high-quality marine fish to meet future demand. However, this will require large commercial operations. The realization of its full potential is still at least five or ten years.

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Using the pond itself as a biofilter: A review of theory and practice

By Yoram Avnimelech

Among the merits of the bio floc technology (BFT) system with control of heterotrophic bacteria within the culture ponds, is the recycling of protein and savings from feeds. BFT also marks a change of aquaculture to a biotechnological industry and needs a new set of design parameters.



Biofloc technology ponds, USA

Intensive aquaculture systems are important to efficiently produce fish and shrimp. However, an intrinsic problem of these systems is the rapid accumulation of feed residues, organic matter and toxic inorganic nitrogen. This cannot be avoided, since fish assimilate only 20-30% of feed nutrients. The rest is excreted and typically accumulates in the water. Often, the culture water is recycled through a series of special devices (mostly biofilters of different types), requiring energy and maintenance to degrade the residues. The result is that in addition to the expenses of purchasing feed, significant additional expenses are devoted to degrade and remove two thirds of it.

There is a vital need to change this vicious cycle. An example of an alternative approach is a bio floc technology (BFT) system, where the water treatment is based upon developing and controlling heterotrophic bacteria within the culture environment. Feed nutrients are recycled, doubling the utilisation of protein and improving feed utilisation. Other alternatives, mostly based upon the operation of a water treatment/feed recycling component besides the culture unit are also relevant. BFT systems are being used and their number has increased dramatically during the last 10 years. This is most notably with shrimp.

Why BFT

The justification for intensification stems from specific culture, environmental and economic reasons. Several reasons for intensification are listed below. These have different priorities under different conditions.

- Environmental regulation prohibiting or limiting water disposal.
- Biosecurity concerns limiting water intake.
- Water scarcity or cost.
- A demand for product quality control and transparency, usually difficult to achieve in intensive systems.
- Feed utilisation may be higher than in conventional systems.
- In cases where production is close to markets, space limitation is also of concern.
- Intensification enables easier temperature control.
- Intensification and automation may save labour.

However, intensification costs money and is not always the recommended mode of development.

Fish (and shrimp) can be cultured at very high density in aerated-mixed ponds. However, with the increased biomass, water quality becomes the limiting factor, due to the accumulation of toxic metabolites, the most notorious of which are ammonia and nitrite. To realize the potentials of aerated-mixed ponds, water quality has to be controlled.

There are three different approaches to control water quality.

- (a) Replace pond water with fresh water, usually at exchange rates of over 5 times a day. However, this option, is in contrast to environmental constraints, bio-security and water scarcity.
- (b) Recycle the water through an external unit ("biofilter") that treat and purify the water.
- (c) Treat water quality within the pond system, using algae in partitioned aquaculture ponds, or bacterial communities (e.g. biofloc technology, BFT).

Some intrinsic features of intensive ponds are high aeration rates and thorough mixing. These existing features of the pond are the ones that we find in almost all biotechnological industries, to maximize activity of micro-organisms. An additional characteristic that encourage microbial dominance in intensive ponds is the accumulation of organic substrates in zero or limited exchange ponds. The organic residues mixed in the water serve as a growth substrate for bacteria, leading to a transition of the pond to a more heterotrophic system. Achieving high heterotrophic biomass and providing optimal conditions toward their activity is an intrinsic trait of intensive ponds.

The nitrogen syndrome

This is an intrinsic problem in intensive ponds. Inorganic nitrogen accumulates in the pond due to several reasons. Fish metabolize proteins as an energy source, leading to the excretion of ammonia which accumulates in the pond. Moreover, while organic carbon in the pond is metabolised to CO₂ that leaves the pond into the atmosphere, the transformation of inorganic nitrogen is not effective in getting the nitrogen out of the system (unless intensive nitrification and subsequent denitrification take place). As a result, the C/N (carbon: nitrogen) ratio continually narrows with intensification and time and toxic ammonia and nitrite may endanger fish growth and health.

The nitrogen syndrome can be controlled by utilising the microbial

system in intensive ponds. A straightforward solution is to raise the C/N ratio, counteracting the nitrogen deterioration trend. Adding carbon-rich and nitrogen-poor feed, the following processes take place:

Organic C → CO₂ + Energy + C assimilated in microbial cells, (1)
 where the ratio of C assimilated to the organic carbon metabolized is defined as the microbial efficiency (E).

For the creation of new cell material, material made of protein, microorganisms need to take up inorganic nitrogen (preferably ammonium). Adding carbonaceous material (CH) leads to the immobilization of inorganic nitrogen into the microbial protein pool.

$$\Delta C_{mic} = \Delta CH \times \%C \times E \quad (2)$$

$$\Delta N = \Delta C_{mic} / [C/N]_{mic} = \Delta CH \times \%C \times E / [C/N]_{mic} \quad (3)$$

where CH is the amount of carbohydrate fed into the pond, C_{mic} is the amount of carbon assimilated in microbial cells, %C is the percentage of carbon in the added feed, and [C/N]_{mic} is C/N ratio in the microbial cells.

The amount of carbonaceous feed needed to remove one unit of inorganic nitrogen, ΔN, following eq. (3) (using approximate values of %C, E and [C/N]_{mic} as 0.5, 0.4 and 4, respectively) is:

$$\Delta CH = \Delta N / (0.5 \times 0.4 / 4) = \Delta N / 0.05 \quad (4)$$

The equations given here, as well as others defining microbial kinetics and input-output data were used to model nitrogen transformation in active suspension ponds. Nitrogen control using carbon addition is predictable and controllable. A more comprehensive modeling effort has been initiated recently. This covers both carbon and nitrogen fluxes in BFT. Inorganic nitrogen in intensive ponds, through the manipulation of C/N ratio, is easily controlled, predictable and inexpensive, as cheap carbohydrates can be used.

Recycling of protein

In addition to controlling inorganic nitrogen concentrations in the pond, the uptake of nitrogen by bacteria is in essence a process that enables the recycling of protein. The ammonium excreted as a waste material of the fed protein is reclaimed as microbial protein. The microbial biomass, when aggregated as microbial flocs, is a good source of protein for tilapia and shrimp. It was found, that the utilisation of protein, conventionally around 25%, increases to about 45% in both shrimp and tilapia BFT commercial ponds.

These findings were further elaborated by studying in detail floc formation and characteristics in at the Oceanic Institute. It was found that there is more than 30% protein in the floc and containing essential amino acids in sufficient quantities. In addition, it was demonstrated that the microbial flocs contain vitamins and trace metals, enabling emission from the feed, saving a significant fraction of the feed cost.

An important contribution to our understanding of BFT systems was made in detailed studies of ponds in Belize. The uptake and utilisation of microbial flocs by shrimp was evaluated using N15 - tagged flocs. The proportion of daily nitrogen uptake of the shrimp contributed by the natural biota was calculated to be 18-29%. With tilapia, a higher contribution of microbial protein was found. Similar results were found, though qualitative, derived from the evaluation of the C13/C12 ratios in feed and tilapia muscle samples.

The utilisation of microbial flocs as a source of feed protein leads to a lower expenditure on feed. Avnimelech reported that feed cost for tilapia production was reduced from USD0.84/kg fish in conventional ponds to USD 0.58 in BFT. McIntosh reported that feed cost using the reduced protein diet in Belize ponds is about 50% as compared to conventional shrimp farming.

The transition from the algal controlled conventional ponds to ponds with heterotrophic bacterial control has many implications. Algal activity is very sensitive to environmental conditions, initially to fluctuating light intensity. Heterotrophic bacteria are less dependent on environmental variability in ponds. The transition toward heterotrophic systems enables better control of the pond and is in essence a transition toward the change of aquaculture to a biotechnological industry.

Change in design parameters

As an industry, it should then follow a clear set of design parameters. Detailed ones have yet to be developed but there are clear principles that should guide the design of BFT ponds. Oxygen should not be a limiting factor. Aeration capacity on the order of 30 hp/ha is commonly used in shrimp ponds (ca 1 hp per 500 kg shrimp biomass), and higher aeration (more than 100 hp/ha) for more intensive tilapia ponds.

Ponds should be perfectly mixed and avoid any stagnant zones where organic sludge is accumulating. Presently, the best aeration-mixing devices are paddle wheel aerators, placed radially in the pond, at a distance from the dykes of about one third the pond width. Aspirator-type aerators (or air lifts in small ponds) should augment the paddlewheels, in such a way to resuspend sludge settling near the center of the pond. However, there is a need for aerators that are better designed and adjusted to BFT demands.

Aerator placement and pond design should be made to prevent the formation of sites in the pond where sludge accumulates. However, it is difficult and not desirable to resuspend the full amount of the sludge generated. There is a need to concentrate excessive sludge at a point in the pond and to drain it out. The common way to do it is by constructing a sludge disposal pit in the center of the pond and periodically draining it. Sludge is drained daily or even more frequently in tilapia ponds and about weekly in shrimp ponds. Sizes of intensive ponds vary from a few dozen square meters to almost 2 ha. It is more difficult to control large ponds. However, as demonstrated by Belize Aquaculture, it is still possible to properly manage 1.6 ha ponds.

Conclusion

Bio floc technology is a viable option for intensive or even extensive aquaculture production. It helps to maintain good water quality without the need for special water quality control compartments (biofilter or similar). In addition, it saves on feed inputs and expenditure and reduces environmental pollution.

A working group on BFT was established by the Aquaculture Engineering Society, and a special session on bio floc technology will be held in the WAS 2008 meeting in Busan, Korea, May 19-23, 2008.



Yoram Avnimelech, an environmental engineer is Professor with the Civil & Environmental Dept, Technion, Israel Inst. of Technology, Haifa, Israel. As a major part of this work he developed closed aquaculture systems and later developing them to biofloc technology. This is changing aquaculture from a

potential polluter to a system supporting the environment. Yoram welcomes discussions on topics related to his expertise. Email: agyoram@tx.technion.ac.il

Diseases and health management

Some completed and ongoing investigations on disease occurrence and technological and traditional ideas in managing health of fish and shrimp presented during the Asian Pacific Aquaculture 2007, Hanoi, Vietnam, 5-8 August 2007, Schering Plough Aquaculture Health seminar and Indonesia Aquaculture 2007, 30 July-2 August 2007, Bali.

Emerging viral diseases in farmed shrimp in Asia

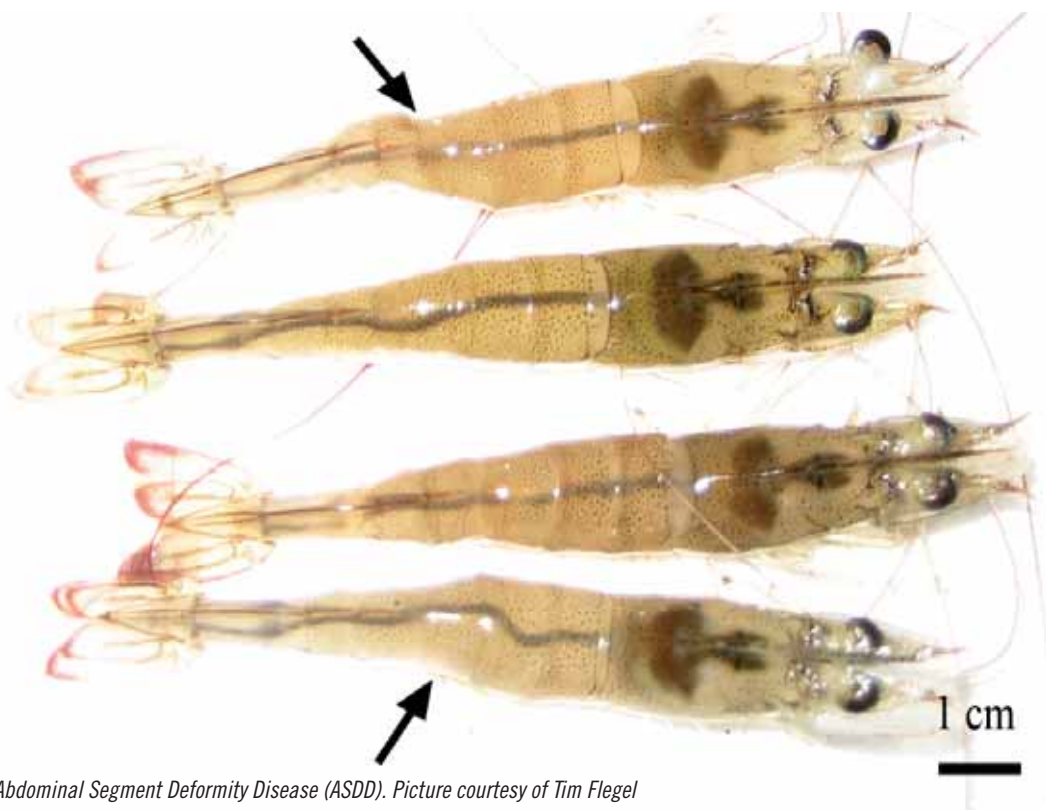
Timothy W. Flegel, Centex Shrimp, Mahidol University, Thailand said that the shrimp industry in Asia now needs to consider diseases for both black tiger and white shrimp in their disease control programs. The two viruses of major concern for both species are still yellow head virus (YHV) and white spot syndrome (WSSV). However, the list of possible exchanges of diseases between species includes infectious hypodermal and hematopoietic necrosis virus (IHHNV), Mourilyan (MOV), *Penaeus monodon*-type baculovirus (MBV) and hepatopancreatic parvovirus (HPV) moving from *P. monodon* to *P. vannamei*, and lymphoid organ vacuolization virus (LOVV), Tuara syndrome virus (TSV), baculovirus penaeus (BP), Reo virus, infectious myonecrosis virus (IMNV) and *P. vannamei* nodavirus (PvNV) moving from *P. vannamei* to *P. monodon*.

An example cited was the IHHNV endemic in *P. vannamei*. The impact of IHHNV is negligible in *P. monodon* but it can cause severe mortality in naive *P. stylirostris* and substantial production losses in *P. vannamei* due to 'runts'. The virus was unknown before it caused severe disease outbreaks in *P. stylirostris* after jumping from grossly normal *P. monodon* translocated for experimental aquaculture. It is a good lesson on the risks of carelessly importing exotic species. The advice was that farmers must now adopt sufficient biosecurity practices to assure that native IHHNV carriers cannot transmit the virus to farmed *P. vannamei*. Conversely, viruses endemic and harmless for *P. vannamei* could jump to *P. monodon* or other economically important Asian

crustaceans and cause disease. The most recent Asian transfer of exotic diseases was IMNV to *P. vannamei* in farms in Java and Sumatra in Indonesia in 2006. This was probably as a result of careless translocation of aquaculture stocks from Brazil. So far, this disease has not been reported in China, Vietnam, India and Thailand.

Newly emerging abdominal segment deformity disease (ASDD) in *P. vannamei* appears to result from transmission of a previously unknown virus from native Asian carriers. Another newly emerging pathogen, Laem Singh virus (LSNV) in *P. monodon*, is now known to be associated with retinopathy exclusively in growth-retarded shrimp from rearing ponds in Thailand exhibiting what has been called monodon slow growth syndrome (MSGs) since 2001. The origin of LSNV is unknown, but it could have resulted from the careless import of living crustaceans for aquaculture (e.g., *P. vannamei* and *Cherax quadricarinatus*) or for the ornamental aquarium trade (many species). *P. vannamei* is unaffected when mixed with *P. monodon* showing signs of MSGs. The case definition of MSGs is *P. monodon* in rearing ponds that show a coefficient of size variation (CV) of 35% or more in the absence of severe hepatopancreatic infections of HPV or MBV, together with 3 out of 5 other morphological features. However, with the current predominance of *P. vannamei* shrimp culture in Thailand, reports of this syndrome are fewer. So far, there have been no reports of disease outbreaks caused by PvNV in Asia.

Wansika Kiatpathomchai, Biotec, Thailand discussed her work on rickettsial-like pathogens that can cause hepatopancreatic infections in pond reared *P. vannamei* from Samutsongkram, Rayong and Suratthani



Gross signs of Abdominal Segment Deformity Disease (ASDD). Picture courtesy of Tim Flegel



provinces in Thailand. These infections are not very common, and the current impact on Thai production is unknown. However, electron microscopy and DNA sequencing work have shown that the agent detected in Thailand differs greatly from that which has been reported to cause necrotic hepatopancreatitis (NHP) in *P. vannamei* in the Americas. NHP was first observed in Texas, USA in 1985 and subsequently in several South American countries where it has become of major concern to the shrimp farming industry. Affected shrimp display reduced feed intake, empty mid and hind guts, soft shells and flaccid bodies and lethargy. In Thailand, results of all specific PCR tests and electron microscopy for the American NHP agent have been negative, indicating that the organism causing hepatopancreatic infections in Thailand is distinct from that which causes NHP in the Americas.

Emerging finfish diseases in South East Asia

Fish mortality associated with infectious disease in South East Asia remains high, according to **L. Labrie** and the team at Intervet Norbio Singapore Pte Ltd. Over a typical production cycle, mortality due to disease ranges from 20%-80%. The intensive disease investigations in cultured fish in the Southeast Asian region conducted over the last few years showed that diseases such as streptococcosis due to *Streptococcus iniae* and *S. agalactiae*, nocardiosis due to *Nocardia seriolae* and infections with *Tenacibaculum maritimum* and *Flavobacterium columnare* are common bacterial infections that affect a wide range of cultured fish species in South East Asia.



Asian sea bass (*Lates calcarifer*) infected with big belly disease (blackened, swollen abdomen) (left) and *Nocardia seriolae* infection in red snapper (granulomas in internal organs especially spleen in this pic). Pictures provided by Intervet Norbio Singapore Pte Ltd.

In addition, some upcoming bacterial diseases potentially harmful for aquaculture species have been identified. These are infections with bacterial pathogens such as *Edwardsiella tarda* and *Streptococcus dysgalactiae*. A previously unrecognized disease, pot belly or big belly has been identified. This is caused by a facultative intracellular Gram negative bacterium. Infections with this previously uncharacterized pathogen causes severe visceral granulomatous lesions in Asian sea bass fry <5g with an associated mortality rate that can be in excess of 70-80%. A second granulomatous disease in Tilapia due to a Francisella like organism causing up to 50% mortality was identified as a serious emerging disease in the region.

Diseases with groupers in Khanh Hoa Province, Vietnam

In Khanh Hoa province, cage culture of the groupers and several other finfish species have been increasing in recent years. From March to July every year, 30% of grouper population showed extensive haemorrhagic septicaemia and ulcerations, according to **Thuy Nguyen Thi Thanh** and **Dung Nguyen Huu** from the Research Institute for Aquaculture No.3. Their investigations showed that monogeneans *Benedenia* sp. on skin and *Pseudorhabdosynochus epinepheli* on gills were most prevalent, followed by *Tricodina* sp. Others ectoparasites were *Caligus* sp, *Apiosoma* sp, *Ambiphyra* and *Zeylandicobdellia* sp. Nine bacteria species were found on infected grouper.

Another group, **Dung Vo The**, **G. A. Bristow**, **D. H. Nguyen** and **D.T. Vo**, suggested that culturing *E. bleekeri* faces less risk of a monogenean infection than culturing *E. coioides* in the area. They showed that the prevalence of monogeneans in *E. coioides* was usually higher than that on *E. bleekeri* in cage and pond cultured specimens collected in December 2006. Fish were infected with at least seven different monogeneans.

In their research on monogenean parasites in cage culture **Do Thi Hoa** and colleagues at Nha Trang University said that the fish are usually affected by two diseases. Farmers called these 'Sesame-fish' and 'Swollen-gill' disease. Losses in production are especially with fingerlings (<20cm) of grouper, *Epinephelus* spp and snapper, *Lutjanus argentimaculatus*. The diseases occur all year round, but is more prevalent during the dry season from April to September. They have identified that gill monogeneans (*Pseudorhabdosynochus* spp; *Diplectanum* spp and *Ancyrocephalus* spp) caused "Swollen-gill" disease and the skin monogenean (*Neobenedenia* spp and *Benedenia* spp) cause "Sesame-fish" disease.



Stocking density, PL/rai (PL/m ²)	Area (rai)	Yields, tonnes/ha	Size, pieces/kg	Survival rate
250,000 (41)	4	6	34	82
350,000 (46)	5	8.6	34	83
250,000 (47)	3.5	4	38	61
250,000 (47)	3.5	4.6	38	70
350,000 (46)	5	6.2	37	65
400,000 (48)	5.5	6	38	57

Shrimp health management

At the end of 2006, massive reductions in prices for the vannamei shrimp prompted the industry in Thailand to relook at its culture practices. In 2006, more than 95% of farmed shrimp production was of the white shrimp *Penaeus vannamei* and in 2007, the proportion increased to more than 99%. During 2006, shrimp prices were generally lower as compared to those in 2005 and prices for the black tiger shrimp *P.monodon* remained higher than for the equivalent size range for the vannamei shrimp. To benefit from this trend, industry associations asked that farmers revert to farming of the black tiger shrimp to achieve higher proportion of black tiger shrimp, of at least 30% of total shrimp production in 2008. However, the management of the health status of black tiger shrimp from the post larvae to adult stages during its culture remains a challenge.

According to **Parinda Kamchum** DVM, Technical & Sales, in Thailand, vaccination at the post larval and adult stages was effective in maintaining health of shrimp. In a presentation at the seminar conducted by Schering Plough Aquaculture on 5 August 2007 in conjunction with Asian Pacific Aquaculture 2007, he showed that for the black tiger shrimp, a 100 ml/day dose of the vaccine (AquaVac Vibromax, SPAH) over 10 days was effective. The average size of post larvae (PL15) was higher than that of PL in the control and unvaccinated group. It was 10.75 mg in comparison to 8.26 mg for the latter. The mean length of vaccinated postlarvae was higher at 13.3 mm versus 11.6 mm for unvaccinated postlarvae. Differences in colour were attributed to differences in that for the hepatopancreas. Consequently, PL 15 and PL 21 were challenged with vibrio. The results showed a lower population of green colony.

In the grow-out trials, shrimp were cultured in six 0.75 ha (26.5 rai) 1.6m deep ponds in a Rayong farm. The vaccination program continued with top dressing of commercial shrimp feed. The vaccine was dissolved in water and applied with fish oil. At 30 days, the dose was 5ml, once a week and at 30-90 days, vaccination continued with 10ml doses, also applied at once a week.

Growth parameters showed that vaccinated shrimp produced higher survival rates, larger shrimp sizes and higher production. These results were compared to those carried out previously without a vaccination program. Results showed that survival rates improved from 30-60% to 57-82%. The average individual shrimp size increased 27.4g (36.5pcs/kg) from 22-25g (40-45 pcs/kg).

In closely similar trials in south America, **Robin Wardle**, Director Global Marketing & Technical Services, said that vaccinated post larvae shrimp had better gut:muscle ratio. A better pigmentation pattern of vaccinated shrimp as compared to the greyish colouration in less healthy PLs were attributed to the colour of the hepatopancreas and that of chromatophores.

In Indonesia, **Murdjani** and **Coco Kokarkin**, recommended double screening of wild *P. monodon* broodstock. The prevalence of WSSV in these stocks ranged from 20-90%. The false negative in post

larvae from these stocks with PCR test have been blamed for crop failures, even in extensive culture systems. The Brackishwater Aquaculture Research Centre in Jepara conducted trials on a double screening method. They used wild broodstock from Jepara and Pangandaran. Results showed that the level of prevalence was 4.67% and 71.43%, respectively and post spawning prevalence was 16.75% and 25%, respectively. Post larvae prevalence was negative and incidence of WSSV was 5% in one location and zero in another. Although costly, this is an effective way to utilise PCR to prevent WSSV outbreaks.

The use of tilapia as a bioremediation technique to control bacteria in a shrimp hatchery was investigated by **Coco Kokarkin** and colleagues. The mucus of tilapia has been shown to suppress Vibrio populations. *P. monodon* nauplii were stocked at 60 nauplii/litre in a rearing tank. Water was recirculated through a 500 litre tank holding 13 juvenile tilapia *Oreochromis mossambicus*, each of 70g (mean weight). Recirculation was continuous from mysis 1 until harvesting at PL12. Analysis of Vibrio showed the control system with no tilapia had five times higher levels of vibrio as compared to treatment systems. Survival rate in control tanks were lower at 26% as compared to 35% in treatment systems.

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GPMT in Indonesia

Investing in the freshwater fish industry in Indonesia



There are opportunities to expand fish feed production in Indonesia particularly for freshwater fish culture where only 60% is intensively cultured. However, overloading of carrying capacity in three major water bodies is a threat to the long term sustainability of the industry.

The members of the Fish Feed Division of the Indonesia Feed Mill association (GPMT), see their role not only to expand their feed sector but concurrently to modernize aquaculture. At Indonesia Aquaculture 2007, held in Bali in August, its current Chairman Denny Indradjaja, elaborated to AAP on the recent activities of the association.

“Currently, we have 10 members out of the 20 or so companies involved in fish feed production in the archipelago. The large companies are all members. Our role is being enlarged as we support the farmers with services, gradually introducing effective techniques to improve their output and improving the knowledge base of farmers. We support the government in meetings such as this Indonesian Aquaculture where we encourage networking and arrange to have presentations to share experiences in other countries such as in China and Vietnam “.

Standards

The latest development helping the sector is the implementation of the Indonesian standards for fish feeds (SNI), introduced some two years ago. Standards are not available for all species under culture but it does provide some guidelines for industry. It will enable a certain level of standardization among the large and small producers with a total installed capacity of 600,000 to 700,000 tpy of fish feeds. Currently standards are available for *Cyprinus carpio*, Dunbo catfish (*Clarias gariepinus*), milk fish, tilapia (*Oreochromis niloticus*). These were developed with the participation of government, members of the association, universities and research centres. The next step is for all feed mills to be certified.

“It will help to develop this industry which produced about 750,000 tpy of fish and shrimp feeds annually. This excludes production for integrated operations. Production of shrimp and fish feeds is increasing at a rate of 10-15% per year. However in fish feed production, there is pressure on members on how to continue to produce cheap feeds despite increasing high raw material costs. With this SNI, the government can understand our constraints. Lower cost feeds cannot meet the standards developed. We are also encouraging feed mills to be certified”.

“Food safety aspects are covered in the standards. The government conducts checks on antibiotic residues in harvested shrimp, at the farm and in feed. We work with them to regulate the industry but do not have the mandate to penalize members”.

Threats

In freshwater fish culture, pollution in the large lakes of Cirata, Jatiluhur and Saguling in Jawa is a major problem. This is a threat for the feed

sector, as the cage culture industry in these lakes uses 40% of current fish feed production of 500,000 tpy. The source of pollution is not limited to wastes from fish and feeds. There is also the contribution from domestic and agricultural wastes. Fish production from these lakes totaled 90,000 tonnes valued at IDR 800 billion per year (USD 90.0 million). It is an important economic activity involving 70,000 cages with 4,000 households. The benefit for the feed sector is 30% of this.

“As feed producers, we want to be recognized as working with the community. With several other stakeholders, we have taken up the challenge of educating fish farmers on sustainable culture methods and on how to conserve its resources. We saw that when members invest one US dollar into the lake, the multiplier effect is five times. In January, we were there to help in the cleaning up of the lake after an upwelling caused massive kills of about 2,000 tonnes of carps and tilapia, valued at IDR 1.6 million. The main cause was the 50 times elevation of ammonia to 0.24 ppm”.

“Every year, we introduce planktonic fish such as the mola *Amblypharyngodon mola* and silver carp *Hypophthalmichthys molitrix* to reduce the natural productivity in the lakes. We are advising farmers to be more efficient in using feeds. As most producers now produce extruded floating feeds, we encourage the farmers to be more responsible by using these feeds. In the lakes, it is still difficult to get the farmers to change from using pelleted feeds. The main drawback is the two tier culture system, where carps are kept in the upper nets and tilapia in the lower nets. Feeds are provided to the carps and leftover feed sink to the next layer to be eaten by the tilapia”.

Opportunities

“In future, opportunities for the feed sector will remain good. It will be in fish feed. Vietnam is already using a million tonnes of feeds for its *Pangasius catfish*. Feed production will also increase for marine fish. Marine fish farms in the Riau Provinces and Lampung are fulfilling demands of consumers in the Singapore market and those in Bali and Lombok are for the demand from the tourism industry. In shrimp feed, 70% of demand is in Lampung and East Java. Demand is increasing further afield in Lombok and Sumbawa. However, our opportunities to be regional players are limited”.

“We are also working to develop domestic markets through campaigns with government, universities and processing industry. In September, we worked with the Directorate of Marketing and Processing with cooking demonstrations and to get children to eat more seafood. The problem is that we still have large volumes of capture fisheries. Fish consumption (24 kg per capita) is higher than chicken as there is easy access to wild catches”.



Denny Indradjaja. With a first degree in aquaculture and two master degrees in industrial engineering and environmental economics from Australia, Denny worked as consultant in an intergovernmental agency on projects related to environmental and economic development policies.

He joined PT Central Proteinaprima (CP Prima) six years ago and is now General Manager Business Research and Relation, based in Jakarta. He is the Chairman of the Fish Feed Division of Indonesia feed mill association, GPMT since 2002.

Improving tilapia fry quality in Thailand

By Pornpun Yutharaksanakul

How a mannan oligosaccharide in feeds can improve growth performance and disease resistance of tilapia fry to *Streptococcus agalactiae*.



Market size tilapia from Manit farm

The Nile tilapia *Oreochromis niloticus* was introduced into Thailand some 30 years ago from Japan. Production rose to 180,000 tonnes in 2007. This makes it an important freshwater aquaculture species in Thailand and accounting for a total of 40% of the annual production and revenue. Tilapia is a species that is important for the domestic market as well as for export. Processed and value added products are exported mainly to the EU and USA. Smaller amounts are exported to the Middle East and other parts of Asia.

The major area for tilapia fry production in Thailand is in the three subdistricts of Chonburi and Chachoensao Provinces to the southeast of Bangkok. Here, there is a well-established network of local and distant traders linking producers to customers all over Thailand. Thailand is also moving to upgrade the quality of tilapia breeding stock and is actively pursuing the introduction of genetically improved strains.

In Thailand, tilapia are cultured, in both semi-intensive and intensive monoculture and polyculture systems and in earthen ponds and cages. The majority of farmers feed the fish with formulated pellet feeds. During grow out, fish farmers prefer an all male tilapia stock because of their higher growth rate and reliable production (Bhujel, 2002).

With increasing intensity of culture of tilapia, reports on parasitic, bacterial and viral diseases disease occurrences are increasing. Among these, *Streptococcus agalactiae* is one of the most widespread and pathogenic causing protruded eyes and spiral swimming. Columnaris, caused by *Flavobacterium columnare*, is another common pathogen occurring in the early stages causing external lesions such as skin and gill erosion, and necrosis.

In commercial aquaculture, fish may be subject to additional stressors that can have both short and long term effects (Wedemeyer, 1997). The use of micronutrients, for example vitamins, trace minerals, probiotics and immunostimulants as dietary supplements may benefit the animal by improving the non-specific immune system and benefit performance by improving the availability and utilization of nutrients through a variety of pathways.

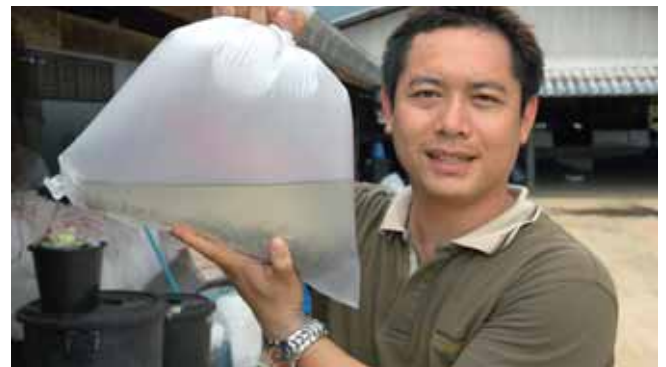
Role of mannan oligosaccharides

Mannan oligosaccharides (MOS) have been shown to affect gut health by pathogen adsorption and immune modulation however their function can be altered depending on the strain of yeast, the fermentation conditions and the different processing methods used in their manufacture (Newman, 2007). Bio-Mos® (Alltech Inc., USA) is a MOS

derived from the outer cell of a specific strain of yeast using a proprietary process developed by Alltech Inc. Its use in terrestrial animals has been well documented and the incorporation of this MOS in poultry and swine diets has been demonstrated to lead to increased body weights and survival (Spais et al, 2003) and improved food conversion rates (Hooge et al, 2004).

The use of MOS in several freshwater and marine species has been studied. Zhou and Li (2004) investigated the effect of different concentrations of a dietary MOS in carp *Cyprinus carpio* Var Jian. They reported higher weight gains, improved feed conversion ratios (FCR), productivity and immune parameters. Significant improvements in growth performance and reduced FCR and mortality have been observed for MOS treated juvenile common carp (Culjak et al, 2006), European cat fish (Bogut et al, 2006) and rainbow trout (Staykov, 2007). Similar results have also been observed in the European seabass (Torrecillas et al, 2006).

One of the key benefits is the ability of MOS to bind or agglutinate bacteria thereby preventing colonization of the gut and its subsequent infection. Zhou and Li (2004) reported that the intestinal microbial populations in Jian carp, were significantly affected by a dietary inclusion of 0.24%. The presence of *Escherichia coli* in the intestinal digesta was significantly decreased while significant increases were observed in bifidobacterium and lactobacillus. Recent work by Dimtroglou et al. (2007) also showed significant reductions in the bacterial load in the



Amorn Luengnaruemitchai, Managing Director of Manit farm with his tilapia

Table 1: Changes in production parameters with juvenile Nile tilapia after an experimental period of 21 days.

Parameters	Control (with sulfa)	Treatment 1 (Bio-Mos at 5g/kg of feed)	Treatment 2 (Bio-Mos at 5g/kg of feed and sulfa)
Total number stocked	885,500	885,500	885,500
Total numbers harvested	581,383	621,842	735,278
Survival %	65.66	70.23	83.04
Total stocked in kg	8.05	8.05	8.05
Total harvested in kg	110.46	123.12	130.87
Average weight fish stocked (g)	0.01	0.01	0.01
Average weight fish harvested (g)	0.190	0.198	0.178
Live weight gain (kg)	102.41	115.07	122.82
Feed offered (kg)	175	175	175
FCR	1.709	1.521	1.425

Table 2: The effect of different concentrations on weight, standard length, average daily growth and feed conversion rate of Nile tilapia fry after an experimental period of 21 days (Mean S.D.)

Treatment	Weight (g)	Standard Length (cm)	Average daily growth (g/day)	Feed conversion rate
Control	0.78 ± 0.16 ^a	2.86 ± 0.24 ^a	0.037 ± 0.007 ^a	1.42 ± 0.10
2g/kg of feed*	0.79 ± 0.19 ^a	2.88 ± 0.20 ^a	0.037 ± 0.009 ^a	1.39 ± 0.25
4g/kg of feed*	0.85 ± 0.20 ^b	2.96 ± 0.25 ^b	0.040 ± 0.009 ^a	1.39 ± 0.25
6g/kg of feed*	0.90 ± 0.19 ^b	3.03 ± 0.22 ^b	0.042 ± 0.009 ^b	1.12 ± 0.09

*inclusion rate of Bio-Mos. Means with the different superscripts within the same column are significantly different at P<0.05.

gut of rainbow trout by reducing the total aerobically cultivated bacteria. Studies showed that the numbers of *Micrococcus* spp., *Staphylococcus* spp., *Aeromonas/Vibrio* spp and other unidentified Gram + bacteria were reduced and increased *Acinetobacteria* spp., *Pseudomonads* spp. and *Enterobacteria* spp. were observed. This was linked to the colonisation of beneficial bacteria associated with the natural gut flora of the rainbow trout when healthy.

In addition Dimitrogrou et al (2007) show the effects on the gut morphology of several species of MOS. In rainbow trout, a significant effect was seen on the perimeter ratios in the anterior and posterior gut regions. This demonstrated a more complicated gut structure and longer villi indicating a larger surface area for nutrient management. An increase in the microvilli density was also observed in the posterior gut region of the rainbow trout.

In the tilapia, Hanley et al 1995 demonstrated that the addition of 6g/kg of Bio-Mos to diets for red hybrid tilapia juveniles in Jamaica for 28 days resulted in a 22.5% improvement in survival and a 27.2% increase in weight of the harvested fry.

Trials at the Manit farm

In 2006 and 2007, several trials on the effects of MOS on growth performance and disease resistance were carried out by Manit Farm, Phetchaburi, Central Thailand. This is a tilapia fry production farm with pond grow out facilities. Fry production takes place in 3.15m³ cages with aeration and water exchange. The farm has the following protocols for fry and nursery operations. Free swimming undifferentiated fry of average weight, 0.23g are stocked at approximately 8,000 fry/m³. During this period of 21 days in the fry production phase all male stock is produced by using a feed with fish meal a 60% protein level. The fish are then moved to the nursery phase. The stocking density is usually 12.5 fish/m² and fed a feed of 32-40% protein. On reaching 50-100g, fish are transferred to the grow out ponds and stocked at a stocking density of 1.5 fish/m². The grow out period is approximately 6 months until they reach a market size of 800-900g.

In the first trial, free swimming tilapia fry, with average initial weights of 0.01g, were fed 3 different diets. The control diet was a commercial feed top dressed with the antibiotic, Sulfa-trimethoprim (Tribrissen, Schering Plough). Both treatment diets had Bio-Mos added at 5g/kg of feed but treatment diet 2 also contained sulfa. The results (Table 1) showed increases in survival rate, live weight at harvest and lower FCRs in the treatment groups. (Note: Sulfa is the most acceptable antibiotic for farming aquatic animals, poultry and livestock. Before

Table 3: Effect on survival rate (%) of Nile tilapia fry after an experimental period of 21 days (Mean S.D.)

Treatment	Survival rate (%)**
Control	89.67 ± 9.07
2g/kg of feed*	94.00 ± 10.39
4g/kg of feed*	95.67 ± 3.21
6g/kg of feed*	96.33 ± 6.35

*inclusion rate of Bio-Mos
**All values are not significantly different at (P>0.05)

use, sensitivity tests have to be carried out and authorization obtained from the farm veterinarian. On the farm, it is dressed onto commercial pellets. In Thailand, the required withdrawal period is 2 weeks and this may be increased to 3 weeks if lower temperatures occur. Personal communication, Amorn Luengnaruemitchai).

Following the success of this preliminary trial, a more detailed trial was carried out in triplicate. The aim was to investigate the effect of three dietary inclusions (2, 4 and 6 g Bio-Mos/kg feed) on growth and survival of the Nile tilapia and also to investigate its effects on the disease resistance of the fry to *Streptococcus agalactiae*.

The results (Table 2 and 3) showed significantly higher differences in average weight, length and average daily growth of tilapia fry when the incorporation rate was 4 and 6 g/kg of feed (P<0.05). There were no significant differences between the feed conversion rates (FCR) and the survival rates of all the experimental and control groups (P>0.05). However when tilapia fry were challenged using *Streptococcus agalactiae*, all the Bio-Mos treated groups showed significantly higher resistance to the pathogenic bacteria (P<0.05) with mortality of 43.33±20.82, 3.33±5.77, 0.00±0.00 and 0.00±0.00 % for the control and 2, 4 and 6 g/kg respectively (Table 4).

Table 4: Disease resistance against *Streptococcus agalactiae*. Mean S.D. are values for mortality.

Treatment	Mortality (S.D.)
Control	43.33 ± 20.82 ^a
2g/kg of feed*	3.33 ± 5.77 ^b
4g/kg of feed*	0.00 ± 0.00 ^b
6g/kg of feed*	0.00 ± 0.00 ^b

*inclusion rate of Bio-Mos
Means with the different superscripts within the same column are significantly different at P<0.05.

Conclusion

These results indicate the benefit of Bio-Mos as a feed supplement for tilapia fry resulting in better growth and disease resistance.

Acknowledgements

The author would like to acknowledge the help and support of Mr Amorn Luengnaruemitchai the Managing Director of Manit Farm and Ms. Chinnapat Samrongpan, Dr Nontawith Areechon and Dr Prapansak Srisapoome of the Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand.

References are available on request from the editor.



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Highlights of aquaculture practices in Taiwan

By I Chiu Liao and Eduardo M. Leaño

With a long history in aquaculture, Taiwan has lead developments in Asia. Its prosperous stage (1963-1987) was when artificial propagation and mass larval production was introduced and intensive culture system was practiced. The transition stage (1988-present) was characterized by the collapse of the industry due to diseases and other related problems. This is now followed by developments of new technologies for a sustainable industry.



Hyper-intensive recirculating system designed and built for commercial production of grass prawn and other shrimp species

Today, a total of 154 species of aquatic organisms are cultured in Taiwan. Topping the list in terms of production are tilapia, milkfish and hard clam (Table 1). Taiwanese farmers chose to culture a highly diversified range of species to have optimum use of aquaculture facilities (e.g. ponds, tanks), avoid risks of disease outbreaks, allow polyculture and/or crop rotation and provide alternative commodities in the domestic market. Through this, they enlarge and develop existing and new markets.

Several aquaculture practices have become well established and are popular domestically, regionally as well as internationally. These include culture systems for the marine shrimp or grass prawn (*Penaeus monodon*), grey mullet (*Mugil cephalus*), milkfish (*Chanos chanos*), eel (*Anguilla spp.*), and more recently, cobia (*Rachycentron canadum*) and yellow-fin tuna (*Thunnus albacares*).

Marine shrimp

Penaeus monodon became popular as soon as the larval rearing technology was established in 1968 (Liao et al., 1969). Private hatcheries were rapidly established throughout the country and produced significant

amount of post larvae for stocking in grow-out ponds. Farmers also adopted easily the highly intensive grow-out culture technology. Annual production increased significantly year after year from the early 1980's, reaching a high of 95,000 tonnes in 1987 (Liao, 1989). This made Taiwan a leading shrimp-producing country as well as a role model for other countries where the technology was introduced and adopted.

Disease outbreaks in the late 1980s resulted in the collapse of the industry from 1988 (Liao, 1989). Annual production reduced significantly and it has not recovered until today. Despite this scenario, efforts are now being undertaken to improve the existing culture techniques and while rigorous disease preventive measures are being applied for sustainable production.

Grey mullet

It all started with two larvae which were successfully reared in 1969, followed by studies on induced breeding and the cycle was closed in 1976 (Liao, 1977). These served as a solid foundation for the artificial propagation of other marine fishes. Grow-out culture of mullet did not become popular as other marine fishes but pond cultivation is still practiced especially in Southern Taiwan and mainly for the production of roe. Roe is collected from berried females just before the natural spawning season. These are then cleaned, salted and dried and marketed either domestically or for export (Chao et al., 2006).

Milkfish

The first success in the artificial propagation recorded in 1978 demystified the early developmental stages of this species (Liao et al., 1979). The results paved the way to an establishment of mass larval production in 1984 (Lin, 1985). Mass larval production then provided grow-out farmers with ample supply of milkfish fry and supported a fry export industry for many years. Efficient grow-out culture system was also developed which resulted in a higher and stable milkfish

Table 1. Top 10 commercially important aquaculture species in Taiwan for the year 2006.

Rank	Common Name	Production (tonnes)	Value (x NT\$1000*)
1	Tilapia	72,574.3	2,426,076
2	Milkfish	56,135.2	1,952,904
3	Hard clam	48,187.1	1,602,357
4	Oyster	28,547.0	3,039,295
5	Eel	23,838.3	7,319,301
6	Freshwater clam	13,220.7	574,801
7	Pacific white shrimp	10,361.1	1,886,294
8	Giant freshwater prawn	9,877.9	3,552,232
9	Groupers	9,500.2	1,729,676
10	Perch	6290.4	487,342

* US\$1=NT\$32.5



Milkfish harvest from culture ponds

Table 2. Milkfish fry production and export from 1996 to 2005.
Unit: million fry

Year	Fry production	Import	Export	Domestic use
1996	500	--	350	150
1997	450	--	300	150
1998	250	10	100	160
1999	300	10	150	160
2000	300	100	250	150
2001	400	40	280	160
2002	400	60	300	160
2003	200	70	100	170
2004	150	70	30	190
2005	130	80	10	200

production up to the present time. The grow-out culture technology is still one of the best in the Southeast Asian region. Currently, high fry production is still sustained but an over-production of fry coupled with low import demands from neighbouring Southeast Asian countries has negatively affected the fry export industry (Liao and Chao, 2007). In 2005, only 10 million fry were exported which was significantly lower from the 100 million fry exported in 2003 (Table 2).

Eel

Although the mass propagation of fry is still not possible, it did not prevent the eel from being a popular culture species (Liao, 2005). This is due to its high market value, high production and survival rate, well-studied pathology, well-established culture technique and high consumer demand. Modified outdoor culture system is presently used in Taiwan consisting of rectangular hard (concrete) or soft (earthen) ponds. Innovations on intensive recirculating culture systems and feeding strategies were also introduced and recommended for commercial use. Taiwan is still the main exporter of live eels to Japan, but has lost its competitiveness to China in exporting processed eels (Lee et al., 2003). Nonetheless, the eel continues to generate high foreign exchange. A domestic market was also recently explored and is helping to sustain commercial production of this species.

Cobia

The collapse in the culture of several species gave the opportunity to evaluate other candidate species with aquaculture potential. Filling a gap, cobia culture became highly successful due to its many positive attributes including fast growth rate, good meat quality, and high market price. It started in the early 1990s and the technology for mass larval production was easily established in 1997 (Chang et al., 1999).

From then on, cobia production increased from 1,800 tonnes in 1999 to a high of 4,000 and 3,800 tonnes in 2004 and 2005, respectively. Production was 3,500 tonnes in 2006 and 3250 tonnes in 2007.

Domestic and export demands are increasing steadily and thus efforts are being done to improve nursery and off-shore grow-out culture, to prevent and/or control diseases effectively, and to develop efficient post-harvest technology.

Yellow-fin tuna

This is the most recent aquaculture practice in Taiwan. Off-shore cage culture started in 2002. Tuna juveniles (~1 kg size) were collected by long-line, carefully handled to minimize stress, and then stocked in off-shore cages. Completed culture runs showed that growth rate was very fast attaining final weights of 8-10 kg after one year of culture, and 20-30 kg in two years. The flesh quality of cultured tuna has a higher fat content (12-15% total fat) than wild caught tuna. This could be mainly due to the formulated feeds that were used during



Offshore cobia culture. Production was 3,500 tonnes in 2006 and 3,250 tonnes in 2007

the culture. These preliminary results showed the huge potential of tuna cage aquaculture, with a high market demand (especially for sashimi) both domestically and internationally.

Conclusion

These breakthroughs in Taiwan, well recognized globally were attributed not only to optimal climate and good culture conditions but mainly to the ambitious aquafarmers and diligent scientists. The latter group established technologies and disseminated them readily to the industry.

However, increases in aquaculture production have not been sustainable due to several negative factors including biological, physical and social problems, as well as inappropriate government policies and laws. Despite all these setbacks, new technologies are now being implemented in order to revive and sustain Taiwanese aquaculture (Liao and Chao, 2007).

Nevertheless, aquaculture in Taiwan will definitely remain to be an important industry. Thus, collaborative work and responsible projects are needed in order to have sustainable aquaculture in the future. Emphasis should be given to research and development on disease control/prevention and fish nutrition, further development of culture systems (e.g. intensive and super-intensive, recirculating, off-shore), application of biotechnology for improved and sustainable production and environment-friendly culture practices.

Lastly, it is hoped that the past and present status of Taiwanese aquaculture may serve as a lesson for other countries where the aquaculture industry is still developing or at its peak (Liao and Chao, 2007).

References are available on request



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World Aquaculture 2008

'Aquaculture for Human Wellbeing - The Asian Perspective'

In May, this year, the annual international conference & exposition of the World Aquaculture Society returns to Asia. It was held in Bali in 2005. This will be the first major international aquaculture conference in Korea. World Aquaculture 2008 will be held at the Busan Exhibition and Convention Centre, Busan from 19-23 May, 2008. The trade show will be held from 20 to 22 May, 2008.

Early Registration Deadline Extended for Korea Meeting

The deadline for receiving the early registration price for World Aquaculture 2008 has been extended to March 31, 2008. For more information on conference and trade show:

World Aquaculture 2008, 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

Special producer programs

World Aquaculture 2008 will have a special farmer's day with the latest in practical knowledge for the Korean aquaculture producers. Additional producer sessions for shrimp and prawn are being planned.

Uniquely on *Penaeus monodon* culture

At the show, Uni President Vietnam, Gold sponsor of World Aquaculture 2008 will organise a half-day session on the culture of *Penaeus monodon*

on May 22nd from 13.50 to 17.40. Currently, the production of this shrimp is overtaken by that of the vannamei shrimp in most parts of Asia. However, there are interests in industry in many countries to revive and expand black tiger shrimp farming to meet the demand for larger size shrimp. The aim of the organizers is to present some positive developments in its breeding and grow out as well as present challenges in nutrition, disease and marketing, to prepare the way forward.

- Nutrition requirements of *Penaeus monodon*- Professor Shi-Yen Shiau
- Developments, domestication and breeding of a specific pathogen-free broodstock of shrimp *Penaeus monodon* from Madagascar, Dr Marc Le Groumellec, Director of Aqualma, Madagascar.
- Important diseases of the giant tiger shrimp *P. monodon* in Asia- Prof Timothy W. Flegel, Faculty of Science, Mahidol University.
- Review on the semi intensive grow out and pond management of *Penaeus monodon*- Herve Lucien-Brun, General manager, Aqua Techna
- The status, challenge and perspective of black tiger shrimp *Penaeus monodon* farming in Mekong delta –Vietnam, Nguyen Van Hao, Director, Research Institute For Aquaculture No. 2, Vietnam
- Global production and trade of farmed shrimp, Jacques Gabaudan, Manager of DSM Nutritional Products.

This session will be chaired by Professor Shi-Yen Shiau, National Taiwan Ocean University, Taiwan and Dr Jang, In Kwon, Director of National Fisheries Research & Development Institute, Korea.

Some reasons why you should attend the Aquaculture 2008 meeting in Busan, Korea

- Diversity of local aquaculture in Northeast Asia, including China, the Koreas, and Japan is astounding with large-scale commercial aquaculture of many freshwater and marine fishes, shrimp and other crustaceans, a variety of bivalves and other molluscs, echinoderms, tunicates, and seaweeds.
- Cutting edge technology is being applied to aquaculture in Korea. Korean engineers have been conducting research to contribute with sophisticated recirculation systems, off-shore cages, and massive long-line seaweed arrays.
- Government support, both at municipal and national levels is astounding for this WAS 2008 conference and has allowed Busan 2008 to provide facilities, receptions, entertainment, shuttle services, student support, and conference tours to a level unprecedented for aquaculture conventions.
- BEXCO, the brand new Busan Exposition and Convention Center is a spectacular architectural wonder with numerous meeting rooms adjacent to a huge trade show floor. There is an entire floor of restaurants with a range of cuisine and prices.
- Transportation to Busan, Korea's second city. There are direct flights from the US, Japan, China and several other countries. Participants flying into Seoul-Incheon can take a limousine bus (USD14) to the Seoul bus station and take the Korean Bullet Train or KTX to Busan. The KTX leaves every 20 minutes and the USD 49 train journey at speeds reaching 300 kph takes about two hours through farmlands, urban centers and mountains to the southern coast. Within Busan, a free multi-vehicle shuttle service will move participants between the convention center and hotels.

Explore the cradle of Aquaculture in Taiwan

Meet you in World Aquaculture 2008, Busan Korea (May 20-22, 2008)



Fish Breeding Association Taiwan

TEL: 886-7-813 6870 / FAX:886-7-813 6871

EMAIL: taiwan.fba@msa.hinet.net

WEB: www.fish.org.tw

BOOTH NO: 110



Blueocean Biotech Co., Ltd. (Grouper Production & Marketing)

TEL:886-8-871 7718 / FAX:886-8-871 7716

EMAIL:sale@biocean.com.tw

WEB:www.biocean.com.tw

BOOTH NO:106

Shyeh Duwai Enterprise Co., Ltd. (Aquaculture Equipment & Systems)

TEL:886-7-389 3870 / FAX:886-7-382 9892

EMAIL:aquatic.tw@msa.hinet.net

WEB:www.aqua-systems.com.tw

BOOTH NO: 107

High Free Biotechnologies Ltd. (Aquaculture Equipment & Feed Additive)

TEL:886-7-721 1686 / FAX:886-7-751 9435

EMAIL:geemann.tw@yahoo.com.tw

BOOTH NO: 108

Hanaqua Tech Inc.. (Feed Manufacturing, Trading of Aquatic Feed Ingredients, Seafood Supply, Consultation of Aquacultural Industry)

TEL:886-7-557 0119 / FAX:886-7-557 7292

EMAIL:hanaqua@ms11.hinet.net · service@hanaqua.com

WEB: www.hanaqua.com

BOOTH NO: 109

Hai-Yu Enterprise Co., Ltd. (Shrimp Hatchery & Organic Aquaculture)

TEL:886-7-386 9027 / FAX:886-7-386 8875

EMAIL:haiyultd@yahoo.com.tw

WEB:www.haiyu.com.tw · www.ezone.com.tw/fish

BOOTH NO:111

Taiwan Hung Kuo Industrial Co., Ltd. (Larval/On-growing Feed Manufacturer)

TEL:886-3-990 2211 / FAX:886-3-990 2216

EMAIL:ken@luckystarfeed.net

WEB:www.luckystarquafeed.com

BOOTH NO:219

GeneReach Biotechnology Corporation (Shrimp Virus Detection System & Virus Information Provider)

TEL:886-4-2358 0768 / FAX:886-4-2358 0769

EMAIL:sales@i-screen.com.tw

WEB:www.i-screen.com.tw

BOOTH NO:220

BioChroma Life Science Co., Ltd. (Feed Additive)

TEL:886-3-597 2003 / FAX:886-3-597 2570

EMAIL:frankdu@biochroma.com.tw

WEB:www.biochroma.com.tw

BOOTH NO:221

Tekho Company Ltd. (Fish & Aquarium Trading)

TEL:886-6-263 0112 / FAX:886-6-291 7793

EMAIL:tekhoco@ms67.hinet.net

WEB:www.tekho.com.tw

BOOTH NO:323

Nice Garden Industrial Co., Ltd. (Aquatic Feed, Feed Additives, Equipment, Raw Material)

TEL:886-2-2560 3566 / FAX:886-2-2560 3888

EMAIL:info@nicegarden.com.tw

WEB:www.nicegarden.com.tw

BOOTH NO:316

Trade show

With two more months to go, some 82 companies have already confirmed their participation. However, the organisers said that they expect more exhibitors in the coming months as it is still early. Below are details on activities on some of the exhibitors.



Fish and shrimp feeds

Uni-President (Vietnam) is a Taiwanese-based aqua feed company and a leading shrimp feed producer in Vietnam. Apart from feeds for marine shrimp and catfish, it has feeds for fresh water prawn, tilapia, grouper and seabass. In 2006, a new feed mill was set up in the Mekong Delta to focus on tilapia and catfish feeds. To keep pace with the global market trends, it now has an integrated business model with a hatchery and laboratory facilities. In mid 2007, it went upstream with a new hatchery with bio secure facilities for broodstock culture, larval and nursery rearing of postlarvae of both the black tiger shrimp and vannamei shrimp. It is also equipped with laboratory facilities, complete with PCR- polymerase chain reaction and other equipment for the monitoring of diseases.

"Our plan is to play a larger role in the industry in Vietnam. The estimated country wide demand is 35 billion post larvae, valued at USD 100 million. Our goal is not just a volume producer but supplying quality post larvae. We will start the Specific Pathogen Resistant-SPR vannamei postlarvae business from March 2008. Next is to produce Specific Pathogen Free-SPF monodon PL from domesticated monodon broodstock. SPF monodon PL from domesticated monodon broodstock", said Jeff, Jie-Cheng Chuang, Vice President of Uni-President Vietnam Co., Ltd.

Uni-President (Vietnam) Co Ltd

Web: www.uni-president.com.tw; www.aquafeed@upvn.net
Contact person: Mr. Chuang Jie Cheng **Email address:** jeff@upvn.net
Booth 401-404

Skretting, a leading manufacturer of marine fish feeds with sales activities on all continents will use the exhibition to launch a new innovative range of rotifer & artemia enrichment products under the name of 'Origo'

"Korea has major aquaculture activities in flounder, red seabream and rockfish. Our factory near Fukuoka Japan is well-placed to service this segment of the Korean market' says Rik van Westendorp. 'Fish nutrition is our core business and to demonstrate our commitment to scientific progress, we will sponsor the Nutrition Session of the Conference'. Product development manager Arjen Roem will also be present at the stand. 'The marine hatchery segment is well developed and high-tech in Korea. That is a good match for our products.

Skretting

Web: www.skretting.com
Contact person: Mrs. Kanae Watanabe **Email:** watanabe@skretting.com
Booth 613-618



Aquaculture solutions

Novus Aqua is now expanding globally after establishing itself in the markets in Asia Pacific since 2006. It will also operate Novus Global Aqua Research Center in collaboration with Nong Lam University, Ho Chi Min, Vietnam from 2008 (see page 42).

With innovative R&D, it has products, services, and business solutions to help solve the industry's present and future challenges. The company's aim is to help the industry grow in the right direction by consolidating the expertise of industry experts. An example was the "Aquaculture Today and Tomorrow" conference organized at VIV Asia 2007 and VIV India, said Dr. Farshad Shishehchian, Global Aqua Manager.

Korea is the one of top 10 feed producers in the world. To best serve the market, at World Aquaculture 2008 in Busan, Novus will launch the MERA™ line of products to serve the feed mill customers. These offer solutions to the industry and aqua feed producers by focusing on cost reduction, higher profitability, and value addition to products.

Novus International, Inc.

Web: www.novusint.com
Contact person: Dr. Farshad Shishehchian
Email: aquanovus@novusint.com
Booth 320

Micro-algae for aquaculture

New from Belgium and to the World Aquaculture trade shows is SBAE Industries. The company was established in 2006 by Dr Koenraad Vanhoutte, an expert in algae production and Jan Vanhoutte, Operations Director. It is involved in the industrial production of micro-algae for a wide range of applications from nutritional supplements for fish feeds and other aquaculture activities, from hatchery to grow-out, to cosmetic products, omega-3 additives for the food industry, and bio-fuel production. The ground-breaking technology has enabled SBAE to develop a stable industrial manufacturing process for micro-algae and plan for annual capacity of 30 tpy in 2009.

The outdoor and indoor platform technologies developed allows it to serve all the potential and existing algae applications. Specially for aquaculture, SBAE can offer 100% pure algae solutions for the aquaculture. Some of the advantages of the grades produced by SBAE Industries are:

- guaranteed no toxic residues
- proven lower mortality rate in hatchery
- additional nutritional benefits of the algae
- continuous (high volume) production process
- clean surface water in the hatchery
- hassle-free with stable on-site algae production

According to Jan and Koenraad Vanhoutte, their objective at the trade show will be to present the SBAE product portfolio especially developed for the aquaculture industry. This will enable them to communicate with future contacts and to enhance their visibility in the Asian market.

SBAE Industries NV/SA

Web: www.sbae-industries.com
Contact: Giuseppe Grotti, Business Development Manager;
Email: giuseppe.grotti@sbae-industries.com
Booth 535

Exhibitor	Exhibitor	Exhibitor
Korea	Thailand	Taiwan
AGW_PNU	Akva Group	Fish Breeding Association Taiwan
AqualInfo Co., Ltd.	Alltech	Shyeh Duwai Enterprise Co., Ltd
Bowwow Korea	CP Group	High Free Biotechnologies Ltd.
Cargill Animal Nutrition	DSM Nutritional Products	Nice Garden Industrial Co., Ltd.
C J Corp	Inteqc Feed Co., Ltd.	Hanaqua Tech Inc.
Dae Yang Air Stone Ind., Co.	GePro Geflügel Protein GmbH & Co Vertriebsgesellschaft. KG	Sino-Aqua Corporation
DRS CORP	National Center for Genetic Engineering and Biotechnology	BioChroma Life Science Co., Ltd.
Green Cross Veterinary Products. Co Ltd	Moana Ltd.	Blueocean Biotech Co., Ltd
Hatech Limited	Novus Aqua (see preview)	GeneReach Biotechnology Corporation
Ho Won Bio	USA	Hai-Yu Enterprise Co., Ltd
Koama Co	4Cs Breeding Technologies, Inc.	Taiwan Hung Kuo Industrial Co., Ltd
Kofec	Advanced BioNutrition Corp	Tekho Company Ltd.
OceanTech	American Soybean Assn.	Canada
Woosung Feed	Aquafauna Bio-Marine, Inc.	Skretting (see preview)
Australia	Aquatic Eco-Systems, Inc.	Point Four Systems
NutraKol Pty Ltd	BNU Bio	Nigeria
Wiley-Blackwell	Carter Day International, Inc.	Ajibola Atanda Lukuman farms
China	Colorite Plastics	Colombia
Zhejiang Fordy Machinery Co., Ltd.	Diamond V Mills	ETEC S.A.
India	GTC Nutrition	Mexico
Zymonutrients Private Limited	Gulf Breeze Aquaculture and Seafood	Panorama Acuícola Magazine
Vietnam	Jung Ho Tech	Netherlands
Uni President Vietnam (see preview)	Magic Valley Heli-Arc & Mfg. Inc.	Dishman Netherlands BV
Singapore	Maz-ZEE Bio Co. Ltd	Sonac B.V.
Aquaculture Asia Pacific Magazine	Northwest Marine Technology, Inc.	Norway
Biomin	Ocean Star International, Inc.	Aker BioMarine
UK	OceanSpar LLC	Belgium
Fish Farming International	Samyang Anipharm Co.	INVE Aquaculture
Dragon Baits Ltd.	Schering-Plough Animal Health Corporation	SBAE Industries (see preview)
Fishgen/Tiltech Aquafarms LA, USA	Troutlodge, Inc.	France
Seabait Limited	Wenger Manufacturing, Inc.	Faivre SARL
Taylor & Francis Group	World Aquaculture 2009	
University of Stirling	YSI, Inc.	

The Taiwan group

In this World Aquaculture 2008 trade show, there will be a large presence of companies from Taiwan, under the umbrella of the Fish Breeding Association Taiwan. The focus will be to showcase technological advances of industry in Taiwan. Details on products and activities are given below. Please refer to the advert on page 35 for the full addresses of these companies.

Fish breeding and marketing



Members of the **Fish Breeding Association Taiwan (FBA)** comprise industry involved in fish breeding in Taiwan and from other parts of Asia. FBA was established under the Council of Agriculture, Executive Yuan in May 1996.

The main aim of the FBA is to develop and provide techniques and information on breeding and nursery technology. It is also to strengthen the exchange of experiences among members and industry, locally and internationally. It also promotes and conducts research in aspects

of fish breeding and culture and develops new breeds with good market potential. Its principal mission is to establish a validation system for fry quality. The association integrates the international marketing efforts of member companies.

Fish Breeding Association Taiwan (FBA)

Contact: Robin Cheng

Email: taiwan.fba@msa.hinet.net

Web: www.fish.org.tw Booth 110

Blueocean Biotech is a leader in the production and marketing of various grouper species in Taiwan. The current focus is on the breeding of the "Malabar grouper" *Epinephelus awoara*. Annual production is more than 1,000 tonnes. In addition to its grouper farming base in Pingtung, Taiwan, Blueocean also has its own sales system. This consists of one large scale transport facility in Taiwan and Fujian, China, and a sales outpost in Shanghai.

Blueocean Biotech Co., Ltd

Contact: Alex Hou

Email: sale@biocean.com.tw

Web: www.biocean.com.tw **Booth 106**

Tekho is an international trading company for aquatic products. There is also the An Pin Live Fish Centre, located in Tainan Taiwan for the import and export of live fish. The centre can hold 1.4 million fry and fingerlings of 2.5 to 4 inches or 70 tonnes of adult fish. It has the first and biggest life fish centre in Taiwan. All fish use RFID (Radio-frequency identification). The centre has HACCP and TGAP accreditation

Tekho Company Ltd.

Contact: Shirley Chong

Email: tekhoco@ms67.hinet.net

Web: www.livefishcenter.com **Booth 323**

Aquaculture supplies

Shyeh Duwai Enterprise Co., Ltd. will be marketing its aquarium & aquaculture life support systems, filtration equipment, zebrafish housing system, chiller / heat pump systems, protein skimmer and UV sterilizers.

Shyeh Duwai Enterprise Co., Ltd.

Contact: Jerome Hsieh

Email: aquatic.tw@msa.hinet.net

Web: www.aqua-systems.com.tw **Booth 107**

This focus of **High Free Biotechnologies Ltd** is on improvements in fish and shrimp breeding, culture and water management. It has an experimental farm. With over thirty years of experience, the group provides water management bio-products, high efficiency aerators, and fish and shrimp feed additives. At the trade show, the company is seeking new business partners. It also welcomes an exchange of ideas and information at its booth.

High Free Biotechnologies Ltd.

Contact: Jung Fu Chen

Email: geemann.tw@yahoo.com.tw **Booth 108**

Consultancy and technical services

Services by **Hanaqua Tech** to the aquaculture industry includes consultancy by T.A.C. (Taiwan Aquaculture Corps.), a company affiliated to Hanaqua. It also provides turn-key projects in aqua feed mills, technical services in operations of feed mills, aquatic feed formulation and import and export of feed ingredients and seafood. It markets feeds for shrimp and freshwater and marine fish tailored to demand.

Hanaqua Tech Inc.

Contact: Peter Chiang (peter@hanaqua.com.tw)

Email: service@hanaqua.com

Web: www.hanaqua.com **Booth No: 109**

Complete feeds, ingredients and additives

Hung Kuo Industrial Co., Ltd. is an aqua feed company, established in 1984. It has numerous high quality feeds marketed under the 'Lucky Star' brand. For more than 20 years, 'Lucky Star' is considered as a premium quality feed for *Penaeus japonicus* and *P. monodon* shrimp.

It has contributed to the success of many farmers. Since 2005, with the cooperation of larval feed production specialists, new marine fish and shrimp encapsulated larval diets have been introduced in several markets.

Taiwan Hung Kuo Industrial Co., Ltd.

Contact: Ken Hung & Jack Hung

Email: ken@luckystarfeed.net

Web: www.luckystarquafeed.com **Booth 219**

Biochroma was founded in 2002, to develop proprietary technology for carotenoids. Today, it is recognised as one of the few companies generating a variety of carotenoids through environmental-friendly and economical methods. Many well-known carotenoids, such as lycopene, astaxanthin, canthaxanthin, β -cryptoxanthin and zeaxanthin, are currently produced commercially. At the show, the company is also seeking collaborators to explore the potential of its proprietary technology in the derivation of novel carotenoids.

BioChroma Life Science Co., Ltd.

Contact: Frank Du

Email: frankdu@biochroma.com.tw

Web: www.biochroma.com.tw **Booth 221**

Nice Garden Industrial Co., Ltd was founded in 1984. For the aquaculture industry, it has products specifically in nutrition and health. The main areas are in feed premix, produced in Taiwan via a turnkey technology from DSM. Larval feed, feed raw materials and additives are designed to provide enriched nutrition for better growth. Immunity modulators are designed to provide a higher tolerance to stress and disease.

Nice Garden Industrial Co., Ltd.

Contact: Jerry Hsu

Email: jerry@nicegarden.com.tw; info@nicegarden.com.tw

Web: www.nicegarden.com.tw **Booth 316**

Hai Yu is a manufacturer of shrimp larvae and grow out feed in Taiwan. It pioneered shrimp larvae production in Taiwan and then became a global authority in shrimp larvae breeding and prawn culture. This technology developed at Hai Yu led to the success of Taiwanese shrimp farmers in breeding shrimp. The 'ly Miao Pao' series of products are still the best shrimp larvae feed in the global shrimp feed market. The company is now launching organic shrimp products.

Hai-Yu Enterprise Co., Ltd.

Contact: Jeffrey Liu, Jackie Cheng

Email: haiyultd@yahoo.com.tw

Web: www.haiyu.com.tw; www.ezone.com.tw/fish **Booth 111**

Disease diagnostics

GeneReach Biotechnology Corporation has been focusing on research on viruses in aquaculture since its establishment in 1997. It launched the semi-quantitative IQ2000 TM PCR test kits and later developed a completely new shrimp virus detection kit in 2006 to simplify the whole operation process for the farmer. At the recent 3rd Southeast Asia International Aquaculture & Animal Husbandry Expo in China, it launched the shrimp virus detection kit - i-screen which drew the attention of shrimp farmers. This novel virus detection platform features convenience and easy-operations. At this show, it will display i-screen WSSV and TSV detection kits for farmers.

GeneReach Biotechnology Corporation

Contact: Simon Chung

Email: sales@i-screen.com.tw

Web: www.i-screen.com.tw **Booth 220**

New enrichment feeds for marine hatcheries in Asia

A year of R&D and global commercial trials, feeds to provide higher yields of more nutritious and active live feeds, more reliable and in half the time than traditional feeds are ready for markets in Asia.

Skretting is launching a new range of culture & enrichment feeds for rotifers and Artemia in marine hatcheries. This will make its first appearance in Asia at the World Aquaculture 2008 conference in Busan, Korea, in May. The world leading fish feed manufacturer is the Nutrition Sponsor at this event.

Redesigning live feed

Eamonn O'Brien, Product Manager for Skretting Marine Hatchery Feeds, said, "Origo is the Latin word for 'origin, beginning, start' and we chose it to symbolise the start of the larval feeding. The word also reflects our nutritional philosophy. Using nature as a starting reference point, we are offering live feed and ultimately the fish larvae, a more balanced and natural nutritional profile. The feeds are suitable for all marine species with a live feed component. In particular, in the Asian market we have species such as flounders, groupers and barramundi in mind".

"The concept is totally original. Our intention in developing them was to break away completely from traditional yeast-based and emulsion type feeds and, in doing so, to deliver definite advantages. The Ori-Go feeds form the final range that completes our portfolio of marine hatchery feeds, which began to arrive in the market from 2006."

Dr Arjen Roem, Product Development Manager for Skretting Asia, said, "In the history of hatchery enrichment feeds, we will note that there has been very little development in live feed culture and enrichment in recent years. We knew the industry was clearly calling for new concepts to help address the issues that they face, such as fry quality."



Eamonn O'Brien (left), attending trials at a flounder hatchery in Korea.

"Our goal was to redesign the live feed as optimally formulated living feed capsules for the larvae. We also invested in advanced production technology from hi-tech industries. As a result, Ori-Go feeds offer two clear advantages compared with algal pastes used in hatcheries. First, they are formulated without water, which means they are more stable with better biosecurity, giving a far longer shelf life. Secondly, they effectively provide nutrition based on several algal species, not one or two, and this significantly enhances the nutritional profile".

A 'food assimilation approach'



Dr Arjen Roem

Arjen added that the feed concept of Ori-Go enrichments is as a 'food assimilation approach'. The nauplii digest the enrichment and transfer its 'goodness' to the tissue of the nauplii. This results in complete utilisation of the enrichment feeds. Water quality is maintained at an optimal level.

The utilisation of the feed means the faecal pellets do not affect water quality and are not re-ingested by the nauplii, because of their size (Figure 2). During artemia enrichment, traditional enrichments usually lead to waste that is continually recycled through nauplii, leading to a build-up of the bacterial population and sick nauplii.

"We took these feeds to several leading hatcheries in the Mediterranean region, notably those in Italy, France, Spain and Turkey and also those in Norway and the US. They were tested in commercial conditions. Results were better than expected and the feedback from hatchery managers was very positive. They reported faster enrichment and better water quality, which means up to 40% less oxygen was required".

Single feeding

In addition, the higher efficiency meant that only one feeding was sufficient and a second feed at night was not necessary. One manager said the culture diet was just like real algae and he would no longer

Skretting Concept of Protein dynamics during larval rearing

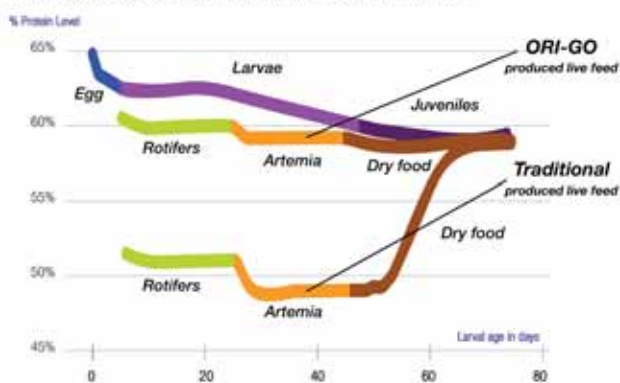


Figure 1. Protein dynamics during larval rearing. Traditional methods do not maintain sufficient protein levels during rotifer and artemia feeding phase.

A 'food chain' approach

This range is based on natural raw materials that closely reflect the nutrition rotifers and Artemia consume in the wild and that is optimised to the physiology of the live feeds. This 'food chain' approach has resulted in more efficient utilisation of the feeds. That is reflected in practical terms in reduced product consumption. The nutritional profile of the previous generation of live feeds available for larvae today, show that there is often an imbalance, for example with respect to protein and lipid levels.

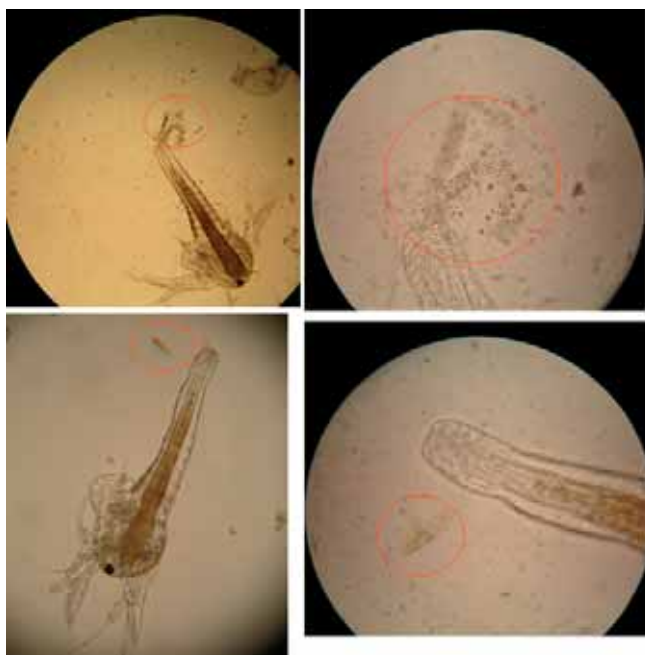


Figure 2. Top: Traditional enrichments, note dirty water and expelled enrichment micelles, which will be re-ingested, bottom: Clean water and faecal pellet, with Ori-Go Artemia enrichment

need to produce his own. Based on that experience, the company is confident that these feeds will provide higher yields of more nutritious and active live feeds, cleaner, more reliably and in less time than traditional feeds. They require less labour, less energy and less oxygen. These are all important savings.

Markets in Asia

Following further successful trials in Asia, with grouper hatcheries in Indonesia and flounder hatcheries in Korea, Skretting is introducing two Ori-Go feeds to the Market in Asia. These are Ori-Culture and Ori-Green.

Arjen said, "Ori-Culture is a rotifer culture diet based on a selection of algae naturally consumed by rotifers. We prepare this feed as a stable free-flowing powder and it provides excellent reproduction, with high levels of activity in the cultivation of rotifers over a range of densities. As it matches the needs of the rotifer very closely, there is little waste. Bacteria do not flourish and the water remains very clean."

"Ori-Green enrichment feed is also based on natural algae with

proteins, phospho-lipids and marine oils rich in HUFAs (highly unsaturated fatty acids). It is so effective, our trials have shown enrichment time for rotifers can be as short as two hours. Formulated as micro-particles, this is a dry green powder. Dispersed in water, it provides for the nutrition for rotifers and Artemia, close to natural zooplankton, with a higher protein content and better lipid balance than conventional feeds currently available."

He added that all this means that less feed is needed for the clean, quick production of highly active rotifers and Artemia. The enrichment feed can even be used in combination with Artemia hatching to offer a very efficient option in the live feed room.

Some of the beneficial features of this feed range was gained through the hi-tech manufacturing methods used. These deliver two important benefits. First, the specifications can be closely controlled and deliver consistent quality within batches and from one batch to the next. Secondly, the particle sizes are closer to a natural diet. They are generally larger than traditional diets, which means the rotifers and Artemia eat more efficiently and become enriched faster. Also, within each feed, there is a range of particle sizes and these pack more densely in the gut, to increase the level of enrichment. In addition, the physical form of these feeds gives them a long shelf life and makes preparation quick and simple.

All the Ori-Go products are formulated and produced in a dedicated newly conceived production unit located close to Skretting's starter feeds technology centre in France. State-of-the-art technology is applied to ensure consistent high quality in the production of these feeds and meet the most stringent demands in terms of size and physical-chemical characteristics.



Ori-Culture is used for this high quality rotifer culture

A dedicated international team of technical specialists provide support for hatcheries to attain optimum performance from each product. In the months since its introduction, the Skretting portfolio of marine hatchery feeds is helping marine hatcheries around the world to be more productive and meet the growing demand for high quality, healthy, vigorous fish.

What to expect in AQUACulture Asia Pacific Magazine in 2008

Issue	January/ February	March/ April	May/ June	July/ August	September/ October	November/ December
Focus on current trends & challenges	Aqua Feed Production	Disease & Health Management	Food Safety	Sustainable Aquaculture	Organic Aquaculture	Cage Culture
Industry review	Marine shrimp	Marine fish	Catfish	Tilapia	Freshwater prawn	Hatchery
Features on success stories, best practices, new technology and developments						
Feed technology NEW	Enzymes & feed additives	Feed processing	Immuno-stimulants & Feed ingredients	Novel protein meals & amino acids	Nutrition & Formulation	Extrusion & Larval feeding
Technical	Culture technology	Recirculation technology	Product quality & markets	Biotechnology & diseases management	Pre & Pro-biotics	Health management/ Larval feeding
Shows	Victam & FIA Asia 2008	World Aquaculture 2008	Vietfish 2008	Australasian Aquaculture 2008	Aquaculture China	



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MOU on aqua research facility in Vietnam



Pictured after the signing ceremony, from left Yiannis Christodoulou, Sales Director of APEC (Asia Pacific excluding China), Dr Le Thanh Hung, Dean, Faculty of Fisheries and Dr Trinh Troung Giang, Rector of Nong Lam University, Thad Simons (CEO of Novus), Dr Farshad Shishehchian (Global Aqua Manager), Giovanni Gasperoni, VP and Dr Nguyen Nhu Pho, Nova Group, Vietnam.

Novus International Inc., a global leader in animal health and nutrition will construct an aqua research facility in Nong Lam University, Ho Chi Minh City, Vietnam. A MOU signed between Dr Trinh Troung Giang, Nong Lam University and Mr Thad Simons, President and Chief Executive Officer of Novus International, Inc. in Bangkok on March 6, 2007 will provide Novus with 1,000m² of land at the Nong Lam University Campus for the construction on the USD 0.5 million research facility which is expected to be completed in mid 2008. The facility will include a fish hatchery with re-circulating tanks for Pangasius catfish, tilapia and

shrimp, a water process laboratory, feed processing laboratory and general laboratory with microbiology equipment and glass aquaria.

At the signing ceremony, Thad Simons said, "This facility exemplifies our commitment to the development of healthy, science based, innovative products and programs for the aquaculture market." Founded in 1955, Nong Lam University's current student body consists of 20,000 undergraduate and 1,000 graduate students in 37 fields of study. Undergraduate aquatic degrees are offered in Aquaculture, Aquatic Products Processing and Aquatic Animal Health Management. Master and Ph. D. programs are also offered in aquaculture. Dr Trinh said that such collaboration with industry is new to the university and will bring direct benefits to industry as well as enhance its reputation as a major centre of learning in Vietnam.

Novus will continue the development of aqua products and programs based on research conducted at the new facility. It is anticipated that these new products and programs will be similar in nature to MERA™ Met Ca Plus Catfish and MERA™ Met Plus. MERA™ Met Ca Plus Catfish was developed to improve nutrition, quality, disease prevention and overall health in catfish while reducing the usage of fishmeal.



At the MOU signing, Dr Trinh Troung Giang (right) and Thad Simons.

Safer and healthier shrimp in Thailand



The Department of Fisheries of Thailand (DOF) organized the final workshop of the project, entitled "Innovative Strategies for the sustainable farming of safer and healthier shrimp". This project, funded as part of the EU-Thailand Economic Co-operation, Small project facility (Grant contract ASIE/2006/126-034) for the production of quality-certified seafood was a collaboration between DOF, SBBU/BIOTEC, University of Ghent and INVE Technologies, Belgium. More than 60 people representing every level of the sector attended the workshop on 12 December, 2007.

The overall objective of this project, with its training and information components, was to support the Thai shrimp farming industry by giving them specific tools to produce healthier shrimp and safer for human consumption, without the prophylactic nor therapeutic use of antibiotics and chemicals. Selected biotechnological products and techniques,

reviewed by Dr Olivier Decamp (INVE Technologies), were tested under Thai conditions, both in laboratory (SBBU/BIOTEC) and at DOF stations (Songhkla, Satun, Samut Sakhon and Phetchaburi). Regional seminars were also organized during previous months in order to transfer information on new and effective health management practices. Prof Sorgeloos (University of Ghent), Dr Panom Sodsuk (DOF) and Ms Waraphorn Jangsuthivorawat (SBBU/BIOTEC) reviewed the training and application of new analytical techniques (including the standardized WSSV challenge test that was developed by 3 laboratories of Ghent University in collaboration with INVE Technologies).

The presentations highlighted the benefits of biosecurity measures (efficient disinfection and monitoring of microbial load), and safe and effective probiotics in larviculture and on-growing, both for white shrimp and tiger shrimp. Among the results presented were improved production reported by the Satun coastal fisheries R&D centre:

- Markedly reduced vibrio at various stages of production between zoea 1 and PL14 stages
- Faster shrimp development
- Lower variability between tanks
- Improved survival (average of 45% in the control tanks as compared to 78% in the treatment tanks)

The workshop ended with a discussion led by Dr Olivier Decamp and Dr Srirat Sodsuk (DOF). This project will help farmers pass and reach the goal of the two DOF quality control programs, the Code of Conduct (CoC) and Good Aquaculture Practice (GAP). More information is available upon request from Olivier Decamp (o.decamp@inve.be).

Biomin opens ACAN and office

On March 4, Biomin celebrated the opening of its new office and Aquaculture Centre for Applied Research (ACAN), both in Bangkok, Thailand. The latter is part of the company's centre of Applied Nutrition Research (CAN) network. Facilities at the centre include three different systems with circular tanks of 120, 350 and 500 litres, each with independent water recirculation systems. With this facility, the company

will bring some of the products and knowledge of how they work in animals to aquatic species and customize these for fish and shrimp species. It will also conduct trials with marine and freshwater fish species such as the Asian seabass and hybrid catfish and generate valuable information for the industry.



At the office, Dr Erich Erber, Erber AG cut the ribbon with Dr David Saunders, CEO Asia Pacific, Biomin



At ACAN, Dr Pedro Encarnacao, Biomin's aquaculture specialist cuts the ribbon

Contract research in aquaculture

Aquatic Biolabs (ABL) is set to become a major player in the aquaculture industry with a range of services. The core service of ABL, founded in 2007 by Ms Tanuttha Suyawanish in Thailand is to provide contract research or product testing to support the R&D and marketing efforts of companies. Products include feed additives such as attractants and pigments, health additives including immunostimulants and probiotics. Protocols ranging from farm and cage trials to small scale wet lab trials are custom made and designed to meet specifications of the customers. The trials can be conducted with fish and crustacean species of economic importance. Services are targeted at companies involved in nutrition and health management in aquaculture, as well as in commercialization of products in aquaculture.

ABL has its offices in Bangkok and will have facilities (ponds and wet lab) in the South of Thailand. It provides consulting on location when customers conduct in house trials. The managers and directors of the company have vast experience in shrimp and aquatic animal



farming dating back to the mid 90's in Thailand. These are mainly in hatcheries, shrimp farms and in R&D departments of aquafeed companies. For the last four years, ABL has built a network of farm managers in Thailand who are well known experts in their field. More information: aquatic@aquaticbiolab.com, web: www.aquaticbiolab.com

New appointments



As part of its expansion in Asia, Diamond V Mills, a 65 year old privately held USA-based producer of fermentation metabolites used for animal feed supplements has announced the appointment of **Dr. Brian Hunter** as Director of Aquaculture Business and Technical Development. Dr. Hunter will serve Asian and global customers from the new regional Diamond V office in Bangkok,

Thailand. Dr. Hunter holds a Masters in Fisheries and a PhD in Agricultural Biochemistry and Nutrition, both from the University of Arizona, USA. He has been involved with a range of aquaculture activities, including commercial fish farming, nutrition and disease research, and seafood marketing.



Novus international Inc. with its headquarters in St. Louis, Missouri, USA has announced the appointment of **Dr Farshad Shishehchian** as Global Aqua Manager, based in Singapore. Dr Farshad joined Novus in 2006 as Regional Aqua Specialist. He has 15 years of experience in the global aquaculture industry and a PhD in Aquaculture and Ecology and an MSc in Marine

Biology. Novus International began its focus on the aquaculture industry in 2006, initially in the markets in Asia Pacific. In 2008, it will expand to global markets.

In Ireland, industry in Asia share concerns

The aim of Alltech's Aquaculture seminar series, held annually in Dublin, Ireland is for experts to present new and relevant information for the development of industry, specifically for that in Europe. This year, the group also included participants from industry in Asia. They also participated in an aqua forum, a round table discussion with specialists from diverse backgrounds on common needs for industry in Europe and Asia. It was an opportunity for industry in Asia and Europe to learn from each other.



Chris King

Top on the list of issues shared by both the Asian and European groups was raw material cost, availability and sustainability. Chris King, Asia Pacific Commercial Manager Aquaculture who led the Asian team from Thailand, Malaysia, India, Indonesia and Vietnam, said, "In feeds, the concern was common. Raw material prices have risen substantially. World current and future grain demand is unlikely to allow any easing of plant protein. Even though the price of fish meal has stabilized recently, the pressure on supply will continue as aquaculture expands. Most of us agreed that the key factor is feed efficiency and a better utilisation of raw materials is now critical. In India, there was hardly any compound feeds used for fish culture for decades and it is only recently we are seeing these in the market. This is a positive trend towards better feed efficiency. High raw material prices are squeezing profit margins for feed producers and farmers as market prices are not moving upwards. Variability of quality of some materials is also a strain on producers. Participants also expressed interest with information on how to use enzymes as a way to utilise raw materials and reduce the environmental load. They also asked on ways to increase the use of carbohydrates in feeds".

Participants also expressed the concern that although ten essential amino acids are required, aqua feeds for several species are still not formulated on amino acid composition. Information on mineral nutrition is inadequate such as its role in disease control and effects of minerals on the environment. According to Dr Shuichi Satoh, Tokyo University, Japan, fish feeds based on fish meal already can provide total phosphorus (P) surpassing the mineral requirements needed for optimum growth. An increment of dietary lipid resulted in greater deposition of minerals

in the yellowtail leading to reduction of N and P excretion. Some options to reduce N and P excretion include dietary citric acid (CA) which can increase availability of P in fish and amino acid chelated trace metals.

"Another concern was on developments in selective breeding where the emphasis has been on increasing productivity and fillet yield. In aquaculture species, this has been at the expense of selection for disease resistance. Thus industry has to look at ways to combat diseases, through sound farm management protocols incorporating biosecurity and as well as with nutrition", said Chris

"On the issue of food safety, concerns were raised on the use of antibiotics etc in the production process. Discussions were also on the source of mycotoxins in feeds, adulterations of feeds such as cadmium contamination in zinc sulphate, fake proteins and the inability of marine shrimp and fish producers to meet the food safety standards imposed by markets. Thus, mineral and feed additives to enhance fish health are vital", added Chris

The theme of the conference was 'gut efficiency: the key ingredient'. Research on mannan oligosaccharides (Bio-Mos) also considered its role in enhancing fish health. The team from Plymouth University, UK said that MOS reduces bacterial load and changed gut microflora in closed recirculation systems resulting in positive effects on the immune status of species such as European sea bream. In Croatia and China, carps fed diets with added MOS at 2kg/tonne and 2.5 kg/tonne, respectively, showed higher weight gain, better FCR, lower mortality and improvement in immune parameters.

Trace minerals and fish health were covered by some presenters. Increasing dietary zinc showed a decline in immune responses. In the case of selenium, the team from Plymouth University, UK showed there was low availability for selenium from fish meal and studies comparing inorganic selenium with organic selenium (Selplex) showed little difference between the control diet and inorganic selenium but higher digestibility with organic selenium. This accumulation of selenium in the flesh can benefit consumers as an additional source of Se.



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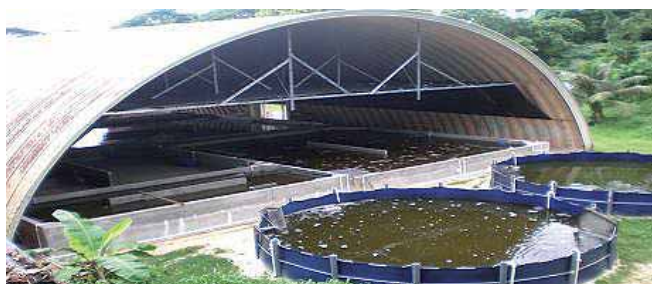
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Now shrimp broodstock from Saipan

Saipan SyAqua, located on the island of Saipan, a US territory in the North Marianas island has emerged as a new supplier of shrimp broodstock for hatcheries in Thailand, Indonesia and elsewhere.



SyAqua Tanks

The company has been approved as a *Penaeus vannamei* broodstock supplier to hatcheries in Thailand, after a visit by the Department of Fisheries in December 2007. The Director General of Aquaculture, Department of Marine Affairs & Fisheries, Indonesia has also approved the company as a broodstock supplier. A pilot shipment consisting of 250 broodstock (1:1 male:female) of 10-month-old broodstock were supplied to one of the largest hatcheries in Indonesia at USD25 per piece, exclusive of freight and packaging cost.

SyAqua is a multinational biotechnology company focusing on improving shrimp farm performance and shrimp meat quality and reputed as a leader in applying advanced statistical methodology to improve genetic qualities in shrimp breeding. It has worked closely with the Oceanic institute in a five year USD16 million research project that started in 2002 to develop genetic lines and production techniques for the shrimp industry. Saipan SyAqua, a joint venture with the SyAqua group, was established in 2004 and is an integral part of the SyAqua group breeding program, Saipan is being used to protect important SyAqua lines as well as provide information for further line development.



Glen Illing

Glen Illing, Managing Director of the SyAqua Group said, "Saipan is unique. It is the closest US territory to Asia. There are no other shrimp operations for miles which is important for biosecurity. As there are many economically devastating diseases that can afflict shrimp farming, a source of healthy broodstock is essential. Movement of shrimp broodstock is controlled to protect local shrimp farms by the respective departments of fisheries in

most countries".

"We are now building a better shrimp on the island of Saipan by improving growth rates, disease resistance and tolerance to adverse environment conditions. The result is more profits and better stability for shrimp farmers. We have opened our program to supply broodstock to the global shrimp farmers from this bio-secure island and deliver genetic improvement from SyAqua breeding program is an alternative from the Hawaii broodstock suppliers".

There are stringent requirements to export parent broodstock shrimp to other countries. A farm or facility must be approved by veterinarians from the State Department of Lands and Natural Resources and a two-year disease free certification from a state recognised pathology laboratory is required. Saipan SyAqua is certified by the University of Arizona Aquaculture Pathology Laboratory. The company

uses a three-phase system to grow its shrimp. All shrimp are grown in tanks, a restriction on Saipan to protect the environment. At any given time, it has three cultures going on so that in a year, the farm has 500,000 shrimp.

"Saipan SyAqua Inc joint venture partnership with SyAqua is very complimentary and works extremely well. We manage the production and SyAqua Asia technical team handles the genetic program and broodstock sales," said Tony Pelligrino, entrepreneur and President of Saipan SyAqua. He added that the farm has undergone major changes. More land is being acquired to set up a purpose built nucleus and testing facility. This will make the operation more efficient and enable SyAqua to increase the selection intensity and provide more data for the breeding program.



Rommel G. Catalma

Meat quality

Aside from culturing broodstock for export to shrimp-producing countries, Saipan SyAqua also grows out shrimp for hotels and restaurants. In this way, it obtains valuable information on the meat quality aspects of its products. Production is small at 3,000 lbs a month (1,363kg/month) and sold locally at USD 8/lb (USD17.6 /kg). It hopes to increase production by the end of the year.

Rommel G Catalma, Operations Manager said, "Our system is different from most commercial shrimp production because we grow shrimp at a very high density to maximize space. We continue to fine-tune our operations to improve production and lower costs. Now we have standard operating procedures that has been proven effective. Our thrust now is to further lower production cost by improving production efficiency and sourcing of equipment and raw materials,"

Saipan SyAqua will increase shrimp production by 200% with the expansion of its shrimp growing facility in China Town. This will be an additional of 32,000 m² to the current 16,000m². Not only will Saipan SyAqua double its capacity in the future but the new tanks will also be bigger and deeper. These will be ideal for large size shrimp. The target size of shrimp is 13-15 pieces of shrimp per lb (28-33 pieces/kg). Further information: SyAqua@syaqua.com Web: www.syaqua.com

India International Seafood Show 2008

By R A M Varma

The conference and trade show started off on a sombre note with industry expressing concerns of reduced margins, shortage of raw materials and appreciation of the rupee. Achieving the target of USD 6 billion by 2015 was discussed.



This three day biennial event was jointly organised by the Marine Products Export Development Authority (MPEDA) and the Seafood Exporters Association of India (SEAI) from February 8 to 10, 2008 in Kochi, India. It gathered stakeholders of the seafood industry in India from buyers, sellers, machinery and equipment suppliers, policy makers to related industry players.

Chairman of MPEDA, Mr G. Mohan Kumar said that the country's seafood export industry is confronted with issues such as appreciation of the rupee, acute shortage of raw material and the US anti-dumping duty on Indian shrimp imports. A reduced fish catch in the eastern and western coasts caused a fall in the exports this season. Export volumes are significantly lower as compared to the same period of the previous year. Overall, exports are likely to register a 20% fall this year.

Brand equity

Nevertheless, MPEDA is planning to export USD 2 billion worth of seafood by end of March 2007 and around USD 6 billion by March 2015. It has appointed Lintas Personal to carry out a USD 5 million campaign to build brand equity in important fish markets overseas. India's export of seafood is dominated mainly by the black tiger shrimp, fresh water prawn and scampi. The Indian fish industry is looking at co-branding by small and medium units and launching ready-to-cook and ready-to-eat seafood in domestic and overseas markets.

Mr A J Tharakan, leading exporter and Vice-Chairman, MPEDA stressed on the need for a consolidation of the seafood industry. Unless there is a major consolidation of production, sales and marketing among larger seafood companies, the Indian seafood industry will remain a marginal business incapable of effectively competing globally and in creating a recognised international brand.

Aquaculture to combat declines in wild catches

An option to increase seafood supplies is through deep sea fishing but this is a capital intensive activity requiring not only expertise but also a fishing culture. Joint ventures will be necessary to make these operations commercially viable, said Tharakan. He added that the way

to increase supplies is to promote the culture of catfish, tilapia, basa and other higher value finfish i.e. those with established international markets. There is a need to use inland water bodies for sustainable aquaculture. Fishing communities need to be given cage culture rights so that they have alternate source of income during the dry season. He suggested that this diversification of aquaculture species includes that of the white shrimp *Penaeus vannamei* (see page 4).

Trade show

An exhibition of various seafood products, machinery and other inputs needed for seafood processing was also inaugurated in which exhibitors from China, Malaysia, Japan and Iceland participated. Most of the 60 odd foreign participants were scouting for marine products from India and several deals were sealed, although details were not available. Among the visitors was Mr Oshio Kojima, chief executive officer of Japanese hotel chain Maruha Restaurant Systems Co. Ltd, who was in Kochi to source live Indian crabs. He was joined by Tetsuji Totsune, president of Tokyo-headquartered Maple Foods Ltd, which supplies ready-to-eat and ready-to-cook food. Tetsuji said that the seafood show is a platform for him to meet several producers and suppliers and that he plans to import more seafood products from India.

At the show, MPEDA presented 18 awards for outstanding export performances in various categories. Some of these were for the highest overall exports, highest export quantity and highest export of frozen cephalopods. The outstanding performance award was presented to Castlerock Fisheries Pvt Ltd, Mumbai.

**R A M Varma is a seafood consultant based in Cochin, India*



Derek Loudon won the "Friends of India" award at the seafood show for leading in the import of India's black tiger shrimp. He has been sourcing shrimp from India for the last 25 years. He is the director of Scotch Frost of Glasgow Ltd, a leading supplier of food materials to end-users and hotel chains across Europe. He imported some 100 containers of shrimp worth USD 10 million from India in 2006.



6th Philippine Shrimp Congress (PSC 2008)

Production innovations and market access

The 6th Philippine Shrimp Congress (PSC 2008) is scheduled from May 28-30, 2008 at the newly renovated Bacolod Pavilion Resort Hotel, Bacolod City.

With the theme "Production innovations and market access", this year's shrimp congress will focus on technologies and issues on cost-efficiency, biosecurity and development of new markets, both for the black tiger and the white shrimp. The growing popularity of white shrimp (*Penaeus vannamei*) farming in the Philippines is expected to dominate discussions and is anticipated to fuel the expansion of the industry, after years of stagnation due to diseases with the black tiger (see related article: White shrimp at 12.5% of Philippine shrimp production, p4)

This is the most important gathering of the Philippine shrimp industry in 2008. The three day congress and simultaneous trade exhibition is expected to attract no less than 700 industry leaders and members involved in the grow-out and hatchery operations, feed milling, processing/exporting and equipment. Also in attendance are representatives from the government, academia and researchers.

The organizers have lined up the following sessions.

- Global, regional and national perspectives
- Grow out technology updates
- Update on shrimp diseases
- Hatchery and maturation

The technical sessions will start on May 29 with reviews on shrimp farming in Vietnam, Thailand and Ecuador by Nguyen Binh, Bayer Animal Health Philippines, Dr. Poernlerd Chanratchakool, Novozymes

and Fernando Garcia, Epicore Biotechnologies, respectively.

Discussions on the domestic market and advances in grow-out technology will include the following;

- The Philippine shrimp industry: the road ahead by Fred Yap, Aquaculture Consultant
- Opening up markets for Philippine shrimp: challenges and constraints by Lourdes Tanco, Mida
- Trade Developments on black tiger shrimp culture in Negros island by Roslyn Usero, NPPMC
- Sharing of field experiences on black tiger shrimp culture by B-meg Feeds, Oversea Feeds and CP Feeds
- Updates on white shrimp farming in Luzon-Vic Estilo by UP Aquaculture Society
- Sharing of field experiences on white shrimp culture by William Kramer, Hoc-Po Feeds, Gina Regalado, Intaq Feeds and Audie Lim, Santeh Feeds

At press time, 29 exhibitors have confirmed their participation in the trade show. Organisers said that PSC 2008 will offer a good opportunity for companies engaged in aquaculture to touch base with the burgeoning local industry to promote technology, products and services.

More information:

The Congress Secretariat

Tel/Fax: +63 34 434 2559, +63 34 433-2131,

Email: philshrimp@aquaphil.org Web: www.aquaphil.org.

Seventh Symposium on Diseases in Asian Aquaculture (DAA VII)

"Communication, co-operation and co-ordination: key issues in aquatic animal health management"

This is the theme for this meeting organised by the Fish Health Section (FHS) of the Asian Fisheries Society (AFS) to be held in Taipei, Taiwan from 22-26 June 2008. Main sponsors for this meeting are Unipresident and Pharmaq. Following the meeting, there will be a 2-3 day special seminar on recent advances in the immunology of fish and shellfish and a 3-day training workshop on pathogen risk analysis for aquatic animal movement.

Under the broad heading of "key issues in aquatic animal health management", the symposium anticipates 15 keynote addresses by leading world experts, 12 invited lectures, and around 60 contributed oral presentations by researchers, scientists, farmers and students. There will be space for 150 posters presentation. Some of the topics include, global perspectives in managing aquatic animal health; emerging issues in aquatic animal health management; epidemiology,

detection and diagnosis of pathogens in fish, shellfish, molluscs and their environment; biosecurity and containment in aquaculture systems and pathogen risk analysis, probiotics, therapeutics and other fields and recent developments in genomics, proteomics and bioinformatics: implications for aquatic animal diseases. The way forward in aquatic animal health management and in international trade, aquatic animals and risk will be covered.

The early bird registration is from January 1, 2008 to March 31, 2008.

More information:

Conference Secretary

Email: daaseven@gmail.com

Web: homepage.ntu.edu.tw/~daaseven/doc/daabrochure.pdf

March 28-29

Giant Malaysian Prawn 2008
Kuala Lumpur, Malaysia
Email: myfisoc@gmail.com
Web: www.vet.upm.edu.my/~mfs

May 13-14

7th Practical Short Course:
Aquaculture Feed Extrusion, Nutrition & Feed Formulation
Miami, Florida, USA
Email: aquafeed@scarlet.be
Web: www.membraneworld.com

May 19-23

World Aquaculture 2008
Busan, Korea
Email: worldaqua@aol.com
Web: www.was.org (IBC)

May 28-30

6th Philippine Shrimp Congress
Bacolod City
Email: philshrimp@aquaphil.org
Web: www.aquaphil.org

June 1-5

XIII International Symposium on Fish Nutrition and Feeding (ISFNF)
Florianopolis, Brazil
Web: <http://www.isfnf2008.com.br>

June 12-14

Vietfish Fisheries International Exhibition
Ho Chi Minh City, Vietnam
Email: quothanh@vasep.com.vn
Web: www.vietfish.com.vn

June 22-26

DAA VII-7th Symposium on Diseases in Asian Aquaculture
Taipei, Taiwan
Email: daaseven@gmail.com
Web: <http://homepage.ntu.edu.tw/~daaseven/index1.htm>

July 22-25

IIFET 2008 Vietnam
Nha Trang, Vietnam
Email: iifet2008@yahoo.com;
haolevan@yahoo.com
Web: www.ntu.edu.vn/iifet2008/

July 25-27

The Seventh International Conference on Recirculating Aquaculture
Roanoke, VA, USA
Email: aqua@vt.edu
Web: www.cpe.vt.edu/aquaculture/r-aqua/

August 3-6

Australasian Aquaculture 2008
Brisbane, Australia
Email: sarahjane.day@aquaculture.org.au
Web: www.australian-aquacultureportal.com (p41)

September 14-18

12th International Lupin Conference
Fremantle, Western Australia
Email: lupinconference@lupins.org
Web: www.lupins.org

October 12-14

8th International Symposium on Tilapia in Aquaculture
Cairo, Egypt
Web: <http://ag.arizona.edu/azaqua/ista/ISTA8/IST1m>

List your events in AQUA Culture AsiaPacific Magazine for FREE. Fax details to: +603 2096 2276 or email to the Editor at zuridah@aquaaasiapac.com

Aquaculture without Frontiers (AwF)

is an independent non-profit organisation that assists in the alleviation of poverty in developing countries by supporting projects designed to provide fish for food and income through sustainable small-scale aquaculture. AwF has also assisted in tsunami relief work.

So far we have project activities in Bangladesh, India, Indonesia, Malawi, Nepal and Thailand and our AwF Volunteers have provided assistance in several other countries including Ghana, Kenya, Liberia, Papua New Guinea and Peru.



Please help us to help others by donating yourself or by organising fund-raising activities!

Further information on our activities can be found at:
www.aquaculturewithoutfrontiers.org

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Aquaculture For Human Wellbeing-The Asian Perspective

May 19-23, 2008

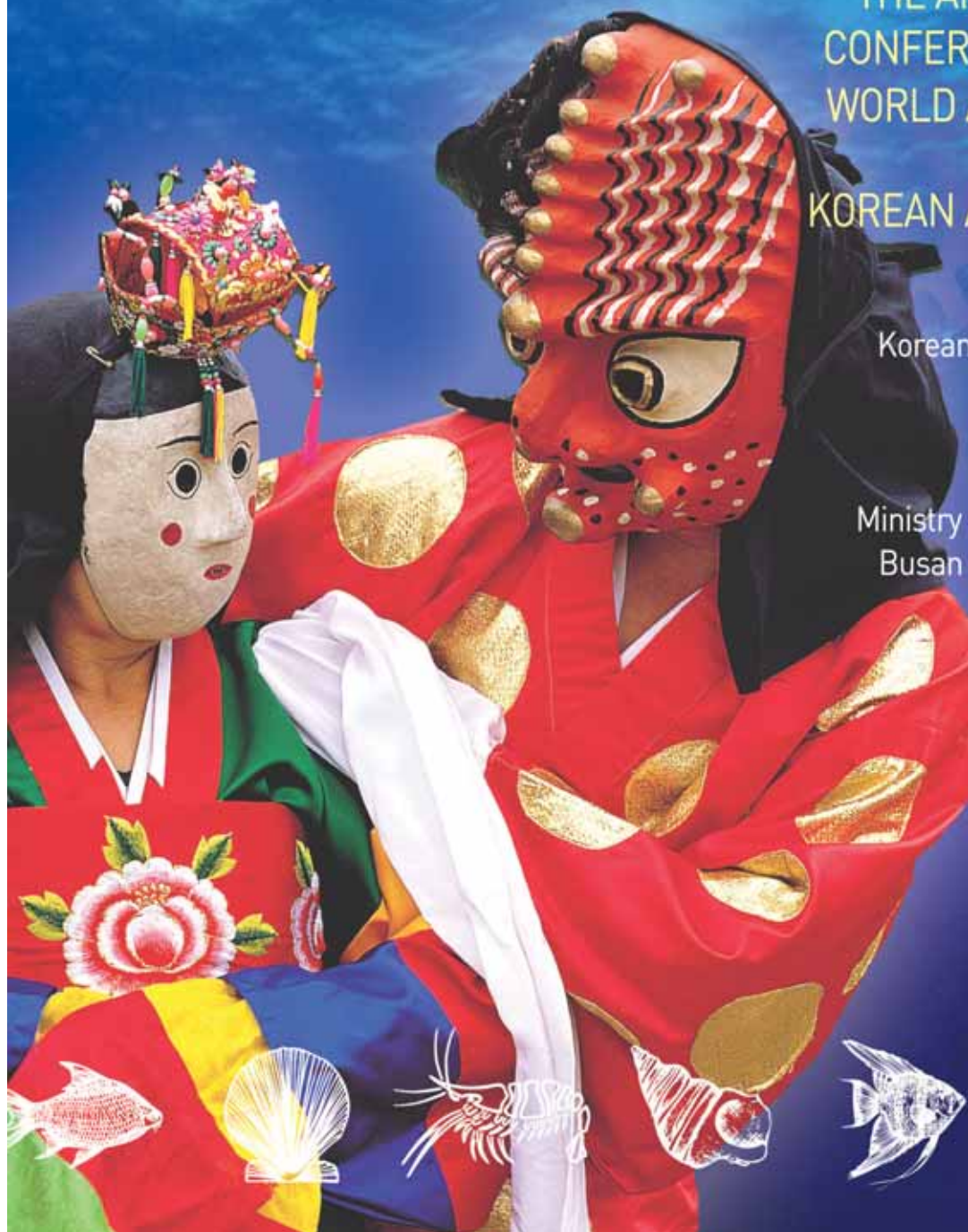
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